ABSTRACT

Title of dissertation: MEMBERSHIP DIVERSITY AND TACTICAL ADAPTATION WITHIN VIOLENT NON-STATE ORGANIZATIONS

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This dissertation examines why some violent non-state organizations experiment with and develop a broader repertoire of tactics and targets to achieve their political goals while other groups consistently utilize the same methods across their lifespan. Social movement theory argues that challengers to the state's authority should continually innovate their repertoires of contention to mobilize support and sustain an effective challenge against the state; however, rebel groups vary markedly in the size of the tactical repertoires that they employ in their campaign to alter the status quo. Some non-state organizations are more capable of experimenting with and implementing new variations on existing methods than others.

I explore the factors that shape a militant organization's "adaptive capacity." Specifically, these are the conditions that make an organization more or less capable of the incremental innovations necessary for expanding its set of violent repertoires and generating a larger tactical menu from which it can draw when selecting a strategy to challenge the state. The project first delves into how measure tactical adaptation, employing a text as data pipeline to classify and nu-

merically compare descriptions of violent events. It then argues develops a theory of membership diversity as an internal driver of tactical adaptation. The theory emphasizes the stochastic elements that underpin membership interactions, arguing that individuals bring with them prior knowledge and experience when joining an organization and that knowledge diversity in an organization positively impacts an organization's adaptive capacity. The argument establishes two distinct mechanisms that focus on the endogeneity inherent to how solution concepts emerge and members learn in an organization.

The project directs the analytical focus on *who* is in a violent organization and argues that the answer to this question can shape (*a*) the ultimate outcome of a civil conflict, (*b*) how analysts assess the military capabilities of an armed group, (*c*) other arenas for innovation, such as rebel governance or institution building, and (*d*) the underlying severity of the conflict. the theoretical framework advanced here atomizes the individual and thinks carefully about the information he or she possesses and how such information can operate contagiously in a closed system. Moreover, the theory generates a framework whereby individual-level interactions and outcomes contribute to larger organization-level outcomes that we observe. The theory reduces the concept of diversity down to its most basic element: information. This allows one to think about the impact of membership diversity more formally and to treat it as another resource that a violent organization has available to it.

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by

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Chapter 1

Introduction

On the 24th of December 2010, Boko Haram—an Islamic extremist organization operating in northern Nigeria—detonated an improvised explosive device (IED) made of dynamite in a shopping mall in Jos, Nigeria. The explosion killed 38 individuals and left 74 wounded. That same evening, members of Boko Haram attacked two Christian churches by throwing petrol bombs, resulting in the death of churchgoers and a pastor. The day marked a shift in tactics for the insurgency group. Prior to that point, the insurgents mainly attacked community figures and religious institutions by shooting at their targets while riding on motorcycles or through targeted assassinations at the victim's home. Yet December 24, 2010 differed from these previous attacks in both form and scale. It was the beginning of Boko Haram's experimentation with the bomb.

From that moment onward, the group used IEDs to target religious institutions (strapping bombs to the backside of pews or entryways), banks and commercial businesses (using IEDs to create distractions or to gain access to vaults), mar-

ketplaces (blowing up cars and hidden containers in crowded areas), and military installations. Boko Haram experimented with strapping bombs to bicycles (and tricycles), rickshaws, kiosks, motorcycles, vehicles of different types and sizes, and finally people. They used them to deceive military, police, and Civilian Joint Task Force (CJTF) members by detonating bombs, waiting for security personnel to arrive, and attacking first-responders. They planted them strategically in case an offensive attack was forced into a retreat. They used explosive devices – such as petrol bombs – as distractions, throwing them as they fired upon state targets, magnifying their presence and creating confusion. They even targeted cell phone towers with explosives to temporarily knock out the communication abilities of telecommunication companies that the group claimed provided information to state authorities.

Even after Boko Haram shifted to rely heavily on suicide bombing in 2014, the group continued to experiment with the method in a number of ways. These "poor man's smart bombs" were used in concert with armed guerrilla operations to take out military bases, barracks, and check points. Sometimes individual bombers would be used and other times multiple bombers would descend upon a target simultaneously. In cases where vehicle-based suicide bombs would not work, the group would strap them to men, women, and even children. The result was horrific and yet effective. Most of these experiments with the bomb were both resounding successes and utter failures — with IEDs often failing to detonate or detonating too soon. Boko Haram's use of explosive methods demonstrates an organizational capacity to produce violence in creative and new ways.

In contrast, consider Abu Sayyaf (ASG), a similarly affiliated jihadist organization based in the Jolo and Basilan Islands in the Philippines. ASG also employed explosives, but did so in a more limited and redundant way. The group's initial use of explosives revolved around throwing grenades into crowds and rigging homemade IEDs to target transportation services, businesses, and religious institutions. The most notable (and successful) of these attacks occurred on February 24, 2004, when an eight-pound bomb—consisting of dynamite and hidden inside a TV set—was detonated on a Superferry in Manila carrying 899 passengers. The attack was devastating, resulting in 116 deaths. Shortly thereafter, the group expanded its set of targets to include government buildings/officials and military patrols/personnel and infrastructure targets, such as bridges, electricity pylons, and water utilities. However, with the exception of the Superferry bombing, these attacks were always limited in scale and followed the same basic formula: an IED, disguised in some fashion, placed on or near the target. Though the group appeared to experiment with different bomb-making technologies — such as nail bombs and remote detonators — it rarely appeared to adapt its methods or approach. With respect to its use of explosives, the group was far less creative in its production of violence.

Why are some violent organizations capable of tactical adaptation while others fall into tactical routines, repeating the same approaches over and over again? The use of IEDs by Boko Haram and Abu Sayyaf are illustrative of the ways in which violent organizations can employ and adapt the same violent products differently. A violent production is when a method is tied to a means and aimed at a target. For violent non-state organizations, adaptation of these products is

necessary to reduce anticipation and counter-adaptation by the state and to retain relevance as a political organization. The ways groups adapt and experiment with different violent productions point to an often overlooked reality in the study of political conflict: that is, some violent organizations appear more capable of tactical innovation and adaptation than others.

This dissertation examines why some violent non-state organizations experiment with and develop a broader repertoire of tactics and targets to achieve their political goals while other groups consistently utilize the same methods across their lifespan. Social movement theory argues that challengers to the state's authority should continually innovate their repertoires of contention to mobilize support and sustain an effective challenge against the state (McAdam, 1983; Tarrow, 2011; Tilly, 2003); however, rebel groups vary markedly in the the size of the tactical repertoires that they employ in their campaign to alter the status quo. Some non-state organizations are more capable of experimenting with and implementing new variations on existing methods than others.

Existing work argues that tactical diversification, adaptation, and innovation among violent non-state organizations is largely shaped by four factors: (1) organizational affiliations and partnerships with other groups (Acosta & Childs, 2013; Horowitz, 2010; Wahedi, 2018), (2) organizational bureaucracy (Horowitz, 2010), (3) public support (Bakke, 2014; S. Kalyvas & Sánchez-Cuenca, 2005; Polo & Gleditsch, 2016), and (4) organizational competition (Horowitz, Perkoski, & Potter, 2017).[1] Among the first group of explanations, the central determinate is *who*

[1]In addition, one could argue that organizations choose methods that are likely to be the most effective (Arreguin-Toft, 2001). However, as Horowitz (2010) notes, we should observe a unique empirical pattern in tactical adoption if this were true. Specifically, tactical adoption by other

the organization is connected to and the process by which information diffuses across these information networks. The idea is that adaptation is risky and information about tactics is closely guarded; thus, groups must learn through direct ties with trusted allies (Horowitz, 2010; Wahedi, 2018). The second group considers the inevitability of bureaucratization and specialization within organizations. The specialization of skills and expertise generate social incentives for members to *not* adopt novel ideas (Horowitz, 2010). Put simply, new ideas threaten old skill sets, and the more this is true, the less likely a new idea will be adopted. The third group considers how reliant a violent organization is on the local population and whether certain tactics are amenable to a group's base. An organization that is highly dependent on public support is less willing to adopt methods that will threaten that support (Bakke, 2014; S. Kalyvas & Sánchez-Cuenca, 2005). The final line of thinking highlights organizational competition. Competition with both rivals and the state is believed to drive the need for diversification and adaptation (Cunningham, Dahl, & Frug, 2017; Horowitz et al., 2017). Groups should only switch up what they do when they face competitive pressures.

The use of IEDs by Boko Haram and ASG provides a useful way in which to view these arguments. First, both organizations share similar affiliation networks — initially aligning with Al Qaeda before pivoting to the Islamic State (IS). If network affiliations are the primary method in which organizations learn and adapt, then why do we observe widely different use of the same method (e.g.

groups should correspond with perceived effectiveness. For example, if Group A successfully implements an attack, then Group B and C should be more likely to adopt that tactic. This implies an immediate diffusion of techniques and assumes that all conditions for implementation are similar and that organizations can fully observe one another. As Wahedi (2018) highlights, learning through emulation is difficult.

IEDs) between these two groups? In theory, both groups should have access to similar types of information, and yet we observe different forms of adaptation. Second, if bureaucratization shapes how capable groups are at adopting new ideas, then both organizations should become less innovative over time. However, one of ASG's most innovative attacks—the Superferry bombing in 2004—came 13 years after the group first formed, and Boko Haram's adoption (and adaptations) of suicide methods came 12 years after the group's start.[2] Third, both groups operate in similar settings: they represent Muslim populations, proclaim an extremist Islamic ideology, and operate in the periphery. Both rely on extortion, ransom, and external funding sources, minimizing their reliance on public support for organizational survival. In a sense, both are similarly unconstrained by local conditions, but still they deviate in their adoption of similar tactics. Finally, only ASG faces multiple competitors, whereas Boko Haram remains relatively unchallenged in Northeastern Nigeria.[3] If external competition was the main driver of organizational adaptation, then one would expect ASG to be the more adaptive of the two organizations, and not the other way around.

Why are some organizations more adaptive than others, especially when situated within similar affiliation networks, local conditions, and competitive environments? Existing theory speaks well to the conditions that shape how information moves between organizations and the external factors that constrain their

[2]Boko Haram did not turn to violent methods until the execution of its leader, Mohammed Yusuf, in July 2009. However, if bureaucratization is an impediment to idea adoption, then the initial founding of the organization is an important start date as bureaucratic features likely carry over from those initial non-violent years.

[3]Note that in 2014 there is an uptick in activity by Fulani Extremist in Nigeria. However, their activity is more centrally located in the country and their cause differs from Boko Haram's. Thus, their role as a "competitor" is limited.

operations; however, it offers little guidance for understanding an organization's 'innovative capacity.' Are all organizations equally capable of adaptation and innovation? If so, we should observe the same level of experimentation between groups as organizations fit 'tried and true' technologies to their specific contexts; yet, as illustrated with the use of IEDs among Boko Haram and ASG, there are considerable differences in the variety of ways similar organizations employ similar methods. If all organizations are *not* equally capable of experimenting and adapting, then what are the factors that make a collection of fighters more or less capable of innovating?

1.1 Layout of the Dissertation

In this dissertation, I explore the factors that shape a militant organization's "adaptive capacity." Specifically, these are the conditions that make an organization more or less capable of the incremental innovations necessary for expanding its set of violent repertoires and generating a larger tactical menu from which it can draw when selecting a strategy to challenge the state. Tactical adaptation brings with it clear strategic benefits for militant organizations in civil war. It reduces the state's capacity to anticipate the organization's behavior (McAdam, 1983; Tarrow, 2011; Tilly, 2003). It increases the organization's ability to captivate domestic and international audiences. Most importantly, it increases the likelihood that a militant organization will enter into negotiations with and gain concessions from the state (see Chapter 2). Organizations with a larger menu of

strategic options (i.e. more repertoires) are more likely to mix repertoires (adapt tactically) than consistently repeat the same method over again (tactical routines).

Chapter 2 delves into how to think about measuring tactical adaptation. In that chapter, I show how traditional approaches to measuring adaptive strategic behavior are limited conceptually and empirically. Moreover, I demonstrate that existing measures often fail to map onto outcomes of importance, such as an organization entering into negotiations with or gaining concessions from the state. The chapter then outlines a novel strategy for measuring tactical adaptation using raw descriptive accounts as inputs and comparing events through an event history network, where a topic weighting scheme is utilized as way of comparing events. The chapter both introduces a viable metric for thinking about adaptive behavior and a strategy for measuring it.

I then outline the current thinking with regard to tactical adaptation and innovation in Chapter 3. I show how existing research has primarily focused on factors external to the organization that either drive or constrain adaptation and innovation within violent organizations. However, as the chapter points out, few if any studies consider the internal drivers that shape an organization's innovative capacity.

From there I move to Chapter 4, where I develop a theory of membership diversity as an internal driver of tactical adaptation. The theory emphasizes the stochastic elements that underpin membership interactions, arguing that individuals bring with them prior knowledge and experience when joining an organization and that knowledge diversity in an organization positively impacts an organiza-

tion's adaptive capacity. The argument establishes two distinct mechanisms that focus on the endogeneity inherent to how solution concepts emerge and members learn in an organization.

The theory is presented in Chapter 4 as a set of assumptions for which testable implications are derived through simulation in Chapter 5. The theorized complexity inherent to membership interactions is explored as an agent-based model. In this framework, the model uses computational approaches as a theory generating tool (Siegel, 2018). The comparative statics of the computational model establish how the model's assumptions translate to testable implications.

Chapter 6 considers how one goes about measuring membership diversity in organizations where membership rosters are not observable. The temporal story baked into the theory and simulation require a level of temporal granularity about membership dynamics in armed organizations that is absent in existing measures. I develop a measurement strategy that examines where organizations operate geographically to construct a proxy for membership diversity. Specifically, I look at different ethnic populations that an armed organization is "exposed" to using the new geoAMAR data which tracts the geo-spatial location of all socially relevant groups (J. Birnir & Satana, n.d.).

The hypotheses of the theoretical model are then examined in Chapter 7 using original monthly data on the tactical patterns of a sample of 75 violent non-state organizations operating on the African continent from 1998 to 2016. From this analysis, I find empirical support for the theory's main conclusion: as militant organizations grow more diverse, they become more adaptive.

Finally, in Chapter 8, I conclude with discussions about existing limitations to the design and future avenues of research. The chapter outlines how the theory can be exported beyond the context of political violence to consider campaigns, civil society, and protest organizations.

1.2 Contributions

The dissertation makes several important contributions to the study of violent political conflict. First, it demonstrates how membership diversity can translate into military capacity, making militant organizations more effective and successful. Membership diversity is treated as an organizational resource that shapes a militant organization's behavior. In doing so, the study establishes a vital metric for assessing a violent organization's military capacity and latent threat potential.

Second, the project demonstrates how computational approaches can be leveraged to step beyond the unitary actor assumption underpinning most theories of violent organizational behavior. The theory demonstrates how micro-level assumptions can be explored as algorithmic features, yielding novel insights into how micro-level (individual) interactions aggregate to observable outcomes on the organizational level. In doing so, the theory challenges rational choice expectations regarding organizational behavior. An optimal response to any external stimulant is both a function of the members present at the time and the pool of information available to the organization. Thus, endogenous drivers shape the types of responses an organization can produce.

Third, the project outlines a novel way of empirically examining the types of violence that violent non-state organizations produce. It does so by decomposing descriptions of events and comparing the differences between violent productions over time. This offers a novel way of measuring when organizations adapt or fall into routines. Moreover, the use of a topic model to distill down event descriptions offers a new way in which to measure and conceptualize incremental innovations.

Finally, the theory establishes a relationship between the level of diversity within an organization and the likelihood of observing innovative outcomes. However, measuring diversity within organizational contexts that cannot be immediately observed presents unique challenges. The project makes an important contribution to this problem by outlining a strategy for measuring diversity within a violent organization by tracking the ethnic populations an organization is "exposed" to over time. This method yields an empirically viable yet temporally dis-aggregated metric for diversity within these violent organizational settings.

All in all, the project encourages scholars of conflict to think about membership as an important component when assessing the lethality and strength of violent organizations. The innovative capacity of groups can shape an organization's ability to gain concessions from the state and inflict irreparable harm against its citizenry. Thus, it is of vital importance that scholars understand the factors that underpin innovation among these types of actors.

Likewise, the project pushes against treating violent non-state organizations as unitary actors. Rather, this dissertation encourages conflict scholars to consider in greater detail theoretical mechanisms that take the interaction of many actors

at their core. The theory building framework employed in the proceeding chapters offers new avenues of research as scholars begin to treat violent non-state actors as the collectives that they are.

Chapter 2

Measuring Tactical Adaptation by Militant Organizations

> "All warfare is based on deception. Hence, when we are able to attack, we must seem unable; when using our forces, we must appear inactive; when we are near, we must make the enemy believe we are far away; when far away, we must make him believe we are near." - Sun Tzu, The Art of War

Being unpredictable is a militant organization's greatest military asset. The ability to vary tactics and targets lies at the heart of keeping a domestic audience terrorized (and captivated) and a security apparatus guessing—both of which shape how these organizations survive and succeed (Horowitz et al., 2017). Existing research has focused on the unique tactical forms violence can take—such as the use of selective or indiscriminate violence against civilians (S. N. Kalyvas, 2006) or suicide bombings (Horowitz, 2010, 2015; Pape, 2003)—but few studies consider how tactics are used in combination over time. While some have begun to

address thes eshortcomings by focusing on tactical diversification (Horowitz et al., 2017) and differentiation (Cunningham et al., 2017)[1], these studies only consider the broad usage of particular tactics over time, not the sequence in which those tactics are employed. Higher levels of tactical diversification and differentiation by militant organizations is not a sufficient condition for adaptation: for example, an organization might diversify by adding a new tactic to its tactical arsenal in a given year, yet still rely primarily on the same limited repertoires to commit violence during that period.

This chapters inspects whether militant organizations regularly vary and adapt their repertoires of contention. First, it asks, how can one measure tactical adaptation? Is tactical adaptation associated with positive strategic outcomes—such as entering into negotiations with the state or gaining concessions—as broadly theorized? Finally, does tactical diversification increase or decrease how adaptive militant organizations are?

The lack of empirical information regarding how militant organizations adapt and vary their violent repertoires is surprising. From a theoretical perspective, adaptation is a concept that is fundamental to the study of both violent and non-violent forms of contentious politics. The ways in which challengers adjust to changing circumstances and aggression by state and other non-state actors are theorized to promote a tactical interaction whereby adaptation is the primary determinant of organizational survival and success (McAdam, 1983). Moreover, the ways in which resource and membership constraints condition organizational

[1] Also, see work on insurgent learning and randomization of combat (Wright, 2016).

behavior presupposes that to retain political or military relevance, militant organizations must adapt strategically (Cunningham et al., 2017; Horowitz et al., 2017). In other words, resource sensitivities—in whatever form they take—should promote innovation, adaptation, and adjustment as novelty carries the dual reward of increased political relevance (increasing the likelihood of capturing the fleeting attention of a domestic audiences) and greater military capacity. Any novel utilization of resources that increases a unit outcome given the same marginal input by definition increases an organization's capacity and value.

The notion that militant organizations inject randomness into their tactical repertoires by mixing potential responses to an opponent's actions is well established in game theoretic and empirical accounts of conflict (Dixit & Skeath, 2015; T. S. Thomas, Kiser, & Casebeer, 2005); however, from an empirical perspective, little is actually known regarding the propensity for organizations to switch-up their strategic repertoires. This limitation primarily stems from three sources. First, analyses of conflict tend to hone in on specific tactics and types of violence, but rarely consider the use of different approaches in combination (Horowitz et al., 2017). Second, existing data collection efforts on political violence understandably try to reduce violent activity to specific categories or domains; however, in doing so, important information about the differences/similarities among the violent outputs of a specific actor are discarded, making events appear uniform and generic. Finally, when considering multiple forms of activity jointly, researchers tend to rely on aggregated counts by either taking the frequency of particular activities (Eck & Hultman, 2007; Hultman, 2007) or summing the unique features

observed during a specific time period (Horowitz et al., 2017). Both approaches conflate usage with adaptiveness, as both forms of operationalization inadequately consider the commonalities and discrepancies that underpin how events relate to one another.

In this chapter, I address these shortcomings by developing a novel measurement strategy for assessing when militant organizations mix their violent repertoires. The metric measures similarities and dissimilarities in the violent productions organizations produce, offering insights into when militant organizations are mixing repertoires (being adaptive) and when they repeat the same repertoires over and over again (fall into routines). Specifically, I treat event descriptions as unstructured data, which I reduce down to a distinct number of relevant topics. I then use the resulting weights vectors from these topics models—which describe how individual events load onto the relevant topics—to examine the similarity between events. The metric situates activity in its respective history record, so that event comparisons are backwards-referencing and constrained to only consider specific temporal windows, much like a citation network. The approach offers a strategy for measuring and understanding the sequencing of repertoires across organizations and time.

I generate the metric for 75 UCDP-defined organizations using integrated event data to gather a census of organizational activity. I then validate the measure by first examining the event history record of the militant organization Boko Haram. The quantitative case study demonstrates that the militant organization's propensity to mix repertoires varies over time. In addition, I show that the routine usage

of specific repertoires can be backed out qualitatively – that is, I can identify the methods and targets in which the organization consistently invests resources.

From there, I examine the relationship between adaptation and positive political outcomes, such as entering into negotiations and gaining state concessions. Theories of violent non-state organizations assume that these groups minimize the capacity for the state's security apparatus to predict their actions by relying on more than one strategy. Organizations do this by varying their behavior and strategies (Goetzmann & Kumar, 2008). Being unpredictable yields the dual benefit of increasing the costs of conflict by complicating the state's counter-insurgency operations and efforts Atran (2003) while simultaneously increasing the visibility and relevancy of the organizations, as operations have an increased probability of capturing and holding public attention (Weimann & Winn, 1994). For these reasons, tactical adaptation is argued to increase the probability of an organization reaching favorable political outcomes, such as entering into negotiations with the state and/or gaining concessions (Horowitz et al., 2017). I examine the metric's ability to predict such positive political outcomes as a validation strategy.

Finally, I examine whether tactical diversification is related to an organization's tactical adaptation. Existing research argues that tactical diversification functions as a proxy for tactical adaptation. I test this claim and find no meaningful relationship between an organization's propensity to mix repertoires and the increased use of distinct tactics over time.

The chapter makes two main contributions to the study of political conflict and violent non-state organizations. First, it offers a novel method for measuring

the sequence of events that can be easily implemented on raw textual accounts of a militant organization's violent output. The metric opens up a whole new way of analyzing organizational behavior and the tactics that violent organizations utilize over time. Second, it demonstrates that militant organizations may rationally respond to changing circumstances by tactically diversifying but that these efforts may not translate into greater levels of tactical adaptation. The findings point to an underlying paradox: attempts to increase the types of available strategies may result in an decrease in the organization's capacity to mix strategies. The implications of this finding direct future research to examine in more depth the internal factors that shape how violence is ultimately produced within these organizational settings.

The chapter proceeds as follows: Section 2.1 defines violent repertoire, explains how the concept is analyzed in the field, and notes how I deviate from prior specifications in this study. Section 2.2 outlines in detail the measurement strategy for generating the adaptation metric. Section 2.3 explores the metric with a quantitative case study of Boko Haram. Section 2.4 builds the metric out for 75 militant organizations and (a) examines the distribution of the score across organizations, (b) explores whether adaptation is associated with positive political outcomes as broadly theorized, and (c) investigates whether tactical diversification makes organizations more adaptive. Section 2.5 concludes.

2.1 Defining Violent Repertoires

What is a violent repertoire? Existing work on violent tactical repertoires tend to focus on two domains: methods and targets. The literature on methods hones in on specific deployments of particular tactics, such as the use of suicide bombings (M. M. Bloom, 2004; Brym & Araj, 2006; Victor, 2003), sexual violence (D. K. Cohen, 2013), and improvised explosive devices (IEDs) (Wilson, 2005). This work highlights the strategic logic underpinning the use of particular methods within certain contexts. Research on targets examines why militant organizations target specific populations, such as particular ethnic and/or religious groups (Rørbæk, 2017) or non-combatant communities more broadly (Hultman, 2007). These studies largely examine tactical features in isolation. More recent work has begun to incorporate information on both methods and targets together to understand tactical diversity (Asal & Rethemeyer, 2008; Horowitz et al., 2017; Polo & Gleditsch, 2016); however, these studies tend to focus solely on the method employed, or lump targets into broad categories of "soft" (civilians and businesses) or "hard" (military and police) distinctions, omitting vital information regarding target heterogeneity.

The focus on particular methods, or even the combining of methods, overlooks an important reality regarding the production of violence: the *means* in which violence is committed is only half the story. Consider a hypothetical group that seeks to destroy an armored truck parked outside a military barrack. Shooting at the truck would hardly accomplish the goal whereas a rocket-propelled grenade or a well-placed IED might fare better. The point being that the method is

endogenous to the target. Likewise, focusing on particular targets while excluding information on the methods utilized to perpetrate the attack alters how the event is interpreted and understood in the larger strategic context.

For example, consider an attack perpetrated by Boko Haram on May 20, 2014 in Jos, Nigeria. Boko Haram detonated a vehicle laden with explosives in the Terminus Market in Jos. Once first responders arrived, the group detonated a second bomb, killing police and service personnel. To view this incident solely in terms of the methods, one would define it as a bombing; in terms of targets, one might define it as one-sided violence. However, when appropriately dissected, the incident reflects a coordinated bombing and ambush aimed at both civilian, health worker, and state targets. To adequately capture the nuances of an event such as this and to compare it to other events in a time-ordered sequence, information regarding weapons and targets needs to be retained.

To this end, I define a violent repertoire as a method or tactic that is intent on causing damage or harm to a specific *type of target.* A violent repertoire is a series of corresponding features that describe both the methods (weapons) and targets used to perpetrate a violent event. As such, features of an event are pooled to more accurately describe the entirety of a violent outcome. In this setup, the use of a car bomb parked and detonated in a marketplace and an IED placed under a pew in a church constitute distinct tactical profiles. As I demonstrate below, leveraging information on an organization's tactical profile is particularly useful in understanding the similarity between events. Moreover, building these weapon

and target features can be easily produced when descriptive accounts regarding event activity are utilized.[2]

Measuring tactical adaptation requires greater emphasis on what organizations do over time to isolate the relative similarities and dis-similarities in activity. Prior work that examined the effect of political adaptation broadly considers what tactics are used within a set period of time (i.e. year) and compares differences in the counts across time periods (Horowitz et al., 2017). Organizations with a higher counts are then assumed to be more adaptive than organizations that tend to "put all their eggs in one basket."

