



START

Statistical Analysis of Event Data Concerning Boko Haram in Nigeria (2009-2013)

John Stevenson

January 2015

National Consortium for the Study of Terrorism and Responses to Terrorism
A Department of Homeland Security Science and Technology Center of Excellence
Based at the University of Maryland

8400 Baltimore Ave., Suite 250 • College Park, MD 20740 • 301.405.6600

www.start.umd.edu

About This Report

The primary author of this report is John Stevenson, Postdoctoral Researcher at START, University of Maryland. Questions about this report should be directed to John Stevenson at jstevenson@start.umd.edu.

The authors would like to acknowledge and thank the following individuals, without whom this research would not have been possible:

START Research Staff: Amy Pate, Garrett Tippin

START Research Assistant: Jacob Schwoerer

This research was supported by a Centers of Excellence Supplemental award from the Office of University Programs, Department of Homeland Security, with funding provided by the Strategic Multilayer Assessment (SMA) office, Department of Defense, through grant award number 2012ST061CS0001-03 made to the National Consortium for the Study of Terrorism and Responses to Terrorism (START). The views and conclusions contained in this document are those of the author and should not be interpreted as representing the policies, either expressed or implied, of DHS, DoD, or START.

About START

The National Consortium for the Study of Terrorism and Responses to Terrorism (START) is supported in part by the Science and Technology Directorate of the U.S. Department of Homeland Security through a Center of Excellence program based at the University of Maryland. START uses state-of-the-art theories, methods and data from the social and behavioral sciences to improve understanding of the origins, dynamics and social and psychological impacts of terrorism. For more information, contact START at infostart@start.umd.edu or visit www.start.umd.edu.

Citations

To cite this report, please use this format:

Stevenson, John. "Statistical Analysis of Event Data Concerning Boko Haram in Nigeria (2009-2013)," Report to the Strategic Multilayer Assessment Office, Department of Defense, and the Office of University Programs, Department of Homeland Security. College Park MD: START, January 2014.

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Executive Summary

Using ICEWS and GTD data concerning Nigeria and Boko Haram from 2009 through 2013, this report draws on two distinct statistical methodologies to estimate which kinds of activities alter the *frequency* of terrorist events and which kinds of activities reduce the *probability* of future terrorist events.

To assess the probability of future terrorist events, I simulate the effects of nine distinct scenarios to see the effect this change will have on the predicted probability of terrorist incidence in the following month.

These nine scenarios are:

1. A single military operation in a state
2. Multiple military operations in a state
3. A single police operation in a state
4. Multiple police operations in a state
5. A single vigilante operation in a state
6. Multiple vigilante operations in a state
7. Combined vigilante and military operation in a state
8. Boko Haram operations against police
9. Boko Haram operations against military

As a result of both analyses, this report substantiates the following seven claims:

1. The triggering event that began increasing the frequency of Boko Haram's attacks is likely the jail break of September 2010 in Bauchi.
2. The largest increase in the frequency of terrorist evidence occurred in 2012. Although the frequency was reduced somewhat in 2013, it was still above its pre-2012 baseline.
3. In 2013, despite fewer attacks, the successful Boko Haram's terrorist incidents generate more casualties.
4. Vigilantes have been the most effective vehicle at disrupting the ability of Boko Haram to execute terrorist attacks in successive months.
5. Military operations increased risk in Nigeria by increasing the frequency of terrorist events, as well as the probability that an attack will happen in the following month. The more military operations there are, the more that probability of a terrorist attack in the following month increases.
6. Combined vigilante and military operations reduce whatever increased risk that military operations cause concerning the probability of a terrorist attack in the following month.
7. The most effective interventions at reducing the probability of future terrorist attacks are sustained police operations in the previous month.

Introduction

This statistical analysis is designed to inform the following questions:

1. What policies (across the DIMEFIL spectrum) can be employed to counter Boko Haram's strength and exploit its weaknesses?
2. What are AFRICOM options for engaging U.S. government and foreign partners to deploy policies to counter Boko Haram?

While this analysis is limited in the descriptive inferences it can provide concerning Boko Haram and Nigeria during 2015, the report draws on statistical methodology to forecast how different Nigerian actions change the probabilities of terrorist event occurrences in an effort to guide partnerships toward supporting the most effective policies against Boko Haram.

I organize this report by first describing the data cleaning procedures and the definitions of the variables. Second, I describe structure of the dependent variables and the intuitions behind the choice of modeling forms. Third, I use descriptive statistics and graphical analyses to show how the frequency and lethality of Boko Haram attacks have changed over time. Fourth, using survival analysis, I isolate how military operations increase the frequency of Boko Haram attacks, whereas vigilante operations decrease their frequency. Finally, I conclude using negative binomial regression to forecast what counter-terrorist operations will give the greatest reductions in the probability of a terrorist attack in the next month.

Data Sources and Procedures

To construct the data for this AFRICOM request, START cleaned the ICEWS (Integrated Crisis Early Warning System) data from Lockheed Martin and integrated them into a dataset organized by state-month. We used the event data to determine Nigerian counter-terrorism activity and Boko Haram military operations; we used START's signature data, the GTD, to determine the patterns and timing of Boko Haram terrorism operations. By using two distinct data sources for Boko Haram activity, we were able to distinguish between violent actions that would not necessarily count as terrorist activities, such as gun battles with the Nigerian army or prison breaks, which are in line with asymmetric warfare, from those violent activities that constitute terrorism. In this way, START researchers could remain agnostic about whether Boko Haram was "more" of an insurgency or a terrorist group, and allow the group's activities to speak for itself.¹

At its origin ICEWS focused exclusively on countries in PACOM AOR, but later expanded to collect data on 167 countries, excluding smaller polities such as Vatican City. Automated extraction programs based on the CAMEO protocol "scrape" English-language American and non-American news sources and place them into the database. The CAMEO protocol, among other things, identifies a *Source* and *Target* for each interaction it codes, and assigns those interactions to a general category. These interactions are recorded daily for any event, such as a protest or a meeting between ministers, that occurs; generally, any given event

¹ Merari, Ariel. "Terrorism as a Strategy of Insurgency." *Terrorism and Political Violence* 5, no. 4 (1993): 213-251. Bell, Colleen, and Brad Evans. "Terrorism to Insurgency: Mapping the Post-Intervention Security Terrain." *Journal of Intervention and Statebuilding* 4, no. 4 (2010): 371-390.

is catalogued multiple times from different English-language sources. For each event, the headline, newspaper, and relevant sentence(s) are extracted.