However, counting the number of discrete tactics that are used within a given time period does not account for how often those tactics are employed. An organization may attempt to differentiate tactics but largely continue to use the same suite of methods to accomplish their goals. Likewise, the organization may switch to a new method and then repeatedly use that method over and over before switching again and doing the same. In both these scenarios, the repeated use of the same tactics falls more in line with a predictable routine rather than an adaptive process. Counting the number of discrete tactics used within a specific time period misses these possibilities.

In the following sections I propose a textual approach to analyzing the differences in events across time by examining the similarity of events to preceding events. The method leverages unstructured textual data describing event occur-

[2] In this study, I focus on violent production but readily note that organizations can engage in both violence and non-violence to achieve their strategic goals. The focus on violence is to provide useful scope conditions in this initial analysis. That said, the method as described below can be extended to incorporate non-violent processes, such as protest or the provision of goods and services.

rences, reducing accounts down to a feature set of relevant topics. Topics are generated using non-negative matrix factorization (NMF) to extract the latent structures term matrix. The weights of these topic features are then compared using cosine similarity to generate a numeric scale of the difference between events. The approach offers a way to capture when organizations employ different tactical approaches and when they fall into routines (i.e. use similar approaches over and over).

The ability to track whether events within a specific time window are similar or different from one another provides a way of understanding when organizations are adaptive or not. Moreover, by using event history data, the approach scales to time windows that are more granular than a year (which tends to be the temporal unit in existing studies (Cunningham et al., 2017; Horowitz et al., 2017)). This is an important feature as it offers a way of capturing periods of when groups actively mix different repertoires and when they fall into routines.

2.2 Measuring adaptation in a sequence of violent repertoires

Consider the following three events:

- **A**: *An explosive device detonated at a cattle market in Maiduguri city, Borno state, Nigeria. At least 16 people were killed and 24 people were injured in the blast. No group claimed responsibility for the incident; however, sources suspected that Boko Haram was involved.*

- **B**: *A suicide bomber detonated near a military checkpoint in Tungushe village, Kukawa district, Borno state, Nigeria. At least two people were injured in the blast. No group claimed responsibility for the incident; however, sources suspected that Boko Haram was involved.*

- **C**: *A female suicide bomber detonated on the Baga-Monguno highway, Kukawa district, Borno state, Nigeria. In addition to the bomber, two people were killed and four people were injured in the blast. No group claimed responsibility for the incident; however, sources suspected that Boko Haram was involved.*

All three events describe violent activities attributed to the militant organization Boko Haram recorded to have occurred on June 6, 2015 in Nigeria. Event A describes an improvised explosive device (IDE) set off at a cattle market in Maiduguri; Event B a suicide bombing on a military checkpoint in Tungushe village; and Event C a suicide bombing along a highway in Borno. How similar is each event to the other? Qualitatively comparing each event is straightforward. All three involve the use of explosives, though the targets differ. C and B involve the

use of a suicide bomber where for C the improvised explosive was concealed. A and C share the targeting of civilians (though one targets commuters and the other shoppers at a market place) where B targeted military forces. For all three events, the shared commonalities and points of departure can be identified; however, how should one go about quantifying these differences systematically?

Defining similarity is inherently a question of measurement. How does one consistently and reliably measure the commonalities between events in a way that allows for comparisons across a larger time series? This section outlines an approach that leverages event descriptions to calculate the similarity between events. The goal is to produce a unidimensional scale that represents the relative similarity between violent output produced by an organization in an effort to generate a metric for adaptiveness of an organization's violent repertoire. By treating event descriptions as unstructured textual data, commonalities can be systematically derived by isolating prominent terms that appear across descriptions. These descriptions can then be reduced to a distinct number of latent topics. Each event can then be described as a vector of weights that describe how an event loads onto each topic. Finally, comparisons can be made between these weighted vectors via a range distance and similarity metrics.

The following subsections details this data pipeline. First, I review what an event description is and how such data is generated. From there, I outline how I draw textual features from each description by reducing the textual accounts to a finite number latent topics. I then lay out how the topics' weights vectors can be leveraged to measure the similarity between events. Finally, I explain how event

comparisons can be situated within an event history network whereby future events reference past events, which provides a means of averaging event (dis-)similarity within specific temporal windows. The pipeline seeks to yield a consistent and comparable metric of regarding adaptive behavior in an organization's violent repertoires.

2.2.1 Event Descriptions

Scholars of conflict are interested in understanding where, when and why conflict occurs and how conflict events shape future trajectories of violence and other outcomes. Work in this vein has been transformed by the recent emergence of datasets providing event-level information that is spatially and temporally disaggregated, often measured down to a specific location on a specific day. Among the key sources are the Armed Conflict Location and Event Data (ACLED) (Raleigh, Linke, Hegre, & Karlsen, 2010), the Uppsala Conflict Data Project–Geo-referenced Event Data (UCDP-GED) (Sundberg & Melander, 2013), the Global Terrorism Database (GTD) (**(alias?)**), and the Social Conflict Analysis Database (SCAD) (Salehyan et al., 2012). These data have been used widely and effectively in geographical and temporally disaggregated analyses. [3] These event data are primarily generated through media accounts reporting on political activity. [4]

[3] In particular, disaggregated data have been a boon for researchers interested in understanding better how factors such as population (Raleigh & Hegre, 2009), demographics (Weidmann, Rød, & Cederman, 2010), physical geography including terrain and the distance from the capital (Buhaug, Gates, & Lujala, 2009), rainfall (Hendrix & Salehyan, 2012), elections (Salehyan & Linebarger, 2015), and others affect the location and timing of events like protests, terrorist attacks, or battles between rebels and security forces, as well as the influence of peacekeeping (Hultman, Kathman, & Shannon, 2013) and battlefield losses on civilian targeting (Wood, 2014).

[4] The promise of converting news reports into highly granular event data relies on the assumption that events are reported accurately and without bias. However, biases proliferate in various ways — specifically through the decision to cover certain types of stories, the propensity to cover

For the purposes of this article, the descriptions from which these event data are drawn are of particular interest. All event data are associated with a report, article, and/or interview from which each entry was generated. For most of these data (i.e. GTD, ACLED, and SCAD), a description variable is retained offering a qualitative account of the event. The event descriptions listed in the previous section are an example of what these accounts look like. These descriptions are meant to offer researchers a more complete understanding of the activity that transpired.[5]

I leverage these descriptions from three prominent event history datasets to evaluate similarities between events. Specifically, I draw from the descriptions that accompany event entries in the ACLED, SCAD, and GTD datasets. The logic behind the focus on these data is twofold. First, these data contain information on different forms of violent activity, specifically terrorism and organized armed violence against the state. By using these data in concert, it is possible to gain a more complete understanding of the kinds of violence organizations produce (Donnay et al. 2018). Second, these data all provide event descriptions (along with source references when descriptions are sparse), making it feasible to leverage event descriptions in the way prescribed below.[6] Though imperfect, these descriptions

specific areas (i.e. urban over rural), and how events are reported on (i.e. slant) (Davenport & Ball, 2002; Earl, Martin, McCarthy, & Soule, 2004; Weidmann, 2015). I acknowledge that these shortcomings are problematic; however, limitations aside, these data can still provide valuable insights into the processes that underpin conflict.

[5]Moreover, these event descriptions can be particularly useful when integrating multiple event datasets by offering a straightforward way of validating potential matches (Donnay et al. 2018).

[6]The UCDP-GED, which is an event dataset that follows the UCDP inclusion restriction with regard to what constitutes as civil war, is excluded from this list due to the lack of a qualitative description variable. However, in the appendix I leverage a small subset of these data from 2011 onward to demonstrate that addition of these data does not significantly alter the trends reported below.

offer a synthesized version of the news articles from which an entry was drawn that is both readily available and sufficiently detailed.

It is important to note, however, that these event descriptions are not composed without error. Some entries lack a description altogether, whereas others may not be as richly described. Thus, the quality of each description may vary given the analyst who wrote it or the time in which it was written.[7] Thus, it is important to think of these descriptive data as inherently error-laden and noisy. However, such noise should bias the metric away from detecting any meaningful signal in the data. I outline in greater detail below some steps to reduce these shortcomings.

2.2.2 Extracting latent topics

This subsection outlines how event descriptions are cleaned and reduced into a finite number of latent topics using non-negative matrix factorization. Topic modeling offers a way to decompose descriptions into the underlying features that constitute events. These features can then be used to compare events by leveraging the way event descriptions load onto relevant topic features.

For the purposes of this discussion, a feature set is a numerical representation of an event, where each entry in the vector corresponds to a specific topics that relates to what happened in that event. In textual analytics, these forms of document reductions are known commonly as topic models. Topic models start by converting text into a document term matrix (DTM) where the columns denote unique words and the rows the document from which those words are drawn.[8]

[7]See (Eck, 2012) for a larger discussion on analyst variability with respect to the ACLED data.

[8]The cells are counts of how many times words from column j correspond to document i.

Topic models assume that a mixture of topics underlie each document and determine the assignment of words (members) to specific topics (groups). The goal is to reduce the DTM into k number of latent topics.

Topic models come in two flavors: probabilistic topic models using Latent Dirichlet Allocation (LDA) and non-negative matrix factorization (NMF), which approximately decomposes a numeric matrix down into constituent matrices that describe (1) how words load onto topics and (2) how documents load onto topics. To construct the topic features, I used the NMF method. The method performs well when the amount of textual description varies in sparsity. Moreover, as the decomposition is an approximation, the DTM can be reduced analytically, making the examination of a large number of topics feasible by reducing computation time. Finally, recent work has demonstrated how the coherence of topics can be analyzed to determine the optimal number of topics to use (Lee & Seung, 1999; OCallaghan, Greene, Carthy, & Cunningham, 2015). For these reasons, NMF provides a parsimonious approach to reducing event descriptions down into their constituent parts.

To convert the event descriptions into a DTM, the descriptive accounts must first be cleaned. I clean the data by converting the text to lower case, stemming, and removing all digit, stop words, and proper nouns. The decision to clean the data in this manner is as follows. First, stemming provides a method for removing grammatical differences between the same root words, ensuring that different versions of the same words are treated as such, e.g. "assaulting" and "assaulted" → "assault". Second, dropping stop words removes commonly used

words (e.g. “the”, “to”, “until”, etc.), which can drown out other more informative words given their prevalence. Retaining these words would result in added noise when reducing the text into topics. Third, stripping entries of all date, numerical, and location information rids entries of needless specificity that does not generalize across events. Likewise, removing the proper nouns from the text also removes a recurrent source of similarity (e.g. the perpetrator’s name) and dissimilarity (e.g. the name of the victim, or the location of the event, etc.).

Once cleaned, each event description is then a bag of individual words and two-word n-grams. The n-grams are included to retain context for specific combinations of words, e.g. “sets fire”. A DTM is then generated where the columns are composed of both words and n-grams, the rows correspond to each event, and the cells are populated by frequency counts. The resulting sparse matrix retains a set of words that most generalize across the set of event descriptions.

I then reduce the DTM to k number of latent topics using NMF. The specification of k is arbitrary and thus hard to establish *ex ante*. Tuning of this parameter is normally done through qualitative assessment of the topic output by examining the words that load most prominently onto the topic and then attaching meaning (or a label) to the topic. Naturally such an exercise is costly and does not guarantee the the optimal number of topics is located. To this end, I advance two suggestions. First, as k is a tuning parameter in the generation of a metric for which the downstream usage is in a statistical model. The arbitrariness of k is less of an issue as the sensitivity in the results can be assessed to evaluate the parameter’s impact on the robustness of the model. Second, recent work on the

optimal determination of the size of k offers guidance through the the calculation of a topic coherence score.

Figure 2.1: Applied illustration of the descriptions-to-topics pipeline

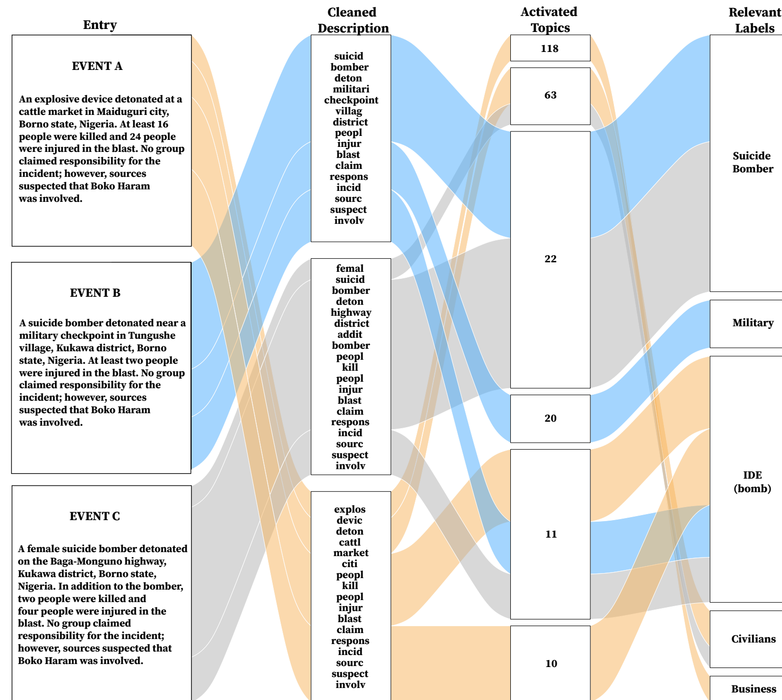


Figure describes an applied application of how event descriptions are processed and cleaned. Topics are then generated via non-negative matrix factorization (NMF) and arbitrarily labeled (the labels merely serve to ease interpretation and assist in flagging irrelevant topics). The bandwidths of the alluvial plot correspond with size of the weight. Only topics that make up 5% or more for a given entry are reported to ease presentation.

Once the number of topics is determined and generated, I manually review each one to (i) flag irrelevant topics and (ii) label each into general categories. The flagging of irrelevant topics removes meaningless topic features—for example, language regarding directions (e.g. "north", "southwest", etc.) tend to cluster; in addition to specific kinds of language that is particular to how descriptive accounts are composed in different datasets, such as the GTD use of attribution language

(e.g. "suspected", "claimed", "attribute", etc.). The fact that these topic features cluster is useful as these topic weights can be removed without issue, retaining only the features that describe tactics, targets, and other particular aspects of an event. Likewise, I assign labels to ease the qualitative assessment of events when examining the validity of both the topic model and the resulting metric. These categories are primarily used to help qualitatively understand event activity in applied settings (see Section 2.3).

Figure 2.1 provides an illustrative example of this process using the three event descriptions introduced at the start of this section. The figure provides intuition regarding the steps in the process of converting textual event descriptions into weighted topic vectors.[9] The output of this process is a weighted numerical description of an event that can then be analytically compared. I refer to these vector values as "topic features."

2.2.3 Calculating event similarity

Once events are reduced down to a set of topic features, I calculate the similarity between events by comparing the weighted numerical vectors. Similarity can be expressed in a variety of ways: as distance (Euclidean distance), correlations, overlapping sets (Jaccard coefficient), edits (Levenshtein distance), or angles (cosine similarity). Of these approaches, cosine similarity is most appropriate given the large number of attributes (i.e. topics) and sparsity. The metric calculates

[9]The textual descriptions are cleaned and decomposed into topics, which I then manually reviewed and labeled. As noted, the task labeling has two purposes: to remove irrelevant topics and to provide a natural way of qualitatively understanding the topic assignments. As the figure highlights, certain topics (e.g. "suicide bombings") map one-for-one to tactical categorizations, whereas others (e.g. "IDEs (bombs)") are captured by multiple topics.

the cosine of the angle between two vectors, which offers a measure of orientation rather than magnitude. Thus, the magnitude of the weights themselves do not dominate.[10]

For the task at hand, the cosine similarity describes how related two or more feature sets are to one another by examining the angle between them. Specifically, a similarity score is generated by measuring how much one vector 'projects' onto another. Recall that on the unit circle, $\cos\theta$ is equivalent to the length of the x axis. By measuring this distance (i.e. the projection one vector on the other), one can generate a score from 0 to 1, where 1 denotes perfect alignment and 0 indicates the two vectors are completely orthogonal.[11] Put simply, the score is the normalized dot product of the two feature sets.

$$\cos\theta = \frac{\vec{vec_1} \cdot \vec{vec_2}}{\|\vec{vec_1}\| \, \|\vec{vec_2}\|} \tag{2.1}$$

By leveraging the cosine similarity between the retained topic features, it is possible to generate a interval scale that conforms to one's qualitative expectations regarding which events are most similar and disparate. By scaling the method out to a whole time series of events, it is possible to capture the broader trends with regard to how adaptive an organization's violent repertoire is over time by honing in on the similarity between events.

[10]That is, the angle expresses the relationship between projections in manner that does not preference large feature weights.

[11]This follows from the angle θ. That is, when the angle is 0, the two features are identical. When it is 90 degrees constitute a right angle, projecting perpendicularly out from one another. Note that on the unit circle, θ is constrained to exist in the domain $(\pi, 0)$. to ensure the function maps to a single location. Thus, $\theta > 90$ degrees is possible, but in practice, the similarity between documents falls within the range of 90 deg and 0.

2.2.4 Event history networks and backwards referencing

A numerical scale for event similarity can be generated by making comparisons between two or more event descriptions; however, for event history data, the order of those comparisons matters. Events are situated in time and thus can only be related to prior entries. Naturally, something that happens today cannot draw from an event that *will* happen three months from now. To get around this issue, event comparisons can be constrained to only consider prior occurrences when assessing similarity.

To this end, think of all the events associated with a particular organization as nodes in a network. The ties between nodes can be understood as 'references' that are directed: current events reference past ones but not vice versa. In addition, the strength (or weight) of each tie is determined by the similarity between each connected node. Thus, an event history network is one where each new event i has $n-1$ ties to all previously added node, and the weight of the ties is a function of the cosine similarity between node i and all prior nodes.

One drawback of generating a network in this fashion is that the addition of any one node produces $n-1$ ties to each existing node. Thus, the network itself quickly becomes dense and the structure predictable.[12] More importantly, the dilemma highlights how multiple comparisons are made simultaneously as the similarity scores are inherently relative—that is, the score lies along the edge not the vertice in the network. In order to produce a general measure of similarity for each event with respect to those that came before it, I average these weighted ties

[12] For this reason, common network metrics, such as degree centrality or eigen vector centrality, shed their usefulness, as the oldest event is effectively the most referenced.

(edges) to generate an aggregate statistic. This yields an expected value of the degree of similarity that the current event shares with respect to preceding events.

Using again the three event descriptions from the start of the section, Figure 2.2 provides an illustration of the reference network. The three events are tied to their position in time, where A, B, and C are assumed to denote the order of the events.[13] As such, a future event (C) references prior events (A and C) but not vice versa. The real number values on the ties reflect the cosine similarity between events using the topic features as comparison vectors.

The figure illustrates two things. First, it shows that the scores conform with qualitative intuition when comparing the descriptions. Specifically, the two suicide bombing events ($C \rightarrow B$) are the most similar of the three with a cosine similarity of .9. In addition, the score highlights the nature of the target: a checkpoint on a road and highway. Second, the comparisons highlight the dissimilarity between the events. Events $C \rightarrow A$ are the least similar as the delivery and context differ. Likewise, $B \rightarrow A$ are relatively dissimilar in target and type.

One particularly useful feature of treating event history data as a reference network is that specific windows can be set to calculate how similar an event is to the j number of events that preceded it. The value of specifying such a window is that event similarity can be contextualized within understandable units (e.g. how similar event i is to the last five events that preceded it, and so on). Specifically,

[13] Almost all existing event data is temporally granular to the coordinate-day. For events that occur on the same day, there is no way to reliably order the entries. As such, the current exercise is a bit of a distortion as C might very well precede A and B and not the other way. A natural solution to this dilemma is to either collapse all event descriptions to a single day or to randomly shuffle the order of events and produce multiple versions of the metric and average across the different versions. I demonstrate in the appendix that this sub-day ordering does not matter substantially in the empirical conclusions made in this paper.

Figure 2.2: Illustration of backwards referencing in an event history network

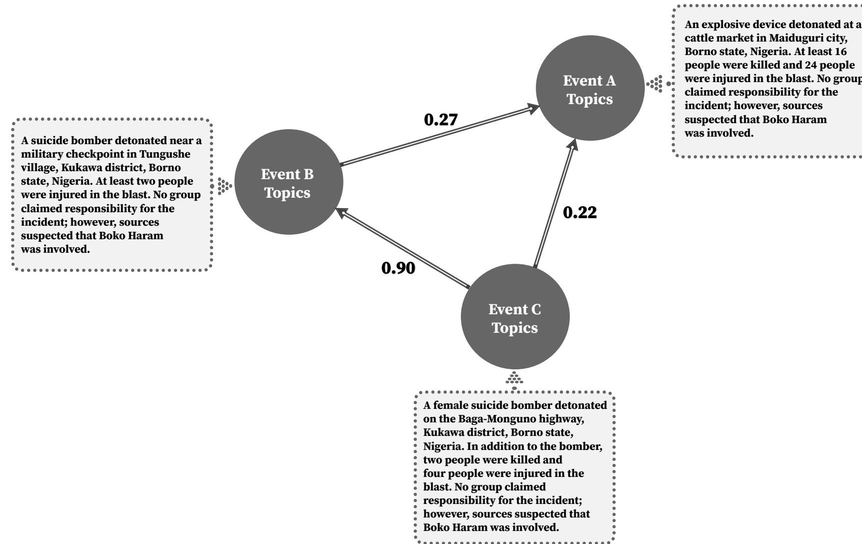


Figure illustrates an event history network where time ordering defines how ties (or "references") are situated between events. The ties denote the direction of the reference with the cosine similarity score reported as the numeric value along the edge.

the average similarity score is the sum of the similarity scores across all j ties divided by j. With regard to Figure 2.2, the average score for A is non-existent as there is no other event in the series to compare it to; for B it is .27, and for C it is .56 (the average of the two ties).

This allows for a straightforward interpretation of the relevant window in which comparisons are being made. In addition, it extends the metric from being more than a rolling average, which windowless averaging would yield. As the next section demonstrates in an applied setting, the degree to which organizations appear adaptive (i.e. there is a high degree of dissimilarity between events) and/or locked in routines (i.e. there is a high degree of similarity between events) depends

partially on the size of these windows. Thus, the approach provides a useful tuning parameter to examine result sensitivity in applied empirical settings.

2.3 The Tactical Adaptiveness of Boko Haram: a quantitative case study

In this section, I analyze the available event history record for all violent productions by the militant organization Boko Haram from 2009 to 2016 to examine the adaptiveness of the organization's contentious repertoires in an effort to provide intuition regarding the behavior of the metric. Boko Haram's repertoires are marked by a diverse array of tactics utilized against an assortment of different target types. I demonstrate that the organization falls in and out of periods of adaptation and routines. I then isolate the general topic features being activated for each event to understand the types of tactical profiles that constitute the organization's repertoire at different moments in time. The analysis demonstrates that not only can one measure when the organization is adaptive or not, but also gain intuition into what specific repertoires dominate the organization's production function during instances when organizations are locked into a tactical routine.

Initially founded in the early 2000s, Boko Haram was a religious organization that turned to violence after its founding leader, Mohammad Yusuf, was executed by the Nigerian state on July 30, 2009. Like many militant organizations organized around an Islamic ideology at the time, Boko Haram held a strict vision regarding the role of religion in the state and civil society and is most notably

known for its opposition to Western education.[14] Once the organization gained new leadership under Abubakar Shekau after Yusuf's death, Boko Haram pursued a campaign of organized violence characterized by targeted assassinations, drive-by shootings, burning of churches, and target attacks on the police. Boko Haram then shifted its tactics to bombings: specifically the use of improvised explosive devices IDEs in public places and suicide bombings, which were most prominently carried out by female assailants. Brutal in their implementations and unceasing in their frequency, the violent outputs generated by Boko Haram were effective in waging a strong challenge against the Nigerian state. The group's atrocities gained international attention when the group kidnapped over 200 Chibak schoolgirls in late 2014.

The event history record of Boko Haram's campaign of violence and terror is cataloged by multiple event data sources. The international prominence of the group, their associations with the militant organizations such as Al Qaeda and the Islamic State (IS), and the general quality of reporting in Nigeria yields an ample record of the group's atrocities over time. As outlined in the previous section, textual descriptions of these events can be leveraged and decomposed into feature topics that can then be compared to gain insight into what the organization does and how often those actions differ over time. By examining how related current events are to the prior event activity, the approach offers a way of assessing the average level of similarity between events in order to make an empirical statement

[14]The organization's official name is Jama'atu Ahlis Sunna Lidda'awati wal-Jihad, which in Arabic means "People Committed to the Propagation of the Prophet's Teachings and Jihad"; however, the organization is commonly referred to as "Boko Haram", which loosely translates to "Western education is forbidden"

regarding how often an organization varies its violent repertoires or falls into a routine.

Figure 2.3 presents cosine similarity scores for all violent activity associated with Boko Haram as recorded in the ACLED, GTD, and SCAD data bases. The data was integrated using the MELTT methodology in an effort to remove duplicative entries (Donnay, Dunford, McGrath, Backer, & Cunningham, 2018).[15] The event descriptions were factorized into 300 topics using both individual word and 2 word n-grams. The topic weights were then evaluated to remove any irrelevant bins. For example, language particular to how event descriptions are described in a particular dataset regularly fall into their own topic bin. By deactivating these topics in the feature comparisons, one effectively removes the aspect of the description that is particular to particular source material. The similarity of events are calculated by comparing events to the k-prior events that preceded them. Four separate windows are considered for k: 15, 30, 60, and 90 days, respectively. Scores are then standardized — that is, the scores are group mean centered so that 0 denotes the baseline average similarity score and the variance is set to 1 given how values vary for the group. Standardization allows for comparing similarity scores across groups, which I explore in the next section.[16] Finally, the scores are averaged by month.

[15]All assumptions and tuning parameters used to integrated the data are reported in the Appendix.

[16]The baseline levels of similarity for groups can differ for various reasons — most notably when some events are described in greater detail on average, there are more ways in which events can appear dissimilar. By standardizing, the scores are constrained to be relative to the group, which is theoretically desirable as the metric seeks to recover discrete changes over time rather than levels.

Figure 2.3 demonstrates that Boko Haram regularly oscillates between periods of adaptation and routines. Values above zero can be understood as being more similar than one would expect on average (routines), and values below 0 denote times when events are less similar than one would expect on average. Again, the scores for different reference windows are reported. The similarity in the scores notes that the larger patterns hold event; however, there are slight departures from the 15 and 30 day windows and the 60 and 90 day windows. This indicates that inferences drawn from the adaptation metric may be slightly sensitive to differences in window size.

The figure shows that initially Boko Haram is quite adaptive. From 2010 until late 2011 event activity is mixed as the group employs a mixture of tactics (bombs, shootings, burning of buildings) and targets (religious institutions, police, civilians). However, around the start of 2012, Boko Haram routinely began to target police and government buildings with a mixture of IDEs and armed attacks. Unlike the prior period, the organization's violent products were concentrated in a few production types. Likewise, another prominent period of routine occurs from mid-2015 to early 2016. During this time, the organization switched to relying heavily on the use of suicide bombing against both civilian and military targets. The adoption of the suicide bomb had been employed as early as 2011; however, the methods usage became more prominent during this time period. Boko Haram was in the routine of blowing itself up.

To better understand the tactical and targeting choices being made at each time period, consider Figure 2.4. The figure describes Boko Haram's tactical

Figure 2.3: Boko Haram Event Similarity Scores

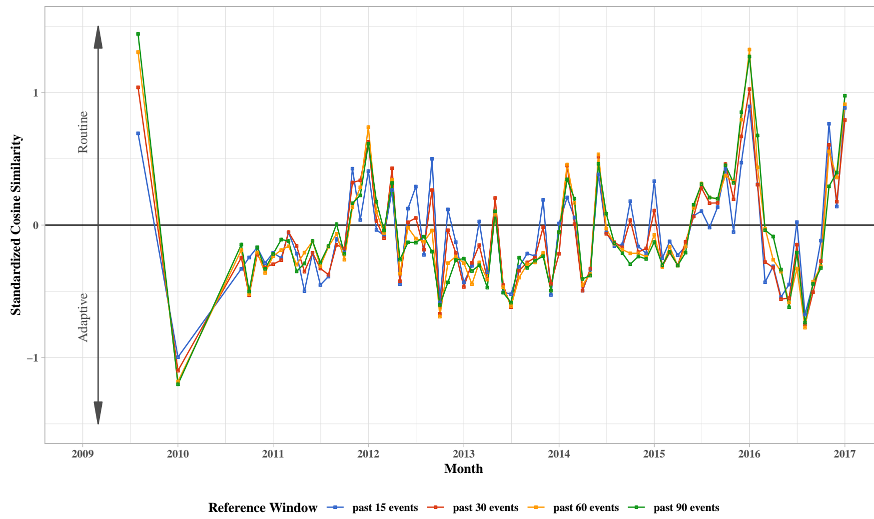


Figure reports the cosine similarity scores between events for Boko Haram from 2009 to 2016. Scores are standardized to have a group mean of 0 and variance of 1. Average scores for each month are reported. Positive scores can be interpreted as months where events are more similar to the previous events on average. Likewise, negative scores denote months where events are less similar on average. Four reference windows are considered and reported. The reference windows refer to how many past events an event is compared to and then averaged by when calculating similarity. For example, a window of 15 events means event i is compared to events $\in \{i-1, \ldots, i-16\}$ and then averaged across all fifteen events to generate a similarity score for that entry.

repertoires distinguishing between tactic and target types. To assign a general marker to understand the topic features, I labeled the feature topics into general bins that corresponded with particular target and tactic types. I then calculated the weighted proportion of each category by summing together the topic weights for the labeled topics and dividing by the total sum of all the weights across all categories. A category with proportion of 5% or greater is then reported

in the figure as a feature for the event.[17] When particular features are highly concentrated (i.e. there are many events for which the feature is activated), the points overlap and appear darker, offering a way of denoting when certain features are most prominently employed. Finally, the top of the figure provides a bar graph describing the frequency of events over time.

Reading Figure 2.3 and Figure 2.4 together is illuminating. First, periods when the organization appears most adaptive (e.g. 2010 to late-2011 and late-2012 to 2014) are denoted by the activation of many different tactic and target categories but few of any categories are regularly utilized. By contrast, periods marked by routine (e.g. late-2011 to mid-2012 and mid-2015 to early-2016) correspond with the consistent utilization of specific repertoires. For example, the 2015-2016 period is marked by a renewed focus in suicide and IDE bombings against both military and civilian targets. Likewise during this time period, the organization relies far less on the use of armed assaults using firearms. The period illustrates a bombing campaign, which emerges prominently out of the empirical picture.

Second, the figures highlight the diverse modes of production that underpin each violent outcome, underscoring the variety of shapes violence can take. In fact, adaptive periods can best be described as tactical experimentation — that is, during highly adaptive periods (denoted when the histogram is lighter), Boko Haram appears to test different ways of innovating on how it produces violence. For example, consider an attack that took place in Dar village in the Adamawa state on October 17, 2015. Boko Haram militants attacked the town's residents,

[17]Note that some topic categories cannot be cleanly categorized but rather fall in a more general category of "armed violence." I do not report this category in the figure as it is a catch all bin.

Figure 2.4: Tactical repertoires of Boko Haram over time

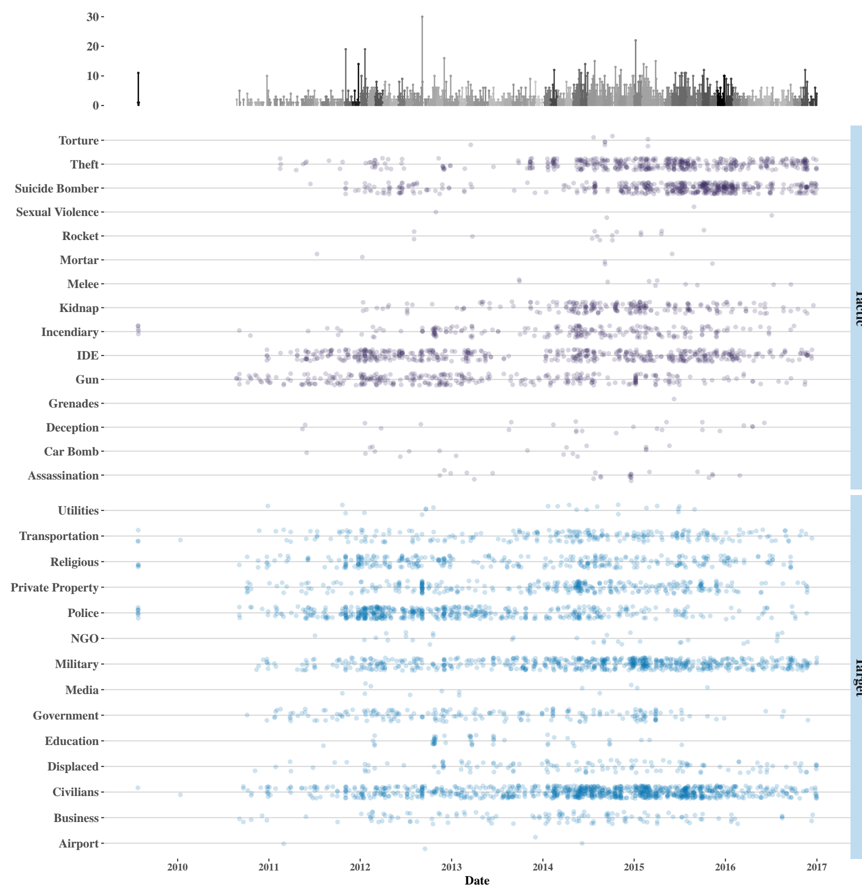


Figure reports activated tactical and target categories for each event. Feature topics are binned into general tactic and target categories. The proportion of categories that contribute to an entry is then calculated by summing the topic weights for each category and then dividing by the total sum of weights for that event. Only categories that made up 20 percentage points or more of the total proportion of weights are reported. Events are made transparent and jittered to capture the density of events around specific labels over time. The histogram along the top of the plot denotes event frequency. The shading on the histogram denotes the values of the 30 event similarity score where darker values denote instances of routine and lighter adaptiveness.

shooting at the crowd. As residents fled, two female suicide bombers disguised as fellow townspeople blended into the flee crowd and blew themselves up, killing 12. Boko Haram's use of deception and mixture of tactics in this instance is indicative

of the organization's capacity to experiment with different methods in new and novel ways, increasing the organization's effectiveness a producer of violence.

By analyzing signatures of violence and comparing the similarity between events, it is possible to observe the ways in which tactics and targeting choices are used in combination and how variation in those tactics differ over time. In doing so, one gains valuable insight not only into the types of violent produces that Boko Haram produces as an organization but also how often the group does or does not mix its strategic repertoires.

2.4 The Adaptiveness of Militant Organizations

In this section, I generate and analyze scores for all militant organizations operating on the African Continent from 1997 to 2016 as recorded in the GTD, ACLED, and SCAD datasets. These data all contain textual event descriptions on which the method is applied. I then examine the differences between the adaptiveness of these organizations. The goal is to understand the adaptiveness of militant organizations on average. Do organizations regularly adapt their repertoires of contention or is it more common for organizations to leverage tactical routines, repeatedly employing the same repertoires over time? The question is primarily a descriptive one, which I outline in detail here.

The ACLED, SCAD, and GTD datasets systematically record violent and non-violent activity (in the case of SCAD and ACLED) for all African states.[18] All

[18]For a more detailed review of these data and the data generating process underlying their construction, please refer to (National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2013; Raleigh et al., 2010; Salehyan et al., 2012; Sundberg & Melander, 2013).

three datasets record different types of violent activity: where GTD focuses on terrorism, ACLED and SCAD focus more on civil war and low-level violence. The decision to use these data is two-fold. First, by leveraging these different data sources together, a more complete picture of conflict emerges (Dunford et al. ND). That is, each dataset is inherently error-laden, relying on different source materials and coding rules to determine when an event falls in or out of its coding domain. [19] Using these data together allows for better triangulation of activity by leveraging more than one data generating process simultaneously (Donnay et al., 2018). Second, when examining the changes in contentious repertoires over time, it is vital to consider different types of violent activity. Work on tactical diversification or innovation often focuses on a particular domain, such as terrorism (Horowitz et al., 2017; Wahedi, 2018); however, militant organizations can produce different brands of violence in different domains. As such, it is important to construct a metric that accounts for the full spectrum of potential violent activity.

The temporal coverage of each dataset differs with GTD extending back the farthest (1970s) and the shortest time period in ACLED (1997 onward). Given the start date of the ACLED data, I restrict the sample to 1997 onward. In addition to this, the descriptive accounts in the GTD data are not consistent until around this time (1997-1998) point. Thus, given the method's reliance on event descriptions, the temporal constraint is necessary as these data are more consistent during this time period.

[19] Conceptual ambiguity in coding rules often means that an event can be recorded by more than one dataset (Donnay et al., 2018). For example, a suicide bombing against a military check point may enter GTD as a terrorist event but also ACLED as armed violence. Thus, the data get at mutually occurring concepts more often than not.

To leverage the information contained in the ACLED, SCAD, and GTD datasets, I integrate them using the MELTT protocol (Donnay et al., 2018). Data integration offers a way to leverage disparate data sources in concert by systematically removing duplicative entries. Moreover, it provides a way to triangulate and disambiguate between differing accounts of the same event. When entries from more than one dataset match, I pool the textual account to use the information from the duplicative pairs — capitalizing on the complementary information in alternative but similar accounts.[20]

One additional concern when using these data in concert is that actor lists are not consistent across each dataset. This means that the definition of an armed actor differs in each, which can complicate consistently attributing activity to the same organization when integrating. Moreover, important theoretical covariates lack for organizations that have not been formally defined and studied by conflict researchers. This poses practical data constraints on any analysis. Thus, though a large number of actors exist across these data, I leverage a common actor key to consistently define the same actor in each source.

I leverage the UCDP actor list to consistently define militant organizations in the GTD, ACLED, and SCAD data. The UCDP data has strict inclusion thresholds for both conflict types and actors. The use of the UCDP actor list also carries the added benefit of matching to valuable organization-level covariates.

As there is no established key that consistently maps the different UCDP actors onto the three datasets of interest, I build one manually by leveraging the spatio-

[20]Taxonomy assumption and a review of the integrated data can be found in the appendix.

temporal co-occurrence between entries across event datasets. Specifically, I use UCDP's event data, which records event activity for all actors in its data list. I then calculate the spatio-temporal proximity of these GED events to the events in the other three datasets. I then count the number of times actor names fall into the same spatio-temporal bins and take the actors with the highest associated number of mappings as potential candidates for being the same actor. I then use a mixture of regular expressions and existing crosswalks, such as TORG Asal, Cousins, and Gleditsch (2015), to validate the output.[21] This generates an actor list of 75 UCDP actors that can be consistently identified across the ACLED, GTD, and SCAD integrated data.

With a consistent population of actors identified, I employ the topic modeling method to analyze each group's event history network. I isolate 300 topics of which 134 are dropped due to being irrelevant.[22] Event history networks are then composed for each group, ordering the sequence of events by day and randomly shuffling the order within each day. A 30 event window is then set for backward referencing when generating the cosine similarity scores between the event vec-

[21]TORG only offers a key between UCDP and GTD actors. However, the crosswalk also offers a fairly comprehensive key of different naming conventions for the same actors, which proves useful in defining the scope of potential naming conventions.

[22]Establishing k as 300 was primarily motivated by two reasons. First, the mean coherence score when comparing topic categories to the word2vec model consistently identified 300 as the optimal number of topics, given the input data (see Appendix). Second, I ran multiple topic configurations and inspected the output manually. Though a large number of topics are eventually dropped, reducing the number of topics down from 300 makes each topic noisier. This makes it more difficult to parse out the irrelevancies in the descriptions, while lumping together the more detailed accounts of event activity so that the granular detail is more difficult to parse.

tors.[23] The reported similarity score is then an average of these scores generate along each activated edge.

Figure 2.5 describes the raw similarity scores for each UCDP organization identified in the integrated data. The boxplots summarize the distribution for each group with outlying values displayed as blue points. The entries are ordered by medians with the least adaptive organizations at the top ranging down to the most adaptive. Each point in the distribution represents the average similarity score by day. Recall that the scale ranges from 0 to 1, where distributions closer to 0 imply consistent dissimilarity (adaptive repertoires) while ones closer to 1 imply regularization (routine repertoires). The figure describes the broad degree of variation both within and between different non-state actors. Some organizations appear capable of consistent adaptation and tend to utilize the same repertoires less often, while other groups develop routine repertoires, which they then employ consistently.

One potential concern is that the value of each score is driven by the production rate of each organization. Militant organizations that commit more violence may have a greater opportunity to appear adaptive as there is more data for the metric to compare. To explore this point, Figure 2.6 plots the group average similarity score on the log of the total number of events in the data. In addition, a loess smoother is added to plot to represent trend. First, there is a slight decreasing trend toward groups appearing more adaptive given less event activity.

[23]As with the Boko Haram example, multiple windows are considered regarding the past ties being referenced when generating the similarity scores. I opt for a 30 event window as it is both sensitive to short term shifts but simultaneously capable of accounting for longer similarity trends.

Figure 2.5: Distribution of Event Similarity Scores by Militant Organization

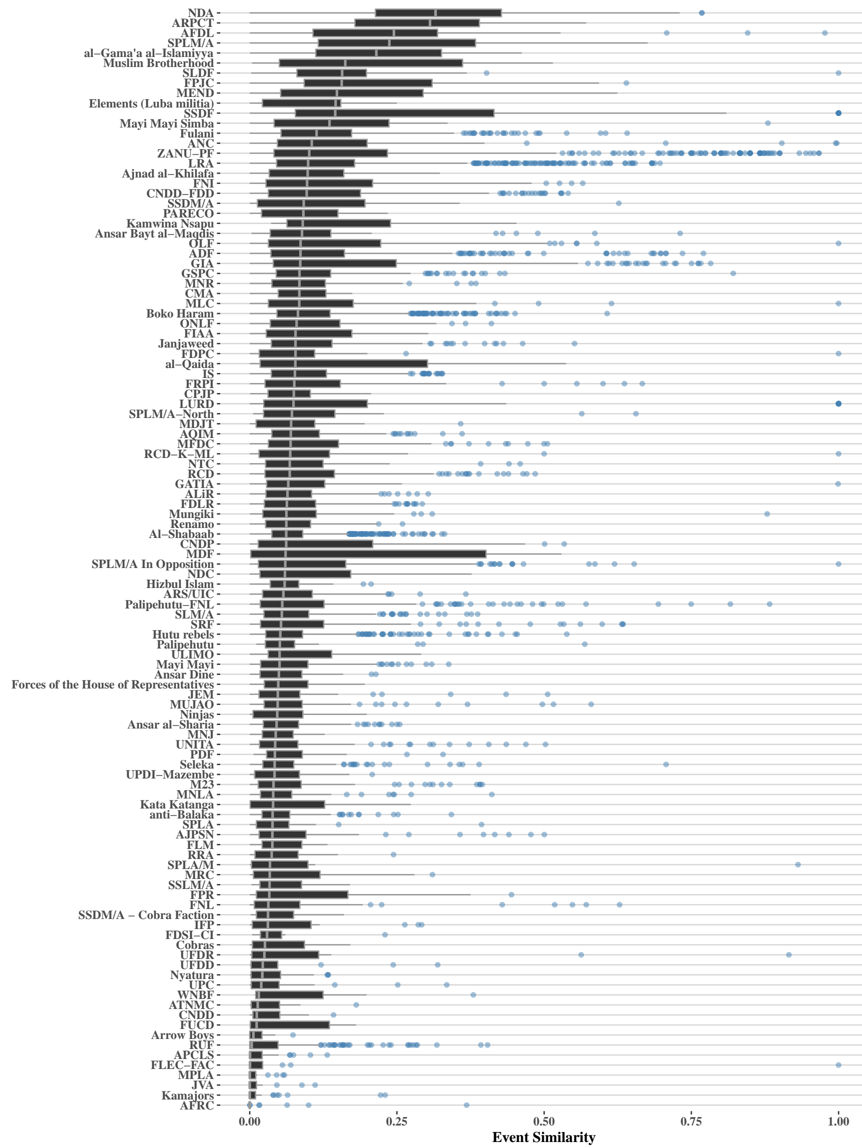


Figure describes the distribution of event similarity scores by militant organization. The box plots display the five number summary of the distribution with the median demarcated by the gray dash in the middle of the box. The blue dots correspond with outlying values. Only militant organizations with 10 or more event entries in the integrated data are reported.

Interestingly this behaves differently than one would expect: groups that produce less events should rely more often on the same methods, as tactical experimentation and adaptiveness are costly (Horowitz et al., 2017). It appears that there

are a mixture of types at the lower end. Ones that are less productive but more adaptive in the activities they carry out, and others that repeat the same types of violence over and over. Second, there appears to be no consistent trend among the more productive organizations. That is, beyond a point, the number of violent events an organization produces is not predictive of how adaptive they will be.

Figure 2.6: Average Event Similarity by Organization on Log Number of Event Entries

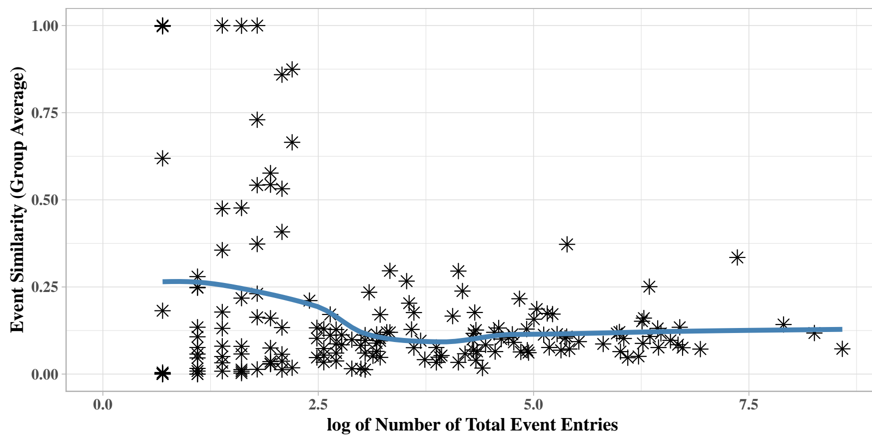


Figure reports the average event similarity score on the log number of event entries by militant organization. The blue line is a loess curve representing the relationship between the data points.

As with the Boko Haram case, the degree of temporal variation in the adaptiveness of militant organizations is likely what matters most. This examination demonstrates that each organization has a different baseline with regard to adaptive behavior; however, adaptation is relative to the events that came before, and groups can appear to mix repertoires at different points in time, even if on average the organization largely relies on routines. In the next section, I explore the empirical relationship between adaptive behavior and positive political outcomes.

2.4.1 Adaptive repertoires and negotiations

Militant organizations minimize the capacity for the state's security apparatus to predict their actions by relying on more than one strategy when waging a challenge against the state. Organizations do this by varying their behavior and strategies (Goetzmann & Kumar, 2008). Being unpredictable yields the dual benefit of increasing the costs of conflict by complicating the state's counter-insurgency operations and efforts (Atran, 2003) while simultaneously increasing the visibility and relevancy of the organizations, as operations have an increased probability of capturing and holding public attention (M. M. Bloom, 2004; Kydd & Walter, 2006). For these reasons, tactical adaptation and differentiation are argued to increase the probability of an organization reaching favorable political outcomes, such as entering into negotiations with the state and/or gaining concessions (Horowitz et al., 2017).

In this section, I examine this central hypothesis in the tactical adaptation and diversification literature — that adaptive organizations are more likely to enter into negotiations with the state and gain concessions. Moreover, I examine whether tactical diversification (i.e. the number of tactics used) contributes to an organization's level of adaptiveness (Horowitz et al., 2017). A dominant hypothesis in the empirical study of conflict is that violent actors seek to minimize exposure to the state's repressive capabilities while maximizing the group's strategic goals given limited resources. The use of mixed strategies are vital to achieving both these ends as reducing the odds that the state anticipates an attack increases the chances of success, the effectiveness of the operation, and the security of the

organization writ large. Considering that organizations are resource constrained and face a capacity disadvantage vis-'a-vis the state, mixing strategies (i.e. adaptation) is a cheap way to increase an militant organization's capabilities. Any measure of adaptiveness should be positively related to likelihood of entering into negotiations with or gaining concessions from the state. As such, I examine the relationship between the similarity metric developed in this paper and negotiations and concessions as a validation strategy.

To examine the relationship between adaptive repertoires and the likelihood of an organization reaching a positive political outcome, I leverage monthly-level data on negotiations and concession for African civil conflict from 1997 to 2010 (J. Thomas, 2014). The data records whether militant organizations enter into negotiations with and/or gains concessions from the state. I use this outcome for multiple reasons. First, the data is disaggregated to the group-country-month, which compliments the degree of temporal granularity of the event similarity metric. Second, the data captures both negotiations and concessions, allowing one to analyze the effect of mixing on different types of outcomes. One would expect the use of adaptive repertoires to increase the likelihood of entering into a negotiations but for that effect to diminish somewhat when looking at concessions. Concessions introduce more actors to the process and thus can be thrown off for a number of reasons that are orthogonal to the adaptiveness of an organization's repertoire (Cunningham 2014). Finally, J. Thomas (2014) collects data on UCDP-defined actors which again allows for consistency in the definition of the organizational unit.

The temporal scope of the design is constrained by the availability of event data. J. Thomas (2014) data extends back to 1989 and goes to 2010; however, as noted, the integrated data used to generate the event similarity score begins in 1997.[24] As such, the temporal scope is constrained to 1997 to 2010. Though not ideal, there is still sufficient variation in the outcome across this time period. Moreover, the temporal granularity of the data itself makes the truncation less problematic.

I adjust the event similarity measure for reasons of interpretation. First, the similarity scores are group standardized in order to make the scores comparable across groups while retaining the relevant information about routine and adaptive spikes in the time series. Second, the score is inverted so that positive values denote adaptive behavior and negative values routine behavior. The score now accounts for the *dis*-similarity in events. I label this variable as "adaptive repertoires," as increases on the scale indicates more adaptive behavior. Finally, the monthly average is taken for each group in order to aggregate the data to the same group-country-level as the outcome variable.

Keeping with J. Thomas (2014), I replicate the model specification in that paper, adding the adaptive repertoire score.[25] I lag the adaptive repertoires score to avoid anachronisms in the relationship. I rely on three of Thomas's positive political outcomes: negotiations, weak concession, and strong concessions. However,

[24]The ACLED data is not available until 1997. Likewise, the descriptive accounts in the GTD data are not consistent until around this time point. Thus, given the method's reliance on the event description, I constrain the temporal scope.

[25]Note that the restriction in temporal scope results in different coefficient values. Most notably the Thomas's key independent variable—a lagged count of successful terrorist attacks—is negative and insignificant, even before including the adaptiveness metric. This is likely due to the reduction in the sample; however, it is interesting given that the effect in that paper likely only persists in subsets of the data structure.

unlike Thomas, I collapse the concession outcomes into binary responses rather than use the raw counts as I am only interested in the occurrence of concessions, not the magnitude.

Table 2.1 reports the finding for the 3 main models from J. Thomas (2014). For details on model specification, please refer to (J. Thomas, 2014). My only addition to Thomas's analysis is the inclusion of the adaptive repertoires metric. In all three models, the adaptiveness of groups is positively and significantly associated with an increased likelihood with both (*a*) entering negotiations with state and (*b*) gaining concessions from the state. Even when considering alternative factors thought to shape the likelihood for rebels to enter into talks and gain concessions, mixing strategies increases the likelihood that an organization will enter into talks and gain something from them.