These data generated massive CSV (Comma Separated Values) files that we turned into Excel spreadsheets for manipulation and cleaning. Using Microsoft Excel, START researchers took these raw data and filtered them to alternate between Nigerian and Boko Haram as being either the *Target* or the *Source* of the Event. This allows us to distinguish between Boko Haram-sponsored violence and Nigerian state-sponsored violence.

For each year of analysis (2009-2013), START researchers sorted the data into 22 distinct types of events:

1. Nigerian Military Leadership Decapitation Strikes ²
2. Nigerian Military attacks Boko Haram forces³
3. Nigerian Military arrests/detains members of Boko Haram
4. Vigilantes/Civilian Joint Task Force/Youth Movements attacks Boko Haram⁴
5. Nigerian Police Leadership Decapitation Strikes
6. Nigerian Police attacks Boko Haram forces
7. Nigerian Police arrests/detains members of Boko Haram
8. Foreign (Non-Nigerian) Leadership Decapitation Strikes
9. Foreign (Non-Nigerian) attacks Boko Haram forces
10. Foreign (Non-Nigerian) arrests/detains members of Boko Haram
11. I/NGO Humanitarian activity⁵
12. State-sponsored human rights abuses/ torture/ extra-judicial killings
13. Fortification maneuvers and troop dispatch by Nigerian Armed Forces
14. Boko Haram attacks Nigerian police
15. Boko Haram attacks Nigerian civilian target (mosque, school, infrastructure)
16. Boko Haram attacks Nigerian military or government target
17. Boko Haram attacks property or persons identified with foreigners
18. Truce or Ceasefire or Hostage Release⁶
19. Boko Haram in retreat or laying low
20. Call for negotiations or restraint⁷
21. Boko Haram or Nigeria issues demand/ information warfare against the other
22. Not Applicable/ No Real Events/ Repeats of Prior Events

² These are operations which kill and target key senior leadership, rather than targeting the group as a whole. See, Jordan, Jenna. "When heads roll: Assessing the effectiveness of leadership decapitation." *Security Studies* 18, no. 4 (2009): 719-755. Johnston, Patrick B. "Does decapitation work? Assessing the effectiveness of leadership targeting in counterinsurgency campaigns." *International Security* 36, no. 4 (2012): 47-79.

³ This includes all operations under the aegis of the Joint Task Force, but does not include operations from the Civilian Joint Task Force, which we are coding as vigilantes.

⁴ Ashionye Ogene, "Nigerian Vigilantes aim to rout Boko Haram", in Aljazeera, 31 May 2014. Accessed at: <http://www.aljazeera.com/indepth/features/2014/05/nigerian-vigilantes-aim-rout-boko-haram-2014526123758444854.html>

⁵ This includes all material assistance to improve civilian resilience, aid with IPDs and refugees, and promotion of CVE

⁶ This can be from either party to the conflict.

⁷ This can be from either party to the conflict.

Once categorized, the events were aggregated into state-month count data. The data contains a total of 170 state-months which experienced terror attacks, out of the 2280 months in the analysis.

These data sources introduced two notable constraints into the analysis. First, due to deadlines, START researchers were not able to code an equivalent to the GTD database for Nigerian human rights abuses, creating a gap in our analysis of the role of state-sponsored violence in mitigating or increasing the efficacy of Nigerian operations to dismantle and defeat Boko Haram. Examples of state-sponsored human rights abuses include reports of people being shot dead by the army or beaten to death, especially in the states with states of emergency, according to Amnesty reports.⁸ Moreover, Amnesty International has shared video footage, images and testimonies as evidence of war crimes, including extrajudicial executions, mass graves, and cooperation with civilian elements killing with state-sanction.⁹

Second, 2013 is the most recent year of the GTD data publicly available. To promote comparability, we similarly limited our data analysis to events occurring on or prior to 31 December 2013 in the ICEWS data.

START also coded measure of calendrical time in months from January 2009 through December 2013 to meet the requirements of survival analysis. This month count is based on intervals of 10 rather than 12. However, since converting intervals to their corresponding calendrical date can be intuitively difficult, for ease of reference I have listed the corresponding dates below in Table 1.

Table 1: Descriptive Data Label References

| Analysis Time (Period Number) | Corresponding Calendrical Time |
|-------------------------------|--------------------------------|
| 10 | October 2009 |
| 20 | August 2010 |
| 30 | June 2011 |
| 40 | April 2012 |
| 50 | February 2013 |
| 60 | December 2013 |

The final measure of time that START constructed was “Gap Time” to denote how many months had passed since the last terror attack in any given Nigerian state. Gap Time took on values between 0 and 60. The median value of Gap Time is 16; this means that the median expectation is that any Nigerian state would experience 16 months between terrorist attacks, if all attacks were distributed equally in space and time.

⁸ News Africa, “Nigeria Army “Abuses” in Boko Haram crackdown—Amnesty:

⁹ Amnesty International, “Nigeria: Gruesome Footage implicates military in war crimes”, 5 August 2014.

<http://www.amnesty.org/en/news/nigeria-gruesome-footage-implicates-military-war-crimes-2014-08-05>

Statistical Modeling Strategy and Model Assumptions

Statistical models enable us to estimate changing risk of terrorist incidents in the context of Nigerian state responses. Using descriptive and statistical analysis, we answer the following questions:

- What are the key events which played a role in increasing the frequency and the lethality of Boko Haram terrorism?
- Which kinds of Nigerian state actions are most associated with increases in Boko Haram terrorist incidents?
- How do Nigerian actions shape the risk of future terrorist incidents in any given Nigerian state?

To model Boko Haram activities in the context of Nigeria's responses, as well to assess the effectiveness of Nigerian response in reducing risk of terrorist incidence and reducing casualties, START created a host of count data and constructed variables representing two distinct outcomes of interest. The first variable is the number of months, in any given Nigerian state, between terrorist attacks. The second outcomes of interest are arranged into a set of count variables measuring the number of civilians killed per month in Boko Haram attacks, the total number of Boko Haram attacks, and the number of vigilante operations against Boko Haram. Due to the diverging data formats of these outcomes, two distinct statistical modeling forms will be used, respectively, in estimating those outcomes: the series hazard model, which is a form of event history analysis, and the negative binomial regression.

The portion of the analysis focused on *the risk of Boko Haram terrorist incidents* will use a special case of survival analysis called the series hazard model. Survival analysis, most simply, is the statistical estimation of the time to an event or set of events for subjects in a common population pool. Survival analysis estimates the risk that any given subject will experience the event as more time passes. This event can be anything—a heart attack, default on a loan, getting a job—that effectively removes one subject from the “risk pool,” those subjects who can still experience the event. In the purest form of survival analysis subjects exit the pool when either the study ends (“censoring”) or when a subject experiences an event (“failure”). Survival analysis in the case of Boko Haram, therefore, is best thought of as the empirical analysis of the “time-to-event,” which is the experience of a terrorist incident.

The structure of the data have been arranged to enable survival analysis. Each state of Nigeria is treated as a distinct subject, which alternatively may or may not experience “failure”—a Boko Haram terrorist attack as denoted in the GTD—in any given month. The dependent variable for this analysis is the number of months since the last terrorist attack in that state between January 2009 and December 2013. The total number of subjects (Nigerian states, as well as Niger and a “null” state for non-geo-located attacks) is 38. The total time at risk—the cumulative number of months across all the states—is 1,737 months. With 167 months in which at least one state experienced a terrorist attack from Boko Haram, the event incidence rate is 1.38%, reflecting the concentrated and isolated nature of Boko Haram operations. These descriptive statistics are summarized below in Table 2.

Table 2: Descriptive Event Analysis Statistics

| | |
|--------------------------------|-------|
| Number of Subjects | 38 |
| Total Time at Risk | 1737 |
| Total Number of Failure Months | 167 |
| Incidence Rates | 1.38% |

Two factors complicate the use of the simplest forms of survival analysis for the empirical analysis of Boko Haram. First, Nigerian states can and do experience multiple occurrences of terrorist incidents. The empirical effect is to create multiple observations per subject. Second, there are time-varying covariates: the model must be able to take into account the various timing of different type of Nigerian responses relative to terrorist incidence. As some states may be more susceptible to Boko Haram activities than others and experience multiple failures, START researchers choose a modeling form that allows for changing rates of failure over time within a state, as well as the differential risk over time between states.

I ran three specifications of the Cox proportionate-hazard models to account for potential bias introduced in the structure of the data from observational linkage by state, the presence of autocorrelation and heteroskedasticity, and observational linkage by time (due to the changing nature of Boko Haram capabilities). The standard ways to deal with these problems are to run models that calculate standard errors with clustering by state, robust standard errors, or clustering by period, respectively. All of the models return similar results with no statistical or substantive differences, so I will use models that cluster by state so that the effects observed are sensitive to the differences in states. Clustering errors by state follows the best practices in the applied use of risk analysis as developed in biomedical research dealing with multiple events occurring in the same subject.

In addition, I chose the Cox statistical form for my event analysis for three reasons. First, the Cox proportional hazards model form is the most popular in applied research because the Cox model avoids making any assumptions for the shape of the baseline hazard function. This gives the Cox model a relative advantage over standard parametric models, which are often not able to model the hazard functions of real-time data. Second, although the best model for post-estimation is the Weibull, various statistical packages generate opposing signs for all the distributions except for Cox; using the Cox will promote the useability of the model form in a variety of software packages as new data becomes available. Third, series hazard model is a variant of the Cox Proportionate Hazard Model which does not drop subjects from the analysis for experiencing similar types of failure. Series hazard modeling, therefore, provides an avenue for analysis accounting for the effects of different kinds of actions on the time-to-terrorist incidence; in other words, we can incorporate the actions of the Nigerian government as well as Boko Haram which occur at specific, discrete points in time, on the changing risk of terrorism incidence.¹⁰

¹⁰ For more descriptions of the use of series hazard modeling in terrorism studies, see Dugan, Laura. "The series hazard model: an alternative to time series for event data." *Journal of Quantitative Criminology* 27, no. 3 (2011): 379-402.

The portion of the analysis focused on the forecasting the effective of interventions to cause *increases* and *decreases* in *terrorist incidents* will use the negative binomial regression on two different outcome variables: the number of civilians killed per month in Boko Haram attacks and the total number of Boko Haram attacks. The important assumptions of the modeling choice of using count data as independent variables is that all events have equal weight in terms of importance and value on affecting whether the number being measured is large or small. The model determines which independent variables increase the number and which decrease the number.

Since the outcome variables are discrete counts, I have as choice of models the (general) Poisson regression or, the more specialized instance of negative binomial regression.¹¹ In addition, the outcome variables that are percentages can also successfully be estimated using Poisson regression.¹² There are no statistical tests that can truly help distinguish between which of these models are appropriate in terms of not yielding either biased estimators or biased standard errors; however, since negative binomial regression adjusts variance independently from the mean, if the variance of the data is greater than the mean, then the negative binomial regression form will be used.¹³ If the data do not exhibit these features, the generalized Poisson regression is the recommended procedure in empirical conflict analysis.¹⁴

The initial analysis, reported in Table 3, indicates that the variances are much larger than the means, making the negative binomial regression form the appropriate model for analysis.

Table 3: Descriptive Statistics of the Dependent Variables

| Variable | Mean | Variance | N |
|-----------------|----------|----------|------|
| Fatalities | 1.567105 | 153.1899 | 2280 |
| Monthly Attacks | 0.352193 | 3.507762 | 2280 |

In addition, I ran three specifications of the negative binomial models for each outcome variable to account for potential bias introduced in the structure of the data from observational linkage by state, the presence of autocorrelation and heteroskedasticity, and observational linkage by time (due to the changing nature of Boko Haram capabilities). The standard ways to deal with these problems are to run models that calculate standard errors with clustering by state, robust standard errors, or clustering by period, respectively. All of the models return similar results with no statistical or substantive differences, so I will use models that cluster by state to promote greater comparability between the survival analysis and the negative binomial discussions.

¹¹ Jerald F. Lawless, "Negative binomial and mixed Poisson regression" in Canadian Journal of Statistics, 15: 3, pp. 209-225, Sept 1987.

¹² Edward L. Frome, The Analysis of Rates Using Poisson Regression Models in Biometrics 39, Sept 1983, pp. 665-674. Edward L. Frome and Harvey Checkoway, Use of Poisson Regression Models in Estimating Incidence Rates and Ratios" in Am. J. Epidemiol. (1985) 121 (2): 309-323.