To explore the substantive effects, Figure 2.7 plots the predicted probabilities of an organization's adaptive repertoires on the probability of entering into negotiations and gaining weak and/or strong concessions from the state. Recall that 0 denotes the mean for the standardized scores and that positive values indicate country-months when an organization's violent productions are more dis-similar, i.e. instances when organizations are mixing repertoires, and negative values are when an organization's productions are more similar, i.e. instances when the groups utilize the same repertoires.[26]

The figure shows that when militant organizations mix up the sequence of contentious repertoires they employ, they are more likely to achieve positive po-

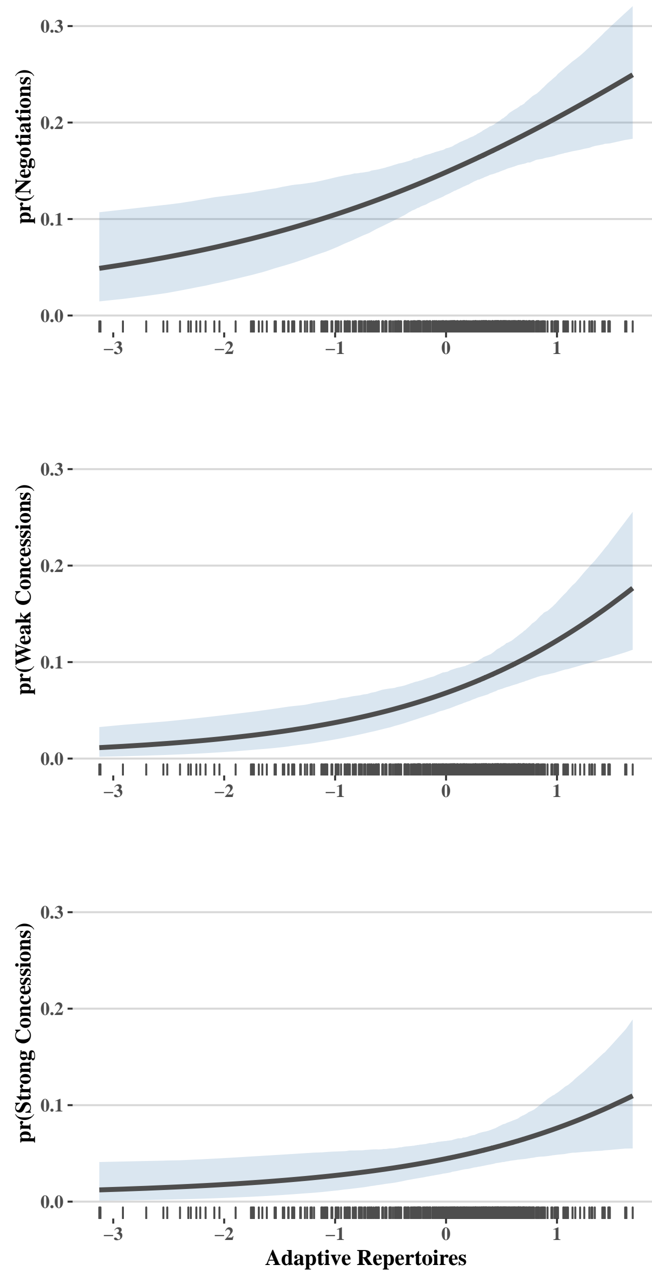
[26]Since the scores are standardized, they are interpreted in terms of standard deviations.

Table 2.1: Adaptive Repertoires on State Negotiations and Concessions

	Negotiations	Weak Concessions	Strong Concessions
	(1)	(2)	(3)
Adaptive Repertoires$_{t-1}$	0.525**	0.751***	0.646*
	(0.206)	(0.257)	(0.337)
Controls (Thomas 2014)			
Number of Successful Terrorist Attacks$_{t-1}$	−0.329	−0.301	−0.304
	(0.339)	(0.283)	(0.386)
Rebel Relative Strength	1.072***	0.602	−0.082
	(0.335)	(0.401)	(0.572)
Main Group	−1.119**	−0.713	−0.881
	(0.484)	(0.588)	(0.677)
Explicit Support	2.457***	0.659*	0.139
	(0.473)	(0.374)	(0.471)
Regime Type	0.076	0.366**	0.473**
	(0.140)	(0.170)	(0.214)
ln(Deaths)	0.158	0.306*	0.579**
	(0.133)	(0.164)	(0.240)
Number of Conflict Episodes	−0.582	0.066	0.743
	(0.491)	(0.540)	(0.753)
Episode Duration	0.001	0.011**	0.008
	(0.003)	(0.005)	(0.006)
Third-Party Mediation	1.960	−17.257***	−19.116***
	(1.602)	(2.531)	(3.554)
Territorial War	2.138***	2.714***	3.065***
	(0.611)	(0.875)	(1.037)
Ethnic War	2.020*	1.140	0.817
	(1.097)	(0.854)	(0.898)
Number of Ethnic Groups	−0.275	0.436	1.706***
	(0.287)	(0.431)	(0.516)
ln(GDP)	0.283	0.410	0.025
	(0.190)	(0.289)	(0.370)
Constant	−14.411***	−18.450***	−12.998
	(4.934)	(6.802)	(8.220)
Observations	610	610	610
Log Likelihood	−184.958	−126.223	−85.899
Akaike Inf. Crit.	399.916	282.446	201.798

Note: *p<0.1; **p<0.05; ***p<0.01
Standard errors are clustered by conflict id.

Figure 2.7: Predicted Probabilities of Adaptive Repertoires on Positive Political Outcomes



litical outcomes. Specifically, when moving from the minimum to the maximum the probability of entering into negotiations in a given month increases by 20%. Likewise, for the concession outcomes, groups are 16% more likely to gain a weak concession and 10% more likely to gain a strong concession when moving from min-

imum to the maximum.[27] Thus, consistent with the literature, the adaptiveness of militant organizations appears to be positively associated with the likelihood of a successful political outcome.

Conflict scholars have argued that adaptive organizations capable of avoiding detection, capturing public attention, and taking their adversaries off guard are more likely to survive and succeed (Kydd & Walter, 2006). I have demonstrated that the measure of tactical adaptation developed here holds with this hypothesis. Interestingly, despite the multiple benefits of mixing repertoires, not all organizations do so consistently or to the same degree. In the next section, I explore whether organizations can deliberately increase how adaptive they are by diversifying tactically.

2.4.2 Testing the assumption that tactical diversification leads to tactical adaptation

The literature on tactical diversification assumes that militant organizations that employ a diverse range of tactics in a given time period are more adaptive than those that rely on a limited set of tactics (Cunningham et al., 2017; Horowitz et al., 2017). That is to say, there is a positive association between the number of different methods a militant organization employs and its capacity to mix strategies. Yet focusing on the set and size of an organization's tactical menu assumes those additional methods are used in diverse ways. Tracking organizational behavior in this manner, however, aggregates away the sequence and dynamics underpinning

[27] The discrete differences in these point values are statistically significant at conventional levels.

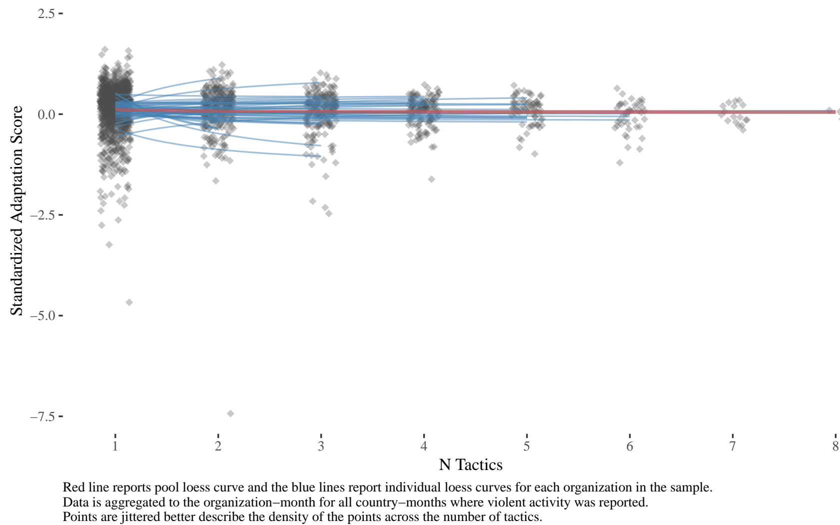
violent productions. In this section, I explore if tactical diversification exhibits the assumed effects on adaptation by examining the relationship between the adaptation metric and the discrete usage of tactics over time (Horowitz et al., 2017). Specifically, I ask: Does tactical diversification—the utilization of an additional tactic or method within a given period—drive tactical adaptation? More importantly, does the number of tactics an organization employs adequately proxy for tactical adaptiveness?

Keeping with Horowitz et al. (2017), I measure tactical diversification as the distinct number of tactic types recorded by the GTD data: (1) armed assault, (2) arson, (3) assassination, (4) hostage taking, (5) facility and infrastructure attacks, (6) suicide bombing,(7) nonsuicide bombing, (8) airline hijacking, and (9) maritime hijacking, and (10) nuclear, biological, chemical, or radiological (NBCR) attacks.[28] I aggregate these data to the country-month, generating a count variable of the number of distinct tactics that a militant organization employs in a given country-month, given at least one violent occurrence during that period. In addition, I no longer constrain the sample size to 2009. Rather, I utilize the entire population of groups mapped to the UCDP actor list from 1997 to 2016.

Figure 2.8 plots the bivariate relationship between the number of tactics (N tactics) and the standardized adaptation score used in Table 2.1. The points denote an organization-month, which have been jittered around the integer count values to offer a better sense of point density; the blue lines are loess curves dis-

[28]Note that I exclude counting coordinated attacks as a tactic as GTD is inconsistent with how they code this variable. Mainly, any calendar date where more than one attack was perpetrated by the same armed actor could plausibly qualify as a coordinated attack; however, the data does not always follow this pattern. Thus, given ambiguity about the inclusion rule, I drop the category.

Figure 2.8: Tactical Diversification on Repertoire Adaptation



aggregated by group; and the solid red line is the loess curve for all values in the sample. Counter to the existing intuition in the literature, there is no discernible relationship between the number of tactics a militant organization employs and its propensity to mix-up its repertoires of contention in a given time period on average. By organization, this flat relationship largely holds minimal divergence in the slope.

To model the relationship between the diversification and adaptation metrics more rigorously, I run three OLS models of which I report the results in Table 2.2. For Models 1 and 2, I estimate the bivariate effect including the log number of events in that given month in model 2. The inclusion of the logged count variable provides important information regarding the activity level of the group. Finally, for model 3, I use group and year fixed effects to constrain the between unit variation, focusing just on the within-year, within-organization temporal variation. Moreover, the fixed effects seek to remove potential omitted variables.

Table 2.2: OLS models of Tactical Diversification on Tactical Adaptation

	Adaptive Repertoires		
	(1)	(2)	(3)
N Tactics	−0.018*	0.017	0.020
	(0.010)	(0.012)	(0.013)
log *N* Events		−0.067***	−0.131***
		(0.013)	(0.020)
Constant	0.128***	0.196***	
	(0.025)	(0.028)	
Group FE	No	No	Yes
Year FE	No	No	Yes
Observations	1,672	1,672	1,672
R^2	0.002	0.018	0.133
Adjusted R^2	0.001	0.017	0.072
Residual Std. Error	0.591 (df = 1670)	0.586 (df = 1669)	0.570 (df = 1561)
F Statistic	3.350* (df = 1; 1670)	15.308*** (df = 2; 1669)	
Note:			*p<0.1; **p<0.05; ***p<0.01

For Model 1 in Table 2.2, the relationship between tactical diversification and the propensity for organizations to mix repertoires in a given month is actually negative. Militant organizations that are more tactically diverse within a given period are *less* likely to mix strategies. This indicates that organizations that diversify in the manner measured by Horowitz et al. (2017) become more predictable rather than less. However, it is difficult to read too far into this effect as it quickly disappears once the logged number of events and the fixed effects are introduced in Models 2 and 3. For these models, there is no statistically distinguishable effect of tactical diversification on the adaptiveness of militant organizations. Interestingly, there is a negative effect between the number of events in a given month and the use of adaptive repertoires. As organizations increase their levels of production, the distinct ways in which those products differ from one another diminishes.[29]

[29] I also ran these results lagging both the *N* tactics and log *N* events metrics; however, the effects are identical and thus not reported.

The lack of a meaningful association between diversification and adaptation is interesting. The literature on the tactical behavior of non-state organizations often leverages these tactical counts to understand when organizations are attempting to differentiate and/or adapt (Cunningham et al., 2017; Horowitz et al., 2017). However, at least from the organizations in this sample, the assumed association cannot be detected. It is important to note that this finding does not invalidate existing theories or empirical work on tactical diversification; rather, it presents a new paradox. Organizations may rationally attempt to expand the set of repertoires that they employ in order to avoid detection by the state and increase the effectiveness of its attacks; however, these efforts rarely if ever appear to accomplish this goal.

This finding presents new theoretical opportunities for conflict research intent on understanding how militant organizations behave and operate. Mainly, organizations may select particular strategies and responses; however, the empirical record shows that a potentially orthogonal process may underpin the micro-level of productions observed in reality. Put differently, the production of violence is delegated down and thus the processes underpinning adaptation likely rest with the design, membership, and organizational features at these levels.

2.5 Conclusion

In this chapter, I demonstrated how one can leverage a militant organization's event history record to analyze the similarity between events in order to understand when organizations do or do not mix their violent repertoires. I then showed

that organizations that mix their violent repertoires are more likely to enter into negotiations with the state and to gain concessions. This finding holds with a dominant assumption in the literature that militant organizations at war with a disproportionately strong state must reduce exposure and increase the effective use of a limited pool of resources. Mixing violent repertoires translates into realizable political outcomes that can increase an organization's odds of success.

I then examined the relationship between tactical diversification and adaptive repertoires. Tactical diversification is used in existing work to proxy for organizational adaptation (Horowitz et al., 2017). However, I found no meaningful association with the number of unique tactics a militant organization utilizes in a given month and its propensity to mix repertoires. This finding points to two realities: first, thinking in terms of the raw usage of a particular tactic or set of tactics often fails to consider the sequence and ordering of these productions. By not considering how repertoires can be used in combination overlooks entire domains of violent organizational behavior.

Second, the findings suggest that the ways in which militant organizations respond to environmental and strategic factors do not consistently translate to reality. Thus, the finding that organizations diversify their tactics in response to external pressure (Horowitz, 2010) and that tactical diversification does not increase the adaptiveness of an organization can live side-by-side. The leadership of a militant organization can enact strategic approaches to increase its perceived best response; however, these responses do not play out to yield the desired effect — at least as currently theorized in the literature. This is likely because the burden

of action and micro-level decision-making are delegated downward, not up. Future work should consider what composing factors of an organization drive the adaptive processes of organizations by examining in greater detail how information, abilities, and authority are distributed among militant organizations.

Chapter 3

The constraints and drivers of tactical adaptation and innovation in violent non-state organizations

Under what conditions should we expect violent non-state organizations to adapt and innovate? Chapter 2 outlined a strategy for quantifying adaptive behavior and demonstrated that organizations that vary their tactical repertoires are more likely to enter into negotiations with and gain concession from the state. In this chapter, I survey the literature on the factors that underpin theories on tactical innovation, adaptation, and diversification in violent organizations. In doing so, I outline a stark gap in the literature on tactics: that is, little if any weight is

placed on the internal dynamics of violent organizations. The chapter aims to set up the theoretical discussion that follows.

Existing explanations on rebel tactics and strategy can be broadly viewed in terms of the "constraints" and "drivers" that emerge externally or internally to the organization. Table 3.1 summarizes the prominent debates in the literature as a two-by-two table. Past research has focused extensively on the *external* factors that influence innovation (and organizational behavior more broadly); however, less attention has been paid to the internal components. Specifically, little is understood about the internal mechanisms that likely increase or diminish an organization's adaptive capacity. This gap in the literature is problematic as it offers little guidance regarding why we observe such differences in level of tactical adaptation by groups situated in similar contexts. The section sets up the theoretical discussion regarding membership diversity as a primary internal driver for adaptation and innovation within violent non-state organizations.

Table 3.1: Innovation and Adaptation within Violent Non-State Organizations

	Constraints	**Drivers**
External	Domestic Support International Approval	Organizational Survival Degree of Competition Network Ties Carriers (foreign fighters)
Internal	Resources Organizational Structure Bureaucratization	Leadership?

3.1 External Constraints & Drivers

Violent non-state organizations continually shape and are shaped by their external environment, especially when groups rely on the local environment for support and resources. Research has shown that violent non-state actors that rely on civilian communities for support and resources are less likely to abuse non-combatant populations (Weinstein, 2006), roam (Beardsley, Gleditsch, & Lo, 2015), and adopt tactical methods that are not locally popular (Bakke, 2014; Polo & Gleditsch, 2016; Stanton, 2013). The idea is that local factors can constrain an organization's potential range of violent production: organizations are less willing/able to adopt approaches that could disrupt relations with their base. Bakke (2014) makes this point explicitly when examining the role foreign fighters played in the introduction of suicide tactics in the Chechen conflict. She argues that local acceptance shapes whether ideas imported by foreign fighters are adopted. Likewise, S. Kalyvas and Sánchez-Cuenca (2005) argue that a group's likelihood of adopting and using suicide tactics is convexly related to public support. Groups that are disconnected from a local base are more likely to use suicide methods, but as reliance increases, the likelihood diminishes as concerns over angering the local population grows.

Similar to domestic audiences, violent organizations can also be constrained by international ones. Stanton (2016) argues that international legal standards can shape violent organizations' decisions to target civilian populations. Reliance on international approval or advocacy to achieve their goals (e.g. Keck and Sikkink 2014) constrains the types of violent repertoires groups develop, biasing organizations against employing specific methodological domains (e.g. terrorism). This

implies that groups organized around goals that require international support (e.g. secessionist movements) are generally more sensitive to how events are interpreted by international audiences.

These arguments highlight the constraints reliance on domestic or international populations place on an organization; however, in doing so, they overlook potential organization-level factors that also influence and shape adaptation (Horowitz, 2010). Focusing on the contextual constraints are vital when comparing organizations across different contexts, yet such considerations are limited in their capacity to address variations among groups located *within* similar contexts.

Broadly speaking, the majority of work on innovation and adaptation in violent organizations is centered on the external *drivers* that motivate such behavior. The most important driver for tactical adaptation is survival. In large part, the ability to wage an effective campaign against the state—one that both garners attention, demonstrates power, and draws support—is seen as a necessary condition for organizational survival and success (Blomberg, Engel, & Sawyer, 2010). Violent organizations have incentives to operate in ways that avoid detection and effective targeting (Beardsley et al., 2015; Parkinson, 2013).[1] Likewise, the state seeks out ways to undermine a violent organization's efforts through its own process of adaptation and innovation (Dugan, LaFree, & Piquero, 2005; Wilkinson & Jenkins, 2013). Thus, violent organizations and the state engage in "tactical in-

[1]If the capacity for an organization to survive is dependent on its ability to register, respond to, and adapt to start-up costs and challenges, then merely observing these organizations is evidence of some capacity to innovate and adapt. Organizations that fundamentally cannot adapt are likely not observed.

teractions" that are marked by adaptations and counter-adaptations, which affect both the pace and outcome of a campaign (McAdam, 1983, 736).

Though a necessary condition for survival, a dominant concern is that adaptation and diversification open a violent organization up to new vulnerabilities and risks. Horowitz et al. (2017) note that "diversification requires organizations to take a risk by spending resources on uncertain outcomes, and it can prove unsuccessful and needlessly costly if the new approach is never fully mastered. This suggests that organizations face competing incentives: to stick to the status quo, utilizing existing approaches they have mastered, or to branch out towards uncertain, though potentially rewarding, new abilities" (4-5). Thus, according to Horowitz et al., organizations should only be expected to diversify when external conditions generate sufficient incentives to justify the incursion of greater risk. The idea is that the need to adapt is variable and groups should only switch up what they do when there exists competitive pressures to do so.

However, this line of thinking is limited in two ways. First, the assumption that groups can perpetually recycle the same methodologies and retain a position of political relevance or military threat runs counter to most thinking on social movements and political violence. Groups must adapt and innovate to retain relevance and capture the public's attention (M. Bloom, 2005; Tarrow, 2011).[2] Moreover, the ability for the state to anticipate an violent challenger's behavior increases its capacity to target them (Beardsley et al., 2015; Toft & Zhukov, 2015).

[2]In addition, see work which argues that violence can be leveraged as a propaganda tools (Martha, 2011), a means of provoking the government (Kydd & Walter, 2006), and/or a way to outbid and brand when there are many competitors (M. Bloom, 2005). Also, see Fortna (2015) regarding potential issues with these arguments.

Thus, there is more at stake than merely the risks associated with implementing new tactics. Organizations that seek to challenge the state are only as powerful as they are relevant and elusive. Tactical redundancies, or "doing what one knows," may be less risky in the short term, but in the long term, such organizations are doomed to fail as the state hones in, the public loses interest, and more adaptive competitors emerge and win out.

Second, this work tends to think about product innovations in rather broad terms, assuming that groups enter into new domains in which they are not familiar when making these kinds of adaptations. For example, the Red Army Faction in Japan attempted to broaden its tactical repertoire and failed spectacularly when the group branched out into the world airline hijackings.[3] It was a costly and ultimately detrimental exercise for the group. However, the majority of product innovations among violent non-state organizations occur incrementally. Experimentation is more about identifying new ways and scenarios in which a method can be altered or employed, rather than trying to implement an entirely new method. Ultimately, focusing on the risks associated with adaptation and diversification is misplaced as it fails to consider the underlying conditions that underpin organizational survival (i.e. that adaptive pressures are constant) and the ways organizations are adapting (i.e. more incremental than radical).

Another key external driver of tactical innovation is information transfers via affiliation networks—which ties prominently to discussions regarding the diffusion

[3]The Red Army Faction's attempt at an airline hijacking failed when the assailants chose a plane too small to take them to their destination, resulting in landing the plane in North Korea where the hijackers were arrested and eventually died in prison (anecdote drawn from Wahedi 2018).

of conflict (Buhaug & Gleditsch, 2006; Danneman & Ritter, 2014; Jervis & Snyder, 1991). The logic is that alliance and affiliations between groups facilitate the direct passage of information regarding tactical methods, technologies, and forms of disruption (Acosta & Childs, 2013; Asal & Rethemeyer, 2008; Horowitz, 2010; Wahedi, 2018).[4] Likewise, the movement of experienced fighters and personnel from one conflict to another can facilitate the transfer of information and ideas (Bakke, 2014; Beardsley, 2011). It is important to note, however, that most work in this arena is not focused on why groups innovate but rather when and how groups *adopt* new methods. Information transfers via network affiliations or the experiences of foreign fighters should be viewed as another contextual condition rather than a root driver. The presence of these networks does well to explain variation in tactics between groups with access to different forms of information; however, it offers little explanatory insight regarding the differences in adaptive capabilities among groups that share similar affiliations.

Understanding the external constraints and drivers that shape organizational adaptation and innovation is insightful; however, most of this work boils down to specific contextual conditions that either increase or decrease the likelihood of tactical adaptation and experimentation. Assumed here is the notion that all organizations are equally capable of adapting and that it is largely the external conditions that shape when and how such adaptations occur. However, anecdotal

[4]Some researchers, like Linebarger (2016), note that potential rebels learn from the activities and outcomes of ongoing rebellions situated in similar domestic conditions, informing their decision to rebel. While this is an important factor when considering the spread of violence, it is less insightful for understanding tactical diffusion as the information learned concerns the state's response and the observed rebel group's underlying likelihood of success, not specifically the range of methods that they employ. For that, work by Wahedi (2018) offers better guidance as she notes that tactical emulation without direct information is rare and difficult.

evidence would direct us to question this assumption. Groups like Boko Haram and Abu Sayyaf are situated in similar contexts—broadly speaking—and yet both groups differ in the degree to which they experiment with similar methods. To understand these *within*-context differences, one needs to consider the internal conditions and drivers that motivate innovative behavior in organizations.

3.2 Internal Constraints & Drivers

The internal conditions that shape an organization's innovative capacity can also be understood in terms of constraints and drivers; yet there are limitations to what we know about this internal process. This section highlights how work on resource mobilization and organizational structure provide a framework to analyze the potential constraints, but little is known about the internal drivers of innovation and the group-level factors that promote or hinder its emergence.

The most prominent internal constraint faced by violent non-state organizations concerns resources. Resources shape how non-state organizations mobilize (McCarthy & Zald, 1977), recruit (Gates, 2002; Gates & Nordas, 2010; Weinstein, 2006), bargain (Nygrd & Weintraub, 2015), and compete (Wood & Kathman, 2015). Resource constraints have been shown to broadly influence an organization's use of violent methods—specifically regarding the use of armed assaults and explosives (Koehler-Derrick & Milton, 2017). Likewise, in the domain of non-violent resistance, resource constraints are argued to directly shape the types of non-violent tactics groups select (Cunningham et al., 2017). The reality is that like most firms, violent non-state organizations cannot implement methodologies

that extend beyond their resource capabilities.[5] In addition, access to resources can impact an organization's behavior in ways that influence the types of targets selected (Weinstein, 2006).

This line of work implies that resource constraints feature prominently in both the methods organizations employ and the targets they select. However, such explanations offer little guidance on why some organizations are more or less tactically adaptive than others given access to similar sources of funding, recruit flows, and opportunities. This work directs researchers to consider the supply chain that underpins violent productions, not necessarily the conditions that promote adaptations and innovations among those products. Moreover, it is difficult to say what effect resources should have on an organization's capacity to innovate. On one hand, the lack of resources should limit what an organization can do, hindering the ways it can adapt; however, on the other hand, resource constraints may force organizations to devise ways to do more with less, prompting creative productions that can effectively garner attention on the cheap.

In a similar vein, the structure of an organization can act as an internal constraint on an organization's adaptive and innovative capacity. From a structural perspective, centralization likely contributes to a group's capacity to implement new tactical approaches. A hierarchical organizational structure is shown to increase the lethality of an organization (Heger, Jung, & Wong, 2012). A central structure likely also factors into an organization's capacity to translate an idea into a product, indicating that implementation is central to any assessment of

[5]For example, the use of a nuclear weapon to achieve some organizational goal can be conceived of and planned for; however, the ability to actually carry out the attack is dependent on the organization's *possession* of the bomb.

innovative capacity (Gill, Horgan, Hunter, & D. Cushenbery, 2013). The capacity to implement and coordinate should indicate that more hierarchical/centralized organizations should be more innovative, and yet organizations that bureaucratize appear to innovate and experiment *less* often. Horowitz (2010) points to the main culprit to this apparent puzzle: specialization. He argues that as violent organizations age, their members get good at producing certain types of violent productions and derive value and status from such expertise. This incentivizes members with expertise to veto new ideas in favor for their preferred method, reducing the likelihood of innovation.[6]

Conflict research has largely focused on the internal constraints organizations face when challenging the state, yet few studies focus on the internal mechanisms that drive tactical adaptation within an organization. This is for good reason: peeking inside a violent organization to understand the decision-making and idea generation process is difficult, if not impossible. As Gill et al. (2013) note, "for an innovation to occur, it must first go through a creative process from idea generation through to full implementation. The transition from a creative idea to an innovative product (in this case a terrorist attack) is the key process to understand," and yet "the ability to predict and anticipate the onset of creativity within a terrorist organization is almost impossible" (130-1). Put differently, adaptation and innovation are in the error term — it is precisely the deviation from the known pattern that marks its occurrence. For this reason, it makes sense that the innovation literature remains primarily focused on the factors that influence

[6]Citing business management and military literature, Horowitz (2010) argues that the organizational capital of a group—i.e. the trend toward bureaucratization and specialization —results in a *reduction* in the likelihood of adopting suicide bombing techniques.

implementation by highlighting the constraints and external drivers. That said, it is important to think about the potential sources of idea generation within an organization and to consider the conditions that drive such behavior. Specifically, the ways in which information is utilized to draw new insights may have common features that generalize across violent non-state organizations.