¹³ Stefany Coxe, Stephen G. West and Leona S. Aiken, "The Analysis of Count Data: A Gentle Introduction to Poisson Regression and Its Alternatives", Journal of Personality Assessment, 91:2, 2009.

¹⁴ King, Gary. 1988. Statistical Models for Political Science Event Counts: Bias in Conventional Procedures and Evidence for The Exponential Poisson Regression Model. American Journal of Political Science 32: 838-863.

Independent Variables for the Series Hazard Models

Constructing this preliminary model is fairly straightforward as we are simply examining which kinds of events are most significant in their effect on the occurrence of a terrorist incident. At the end of this section I include the descriptive statistics for these variables.

The following variables are modeled in their effects:

- Nigerian Military Leadership Decapitation Strikes
- Nigerian Military attacks Boko Haram forces
- Vigilantes/Civilian Joint Task Force/Youth Movements attacks Boko Haram
- Fortification maneuvers and troop dispatch by Nigerian Armed Forces
- State-sponsored human rights abuses/ torture/ extra-judicial killings
- Boko Haram or Nigeria issues demand/ information warfare against the other
- Nigerian Military arrests/detains members of Boko Haram
- Nigerian Police attacks Boko Haram forces
- Nigerian Police arrests/detains members of Boko Haram
- Call for negotiations or restraint

In addition, to examine which Boko Haram activities best telegraph an increased risk of terrorist attacks, we estimated the effects of the following variables in a separate series hazard model:

- Boko Haram attacks Nigerian police
- Boko Haram attacks Nigerian civilian target
- Boko Haram attacks Nigerian military or government target

These operational activities that are drawn from ICEWS; however, they should not to be confused with the data on terrorist attacks from the GTD. Using the ICEWS data, START researchers isolated those operational activities which would not necessarily been classified as terrorist incidents, but did show up in the media sources that ICEWS collates. Whereas START researchers used the GTD data primarily for casualties, attack frequency, and attack location information, we used the ICEWS to identify all other Boko Haram activities and statements in Nigeria during this time frame.

Lastly, to estimate how well non-kinetic forms of engagement have worked to curb Boko Haram terrorist incidences, we constructed a series hazard model using the following variables in isolation:

- Boko Haram or Nigeria issues demand/ information warfare against the other
- Truce or Ceasefire or Hostage Release
- Call for negotiations or restraint

Independent Variables for the Negative Binomial Regressions

Constructing these models are fairly straightforward as we are simply examining which kinds of events are most significant in their effect. Both of the two models use the same independent variables to estimate their effects on two dependent variables, the number of casualties per month and the number of attacks per month. The following variables are included:

- Nigerian Military Leadership Decapitation Strikes
- Nigerian Military attacks Boko Haram forces
- Vigilantes/Civilian Joint Task Force/Youth Movements attacks Boko Haram
- Fortification maneuvers and troop dispatch by Nigerian Armed Forces
- State-sponsored human rights abuses/ torture/ extra-judicial killings
- Boko Haram or Nigeria issues demand/ information warfare against the other
- Nigerian Military arrests/detains members of Boko Haram
- Nigerian Police attacks Boko Haram forces
- Nigerian Police arrests/detains members of Boko Haram
- Call for negotiations or restraint
- Boko Haram attacks Nigerian police
- Boko Haram attacks Nigerian civilian target
- Boko Haram attacks Nigerian military or government target

I have included the descriptive statistics for the independent variables in the table below.

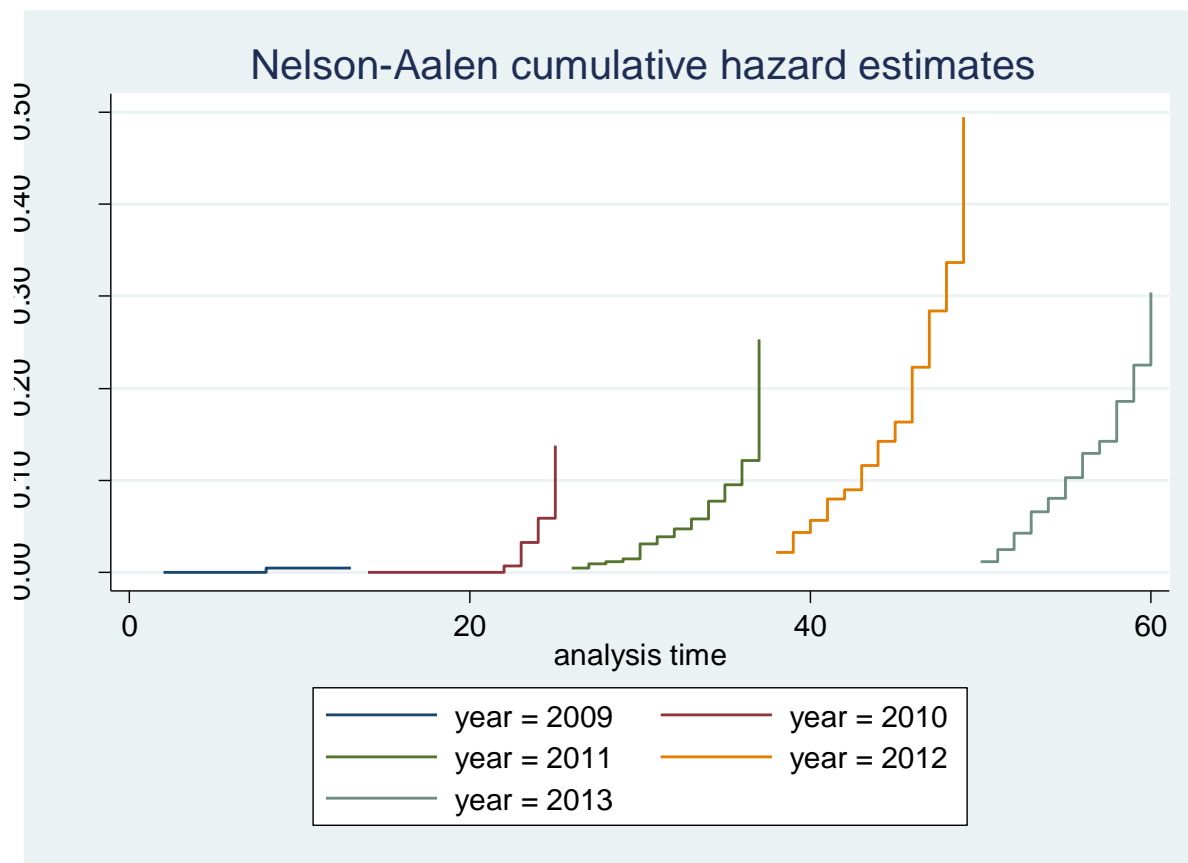
Table 4: Descriptive Statistics of the Independent Variables