An obvious starting place would be to consider an organization's leadership as a key source of innovation and adaptation within a violent organization. Leadership decapitation (i.e. the killing of rebel leaders) reduces an organization's level of activity and its odds of winning a conflict (P. B. Johnston, 2012).[7]. Likewise, removing leaders appears to increase the level of indiscriminate violence by an organization (Abrahms & Potter, 2015). This indicates that effective leadership is central to the strategic coordination of violent activity. Without such leadership, organizational performance suffers and the likelihood of survival diminishes.

However, equating good leadership with innovation assumes that leaders are the primary source of novel ideas in an organization. Such an assumption is problematic for two reasons. First, doing so downplays the sheer volume of problems these organizations face on a recurrent basis. If a leader is the architect of all product innovations and adaptations, then one should expect *less* adaptation as the number of problems increase. The logic is that an individual's capacity to problem solve is finite, and as the number of problems increase, leaders are inevitably overwhelmed. The obvious solution then is to delegate. However, delegation shifts

[7] The effect of decapitation on war termination is mixed. See Jordan (2009, 2014); Price (2012) for alternative explanations that claim the policy has no effect. However, only P. B. Johnston (2012) has an empirical design capable of tracking this effect (Shapiro, 2012)

the potential source of innovation from one to many — prompting one to focus on members and the delegation process rather than leaders *per se*.[8]

Second, focusing on leadership as a source of innovation downplays the importance of the principal-agent problems that complicate implementation (Shapiro, 2013). A manager's capacity to implement an idea is dependent on his or her ability to monitor the agent. The agent's capacity to deviate from the principal's orders increases as the ability to monitor the agent's behavior decreases. Likewise, as information passes hands it can be interpreted differently or ignored entirely. Thus, to say that the driver of incremental innovation is a function of an organization's leadership is to assume a level of monitoring and control that leaders of violent non-state organizations likely lack, especially given the geographies in which these conflicts play out and the security dilemmas that complicate monitoring (P. Johnston, 2008; Shapiro, 2013). If the leader is unable to perfectly monitor the agent, then experimentation and innovation likely emerge from this process of "interpreting" orders. Again, it is useful to consider the ways individual members encounter orders and problems, especially when agents are capable of deviating.

It is important to emphasize that competent leadership is vital in most organizational settings. Leaders and their commanders are the primary directors of any violent non-state organization's efforts (Abrahms & Potter, 2015). However, a leader-centric focus regarding the drivers of adaptation and innovation in an organization assumes that violent leaders resemble CEOs in firms. Grafting business

[8]Alternatively, one could argue that leaders do not deal with all problems, just the important ones. The expectation would be that leaders are responsible for larger more elaborate productions—that is, leaders are likely vital to the development and implementation of *radical* innovations. However, this logic is limited in its capacity to explain incremental innovations.

management concepts onto violent contexts is not new (Haer, Banholzer, & Ertl, 2011), yet the exercise tends to downplay the risks and security challenges associated with production within these particular organizational settings. Moreover, for business management theories to hold, one needs to make strict assumptions about institutions, decision-making processes, and the delegation of authority. Such assumptions might be warranted in some instances, yet broadly speaking, they tend to overlook an important reality: violent organizations are all start-ups. They are organizations "working to solve a problem where the solution is not obvious and success is not guaranteed."[9] Put differently, violent organizations are building and institutionalizing on the fly. Assuming that these organizations behave similarly to large corporations (or even a formal military) emphasizes an established structure and model while undervaluing the prominent stochastic and dynamic realities to influence their operations.

To understand the conditions that might make organizations adapt and innovative, one needs to better consider the organizational environment in which such innovations can potentially emerge. In many ways, one can think of violent non-state organizations as being equivalent to firms. Alternatively, one could be agnostic about the inner process and design of these types of organizations. After all, these are organizational settings where institutions are in flux, the decision-making processes may or may not be clear, participation is constantly shifting, and preferences are discovered as organizations struggle to survive, recruit, and remain relevant. As the next section argues, to best understand the environmental

[9]Quote from Neil Blumenthal, cofounder and co-CEO of Warby Parker, on what a start-up is in Forbes (Robehmed, 2013).

setting that promotes experimentation and adaptation, we need to consider how information potentially moves through an organization and the ways in which members interact with that information.

Chapter 4

A theory of membership diversity and tactical adaptation

4.1 Thinking of violent organizations as "Garbage Cans"

How does information move through an violent non-state organization? Where does information regarding an organization's problems enter? Who might come in contact with it? How are solutions found to resolve those problems?

To answer these questions, one could assume that all information 'trickles down' in an organization. Leaders acknowledge that a problem is a problem. They delegate. Their subordinates delegate further until orders are issued, actions are performed, and problems are resolved. However, there are many hiccups that can occur along the way. Commanders may monitor to ensure their orders are carried out but do so imperfectly (Shapiro, 2013). In addition, commander oversight may

take the form of fire-alarms (i.e. waiting for infractions to be reported by others) rather than costly policing practices (i.e. seeing infractions out) (McCubbins & Schwartz, 1984). Members may deviate from what they were ordered to do when their interests fail to align or when they prefer an alternative way of performing the task (Gates, 2002). Subordinates may wish to undermine the manager who issued an order. The order itself might be misinterpreted. Or in a moment of insight, a member might see a better solution. In short, there are many opportunities for deviation as an idea is implemented into a reality.

One could easily complicated this top-down view of organizational decision-making by thinking of a violent organization as a large sensor where each and every member operates as an independent data collecting node. In this setup, individual members interact with the environment, gather information, and discover problems. These problems can range from the trivial to the profound. Members pass this information up or down, but commanders might have an incentive to keep it secret or hold off on its release. They might misinterpret it. They might devalue their subordinate's (or superior's) evaluation of it. A member might see a solution to the problem and seek to resolve it on his or her own to curry favor, gain a promotion, or to survive. The point being: problems—both real and imagined—can enter an organization at any level. If data collection is a collective process, then the way information moves and how organizations make decisions is subject to an array of random internal and external factors that might influence how that problem is resolved.

Both the "top-down" and "all-sides" decision-making models are plausible, yet they both share an important random feature. In the former, randomness is introduced in the delegation of tasks. In the latter, it is the main feature of the system: problems are pushed (or not pushed) up or down for a multitude of reasons that may be entirely independent of the problem itself. What is interesting to note is that the top-down model is a special case of the all-sides one: the only difference being that the top-down model makes assumptions about *where* information enters and *how* it moves. The all-sides interpretation, on the other hand, remains agnostic about where and how information moves. Instead, it emphasizes that the movement of information in an organization follows a random process and by considering this process one can begin to understand something important about decision-making in a collective system.

Organizational environments where information flows and decision-making outcomes follow a random process are better known in organizational theory as "organized anarchies." M. D. Cohen, March, and Olsen (1972) first introduced the concept when describing their Garbage Can Model of Organizational Choice (hereafter, GCM) as a way of modeling decision-making in universities. The model explores the interaction of participants, problems, solutions, and opportunities within an organization where participation is fluid (the attention participants dedicate to any one problem is highly variable), decision-making technology is unclear (the causal process underpinning how decisions are made is vague), and preferences are problematic (preferences are discovered over time rather than being perfectly predefined at the onset) (M. D. Cohen et al., 1972; Fioretti & Lomi,

2008, 2010). Within such an organization, solutions, problems, participants, and decision-making opportunities are seen as independent and exogenous of one other. As M. D. Cohen et al. (1972) put it: the organization is a "collection of choices looking for problems, issues and feelings looking for decision situations in which they might be aired, solutions looking for issues to which they might be the answer, and decision makers looking for work" (2).

The GCM is a useful theoretical starting point when conceptualizing how information moves within organizations marked by high uncertainty, fluid participation, and imperfect communication technology. The model treats problems, solutions, members, and decision-making opportunities (e.g. meetings) as random independent features that are destined to collide. It is in these random collisions that problems are resolved. The basic idea is that all elements of organizational decision making are present but the pathway in which they meet is unpredictable.[1]

In applying the GCM to violent organizations, I assume that rebel groups are not unitary actors, and that the responses from which a group has to select from in addressing any given problem is dependent on an internal organizational ecology. As Fioretti and Lomi (2008) notes, the GCM "neither reduces organizational decisions to the decisions of individual participants, nor treats organizations as aggregate unitary collective actors endowed with preferences and clearly specified objectives" (194). Past research on violent organizations points to the difficul-

[1]Randomness may creep into an organization in a number of ways. For example, orders could be issued to a battalion that is suddenly wiped out by state security forces, requiring a leader to unexpectedly delegate the task to another battalion. Fighters may come across a previously unknown problem while on patrol. The commander could be suddenly killed, prompting fighters under his/her control to be reallocated to new outposts. Weather conditions may force a meeting to be delayed. These are all just stylized examples, but they point to how organizations operating within wartime environments can be shaped by exogenous circumstances.

ties underpinning the unitary actor and complete rationality assumptions when theorizing about rebel organizations (Cunningham, Bakke, & Seymour, 2012; Seymour, Bakke, & Cunningham, 2016). By treating the decision-making process as a GCM, I merely assume that an optimal strategy is often impeded by an internal process that is completely independent of the problems the solution seeks to address. The underlying implication of the GCM is that the decisions organizations make and the strategies they pursue can manifest in multiple ways.[2]

By thinking carefully about how information moves in an organization, one can gain important insights regarding the factors that potentially shape the innovative process. With that said, thinking about decision-making as a purely random process where each component is entirely independent is limited in two ways. First, it assumes that solutions are independent from an organization's membership. This prevents the model from considering *where* and *how* solutions potentially emerge internally. Fioretti and Lomi (2010) note that this aspect of the GCM marks a clear departure from rational choice theory in that it assumes "solutions are schemes that decision-makers apply to any problem they meet rather than specific responses to specific problems" (115). However, for solutions to be derived independently of an organization's membership implies that no new solutions can emerge from the interaction of participants and problems over time. In essence, members (and the organization in general) cannot learn from the past or discover

[2] In large part, the GCM is concerned with how often organizational decisions actually address problems rather than simply legitimizing the organization's existence. The original model focuses on three types of outcomes: decisions by resolution (where a problem is addressed by a solution), decisions by oversight (where no problem is addressed but a decision is made to legitimize the organization), and flight (where no decision is made and the problem persists) (M. D. Cohen et al., 1972). This line of work focuses on the types of organizational structures that increase the number of problems an organization is capable of resolving (Fioretti & Lomi, 2008, 2010).

new solutions when resolving problems. Second, doing so largely treats members as independent from one another—implying that members do not learn from each other. This overlooks the reality that members can draw information and insights from each other, and that this interaction can feedback into how members resolve future problems.

Building off these limitations, I advance a variation of the GCM that: (*a*) considers the potential sources of solutions in an organization by endogenizing their emergence and (*b*) introduces a learning concept where members learn through interacting with other members. In doing so, I show first that when solutions emerge endogenously within an organization, the past experiences and knowledge of participants is central to how different types of problems are handled. As a result, the more diverse an organization's membership is, the larger the pool of potential solutions from which it has to draw. Second, I show that the past matters. Members learn as they engage in problem-solving and are altered by the exchange. Thus, rather than considering the GCM as a purely random process where each collision is divorced from those that came before it, I fold in information learned in past steps.

This variation of the model offers a framework to think about the role membership and collective knowledge can have on how an organization processes information and the effect this has on an organization's innovative capacity. Specifically, I emphasize the types of information individual members bring with them when joining an organization and the role different types of information can have in shaping the types of solutions an organization advances.

The next section will delve into these two theoretical mechanisms. I will then consider the implications of both on an organization's capacity to innovate.

4.2 Membership Diversity and the Endogenous Emergence of Solution Sets

This section focuses on the composition of an organization's membership, and the sources of knowledge and experience they bring with them. The argument is that the level of diversity in an organization's membership can impact the kinds of responses and strategies the group is capable of producing. In this setup, solutions do not emerge exogenously in an organization but endogenously when members of the organization encounter problems. As a results, the pool of knowledge upon which an organization draws is entirely dependent on the sum of experiences, knowledge, and background of its membership.

A rebel group (R)—like most organizations—is composed of a set of members $M_R = \{m_1, m_2, ..., m_n\}$ that make up its human labor. Rebel groups are labor-intensive organizations functionally dependent on human capital. Without members, the organization ceases to be. When recruited into a violent rebel organization, individual members inherently bring with them past ideas, experiences, and knowledge. These priors inform how that individual member responds and adjusts to new circumstances. Rebel organizations—inadvertently or intentionally—draw on these experiences when formulating solutions to the array of problems the organization faces across its lifetime. This is to say that idea formation is inter-

nally generated, and that as individual members encounter problems, they draw from what they *know* when devising a solution to it.

This assumes that each individual member (m_i) has some pool of past knowledge and experiences from which he or she draws from when dealing with problems. This distribution of information defines the scope and likelihood of the types of solutions that m_i comes up with. In other words, an individual member cannot know anything he or she has never experienced or learned. Thus, any solutions that the *ith* member is capable of producing depends on this past distribution of experience:

$$\kappa(m_i) \sim K_{m_i}$$

where $\kappa(m_i)$ denotes the solution the *ith* member draws given his or her past knowledge and experiences, K_{m_i}.

I argue that individual members who come from a similar background and makeup (e.g. ethnicity, geography, gender, etc.) will on average draw from a similar pool of knowledge and experiences when generating ideas. Exposure to similar places, people, and events are assumed to shape individuals somewhat differently, but there exists an underlying commonality that makes those individuals more similar than individuals who were not exposed to those forms of stimuli. By contrast, individuals who come from different backgrounds draw from different sets of experiences and knowledge when generating ideas. These differences alter how those individuals view the world. The central assertion is that the greater

the difference in the makeup of members, the more diverse the pool of common experiences shared between them.

Put differently, if each member draws from his or her past when formulating a solution, then the differences between knowledge distributions located within a collective will matter when determining the potential distribution of responses. For example, assuming two individuals from similar walks of life take a draw from distribution K_1, and two other individuals from a different background take a draw from distribution K_2, then the variation among the solutions that emerge will increase as $|E[K_1] - E[K_2]|$ increases. That is to say, as the differences in experiences between the two backgrounds increase, the more varied the solutions will be.

Put formally, problems that emerge in an organization (ϕ) are assumed to be exogenous and independent of any other actor. As such, problems are introduced at random points in the organization (e.g. bottom, middle, or top) and each problem has some latent level of difficulty to it. If a problem is denoted by its difficulty, then each solution is judged based on its capacity to address that problem. A plausible response or strategy (θ_{ij}) is then defined as the solution the ith member produces for the jth problem ϕ_j, where $\theta_{ij} = |\phi_j - \kappa(m_i)|$. When multiple members encounter the problem simultaneously, a set of potential responses (Θ) emerge as each individual member devises a response given his or her past experience. The optimal solution (or 'best response') is then any response of all possible responses (Θ) that best addresses the problem.

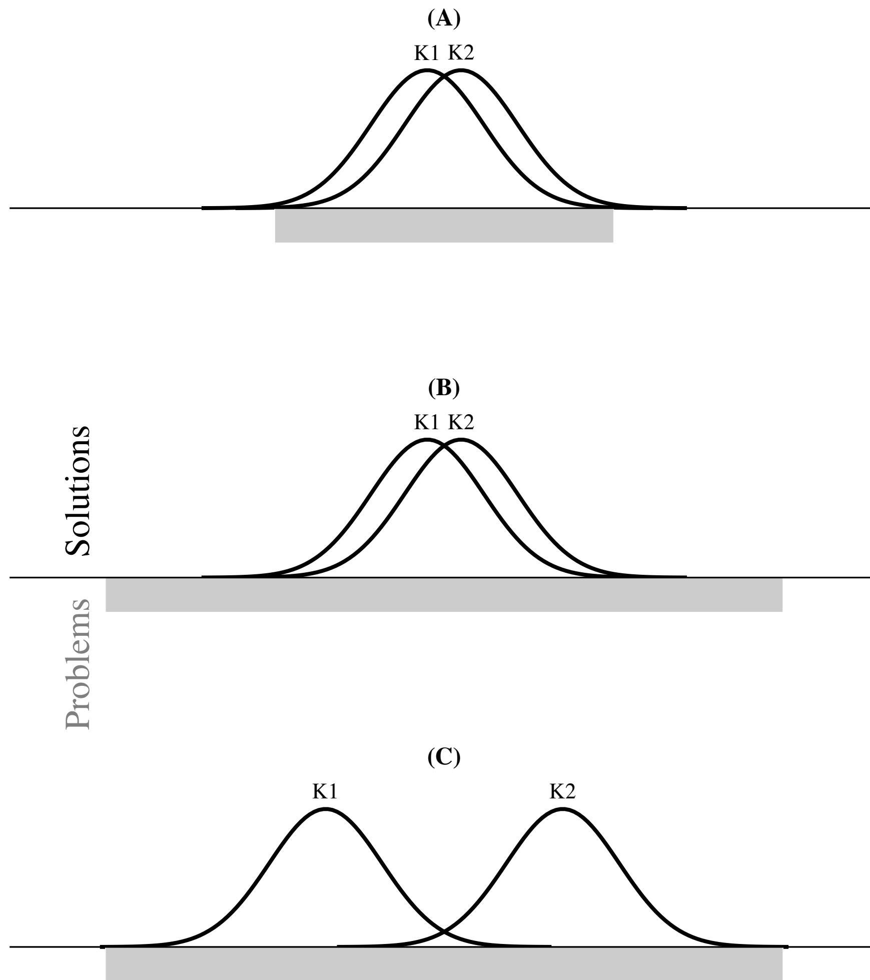
$$\theta_j^* = \min \theta_{ij} \in \Theta \tag{4.1}$$

where the optimal response (θ_j^*) is the one that is best able to address the difficulty of the jth problem given all *available* responses (Θ).

Figure 4.1 offers a stylized illustration of the process at hand. The gray bar represents the range of problems an organization faces. Problems are uniformly distributed, meaning that any level of difficulty is equally likely. The black lines represent the latent distribution from which members from background K_1 and K_2 draw from when encountering a problem and formulating a solution. As depicted, when the range of potential problems the organization faces is limited in scope (see panel A), the lack of differences in the composition and background of individual members is less of an issue, as the common pool of experience is adequate in addressing the range of problems the organization faces. However, as the range of potential problems increases (i.e. problems become more difficult, unique, and/or new), the similarities between members become a handicap as the organization consistently develops sub-optimal responses for any problem that occurs outside its common pool of knowledge (see panel B). This is where diversity in composition and background begins to matter. As a more diverse set of backgrounds and knowledge are folded into the organization, the greater the common pool of knowledge from which the organization has to draw (see panel C).

In sum, the individual experiences and knowledge of an organization's membership forms a common pool of knowledge that an organization taps when making decisions, adjusting to environmental shifts, developing strategy, and responding

Figure 4.1: Illustrative example of potential problems and latent knowledge pools



The range of potential problems are represented by the gray uniform distributions. The latent distributions of potential solutions, K_1 and K_2, represent two past experience and knowledge profiles that members from each respective background draw upon. Panel A represents when these profiles overlap and generally addresses the potential range of problems the organization faces. Panel B outlines a scenario where the potential set of problems exceeds the common knowledge shared between the two profiles. Panel C represents when the knowledge profiles diverge. As a result, each profile is uniquely adept at resolving particular ranges of problems.

to crises. This common pool of knowledge plays a vital role in determining the kinds of ideas that emerge within the organization. With that said, it is important to note that the common pool of knowledge is latent and that solutions only emerge *as individual members encounter problems* and advance solutions. Thus, the emergence of an optimal response to any problem depends on the likelihood that a member with the right background will encounter the problem, draw the right solution, and encounter an opportunity to advance it.

The following theoretical set up thinks critically about how information moves within an organization. Solutions are dependent on membership. Solutions emerge when individuals come in contact and interact with the organization's problems; yet the quality of response generated is highly dependent on that member's past experiences and knowledge. By tying the solution to participants, solutions have a plausible and important source. The ability for a solution to address a specific problem, then, is highly dependent on the knowledge pool and background of its membership (i.e. K_{m_i}). This has an important implication for the quality of the ideas that can emerge within an organization. If the types of problems the organization faces are similar and consistent, then the need to generate a variety of potential solutions is reduced, as the entire range of problems will fall in a common interval. But as the types of problems the organization faces expands, the need for a broader range of potential solutions increases.

The main implication of the argument is that organizations with a more diverse labor force will possess a higher underlying innovative capacity than organizations with a homogeneous group of members. When an organization's problems are

capable of interacting with a diverse array of viewpoints, the probability that an innovative solution will be drawn, aired, and implemented increases. The main mechanism by which this process plays out depends on the repeated, random interaction of members with problems. As members are more readily exposed to the organization's problems, the likelihood that an individual with the right solution will encounter the right problem increases—but only when that membership pool is sufficiently diverse.

4.3 Learning over time: membership diversity and repeated interactions

This section argues that membership diversity can have a long-run positive effect on an organization's innovative capacity as individual members learn from one another. This is to say that participation in an organization is an experience unto itself, and as members participate with and observe other members, they learn from those interactions. I argue that as members are exposed to new types of information, the likelihood of novel ideas emerging is magnified as diverse forms of knowledge converge through a process of endogenous learning. Members with long time horizons in the organization—that is, members who are committed to the organization and choose to invest in its success—are more likely to learn from others than members with short time horizons who view their participation in the organization as transitional and temporary.

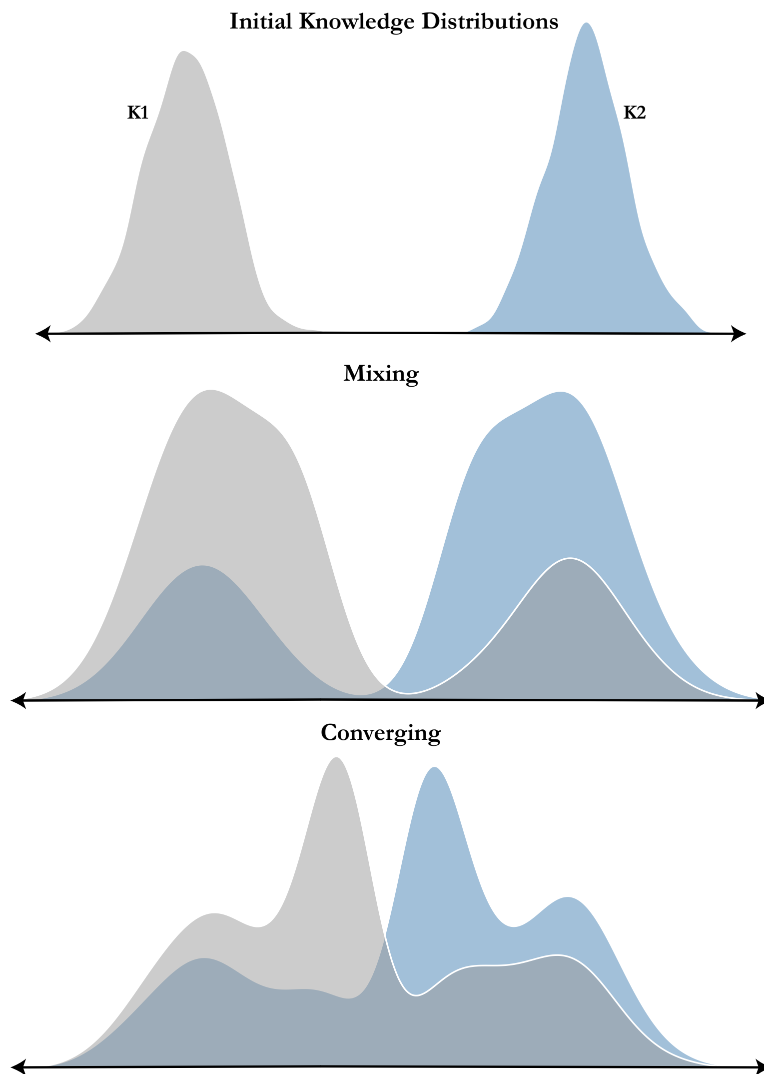
As argued, members draw from what they know when encountering and attempting to resolve the organization's problems. I contend that when engaging in problem-solving tasks, members reveal bits of information about themselves as they propose ideas. Even if the idea is sub-optimal and never advanced, the proposition itself is observed by others. This ability to observe one another results in a learning process whereby members gain information from the experiences and knowledge of other members in ways that expand his or her own knowledge.

Put formally, when m_i takes a draw from K_{m_i} in response to problem ϕ_j, other members ($m_{-i} \in M_{-i}$) can observe m_i's draw and learn from it. I define learning as the process of m_{-i} absorbing information from m_i such that $\kappa(m_i)$ becomes a feature of $K_{m_{-i}}$. That is to say, when a member observes new information, that information is added to his or her knowledge distribution. The effect of this learning process is trivial if such interactions are rare; however, as members interact with greater frequency over time, learning can change the shape of a member's latent knowledge distribution (K_m).

I contend that members learn most from information sources that exist outside their scope of knowledge. This assumes that information from a disparate knowledge distribution will carry more weight than information from a similar one. Incorporating disparate information results in the introduction of outliers to a set knowledge distribution, producing a skew and altering the shape of one's knowledge distribution over time. As a result, diverse knowledge distributions are gradually drawn *toward* one another as outlying data points amass. Put simply,

as individual members learn from one another, they begin to view the world more similarly over time.

Figure 4.2: Illustrative example of endogenous learning



The figure represents two stylized knowledge distributions. In the first panel, we observe the initial disparate knowledge distributions $K1$ and $K2$. As these members repeatedly interact and learn from one another, their sources of knowledge begin to mix, which is represented in the second panel. This process continues until the distributions converge, taking on similar forms as represented in the 3rd panel.

I refer to this process as endogenous learning. Figure 4.2 offers a visual representation of the learning process. As disparate source of knowledge mix, the latent distributions begin to take on similar forms. The downstream implications of this process is that members in a group become more alike as they interact and learn from one another, and that given enough time, two disparate knowledge distributions will inevitably converge into similar forms. I argue that novel solutions emerge *as disparate knowledge distributions are gradually pulled toward one another over time*. As the figure illustrates, it is through this process of mixing of heterogeneous information that the effect of membership diversity is most profound.

As presented thus far, learning is assumed to *always* occur when members interact; however, one could easily assume the opposite. When encountering a new ideas, individual members could become more insular, largely ignoring views that fall outside their establish frame of thinking. Such cognitive dissonance would limit the mixture of knowledge distributions as described above. As a result, membership heterogeneity would bring with it diverse sources of knowledge but that knowledge would be siloed away, reducing any potential magnifying effect of an organization's innovative capacity. As such, it is useful to think of a collective's capacity to learn as a relevant parameter that exists along a continuum such that when high, members readily learn from one another, and when low, members learn less often.

Though inherently unobservable, a member's latent willingness to learn from others in the organization can be thought of in terms of how members choose

to invest in the organization. I argue that members with *long time horizon* are more likely to learn from others than members with *short time horizons.* Members that invest in the mission of the organization, view participation as a long-term commitment, and whose payoff from participating is realized through the organizational success rather than temporary transactions are defined as having a long time horizon. These members invest in the organization. By contrast, members with short time horizons are those that view participation as a transaction, seek immediate returns on their labor, and invest in the opportunities the organization affords rather than the mission it engages in.

In his work on resources and recruitment, Weinstein (2006) argues that members of violent organizations can be broadly categorized into two types: opportunistic and committed. Opportunistic members use membership in the group as a means to a material end that is private rather than collective (e.g. gaining personal wealth). Such members care little about the underlying goals of the organization; instead, they seek out the short-term rewards afforded through participation (Gates, 2002). Committed members, on the other hand, are devoted to the underlying goals of the organization and seek to reap the long-term payoffs, which are only realized if the organization succeeds (e.g. some change in the political status quo or the distribution of power).

I argue that if members have a long time horizon, membership itself can bring with it an underlying commonality that engenders learning. Commitment to an organization encourages members to view each other as engaging in a similar cause, which promotes an underlying sense of collective identity. This commonality en-

courages individuals to value information and perspectives from other members in ways that promote observation and recollection. Put differently, when individuals are highly committed to the organization, they have an incentive to discover ways to increase the organization's odds of success—as the payoffs associated with participation are only realized when the organization succeeds. If learning increases this likelihood, then committed members have an incentive to learn. In addition, as learning occurs through repeated interactions, committed members stick around long enough for such repetitive interactions to occur.

When commitment is low, however, individual members view their participation as transactional and temporary (Gates, 2002; Gates & Nordas, 2010). Learning is less vital as an opportunistic member's payoff is not dependent on the organization succeeding. Thus, there is no incentive to invest in the cause or learn from others as collective success is less of a concern. Moreover, members with short time horizons are more likely to exit the organization on average, especially if pecuniary payoffs begin to diminish. This reduces the likelihood of these members repeatedly interacting in ways that allow endogenous learning to occur.

As argued, membership heterogeneity can increase an organization's adaptive and innovative capacity by introducing diverse sources of information and experience within an organization. By incorporating a endogenous learning concept, it is possible to understand why organizations become more or less innovative over time. If members draw from similar distributions when formulating ideas due to membership homogeneity, then learning only reinforces what each member already knows. However, if diverse sources of knowledge and experiences exist in

the organization, learning can have a profound effect on a collective's innovative potential as different types of knowledge and experience mix. The expectation then is that heterogeneous groups will become more adaptive and innovative over time; whereas homogeneous groups will become less so. That said, the impact of this magnifying effect is mediated by an organization's collective ability to learn, which can broadly be understood in terms of commitment to the organization and its mission. To explore these implications in greater depth, the next sections will use this theoretical setup as the starting point in a series of computational simulations that seek to explore the role of membership diversity and learning in an organized anarchy.

Chapter 5

Computing the Garbage Can: mapping diversity to innovation

In this chapter, I implement the theoretical discussion advanced in the previous sections utilizing an agent-based computational simulation of the garbage can model (GCM) scenario outlined in the previous chapter. These simulations are leveraged primarily as a way of translating the assumptions and logic of the theory into observable implications. Put simply, I leverage simulation as a theory development tool.

The motivation of such a theory building approach is as follows. First, to explore the implications of the theory requires a more rigorous probing of the framework and its actors. Second, as argued, the movement of information regarding an organization's problems, members, and opportunities are theorized to exist and operate in a complex system. To model this complexity requires a framework that can adequately account for the system's endogenous and stochastic elements.

Finally, past studies utilizing the GCM framework all employ computation simulations as their primary analytic tool: as the outcomes of the model are concerned more with emergent properties than well-defined equilibria (M. D. Cohen et al., 1972; Fioretti & Lomi, 2008, 2010).

As noted in Section 4.1, the original GCM is limited in a few key ways.[1] Primarily, the original model assumes that solutions are independent from an organization's membership, and that members never learn from their interactions. In addition to this, the original model's fixation on decision-making *outcomes* (e.g. resolutions vs. procedural decisions vs. leaving problems unresolved) overlooks *when* and *how* new solutions are proposed and implemented. Organizations typically deal with a diverse array of problems, some of which they are capable of devising solutions for and others they are not. By tracking how often the new or the same class of solutions are recycled, one can gain insights into the system's capacity to discover and implement new solutions. The goal is not to focus on factors that produce organizational inefficiencies but to highlight an organization's (in)capacity to experiment.

Building off these insights, I advance a variation of the GCM in this section that (*a*) considers the potential sources of solutions in an organization by endogenizing their emergence, (*b*) introduces a learning concept where members learn through interacting with other members, (*c*) diversifies the types of problems an organization faces rather than keeping problem difficulty constant, and (*d*) tracks the timing and prevalence of new solution concepts in the system. This departs

[1] For a review of the original model, please consult the chapter appendix.

from the original GCM in notable ways. First, it shows that when solutions emerge endogenously within an organization, the past experiences and knowledge of participants is central to the emergence of new solution concepts. As a result, the more diverse an organization's membership is, the larger the pool of potential solutions from which it has to draw.

Second, it demonstrates how participation itself shapes the emergence of new ideas. Members learn as they engage in problem-solving and are altered by the exchange. Thus, rather than considering the GCM as a purely random process, I fold in information retrieved from past steps. Third, the new model focuses on an organization's capacity to resolve different types of problems, which acknowledges that organizations deal with a heterogeneous array of problems requiring heterogeneous types of knowledge. Finally, it tracks the prevalence of novel solutions emerging as organizations ingest and process this array of problems. In doing so, this variation on the original GCM offers a framework to think about the ways membership and collective knowledge can influence how an organization processes information, offering insights about the effect these factors have on an organization's innovative capacity.

5.1 Setup of the Simulation

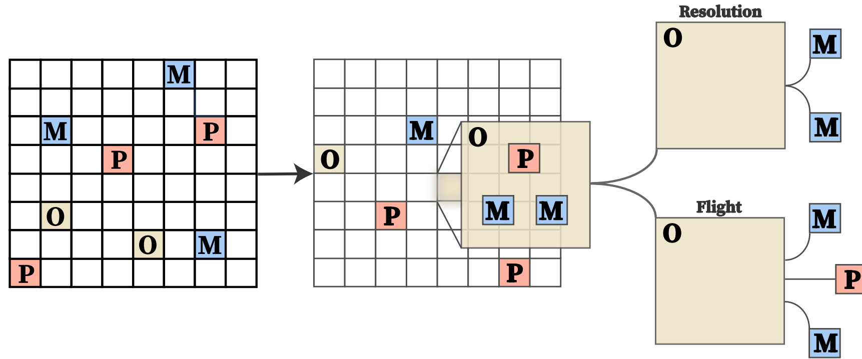
The basic setup of the model is as follows: a set number of members are established and introduced at the outset of the simulation, while opportunities and problems are fed in gradually (two at a time) at each time step. Members, problems, and opportunities then float around stochastically along a two dimensional spatial grid

until they land on the same grid-location (see Figure 5.1 for an illustration). When at least one opportunity, one problem, and two members land on the same grid, the opportunity is activated.[2] The available members then formulate a solution to the problems located in the opportunity and draw from their respective knowledge distributions, producing a response. The responses are considered and resolved over iterations until the joint energy of all the members is used up or all problems are resolved. Once this occurs, the opportunity disappears. When a problem is not resolved, it is recirculated into the space. Note that some but not all problems can be resolved in a given opportunity. The ability to resolve a problem depends on the quality of a solution and the available energy of the present members.

Given that solutions emerge as individual members interact with the organization's problems, the original setup is altered slightly. Rather than applying the same solution to every encountered problem within a decision-making opportunity, solutions emerge as members interact with each individual problem — that is, for each ϕ_j, a unique $\kappa(m)$ is drawn by each member that encounters ϕ_j in the same opportunity, producing a set of responses $\{\theta_{1j}, \theta_{2j}, ..., \theta_{ij}\} = \Theta_j$. Of those responses, a "best response" is selected for that particular problem (θ_j^*), which is conceptualized in equation 4.1 as the entry with minimum residual in the respective solution set. Thus, the inequality is conceptualized in terms of the remaining effort that is required to resolve the problem after a resolution has been proposed. For each decision-making opportunity (O), a resolution is reached when the following condition is satisfied:

[2]The restriction of at least two members needing to be present is a stylistic feature. The logic being: a meeting opportunity only really exists when two or more individuals are present. Moreover, it assumes that resolving the organization's problems is a collective effort.

Figure 5.1: Illustration of the Simulation



The figure provides a simplified illustration of the adjusted GCM simulation. Problems (P), opportunities (O), and members (M) randomly change locations in a defined spatial grid each iteration. When *at least* two members, one problem, and an opportunity overlap on the same grid, the actors activate. First, members draw from their prior knowledge distributions to generate a response to the problem. The "best response" of all proposed responses is selected. If the response and available energy of the members is sufficient to address the problem, the problem is resolved, or else the problem is left unresolved and recirculated (flight).

$$O : \sum_{i=1}^{M} E(m_i) \geq \theta_j^* \in \Theta_j \tag{5.1}$$

where $E(m_i)$ denotes the energy (or ability) of each member in the opportunity, and θ_j^* represents the optimal response given all available *proposed* responses (Θ_j) to problem ϕ_j.

As noted, the value of θ_j^* is the remaining difficulty to be resolved by the available members located in the opportunity. As conceptualized, a perfect solution to a problem will equal 0—as the response is the absolute difference between the difficulty of the problem and the efficiency of the solution, $|\phi_j - \kappa(m_i)|$. The less

capable a solution is at addressing the problem, the greater the effort required on the part of the available members to resolve it. If the solution is unable to adequately resolve the problem, and members lack the ability to account for this inadequacy through sheer effort alone, then the problem is *not* resolved and we observe a "flight."

Within each opportunity, more than one problem can be encountered, and as a result, a series of responses may need to be considered. That is, some set of problems ($\{\phi_1, \phi_2, ..., \phi_j\} = \Phi_{lt}$) are encountered in an opportunity at location l at time t, yielding a set of best responses ($\{\theta^*_1, \theta^*_2, ..., \theta^*_j\} = \Theta^*_{lt}$). These responses are arranged in order of remaining difficulty where solutions with the smallest remainder are addressed first. Each response is then dealt with one at a time until all responses are implemented or the members have no remaining energy.

The joint ability of each available member is seen as a limited resource that reduces as it is used. In this setup, the ability of the members is pooled at the start of each opportunity ($\sum_{i=1}^{M} E(m_i) = \Omega_{lt}$) and each response is dealt with iteratively until $\Omega_{lt} \leq 0$ — after which all remaining problems are left unresolved and the opportunity concludes. In other words, members propose solutions to problems, producing a set of best responses to each problem; given the quality of the response, the remainder must be resolved through the ability and effort of the members, and each resolution whittles down the total amount of energy available in that opportunity.[3] One implication of this is that poor responses

[3]For example, if two members are located in the same opportunity each with an ability equal to 1 then their joint ability equals 2 (i.e. $\Omega = 2$). If two problems are encountered of difficulty $\phi_1 : 1.5$ and $\phi_2 : 2.5$ respectively, solutions are proposed leaving the remaining effort at $\theta^*_1 : .5$ and $\theta^*_2 : 2$. The first resolution, θ^*_1, is addressed first as it has the lowest remainder and is resolved, reducing the available ability (Ω) from 2 to 1.5. The second resolution, however, cannot be

require members to invest more energy to resolve a problem, greatly increasing the likelihood of flight and producing inefficiencies as residual energy is left unused by the organization.

This interpretation introduces three important realities to the model: first, it implies that good solutions make problems easier to resolve. Second, it highlights that members will try to resolve the easiest proposed responses first. Finally, it establishes that members are constrained by time and effort, and that once their joint energy is used up, the remaining problems are left unresolved. Thus, an organization's ability to address a problem is affected by (a) its pool of common knowledge and (b) its capacity to implement a solution. The implication is that organizations with a limited pool of common knowledge can resolve challenging problems but doing so requires a greater amount of organizational energy. Put differently, an organization without brains must use brawn.

In addition to the above, each member also "updates" each time step. By updating, I mean that for each time period in the simulation, the knowledge distribution of each member is expanded by one. The updated value is simply the mean of an individual's knowledge distribution at the current time period. For example, at time $t = 1$ member i updates by taking the mean of the current state of $K_{m_i}^{t=1}$ and appending that draw to the distribution for the next time period,

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addressed because there is not sufficient energy on the part of the present members to resolve the remainder (i.e. $\theta_2^* : 2 > \Omega : 1.5$). ϕ_2 is then left unresolved, and the problem remains in circulation.

such that $K_{m_i}^{t=2} = \{K_{m_i}^{t=1}, E[K_{m_i}^{t=1}]\}$. This feature accounts for the reality that knowledge distributions are not static but change over time.[4]

The primary metric of interest produced by the simulation is the probability of observing an "innovation" at each time step. This metric is generated by rounding each *implemented solution* (i.e. a solution that was the local best response that lead to a problem being resolve) to its nearest integer value and then recording its initial implementation (innovation) and every subsequent implementation (recycled). For each time step, an indicator variable takes on a value of 1 if any innovation occurred within an activated opportunity at time t, otherwise 0. The average is then taken for each realization at each time step across all 50 simulations—yielding a value between 0 and 1. This metric can broadly be interpreted as the probability of observing an innovation at each time step.

Table 5.1 outlines the static and varied parameters and conditions used for each simulation. The rates and number of agents are calibrated to the number of time steps (1000) and the space of the grid. Specifically, 2000 opportunities are introduced gradually: two opportunities are introduced at each time step such that opportunities persist throughout the time period. Likewise, 1000 problems are introduced at a rate of two problems per time step so that the total number of problems are completely introduced by step 500, the halfway point. The ability of each member is held constant at five; thus, each member is assumed to have the same energy and capacity. The problem space is made to be deliberately diverse—with the difficulty of the problems existing between -500 and 500. The

[4]Updating via draws in the mean ensures that updating is centripetal: outside of any changes, an update only reinforces what is already known. However, such an updating concept also makes members sensitive to the influence of new ideas.

"departure" denotes how unique an individual member's knowledge distribution can be from his/her common group. This feature highlights that similar experiences shape individuals in slightly different ways. Lastly, for each varied condition, the simulation will be run 50 times, offering a large enough sample to explore the possible variations of each conditional state while minimizing run times.[5]

Table 5.1: Parameter settings of the GCM simulation

Parameter	Description	Initial Conditions
Static Conditions		
N Simulations	the number of simulations per varied condition	50
Time	the number of time steps in each simulation	1000
Spatial Grid	the symmetric grid in which agents move	10x10
N Opportunities	the number of total opportunities	2000
N Members	the number of total members	100
N Problems	the number of total problems	1000
Energy	the energy of each member to resolve a problem	10
Difficulty†	the range of difficulty of each problem	$[-500, 500]$
Problem Rate	the number of problems introduced at each time step	2
Opportunity Rate	the number of opportunities introduced at each time step	2
Departure	extent an individual member's knowledge distribution can deviate from the group's common mean	sd = 20
Varied Conditions		
Groups	the number of groups with different knowledge distributions	See Figure 5.2
Knowledge Distribution*	the position of a group's knowledge distribution	See Figure 5.2
Learning	the probability members learn from an interaction	None= 0, low= 25%, high= 100%

† values are drawn from a uniform distribution. Conditions denote the min and max.
∗ values are drawn from a normal distribution.

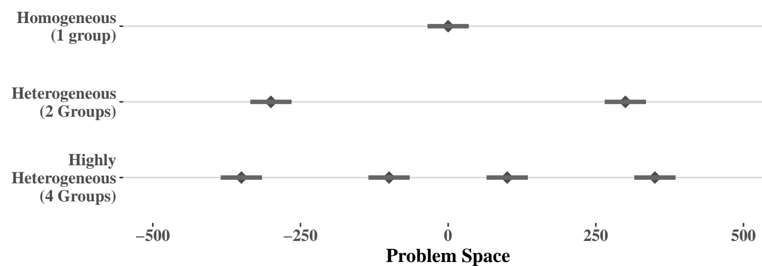
5.2 Homogeneous vs. Heterogeneous Membership

The first set of GCM simulations consider the impact of membership diversity on an organization's innovative capacity. The first configuration considers an organizational environment with only one common source of knowledge. This environment is equivalent to a homogeneous group that is highly exclusive and that tends to recruit primarily from a single population. Anecdotally, we observe this type of setup among armed ethnic militias that only recruit male co-ethnics, such

[5] Details regarding the varied parameters are discussed in the subsequent subsections.

as the Muslim Brotherhood. The latter two configurations consider membership diversity in an organizational environment. Specifically, the second configuration examines settings where two distinct sources of knowledge and experience exist in an organization. For example, armed organizations that recruit primarily from two distinct ethnic groups, such as the Armed Islamic Group of Algeria (GIA). And the third configuration examines settings where multiple sources of knowledge and diversity exist within an organization. Four distinct knowledge distributions are represented in this configuration, each being evenly dispersed across the problem space. This setting seeks to represent violent organizations that recruit inclusively (i.e. across gender and ethnic categories), such as Boko Haram in Nigeria.

Figure 5.2: Distribution of knowledge groups



The figure describes the location of the knowledge distributions for each setting. Three configurations are considered: homogeneous membership, moderate levels of heterogeneity, and high levels of heterogeneity. The placement of each group in the heterogeneous settings seeks to space the distributions equally apart but is largely arbitrary.

Figure 5.2 describes the placement of each knowledge distribution across the set problem space. Again, the problem space seeks to represent the diverse array of challenges an organization faces at any given point in time. For each simulation, the placement of a group's knowledge distribution highlights the reality

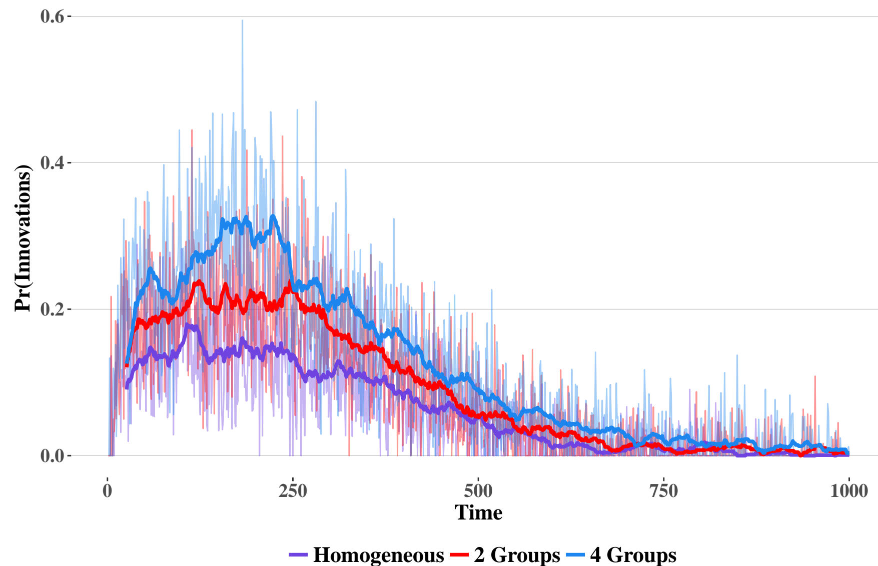
that certain forms of experiences and knowledge are more adept at solving certain types of problems more than others. Though not expressed in Figure 5.2, there are minor deviations regarding the location of each *individual member* with respect to his or her group's knowledge distribution. This feature highlights how individuals may harken from similar backgrounds, ethnicities, geographic locations, and/or genders but each member processes and learns from those experiences differently. Thus, each knowledge distribution is part group commonality and part individual uniqueness.

Figure 5.3 reports the probability of observing an innovation at each time point by averaging the number of observed innovations across all 50 runs for each membership configuration. In addition, the figure reports a 25 time-step rolling average to better capture the temporal trend (bold line). The simulation results confirm the initial hypothetical relationship advanced in the first hypothesis: holding all else constant, more heterogeneous organizations have a higher probability of innovating than homogeneous organizations. Put differently, organizations with diversity have a larger innovative capacity than their less diverse counterparts.

The simulations highlight three important theoretical insights. First, innovation is most likely at the start of an organization. Organizations are quick to discover the types of problems that they are most capable of engaging and resolving. This initial "exploration" of the problem space makes all organizations appear innovative at the beginning. In a way, this feature describes a kind of "honeymoon period" for new violent organizations: most initial activity will garner attention and make headlines as each production carries with it an initial novelty, which

quickly disappears as organizations begin to establish their primary modes of production and recycles solutions more often.

Figure 5.3: Probability of innovation given membership heterogeneity



The figure reports the average proportion of innovations across all 50 simulations at each time step (1000 steps total) for each of the different membership configurations. A 25 step rolling average reported to capture the time trend (thick line corresponding to each category's color). Holding constant all other conditions, the figure demonstrates that the probability of an innovation increases as the level heterogeneity in the simulated organization increases.

Second, organizations with diverse members have a *larger* overall innovative capacity that lasts *longer* than homogeneous organizations. Put simply, heterogeneous organizations have more room to explore as each knowledge group is uniquely positioned to deal with different types of problems—i.e. there is a larger range of problems heterogeneous organizations are able to engage with. The source of an organization's innovative capacity lies in the extent of this latent space in which its collective knowledge covers, which is directly a feature of diversity.

Finally, organizations are less likely to innovate as they age. As an organization ages, the probability of observing an innovation reduces. As described in Figure 5.3, by step 500, the problem space has largely been figured out for each membership configuration and the probability of observing an innovation is virtually non-existent. The simulations demonstrate that membership heterogeneity brings with it a larger initial burst of innovative potential, yet this potential is inevitably depleted. This finding mirrors that of Horowitz (2010) but does so via an alternative mechanism: it is not just that specialization reduces the acceptance of new ideas but that collective knowledge has limits. In a way, novelties within a collective pool of knowledge should be thought of as a limited resource that is used up over time.

The GCM simulations offer some guidance regarding the theoretical expectations of membership diversity on an organization's innovative potential. Specifically, the results also inform the following hypotheses:

Hypothesis 1 *Violent non-state organizations with heterogeneous members will be more innovative than organizations with homogeneous members.*

Hypothesis 2 *As all violent non-state organization age, they will become less innovative.*

Hypothesis 3 *The relationship between a violent non-state organization's age and likelihood of innovating will be non-linear (concave).*

5.3 Membership diversity and learning over time

This section will introduce an endogenous learning concept to the GCM. As argued in Section 4.3, participation in the organization itself can result in an endogenous

feedback: members gradually gain new knowledge and experience when solving the organization's problems by observing and recording the ideas of other members engaged in the same task. When an organization is sufficiently diverse, the mixing of information between members can reshape the organization's collective pool of knowledge in ways that are conducive to innovation but only if those members have long time horizons in the organization (i.e. are committed to the organization and its goals).

The main claim proposed by the learning concept is that as members update, the information learned in past steps begins to influence the shape of their knowledge distributions. The expectation is that if the knowledge being learned is similar to what a member already knows, then learning will only reinforce prior knowledge and beliefs. However, if the knowledge being acquired is sufficiently different, then new information will effectively drag members *toward* the location of that new data point. Ultimately, as members from diverse backgrounds interact more regularly, the effect of learning on the organization's collective knowledge should result in an expansion, increasing the organization's innovative potential. Learning is argued to be dependent on the degree to which members invest in the organization. Members that view their participation as transactional and short term are less likely to learn. By contrast, when members are committed to the organization, I argue that they invest in the mission of the group, view their participation as a long-term commitment, and are more likely to absorb information.

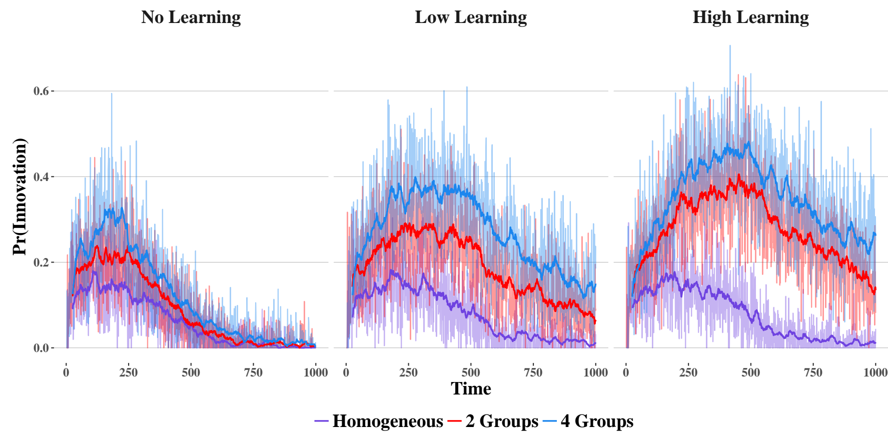
To incorporate learning into the GCM, the following simulations include an additional learning parameter (ρ) that determines whether members record the

solutions proposed in any activated opportunity. Again, learning is defined as the process of m_{-i} absorbing information from m_i such that $\kappa(m_i)$ becomes a feature of $K_{m_{-i}}$. In the simulation, learning is effectively a random draw from a binomial distribution whereby 1 means that all members in a given opportunity record the proposed solutions for each encountered problem and 0 means that no solutions are retained from the encounter. ρ describes the underlying probability of that binomial draw. When the probability of learning is "low" ($\rho = .25$) — i.e. when members view their participation as transactional and short term — there is a 1-in-4 chance that members will learn from an encounter. When learning is "high" ($\rho = 1$) — i.e. when members invest in the organization and view their participation as a long term commitment — learning is guaranteed. These results are presented in comparison to the "no learning" setup ($\rho = 0$) presented in the previous section.