| Variable | Mean | N | Min | Max |
|------------------------------|----------|------|-----|-----|
| Military Decapitation | .003702 | 2161 | 0 | 1 |
| Military-Led Attack | .0471567 | 2163 | 0 | 6 |
| Vigilantes | .0039474 | 2280 | 0 | 2 |
| Reinforcement Maneuvers | .0144737 | 2280 | 0 | 3 |
| Nigerian Human Rights Abuses | .0048246 | 2280 | 0 | 1 |
| Information Warfare | .0307018 | 2280 | 0 | 4 |
| Military Arrests | .0111111 | 2160 | 0 | 2 |
| Police Attack | .0041647 | 2161 | 0 | 1 |
| Police Arrests | .0087922 | 2161 | 0 | 2 |
| Negotiations | .0109649 | 2280 | 0 | 3 |
| Boko Haram Targets Police | .0359649 | 2280 | 0 | 5 |
| Boko Haram Targets Civilians | .0618421 | 2280 | 0 | 7 |
| Boko Haram Targets Military | .0434211 | 2280 | 0 | 8 |

Descriptive Findings

As our aim is to follow the trend lines and not the headlines, summary and descriptive statistics will allow us to see how Boko Haram and the Nigerian context have evolved over time without the use of extensive or complex analysis. Graphically assessing the changing risk of terrorist events is easiest identified with a Nelson-Aalen hazard estimate drawn directly from the sample with minimum parametric fitting. (This estimate is below in **Error! Reference source not found.**)

Figure 1: Nelson-Aalen hazard estimate



In order to better isolate the effects of time, I grouped the estimate by years so that it would be easiest visually to assess the cumulative risk, by year, of a Boko Haram terrorist incident. Sorted by calendar year, this cumulative hazard estimates represent the proportion of months within that year experiencing an attack that year. This means that by the end of 2011, terrorist incidents occurred in one-quarter of all months in 2011. Likewise, by the end of 2012, Boko Haram successfully completed a terrorist attack in about half of all those months.

This graphical form also allows us to isolate the importance of key inflection points that may have increased the frequency (i.e., reduced the time in-between events) of Boko Haram attacks. Between the products delivered to SMA and the ICEWS data, there are five potential inflection points during which Boko Haram capabilities could have increased, military doctrines may have shifted, or ideology may have evolved tremendously.

- July 2009: Mohammed Yusuf killed [Period 7]
- July 2011: Movement Fragmentation [Period 31]
- April 2011: Presidential Election [Period 28]
- September 2012: Boko Haram Begins Attacking Communications Infrastructure [Period 45]
- April 2013: Boko Haram acquires military grade weaponry¹⁵ [Period 52]

Two of these events were drawn directly from the ICEWS data as having been particularly important, given a corresponding social science literature on the importance of certain kinds of development. The first, occurring in Period 31, is movement fragmentation. According the news sources scanned by ICEWS, Boko Haram split on 21 July 2011: "The outlawed Islamic group, Boko Haram, which has been terrorising (sic) Maiduguri, the Borno State capital, has split into two, with the Yusufiyya Islamic Movement (YIM), condemning the attacks and bombings of residences and places of worship by the other faction of Islamic sect that claimed to be fighting a Jihad in the North."¹⁶ Fragmented resistance movements are expected to engage in more terrorist activity—particularly in areas controlled by rival groups—to emerge as the pre-eminent section of the movement. Fragmentation, therefore, is often considered an important inflection in a group change, experimentation, and higher utilization of its capacity.

The second event pulled from ICEWS occurred in Period 45 on 12 September 2012, and was identified as new by the sources ICEWS pulls from: "The group also claimed responsibility for destroying more than two dozen mobile phone towers for various operators in cities across northern Nigeria last week, marking a new type of attack."

The Nigerian election, while mentioned, was not explicitly identified in any report as an inflection point. However, although the relationship between electoral competition and terrorist activity is relatively under-studied, social science evidence does exist that within conflict-affected (which Nigeria is and has been), as well as in fragile or low-income states, of which Nigeria is neither, that electoral-related mobilization can "exacerbate pre-existing tensions."¹⁷

Error! Reference source not found. helps identify key inflection points which increased the frequency of Boko Haram terrorist incidents. The origin of the trend of Boko Haram increasing risk of terrorist incidence emerges in late 2010, shortly after Period 20 (August 2010). This means that the likely

¹⁵ On the effects of external weapons transfers on movements, see Lockyer, Adam. "Foreign intervention and warfare in civil wars." *Review of International Studies* 37, no. 05 (2011): 2337-2364. Kalyvas, Stathis N., and Laia Balcells. "International system and technologies of rebellion: How the end of the Cold War shaped internal conflict." *American Political Science Review* 104, no. 03 (2010): 415-429. On the effects of external transfers on civilian targeting, see Stevenson, J. A. (2014). *Capitol gains: How foreign military intervention and the elite quest for international recognition cause mass killing in new states* (Order No. 3668294). Available from ProQuest Dissertations & Theses Full Text. (1647259837)

¹⁶ On the importance of movement fragmentation to the study of non-state actor dynamics, see: Bakke, Kristin M., Kathleen Gallagher Cunningham, and Lee JM Seymour. "A plague of initials: Fragmentation, cohesion, and infighting in civil wars." *Perspectives on Politics* 10, no. 02 (2012): 265-283.

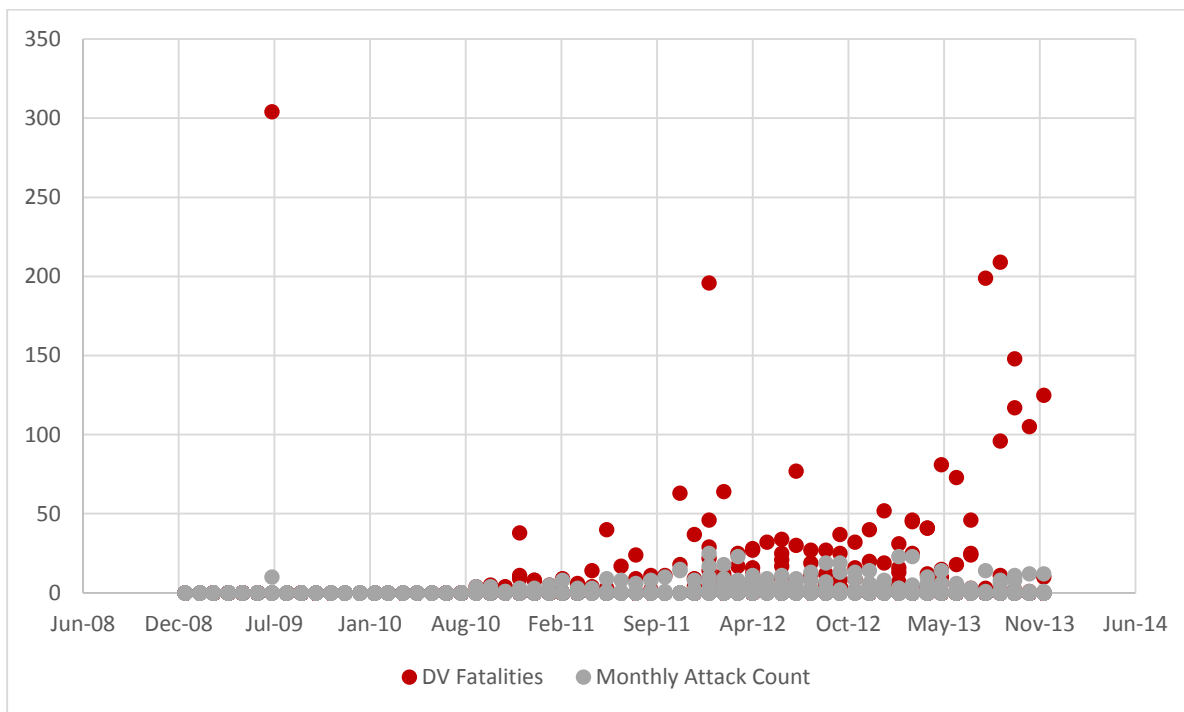
¹⁷ Rao, Sumedh. "Dealing with election-related violence in fragile and conflict-affected states." (2014). <http://www.gsdrc.org/docs/open/HDQ1126.pdf>. See also Collier, Paul, and Pedro C. Vicente. "Violence, bribery, and fraud: the political economy of elections in Sub-Saharan Africa." *Public Choice* 153, no. 1-2 (2012): 117-147.

“triggering risk incident” is the large jailbreak in September 2010 in which Boko Haram freed more than 100 of its members in addition to 759 inmates, many of whom reportedly joined Boko Haram.¹⁸

Second, by the end of 2011, Boko Haram improved its organizational capacity to carry out more terror attacks with greater frequency such that the non-decreasing risk function *did not* reset to 0 in 2012. Yet, in 2012 the rate of increase is far steeper than in other year under analysis. Moreover, 2012 was the year that Boko Haram began attacking communications infrastructure, which means the true origins of Boko Haram’s entrenchment can be likely isolated to changes made in late 2011 and perfected in 2012.

Third, as the scatterplot in **Error! Reference source not found.** depicts, by the end of 2012, the lethality of Boko Haram’s terrorist operations increased, while the number of attacks remained relatively constant.

Figure 2: Scatterplot of Fatalities and Monthly Attack Counts, 2009-2013



Most observations cluster just below the 50 fatalities-threshold from roughly April 2012 to May 2013, and above the 50-fatalities threshold after May 2013 (the month that a state of emergency was declared in three states).

While the key inflection point for increased frequency was the jail break in 2010, the key period in the increase in fatalities occurred in late 2012 and early 2013. Here the acquisition of sophisticated weaponry may have been the cause; with greater technological capacity to use and produce violence, Boko Haram became more deadly in each of its attacks.

¹⁸ From the ICEWS, on 8 September 9th 2010: “Bauchi, Sep 09, 2010 (Vanguard/All Africa Global Media via COMTEX) -- FIVE persons comprising a soldier, policeman, two prison warders and a civilian were, Tuesday night, confirmed dead following an attack on Bauchi prison by members of an Islamic sect, Boko Haram, while 759 inmates at the prisons were set free.”

The Effects of Nigerian Counter-Terrorism Activity on Boko Haram Operations

Three sets of results all concerning whether different kinds of intervening events speed or slow the time until the next terrorist event. Table 5 below displays the results of the analysis of Nigerian responses on the risk of terrorist events.

Table 5: Survival Analysis of Nigerian Responses on Time-Until-Terrorist Attack

| Intervening Events | Cox Coefficients | Cox Hazard Ratios |
|---------------------------------------|------------------|-------------------|
| Military Decapitation | 1.1845054** | 3.26907** |
| Military-Led Attack | .21990258* | 1.245955* |
| Vigilantes | -.25875848** | .7720095** |
| Reinforcement Maneuvers | .37877489** | 1.460494** |
| Nigerian Human Rights Abuses | .55138535 | 1.735656 |
| Information Warfare | .80323249** | 2.232747** |
| Military Arrests | .29256594 | 1.339861 |
| Police Attack | 1.5701681 | 4.807456 |
| Police Arrests | .80618893 | 2.239357 |
| Negotiations | .74952717** | 2.115999** |
| Number of Subjects | 2124 | 2124 |
| Number of Failures | 166 | 166 |
| Time at Risk | 65844 | 65844 |
| legend: * p<.05; ** p<.01; *** p<.001 | N= 2124 | Chi2=320.9347 |

These following variables significantly decrease the time to the next terrorist attack—in other words make it more likely to happen: (a) military operations aiming to kill members of Boko Haram, (b) information warfare, and (c) calls for negotiation.

A striking result of the model is that both decapitation strikes led by the Nigerian military and military operations designed to degrade Boko Haram’s organizational capacity make terrorist attacks more likely to happen. The largest effect in increasing risk is military decapitation strikes aiming to cripple a network; based on the hazard ratios, decapitation strikes decrease the amount of time between terrorist attacks by 226%. A change of this magnitude functionally reduces the time-to-next-event to 0 months, meaning that a military decapitation will lead to a terrorist attack the following month.¹⁹ The effect of targeting the entire Boko Haram network and its military assets, rather than the just its leadership, is comparatively less severe: the increase in risk is only 24.6%. This decreases the time-to-next-event to 12 months, rather than 16.