Figure 5.4 reports the probability of observing an innovation across each time step for each learning and membership configuration. The "No learning" configuration re-reports Figure 5.3. Similarly, the figure clarifies the time trend using a 25 time step rolling average. All conditions except the probability of learning from an exchange are held constant. As argued in Section 4.3, learning can be understood in terms of each member's level of commitment to the organization and its goals. The more committed members are, the greater the incentives to learn from one another.

Aspects of Figure 5.4 remain consistent with the discussion and hypotheses proposed in the last section. First, the parabolic relationship between the proba-

Figure 5.4: Probability of innovation given membership diversity and endogenous learning



The figure reports the average proportion of innovations across all 50 simulations at each time step (1000 steps total) for each of the different membership configurations for each form of learning. A 25 step rolling average reported to capture the time trend (thick line corresponding to each category's color). The learning levels denote the likelihood of members retaining the proposed solutions of other members in an opportunity. If "No," the probability of learning is 0. If "low," the probability is .25; and if high, the probability is 1.

bility of observing an innovation and time holds (H5). Even when an organization's innovative capacity is dramatically bolstered by the endogenous feedback that results from learning, the rate of change begins to diminish after some point. This indicates that though members can learn from one another, the effects are not indefinite as knowledge distributions inevitably converge.[6] Second, the more heterogeneous an organization is, the greater the underlying probability of observing an innovation.

A key finding from the GCM with endogenous learning that confirms the initial intuition outlined in Section 4.3 is that learning only appears to matter under

[6]As Figure 4.2 illustrated during the theory discussion, after a point, disparate knowledge distributions converge.

conditions of heterogeneous membership. Across each learning configuration for organizations with homogeneous membership, there is no discernible increase in the underlying probability of innovation. Learning, it would appear, only increases an organization's innovative capacity if there is a *source of information for members to learn from* — such as the knowledge and experiences of members from different backgrounds. When members observe ideas similar to their own, the value of learning is diminished as the mixing of knowledge distributions only reinforces similar patterns of thinking. Even if members are highly committed to an organization, this commitment will not translate into future innovations if the organization itself is not sufficiently diverse. As a result, organizations that draw highly-committed recruits from a single ethnic population are not likely to benefit from those high-levels of commitment. In fact, organizations with limited heterogeneity (e.g. two groups) and low levels of learning (e.g. a high population of non-committed members) are far more likely to be innovative than their committed but homogeneous counterparts.

It is useful to see when and where innovations emerge across the simulations. Figure 5.5 pools all implemented solutions for each configuration at each time point across all 50 simulations. The points show the best responses used (i.e. proposed solutions that led to a problem being resolved) at each time step, denoting between innovative solutions (the first time that response was used in that simulation) and recycled solutions (subsequent uses of a solution). The figure highlights the main areas where innovation is consistently prominent across the multiple runs of the GCM.

Figure 5.5: Implemented solutions pooled across all simulations

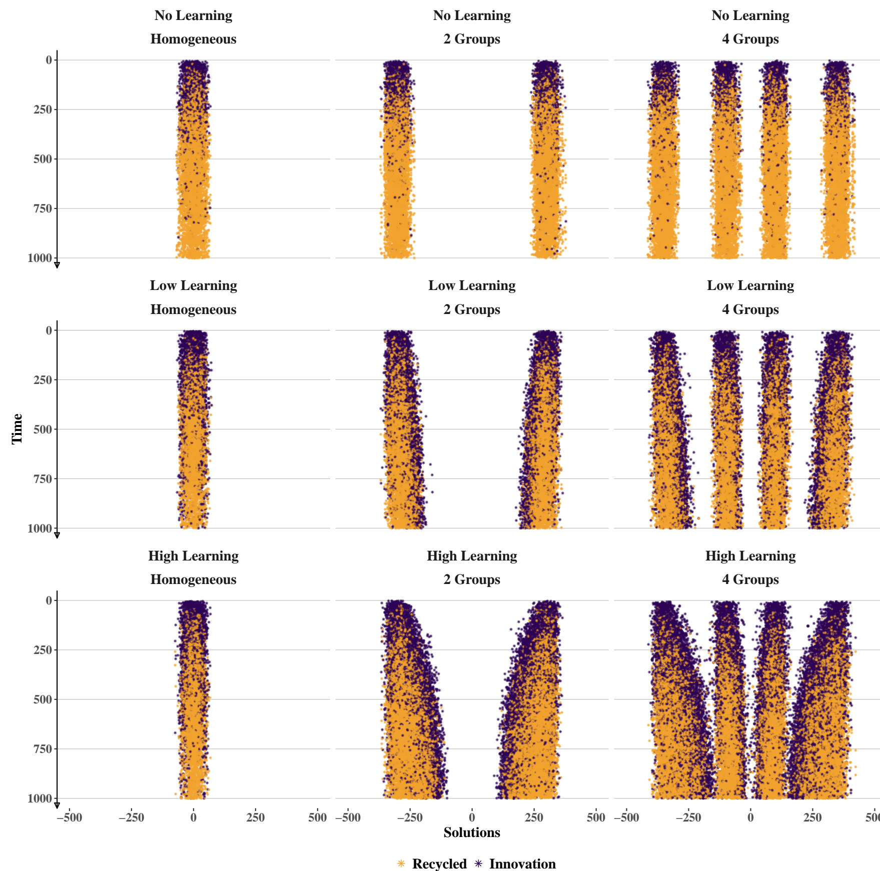


Figure denotes the integer position of every "best response" (i.e. a proposed solution that led to a problem being resolved) across all 50 simulations. Each point delineates between an innovation (the first time that solution was proposed within a simulation) and recycled (subsequent uses of a solution within a simulation). Pooling points across simulations highlights the general regions where innovations are most likely in the system. The figure demonstrates that innovations occur most prominently (a) in the initial time periods of the simulation and (b) at later time periods under heterogeneous membership and learning configurations. Innovations are prominent in the system when disparate knowledge distributions begin to mix.

Figure 5.5 highlights three important implications of the theory. First, innovation is more likely when the different knowledge groups are more disparate. That is, innovations emerge as the groups on the tails are drawn toward the other

knowledge groups. It is through a process of *socialization*—as knowledge groups mix and learn from one another—that the most prominent innovative trajectories emerge. Specifically, we see this in the low/high learning conditions for both heterogeneous models. It is through the gradual convergence of the various distributions that new solution concepts are discovered. The more there is to learn (i.e. the more disparate groups are), the greater the possibility for innovation.

Second, the no learning configurations highlight again that innovation is most prominent at the initial time points, which the members then recycle repeatedly thereafter. Under such conditions, organizations repeat what they know not because of risk (Horowitz et al., 2017) but rather because under these conditions, the basic elements that contribute to the probability of innovation are missing. Innovation requires members to generate solutions that are capable of resolving the organization's problems. Identifying such solutions is only possible when conditions allow members to learn something they did not previously know.

Finally, the effect of learning appears to become more prominent over time. In the low/high + heterogeneous membership configurations, learning appears to occur at an accelerated rate over time (until the maximum is reached), indicating that it is through *repeated* interactions that the effect of learning is most pronounced. This underscores how endogenous learning and membership diversity differ from a contagion mechanism (Duursma & Read, 2017). Exogenous entry of ideas into an organization will have limited impact unless those ideas are continually carried and proposed by members over time. For example, consider Bakke (2014)'s work on the introduction of extremist tactics by foreign fighters in the

Chechen conflict. It is not just that foreign fighters bring extremist ideas. What matters is that those fighters *stick around*, interact with other members, and repeatedly air those ideas in ways that other members can observe and absorb. Even if specific tactics themselves are not adopted, the presence of new knowledge matters.

To re-emphasize, the endogenous learning concept itself is inherently non-observable in the real world. However, as argued, the level of commitment of the members to the organization itself can serve as a useful proxy for learning. The above discussion informs the following observable hypotheses:

Hypothesis 4 *Given heterogeneous membership, violent non-state organizations with highly committed members will be more innovative than organizations with less committed members.*

5.4 Discussion

The GCM simulations help demonstrate that under minimal assumptions regarding the organizational environment, differences in membership composition can have considerable influence on an organization's capacity to innovate. The setup is intentionally simplistic in its representation of organizational decision-making, yet its informative power emerges from its simplicity. It emphasizes the importance of prior experience and knowledge and the way those priors mix in understanding why some groups are more likely to experiment and adapt tactically. In doing so, the theory highlights that problem solving is largely an outcome of a collective

process. This is not to say that violent organizations are not strategic or that they all lack leadership. There is a wealth of empirical evidence that would indicate otherwise. Rather, the argument focuses on the probability of deviations as ideas are ordered, selected, and carried out. Even when assuming a strict chain of command in decision-making, orders can be misinterpreted, deliberately disobeyed, or re-envisioned as they are translated into actions. In a pure principal-agent dynamic, such deviations are viewed as an unfortunate consequence of delegating when a principal's capacity to monitor is limited. For the argument advanced here, such deviations serve as a kind of recurrent opportunity. Ultimately, the argument allows for the possibility that decision-making is not consistently linear, but rather follows from a complex process that is dependent on the available sources of information and how those sources mix over time.

With that said, let me highlight three important considerations to keep in mind. First, it is vital to note that the effect of membership diversity on an organization's innovative capacity is *not dependent on members being in positions of authority*. The theory emphasizes the *system* in which information moves while remaining agnostic about the structure. A potential criticism of this view is that solutions proposed by rank and file members are down-weighted or excluded entirely from the organization's decision-making processes. Even worse, the most diverse members are likely the *least capable* of airing their ideas, especially if they are systematically excluded from positions of authority. However, this line of thinking overlooks the reality that ideas can be commandeered and attribution can be stolen. Members in positions of power at all levels likely have an incentive

to steal and re-brand good ideas as their own, especially when dispute-resolving institutions are weak or non-existent.[7] Moreover, such a reading of the theory devalues the fact that learning is a dynamic process. As argued, members learn over time through repeated interaction with other members. This implies that the components of new ideas can emerge from any number of sources, especially as members are shaped and re-shaped by one another. In essence, information moves in bits, not as complete files—complicating the nature of attribution.

Second, another important consideration is the role of the problem space. The theory assumes that the organization is consistently challenged by a diverse array of problems. It is when members interact with these problems that solutions are elicited. However, it is plausible to imagine conditions where organizations face a consistent set of dilemmas that once understood, no longer challenge the organization in the ways theorized. I argue that such circumstances are highly unlikely given the competition violent non-state organizations are engaged in. As noted, the state and other competitors are constantly adapting and adjusting in ways to undermine, dismantle, and destroy an organization. This process by definition generates new sets of problems that were previous never encountered. That said, this places an important scope condition on the theory. The problem space itself must be diverse: if an organization goes unchallenged, a key driver of innovation is removed. In this sense, the theory aligns with past work that competition can promote adaptation as it complicates the problem space (Horowitz et al., 2017).

[7]For example, when there are no Human Resource or arbitration institutions within the organization by which a subordinate can issue grievances.

Finally, the theory does not undermine existing work on some of the external drivers of innovation, such as the role organizational affiliations and alliances play (Horowitz, 2010; Wahedi, 2018). What's interesting to consider is the implication of direct collaboration with other groups, which affiliation is argued to afford. As theorized, it is through exposure to disparate forms of knowledge that individual members learn and update what they know. Extended exposure, even of a few fighters to an outside group, can have a positive effect on an organization's underlying innovative capacity as these members are reshaped by that exposure. This could produce a new form of information that other members can learn from once those members return. Thus, the theory does not run counter to these existing explanations; rather it complements them in an important way by providing a plausible mechanism by which inter-organizational exposure can increase the likelihood of tactical adaptation, diversification, and innovation.

Table 5.2: Summary of the Testable Hypotheses

Hypothesis 1	Violent non-state organizations with heterogeneous members will be more innovative than organizations with homogeneous members.
Hypothesis 2	As *all* violent non-state organization age, they will become less innovative.
Hypothesis 3	The relationship between a violent non-state organization's age and likelihood of innovating will be non-linear (concave).
Hypothesis 4	Given heterogeneous membership, violent non-state organizations with highly committed members will be *more* innovative than organizations with less committed members.

All-in-all, the theory seeks to offer a basic framework for understanding why we observe such differences in the way organizations adapt and experiment tactically, especially when situated in similar contexts. Table 5.2 restates the observable

hypotheses. The argument emphasizes the types of information that feed into an organization's pool of collective knowledge. It argues that members carry with them prior knowledge and experiences that alter how they view the organization's problems and the solutions they devise to resolve them. Moreover, it stresses that participation in an organization is an experience unto itself, and that members are altered through interaction. As the subsequent chapters will outline, there are many ways one can think about diversity; however, what the theory stresses most is that one must consider *who* is in an organization to understand the true scope of its capacity.

5.5 Chapter Appendix

Original Conceptualization of the Garbage Can Model of Organizational Choice

In the original set up, the GCM is marked by four types of agents: problems, solutions, participants, and meeting opportunities.[8] Each agent is independent, roaming around at random, destined to collide with another. Only when a solution, participant, and opportunity meet or a problem, solution, participant, and opportunity meet do we observe a decision. Participants (m) are marked by their "ability" to address a problem ($A(m)$), solutions (κ) are defined by their "efficiency", and problems (ϕ) are understood in terms of their difficulty. Thus, a problem by resolution emerges when at least one m, ϕ, and κ are attached to an opportunity (O), and the following condition is satisfied:

$$O : \max_{j \in J} k_j \sum_{i=1}^{M} A(m_i) \geq \sum_{q=1}^{\Phi} \phi_q \tag{5.2}$$

where J is the total number of available solutions, M the total number of members, and Φ the total number of problems *present in that opportunity*. In the conditional, the most efficient solution, κ, is multiplied by the cumulative ability of each member located in the opportunity, $A(m)$. Thus, as long as the ability of each member and the efficiency of the solution exceeds the difficulty of the problem, a decision will be reached. However, if the problem proves too difficult or the participants are inundated with problems, the issue is punted down the line and

[8]See Fioretti and Lomi (2008) for a complete outline of the model and an Agent-Based implementation of its implications.

no decision is made (flight). In other words, problems, solutions, and members appear in the same meeting; if the solution is good enough and/or the members in the meeting are skilled enough to solve the problem, then it will be resolved — else the problem persists. Lastly, when no problem is encountered in an opportunity, a procedural decision is made (decision by oversight). These are window dressing decisions made to signal that the organization is doing things but not responding to any issue in particular.

As all agents are independent, this process plays out at random within an organization across its life cycle. A hierarchical structure can be imposed on the model by instituting an exogenous ordering of importance with regard to opportunities, members, and problems (M. D. Cohen et al., 1972). Hierarchy then is restricting access of some set of participants or problems to different opportunities: i.e. some problems may not be deemed important enough to merit consideration within a meeting, or some participants not high enough in the organization to gain access to a meeting.

Chapter 6

Measuring membership diversity by tracking ethnic exposures

The theoretical propositions outlined in Chapters 4 and 5 argue that tactical innovations in the production of violence emerge when a diverse population of members interact with the organization's problems. Individual members from diverse backgrounds bring with them disparate forms of knowledge that increase the probability of innovation as individuals draw from their respective distributions to resolve the multitude of problems the organization faces. Moreover, members observe and learn from one another, resulting in a mixing of knowledge that contributes to more innovative outcomes.

In this chapter, I explore how one would go about measuring diversity in violent organizational settings. In particular, the unit of analysis under consideration presents unique challenges to testing the theoretical propositions outlined in Chapter 5. First, it is difficult to understand the population of members who

participate in a violent organization at any point in time. Past research interested in understanding membership composition within violent non-state organizations has approached this challenge in a number of ways. Some research examines the ex-post composition of combatant populations by surveying ex-fighters via non-random samples (Humphreys & Weinstein, 2006); others use expert knowledge of the group to isolate the dominant ethnic populations contained within (Vogt et al., 2015); lastly, others have looked at the types of individuals that join militant organizations from a larger population (e.g. the types of individuals that join terrorist organizations (Tessler & Robbins, 2007)). However, these approaches are either limited in scale, design, or plausibility as viable pathways to explore the mechanism at play in the theoretical argument.

Second, the inner workings of violent organizations are inherently difficult to observe. Violent organizations have an incentive to occlude their operations from outside observation. The motivation is one of survival. By definition, such organizations are engaged in an armed challenge against the state and are thus ceaselessly fending off the state's (and other challengers') attempts to dismantle, destroy, and undermine the organization's authority. In the past, some studies have drawn inferences from non-random samples of documentation recovered from specific militant organizations. For example, Shapiro (2013) utilizes documents recovered from Al Qaeda to understand the principal-agent dynamics that underpin (and undermine) productions of terrorism. However, beyond the one-off opportunity to gain access to such documentation, the ability to peer inside these organizations is limited. Moreover, organizations where the internal workings are

visible likely differ in important ways from the majority of organizations where such information is not available.

These challenges present major road blocks to testing the theory's observable implications. Mainly, both the theory and the measurement strategy to capture adaptive behavior (see Chapter 2) require a level of temporal granularity that is largely not possible with existing metrics. Thus, to understand when new populations potentially enter into an organization, one must understand when violent organizations are plausibly exposed to the diverse populations from which they could potentially recruit.

In this chapter, I propose a strategy for measuring membership heterogeneity in violent non-state organizations. Specifically, I outline a strategy of isolating the geographic location of organizational activity over time and examining the potential opportunities for exposure to a new ethnic population. Tracking violent organizational behavior is limited to the violent productions that are observable and attributable. Thus, as scholars, we have at best a fractured picture of activity in the group. However, I argue that one also has a plausible conceptualization of what types of populations a group is potentially exposed to and one can use these exposures as proxies for the potential pool of members in an organization.

Where Chapter 2 treated violent organizations as producers, yielding violent products by which they achieve their political aims, this chapter focuses on violent organizations as consumers and absorbers of available labor. Though imperfect, the measurement strategy outlined here offers a feasible strategy for measuring diversity in organizational settings where membership itself cannot be directly

observed. Moreover, it advances a subtle but important assumption: an organization cannot be exposed to stimuli from which it is geographically and temporally removed. The metric seeks to understand where violent organizations operate and the demographic compositions on the ground to inform the potential demographics within the organization itself.

6.1 Research Design Challenges

In this section, I outline the research design challenges for studying the theoretical mechanism presented in Chapter 4 and outline why this empirical approach is most appropriate. The section provides justification for the general approach of the measurement strategy.

An ideal test of the theory would be to compare identical groups situated in the same circumstances and to increase the divergence of prior knowledge (knowledge diversity) in a subset of the groups as a "diversity" treatment. Both groups should then subjected to the exact same types of challenges and stimuli in which they must collectively respond. Moreover, all other group characteristics should also be held constant, such as organizational structure and resources. The difference then in the number and types of incremental innovations observed by the two organizations could then be attributed to the effect of knowledge diversity of the group's membership.

Naturally from a design perspective, the nature of the treatment presents challenges. First, knowledge diversity is not a dial that can be easily increased in a controlled way. Second, determining balance across treatment and control groups

often requires the use of demographic features—which are highly correlated with the treatment. Third, the ability to allow for the spontaneous interactions that are vital to the theoretical functioning of the Garbage Can Model complicates the capacity to assign identical stimuli and challenges to both groups. Finally, the learning mechanism requires that two or more groups be observed over an extended period of time, as the mixing of knowledge distributions requires that individuals are able to repeatedly observe one another. Moreover, simulating participation within a violent organizational setting is both unethical and impractical. Any conclusions drawn from an experimental design would not necessarily transport over to the organizational contexts in which they are designed to inform, even though the probe would be valuable in understanding specific features of diversity for the outcomes observed in collective groups.

An alternative approach would be to probe the empirical record to make distinct comparisons across some known population of violent organizations to compare the distinct differences between organizational units. By matching on organizational features (such as resource endowments, organizational structure, production rates, etc.), it is plausible that groups could be compared in a systematic way. The idea would be that the main differences between groups would emerge in the level of observable diversity across membership populations. However, this approach presents distinct challenges for both quantitative and qualitative analytical approaches.

As noted above, violent organizations are notoriously difficult to observe. Such organizations have an incentive to occlude their internal workings, and researchers

are often only privy to the observable outputs the organization produces (i.e. violent events) or post-hoc reconstructions of the inner workings of the organizations (e.g. process tracing or interviews with fighters). Neither source lends itself to a clean identification strategy. Thus, the empirical record from which information membership diversity would be drawn is difficult to parse.

Qualitative approaches are especially problematic as post-hoc accounts and narratives often unintentionally re-attribute the inception of an idea to some other source (e.g. dominant ethnic populations in the organization rather subordinate populations) or consolidate it in a singular individual (e.g. the leader or mastermind). Rarely is the movement of ideas even discussed in qualitative accounts let alone appropriately attributed. As noted in the discussion in Chapter 5, the problem of assigning the inception of an idea to a specific individual or population in the organization is complicated in two ways. First, attribution can be stolen, thus the original source of an idea can be difficult to identify. For example, take any organizational setting where a good idea from a minority member (e.g. a female co-participant) is stolen by a majority member in a higher position of authority (e.g. a male superior). Second, learning through repeated interactions with other members means that the types of ideas that emerge are partially a function of redundant exposure. Put differently, the components of an idea move around an organization as bytes, not as complete files. Thus, it is potentially impossible to fully trace the nexus of an idea. These realities limit the usefulness of qualitative research design.

Quantitative approaches face similar challenges. First, the empirical record on violent organizations is temporally limited. Though information on, say, ethnic or gender membership in a violent organization is available for a subset of violent actors, this information is highly aggregated or temporally static across time. By aggregated, I mean the data only exists at the group level (i.e. if there is evidence that a specific population was present within a group ever). By temporally static, I mean that the metric might be disaggregated to the group-year but that changes in this metric are rare. For example, the Ethnic Power Relations dataset, which tracks politically relevant ethnic populations, has been tied to specific UCDP actors to generate a measure of the ethnic composition of an armed group (Vogt et al., 2015). However, such a measure (*a*) only accounts for politically-relevant ethnic populations, overlooking socially relevant ones, and (*b*) does not vary to a large degree over time. This presents challenges as the measures for adaptive and innovative tactical behavior developed in Chapter 2 are highly variable. To match an adaptive outcome with such an aggregated measure of ethnic composition would require throwing away most of the variation in the metric.

Second, these empirical data are derived from the news and descriptive accounts of a violent organizations operations and behavior. Thus, the lens of the qualitative record is shaped by how the news and scholarship talk about membership features in a violent organization. A focus on membership outside the domain of forcible recruitment or child soldiers is largely non-existent[1] Thus, detecting the population within an organization is shaped by a fundamental description bias.

[1]A notable exception would be the recent reporting on the Islamic State's social media recruitment efforts for the campaigns in Iraq and Syria. In addition, some scholarship has focused more closely on recruitment dynamics as an important mechanism (Eck, 2014; Weinstein, 2006)

Backing out membership dynamics over time is complicated by the reality that cross-organizational specifics regarding membership are largely non-existent.

To examine the mechanisms at play given these challenges, I propose that the empirical record must be combed to generated observable proxies capable of capturing the—albeit error-laden—signals of interest. First, both the introduction of new and innovative solutions and the positive benefits of membership diversity are time sensitive. Thus, one needs to examine the process dynamically as is, not as retroactively portrayed. Second, membership diversity cannot be viewed empirically (i.e. complete membership logs and demographic data are unavailable), thus composition of an organization must be inferred. Finally, to examine the within-group processes, which are of theoretical interest, the between group differences need to be removed.[2] In the next section I outline a measurement strategy that aims to build viable proxy measurements that help one step beyond these limitations to understand the plausible differences in membership diversity across organizations.

6.2 Measurement Approach

In this section, I outline a measurement strategy that proxies for membership diversity by analyzing how often militant organizations are exposed to different ethnic populations. The metric seeks to isolate a plausible set of local populations that an organization could conceivably draw its membership from as a proxy for

[2]These contextual and between group effects are the primary focus in other studies focusing on information diffusion (Horowitz, 2010; Wahedi, 2018) and conflict environmental conditions, such as competition (Horowitz et al., 2017). However, in the current analysis, what is important is the inner dynamics of the organization, holding all other external factors constant.

a violent organization's potential labor pool. The measure yields a temporally variant understanding of the exposure over time for a relevant time period. Moreover, the data can be extended to any violent organization with a event history record (i.e. some record of geo-located event activity) to isolate the geographic occurrences of activity.

The focus on ethnic diversity over other forms of diversity is primarily driven by three factors. First, ethnicity as a source of social, cultural, and political differences has been of particular focus in political science for the last 50 years (Brubaker & Laitin, 1998; Chandra, 2006; Sambanis & Shayo, 2013; Valentino, 2014; Williams Jr, 1994). Second, multiple sources map the geographic position of relevant ethnic populations cross-nationally.[3] These data make it plausible to isolate the positions of different communities with a degree of precision. Co-ethnicity provides an important source of common information, and disparities across different ethnic groups is a plausible source to target when tracking the difference in knowledge distributions across members (Habyarimana et al. 2014).

Past research has sought to measure aspects of ethnic member composition in armed violent groups (EPR cite, CDC dataset cite). However, as noted, data on ethnic membership is inherently sticky and varies at best by year. Moreover, only dominant populations can be reliably identified as members in these armed groups, which biases these data against detecting minority populations participating within the collective. These realities limit the usefulness of these data as way of testing the theoretical mechanism. To get around these issues, I proxy for

[3]See below for more information regarding these data.