The second largest effects in the model come from events associated with calls for negotiation and propaganda, which captures propaganda against Boko Haram as well as (social) medial propaganda

¹⁹ Mathematically, a 22% decrease of 16 (the median gap time) is -20.16. Without time travel capabilities, this would functionally become a prediction of an attack in the next period, which is a month.

output from Boko Haram. Negotiations decreased the time between terror events by 111.6% and propaganda decreased that time by 123.2%, functionally reducing the time-to-next-event to 0 months.

The only events which increase the time to the next terrorist attack—in other words make it less likely to happen—are operations by the Civilian Joint Task Force (CJTF), self-defense militias with an uncertain relationship to the military-led Joint Task Force. By the end of the period of analysis, there was some institutional support for the CJTF, which, by December 2013, had received \$113 million from the Borno state government.²⁰

With local-led civilian operations being not only more effective, but not counter-productive in reducing the risk of terror events, START researchers wanted to investigate which kinds of activities by Boko Haram telegraph an increase in risk of future terrorist attacks. This means that by tracking these activities, intelligence specialists can augur the times during which Boko Haram is most likely to increase its operations. The results of this analysis are below in Table .

Table 6: Survival Analysis of Boko Haram Operations on Time-Until-Terrorist Attack

| Independent Variable | Cox Coefficients | Cox Hazard Ratios |
|---------------------------------------|------------------|-------------------|
| Boko Haram Targets Police | .78088773*** | 2.18341*** |
| Boko Haram Targets Civilians | .33156645*** | 1.393149*** |
| Boko Haram Targets Military | .23051793*** | 1.259252*** |
| Number of Subjects | 2280 | 2280 |
| Number of Failures | 167 | 167 |
| Time at Risk | 69540 | 69540 |
| legend: * p<.05; ** p<.01; *** p<.001 | N= 2280 | Chi2= 201.17113 |

Unsurprisingly, all activities by Boko Haram significantly decrease the time to the next terrorist attack. The key take away from this specification of the model is that Boko Haram actions against the police, which include their attacking of jails, result in the largest decreases in the time to the next terrorist attack. Anti-police and jail-breaking operations decrease the time until the next terrorist event by 118%, whereas operations against civilian and military targets only increase the risk by 39.3% and 25.9%, respectively. This means that anti-police and jail-breaking operations reduce the time-to-the-next-event to 0 months, functionally, with operations against civilians and military targets reducing that time to nine and 12 months, respectively.

Operations against the police are more effective than other kinds of operations because they reduce organizational capacity of Nigeria to respond while also increasing the amount of labor Boko Haram has for future operations from the freed prisoners. Their operations against the military and civilian targets,

²⁰ Civilian vigilante groups increase dangers in northeastern Nigeria, <http://www.irinnews.org/report/99320/civilian-vigilante-groups-increase-dangers-in-northeastern-nigeria>

in comparison, increase risk less. The policy take-away of this is that of all the counter-terrorist policies implemented by Nigeria in between 2010 and 2013 making jails more defensively resilient, dollar for dollar, or more appropriately naira for naira, may offer the most effective vehicle at disrupting the ability of Boko Haram to execute successive waves of terrorist attacks.

START researchers also wanted to estimate the effect of non-kinetic responses to Boko Haram, specifically due to the awareness campaigns waged by concerned outside powers, often using hashtags. These results are displayed in Table 7.

Table 7: Survival Analysis of Soft Power and Diplomacy on Time-Until-Terrorist Attack

| Explanatory Variable | Cox Coefficients | Cox Hazard Ratios |
|---------------------------------------|------------------|-------------------|
| Information Warfare | 1.0966809*** | 2.994211*** |
| Ceasefires | -45.456303 | 1.81e-20 |
| Negotiations | .90390814*** | 2.469234*** |
| Number of Subjects | 2280 | 2280 |
| Number of Failures | 167 | 167 |
| Time at Risk | 69540 | 69540 |
| legend: * p<.05; ** p<.01; *** p<.001 | N= 2280 | Chi2=153.26238 |

The results in Table indicate clearly that non-kinetic responses have not worked, and that they have not worked about equally well. START’s data was limited in that we were not able to systematically code a particularly kind of non-kinetic responses—relief payments to victims of Boko Haram—but in the ones we were able to model—propaganda, ceasefires, negotiations, and call for negotiations—are counter-productive in decreasing risk.

Forecasting Effective Deterrence of Future Boko Haram Operations

Since the negative binomial regression results show similar effects on the variables as the Cox estimation, START researchers wanted to use this model form to forecast rather than probe the data to clearly detail policy options that lead to success. The regression model is preferred since it is not as focused on measure time-to-events, but rather on the predicted number of events themselves expected to occur.

To forecast how different types of interventions effect the number of attacks per month, I used Clarify to perform my post-estimation procedures.²¹ The model used similarly corrected for errors by state to lead to the most intuitive results interpretation. The post-estimation procedure utilized here used Monte

²¹ Michael Tomz, Jason Wittenberg, and Gary King (2001). CLARIFY: Software for Interpreting and Presenting Statistical Results. Version 2.0 Cambridge, MA: Harvard University, June 1. <http://gking.harvard.edu>. Gary King, Michael Tomz, and Jason Wittenberg (2000). “Making the Most of Statistical Analyses: Improving Interpretation and Presentation.” *American Journal of Political Science* 44, no. 2 (April 2000): 347-61.

Carlo simulations to generate marginal effects from the change in the value of any given set of variables on the probability of a Boko Haram terrorist incidence in any given month. Table 6 reports the predicted changes in the probability of a terrorist incidence occurrence as different events are simulated to occur. The changes in predicted probabilities are compared to a “baseline” scenario in which all variables except for the variable of interest are held constant at their median risk values. In this case all of the variables of interest are set at zero events in that state for any given month so that we can estimate, in isolation, the effect of changing one thing. This means that the baseline probability of a terrorist attack incidence occurs in a region in which there are:

- No Boko Haram attacks against civilians, police or military personnel
- No fortification maneuvers or deployments from the Nigerian Armed Forces
- Neither party is engaged in information warfare or spreading propaganda about the other
- Neither party is calling for or engaging in negotiations
- Neither the Nigerian police or military are arresting or fighting with members of Boko Haram
- There are no reports of Nigerian torture and
- Vigilante groups are not active

Taking the above conditions as a given, I simulate the effects of nine distinct scenarios to see the effect this change will have on the predicted probability of terrorist incidence and report those changes in Table 6. These nine scenarios are:

1. A single military operation in a state
2. Multiple military operations in a state
3. A single police operation in a state
4. Multiple police operations in a state
5. A single vigilante operation in a state
6. Multiple vigilante operations in a state
7. Combined vigilante and military operation in a state
8. Boko Haram operations against police
9. Boko Haram operations against military

Each scenario I estimate below utilizes a one-month lag. This means that I measuring how well the interventions are at reducing terrorist risk one month later. By analyzing the effects of the interventions, it is easy to see what kinds of operations and partners have been more effective at preventing terrorist incidence and which operations and partners have been more likely to increase its occurrence.

Table 6: How Different Events Change Attack Probabilities

| Explanatory Variable | Predicted Probability | Probability Value Change |
|---|-----------------------|--------------------------|
| Baseline Probability | 4.56% | N/A |
| Single Military Operation | 10.77% | +6.21% |
| Multiple Military Operations | 20.78% | +16.22% |
| Single Police Operation | 5.81 % | +1.25% |
| Multiple Police Operations | -10.35 % | -14.91% |
| Single Vigilante Operation | -6.89% | -11.45% |
| Multiple Vigilante Operations | -7.89% | -12.45 |
| Joint Vigilante and Military Operations | -0.00% | -4.56% |
| Boko Haram attacks against police once | 6.20% | 1.64% |
| Multiple Boko Haram Police Attacks | 15.17% | 10.61% |
| Boko Haram single attack against military | 20.84% | 16.28% |
| Multiple Boko Haram Military Attacks | 9.33% | 4.77% |

The results of the analysis are clear that to drastically decrease the predicted probability of future terrorist attacks, aspects of the Nigerian state must be mobilized in active counter-terrorist operations; doing nothing leaves a low, but residual 4.56% probability of at least one Boko Haram terrorist attack per month. Moreover, although every kind of Boko Haram operation signals future terrorist attacks, some are larger signals than others concerning the probability of a future terrorist event. A solitary Boko Haram operation against police forces only adds 1.64% to the baseline probability, whereas a solitary attack the military likely augurs future attacks. Yet, multiple Boko Haram operations against military targets increases the predicted probabilities of future terrorist incident a relatively small amount. This suggests that as long as Boko Haram capabilities are engaged in an offensive against Nigerian military targets, there are less likely to be casualties from terrorist incidents.

The most effective interventions that drastically lower the predicted probabilities of terror incidence have been vigilante operations, multiple police operations, and joint vigilante and military operations. These results, however, are not functionally supporting the arming of state-sponsored militia as a solution to curtailing Boko Haram. In order to interpret these results, we should compare them to the other findings of the model: Some of the largest increases in the probability of future terrorist incidence stem from non-sustained police operations and military involvement, with additional military actions making it worse than single military operations. On the other hands, despite police also being national and centrally trained, sustained police operations and vigilantes have in common their incorporation of

local knowledge of the human and social terrain, agents of the state that are not outsiders representing the comparative alien power of the federal government. This model suggests that the United States should encourage the use of local knowledge in counter-terrorist operations against Boko Haram, and that simply providing technical assistance for combinations of the military and vigilantes to engage in sweeps to clear Boko Haram, as well as ensuring sustained resources for local law enforcement agents to hold and operate in the territory that has been cleared will likely be more effective than military deployments.

This raises practical problems in Nigeria, as the northeast areas where Boko Haram operates the most is now almost completely devoid of police and relying solely on pro-government militias raises serious moral problems as well as negative externalities of unintended consequences from reducing the relative monopoly on the authorization of force that Nigeria is supposed to have. In fact, because the northern areas have so few police outside the major cities, as a quick robustness test I created a series of two-way tables to compare police activity by year.

I found that police activity engaged in direct fighting with Boko Haram has been constant (but low) between 2009 and 2012, with at least one action per year, peaking at five actions in 2012. Police activity involving arrest or detention activities, in contrast, peaked in 2013 and has remained present but increasing over time. For 2009 and 2010, Nigerian police were arresting and detaining members of Boko Haram less than their expected frequency, whereas after 2011 through 2013, the police were more involved in the northeast than the expected frequencies of their actions would suggest.

Conclusions

By analyzing interactions from 2009 to 2013 between Boko Haram and Nigeria in great detail, this empirical analysis generates four findings about best counter-terrorism practices against Boko Haram.

1. Vigilantes have been the most effective vehicle at disrupting the ability of Boko Haram to execute terrorist attacks in successive months.
2. Military operations increased risk in Nigeria by increasing the frequency of terrorist events, as well as the probability that an attack will happen in the following month. The more military operations there are, the more that probability of a terrorist attack in the following month increases.
3. Combined vigilante and military operations have reduced whatever increased risk that military operations cause concerning the probability of a terrorist attack in the following month.
4. The most effective interventions at reducing the probability of future terrorist attacks have been sustained police operations in the previous month.

Military-led counter-terrorist operations are extremely counter-productive toward the goals of reducing Boko Haram's ability to carry out future attacks and decreasing the amount of casualties from terrorist incidents. Police operations and vigilante supported operations have the opposite effect.

Despite police also being national and centrally trained, sustained police operations and vigilantes have in common their incorporation of local knowledge of the human and social terrain. While vigilante groups may be important in the short-term in disrupting Boko Haram activities and serving as local partners in a successful counter-terrorism strategy, arming militias are likely not a long-term counter-terrorism policy, especially if one wants to avoid unintended consequences.

Foreign partners seeking to buttress the capacity of Nigeria to respond to Boko Haram should focus on assisting in the redeployment of the police to northeastern Nigeria, very few of whom remain in the areas of the most intense Boko Haram activity. The only more effective intervention than vigilantes is sustained police operations.

Our findings suggest that the United States should encourage the use of local knowledge in counter-terrorist operations against Boko Haram by simply providing technical assistance for combinations of the military and vigilantes to engage in sweeps to clear Boko Haram, as well as ensuring sustained resources for local law enforcement agents to hold and operate in the territory that has been cleared.