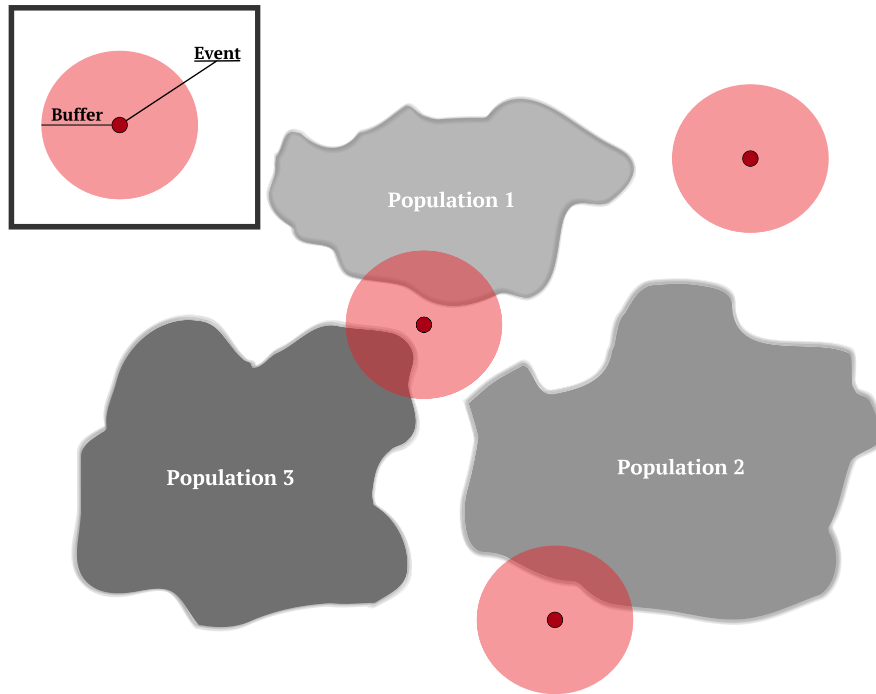
ethnic membership by tracking the spatial coverage of each armed actor over time. I then count the number of ethnic populations the organization is "exposed" to across time.

Figure 6.1 visualizes how the measure is constructed. For each violent event a militant organization produces, I use the geo-spatial coordinates to situate that event in space. I then draw a approximately 16 km radius circle around the event–which functions in drawing a 100 km circumference around the event with a total coverage of approximately 796 Sqr Km—and track all ethnic groups that fall within that spatial window.[4] The idea is that ethnic populations that are near where an organization operates have some non-zero probability of encountering and being absorbed by the group. As groups expand the geographic scope of their operations, they are more likely to encounter diverse populations. Moreover, geographic expansion also necessitates the need for more fighters, resulting in a reduction in selection criteria.

For data on the location of the various ethnic populations on the ground, I use the geoAMAR (J. Birnir & Satana, n.d.). The geoAMAR tracks all socially-relevant ethnic populations. GeoAMAR is the first geo-coded version of the entire AMAR sample frame of 1202 Socially Relevant Ethnic Groups delineated in J. K. Birnir et al. (2015). These data are ideal as the selection criteria into the sample does not discriminate to include only "politically relevant" ethnic populations as the EPR data does. This distinction is crucial as the theory places no emphasis on whether an ethnic population is politically activated; rather, it cares

[4]Note that the size of the buffer window can function as a tuning parameter to test for robustness. Smaller or larger windows will likely have some downstream impact on the size and significance of any estimated effects.

Figure 6.1: Illustrative example of the exposure metric



The illustration describes how the exposure metric is generated. Buffer windows are specified and placed around observed violent events. Ethnic population polygons are then projected onto the geo-referenced space. When a polygon and buffer overlap (as the middle and lower event points do) an exposure is counted. The buffer is designed to draw some range around an event. The assumption is that the organization of interest is not based at the location of the violent event but is plausibly based near by. As the number of events increases in the same area, so does the plausibility of the assumption.

only about the information that membership brings. Thus, geoAMAR expands the EPR groups to also include socially along with politically relevant ethnic populations, providing a more robust sample of groups. Note that titular or dominant groups, e.g. "whites" in the United States, are dropped, as they are coded as populating the entire country polygon.[5]

[5]The effect of the exposure to these groups can be effectively removed by adding a organization-level or country-level fixed effect.

If an event occurred near (where “near” is defined by the size of the window) to a distinct ethnic population as defined by AMAR, that ethnic group is added to a set of distinct groups. I then aggregate the data to the organization-month, and list the number of distinct groups encountered for that month. A measure can then be generated that counts exposure in two ways: as cumulative exposure and novel exposures.

Cumulative exposure accounts for the total number of distinct ethnic groups the organization has been exposed to over time. As the name states, the metric is the cumulative sum of the distinct ethnic groups encountered each month and thus is increasing. In order to reduce the likelihood of counting one-off encounters with ethnic populations, I set a criteria by which an ethnic population must be encountered six or more months before it is counted.[6]

Novel exposures count the total number of *new* ethnic populations encountered within a given month. Put differently, when an event within the specified window falls near an ethnic population never previous encountered within the organization’s time series, that ethnic population is counted as a “novel” exposure. This metric follows a Poisson process as most months pass without encountering a new ethnic population. It is important to note that locating a novel exposure is partially a function of the time window of the sample. That is, for organizations that were in operation long before the 1998 start date of my sample—for example, UNITA in Angola—the metric will count encounters as novel when they are anything but. If the organization’s existence is completely captured within the rel-

[6]This is an additional tuning parameter that can be adjusted to examine result sensitivity. In essence, it operates as a temporal bounds.

evant time window (e.g. Boko Haram in Nigeria) then this concern is diminished. With that said, I treat this artifact of the data as measurement error.

6.3 Applying the Metric

Utilizing the scheme outlined in the previous section, I generate ethnic exposure metrics for all organization-months in the sample of organizations outlined in Chapter 2. As a reminder, these organizations meet the UCDP definition of an armed actor, which is engaged in a violent challenge against the state.[7] The definition requires that 25 battle deaths be recorded for a country-year to qualify as a civil war year and an organization's activity to be tracked (Gleditsch, Wallensteen, Eriksson, Sollenberg, & Strand, 2002; Sundberg & Melander, 2013). When a country-year reaches the UCDP 25 battle death threshold, then violent activity is recorded. In this section, I detail the generation of the actual metric and probe it for plausibility by honing in on the detected exposure with other outside records.

All organizational activity is examined within the relevant time series: that is, all geo-referenced violent events that occurred between 1998 and 2016 are utilized to generate the exposure metric. If an event falls within the range of an ethnic population as defined in the geoAMAR, then the ethnic population is flagged as a potential exposure. Note that an event can be associated with more than one ethnic group if the event occurred next to a particularly diverse location, such as an urban center. Events where no ethnic association was located are dropped. I

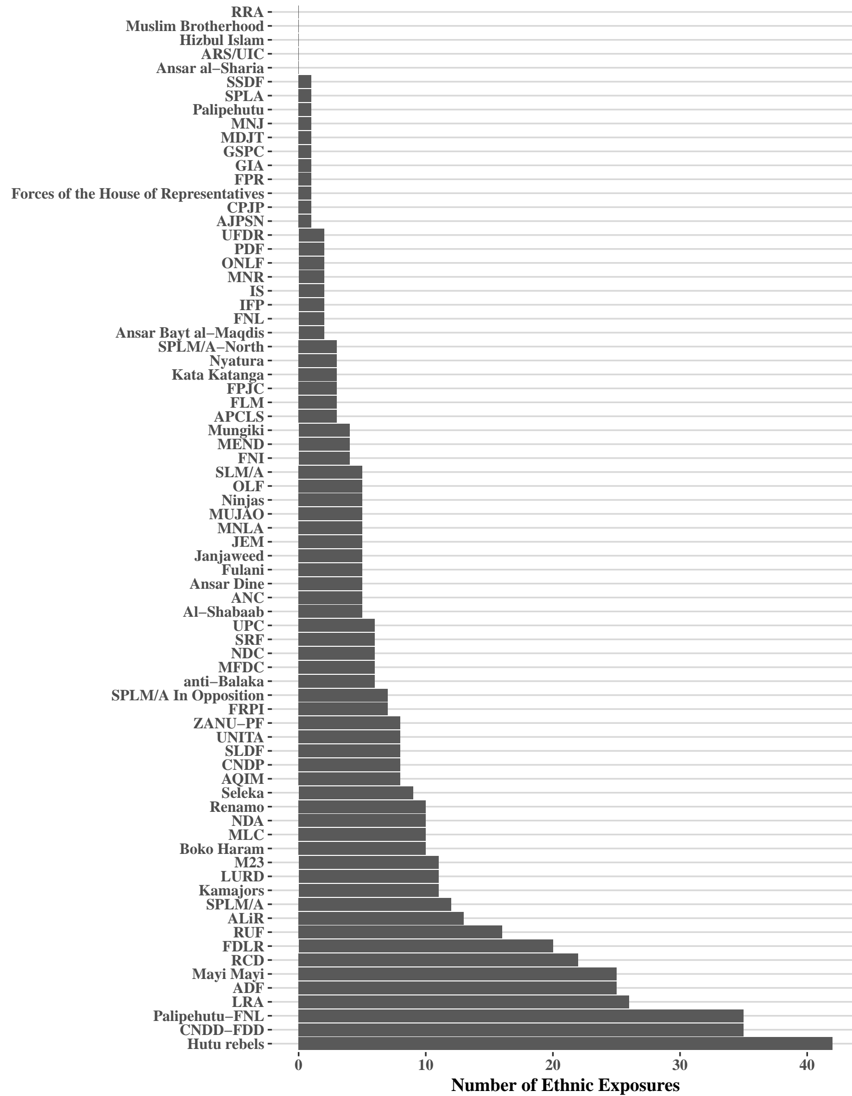
[7]Note also that an organization must have a sufficient time series to be incorporated into the sample.

then count the number of unique ethnic groups that are located within a given month, while simultaneously tracking across month periods for recurrent exposure.

As noted, an ethnic group is only counted as an exposure after the organization has encountered the group for six or more months. Some groups are rarely encountered and appear in the data due to a one-off event that drew the organization within proximity. However, it is less likely that the organization is exposed to that ethnic population as there is no evidence of repeated interaction. Put differently, when an violent organization operates regularly within a specific region, it is more likely the organization is based in that locality, and by extension, the organization is recruiting from that location. Evidence of repeated exposure then serves as a useful threshold for counting exposures.

Figure 6.2 describes the breakdown of the maximum number of ethnic populations in which the violent organizations in the sample are exposed to. There is substantial variation in the number of ethnic populations that an organization encounters. Some organizations, such as the Armed Islamic Group of Algeria (GIA), are rarely exposed to other ethnic populations, where as others are exposed to a large number of them, e.g. the Lord's Resistance Army (LRA). The differences in exposure are stark and highlight an important point: violent organizations often operate in and recruit from highly heterogeneous societies. Though these organizations can and do operate with an ethno-linguistic vision or mission, the demand for human labor highlights the importance of understanding *where* the organization operates over time. In short, the metric proxies for the possibility of membership given the realities on the ground.

Figure 6.2: Total number of ethnic population exposures by organization



The figure describes the number of detected ethnic exposures for each violent organization in the sample. Note that all titular and dominant groups are excluded from the count as these groups are seen as pervasive (and thus their membership need not be inferred).

6.4 Zooming in on Boko Haram

The true value of the metric can be immediately observed when considering the patterns and behavior of more recent violent organizations, such as Boko Haram. Prior data collection efforts—such as the ACD2EPR (Vogt et al., 2015)—have at-

tempted to identify the ethnic composition of armed groups, yet as noted, these efforts are temporally limited, aggregated, and difficult to update on the fly. Rather, by looking at exposures, one is able to define a potential set of different membership compositions.

The ethnic composition of Boko Haram is a case in point. The organization's violent campaign most notably kicked off in 2009 with the death of the group's leader, Mohammed Yusuf. Since then, the organization has conducted a diffuse campaign of violence and intimidation across Nigeria—with the majority of its efforts focused in the Northeastern quadrant.

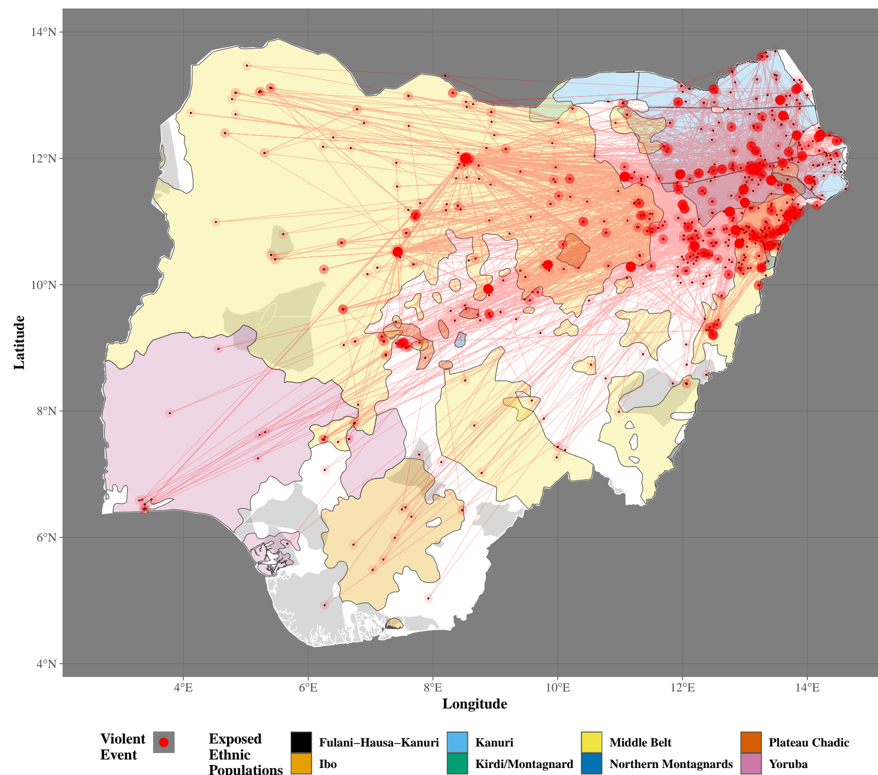
No information exists regarding the ethnic composition of Boko Haram. Data lists such as the ACD2EPR only extend to 2009 and thus offer no information regarding the composition of the group. Some NGO and governmental organizations have surveyed the group to understand the factors that contribute to recruitment. Specifically, a recent Mercy Corp report interviewed a non-random sample of ex-combatant youths. The sample was composed of individuals who identify ethnically with the Kanuri, Fulani, and Hausa ethnic groups—along with 12 other respondents coded as "other" ("Motivations and Empty Promises: Voices of Former Boko Haram Combatants and Nigerian Youth", 2016). In fact, one of the main conclusions of the report is that Boko Haram is ethnically, demographically, and socially mixed. So much so that the report highlights that standard at-risk categories don't seem to apply. Likewise, a scan of Factiva, Lexis Nexis, and other media aggregates yield a mixed bag when scanning the text associations with the organization's name and each ethnic group flagged in the AMAR data.

For most ethnic populations, a link can be made via media sources to almost every population on the list.

The metric can shed light on the potential composition as it takes into account where the group actually operates and the realities on the ground. To drive this point home, Figure 6.3 tracks all violent activity in Nigeria from 2009 to 2016. The data overlays the AMAR polygons on map of Nigeria. It then tracks all violent events conducted by or associated with the organization Boko Haram. The spacial buffers are denoted as windows and the sequence of events is denoted as a path. The figure highlights both concentration of specific activities but also the organization's reach. The color polygons (8 ethnic populations in total) are marked as exposures, whereas the grey polygons denoted populations (16 ethnic populations in total) that the organization was not exposed to given the conditions specified above.

Figure 6.3 highlights how, by tracking an organization's geo-spatial path of productions, one can gain insight into its potential labor source. Though imperfect, this approach makes some important advances. First, it merely requires information about where the organization operates to generate a set of potential members. This means the data can tell the researcher the plausible ethnic configuration and do so at a much faster rate than existing approaches. Second, the data relies on a list of *all* ethnic populations rather than just a subset of politically relevant ones. This is important as the value of knowledge diversity extends beyond whether or not a population is politically mobilized. Thus, the plausible set of participating ethnic groups is more expansive than prior data collection efforts.

Figure 6.3: Boko Haram's plausible set of ethnic exposures (2009 to 2016)



The figure maps all AMAR polygons of socially relevant ethnic populations to their estimated locations in Nigeria. The polygons in color denote the 8 distinct ethnic populations that Boko Haram was exposed to given the measurement strategy. The gray polygons denote AMAR groups that the organization was not exposed to (16 ethnic populations in total). The red points denote all violent activities perpetrated by Boko Haram from 2009 to 2016. The events are made transparent to convey the concentration of activity. Note that all "dominant" and titular groups (specifically, the Fon, Hausa, Hausa-Fulani) are excluded as these groups are pervasive in the country. The figure seeks to offer the reader an intuition regarding the use of event locations as a proxy for exposure.

6.5 Conclusion

This chapter outlined a method that tracked where violent organizational activity occurred as a way to map the set of ethnic populations that an organization was potentially exposed to. The approach lends itself to understanding the ethnic composition of newer, less studied violent organizations. Moreover, the approach is data-driven, which provides an easy framework of tuning parameters in which to adjust one's definition of proximity. The result is a viable strategy for inferring the ethnic diversity of an organization's membership composition. As Figure 6.2 demonstrated, violent organizations differ markedly in the number of ethnic populations that they are exposed to, and that this offers valuable insights into the composition of a population that is not immediately observable.

Naturally, using the proximity of ethnic populations to a militant organization as a proxy for membership is inherently problematic. First, organizations may commit violence near specific populations because they are targeting those populations. Thus, a measure would include these populations as potential members when they are anything but. Second, the idea that proximity is equivalent to membership fundamentally overlooks the processes that bring individuals into an organization. Specifically, resource and social endowments may attract different populations of individuals (Weinstein, 2006). Though these are important limitations to keep in mind, I argue that an exposure metric at the very least offers some insight regarding the *potential* population of members that could be in the organization. It does so at a fine degree of temporally granularity—which more rigorous but static measures lack. More importantly, the key mechanism has to

do with knowledge diversity. I contend that diverse types of information can pass into a group via some second order process (e.g. members interacting and learning from non-combatant populations, even if those populations are not necessarily members in the group). Thus, the measure reflects the reality that exposure to diversity is prevalent and possible.

Chapter 7

Testing the empirical implications of the theory

This chapter puts the metrics developed and generated in Chapters 2 and 6 to work in an effort to test the main observable implications of my theory on diversity and adaptation. I employ a range of econometric models that seek to establish a correlative relationship between the diversity of a violent organization's membership and its capacity to adapt and innovate. Table 7.1 restates the testable hypotheses outlined at the end of Chapter 5. The main conclusion of the table is that knowledge diversity in an organization drives adaptation within an organization's violent productions. To explore these features, I employ variants on both the adaptation and ethnic exposure metrics while controlling for potential confounding variables that result in spurious conclusions.

The chapter proceeds as follows: section 7.1 establishes the main variables in the analysis. Though chapters 2 and 6 focus on the measurement of the two

Table 7.1: Summary of the Testable Hypotheses from Chapter 5

Hypothesis 1	Violent non-state organizations with heterogeneous members will be more innovative than organizations with homogeneous members.
Hypothesis 2	As *all* violent non-state organization age, they will become less innovative.
Hypothesis 3	The relationship between a violent non-state organization's age and likelihood of innovating will be non-linear (concave).
Hypothesis 4	Given heterogeneous membership, violent non-state organizations with highly committed members will be *more* innovative than organizations with less committed members.

main concepts of interest, the analysis here takes different features of these metrics when estimating the conditional correlations and thus some exposition is needed. In addition, I lay out all the control variables of interest and the decision in modeling strategy. Section 7.2 delves into the main empirical analyses. Each subsection contained within looks at the data in a different way, aiming for a more comprehensive probing of the effects. Finally, section 7.3 offers a brief discussion and conclusion. The main finding from the chapter is robust support for the theory's relationship, with some interesting variations in sign and direction of some of the variables of interest. All in all, this chapter establishes empirical support for the theoretical discussion.

7.1 Data

This section outlines the data utilized in the main analysis and establishes key control variables in the design. The unit of analysis is set at the organization-month. Thus, all metrics are aggregated to that level. Consistent with the other chapters,

a violent organization is defined as an armed organization that is engaged in an internal armed conflict where there exists some incompatibility regarding government and/or territory where at least 25 battle-related deaths occurred within a year (Gledistch et al. 2002). All organizations in the sample reached this threshold at some point during the relevant time span (1997 to 2016). Note, however, that the use of integrated data entails that these organizations are tracked even for years when they did not meet the 25 battle-related death threshold (see Donnay et al. 2018). The UCDP definition is used primarily to define the sample of actors but not their activity (for more details see Chapter 2).

The following subsections delve into the main dependent, independent, and control variables. Though the DV and IV draw from the lengthy discussions in Chapters 2 and 6, I include some variations on the specifications outlined there, thus meriting some discussion here. For the control, I outline how each is generated and how it is relevant. The section concludes with a table offering summary statistics of each metric.

7.1.1 Dependent Variables

To empirically examine the implications of the theory, I utilize the adaptation metric (hereafter 'ADAPT') designed and tested in Chapter 2, which measures tactical adaptation for 75 violent non-state actors operating on the African continent from 1997 to 2016. As a reminder, the ADAPT data leverages raw textual descriptive accounts in an armed actor's event history time series to track how similar an event perpetrated at time t is to the events that preceded it. Event

descriptions are decomposed into an array of topic feature weights, which are manually reviewed and cleaned. Events are then compared using these numeric features weights. The metric measures the degree to which an organization mixes or repeats violent repertoires by generating a scale ranging from 0 to 1 regarding how similar events are to one another. The measure is then standardized so that global mean (i.e. the mean across all organizations) is centered around 0 and the variation constrained to 1. The ADAPT data offers contextual the relative differences between violent productions by contextualizing and comparing events in its appropriate historical sequence.

For the purposes at hand, I leverage three features of the ADAPT data. The first is the standardized adaptation metric that varies by month as outlined above. The second metric seeks to get at both the size of an organization's menu of tactics and targets (i.e. the cumulative size of the organization's available repertoires). The final metric examines novel activations of a specific repertoire. That is when there is an incremental expansion of the existing set of repertoire features, which I refer to as an "incremental innovation."

The cumulative repertoires and novel activations are generated by leveraging the topic feature weights used to compare events when generating the ADAPT metric. As a reminder, the feature weights reduce the unstructured descriptions down to their composing weapon, target, and situational features that make up an event description. The novel activation of a feature in a event history series indicates an incremental change in the organization's violent repertoire. For example, in its initial years, Boko Haram relied on drive-by shootings and petrol

bombs aimed at community members and religious institutions. Shortly after, it began using suicide bombings and IDEs to target police and government officials. The initial usage of these targets, weapons, and situations would be counted as a novel feature activation—as these feature weights were not previously activated in the organization's series.

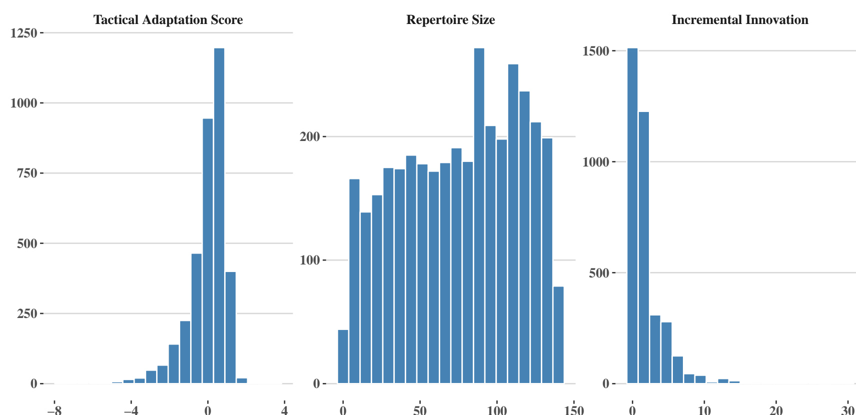
The topic weights are counted when a novel topic feature is activated within an organization's time series.[1]

The motivation for utilizing these measures in addition to the adaptation metric is as follows. The primary implication of the theory is that knowledge diversity among an organization's membership and learning through repeated interaction drives the emergence of novel responses. However, the processes that drive adaptive behavior are likely multifaceted. McAdam (1983) argues that tactical adaptation emerges from a strategic interaction with the state. Responses and counter-responses necessitate adaptation. Moreover, basic game theory highlights the importance of mixing strategies as an equilibrium solution (i.e. specifically mixing strategies to the point where the opponent is indifferent) (Dixit & Skeath, 2015). To say that membership diversity alone is the sole driver of adaptive behavior within organizations would be an oversimplification, to say the least. Rather, examining the cumulative size of an organization's repertoire and the timing of its incremental innovations seeks to unpack further the theoretical outcome. In

[1] Formally, a topic weight is only considered as "activated" when topic label feature weight w_i is $w_i > 0$. Moreover, I only consider substantive activation of a weight. That is, for each non-zero weight for event j, I only refer to a weight as activated if it makes up 1% or more of the total activated feature. $W_j^* \subset W_j$ and $w_{ij}^* \in W_j^*$ where all members satisfy the following $w_{ij}^* > 0$. Thus, the proportion is determined as follows: $\frac{w_{ij}^*}{\sum_{i=1}^{F} w_{ij}^*}$ where F is the size of subset W_j^*. Only weights that exceed the 1% threshold are considered activated for a given event j.

short, adaptation and innovation are entwined. By decomposing these features, I seek to probe the mechanism more closely. Figure 7.1 presents histograms for the three outcome metrics.

Figure 7.1: Distributions of the dependent variables by organization-month



Ultimately, the assumption is that the more repertoires a militant organization has available, the more able it is to mix those repertoires in adaptive ways. Though strategic factors underpin the decision to mix strategies, organizations must have repertoires already established from which to draw or they must generate new ones. The smaller the menu of strategies to choose from, the less able an organization is to mix. The relationship between the size of an organization's available repertoires along with its capacity to innovate can be seen in Table **??**. Table **??** details the OLS coefficients for three models. The first regresses the cumulative number repertoire (`Repertoire Size`) on an organization's adaptation score, controlling for the number of events in that month and lagging the dependent variable by three periods to account for auto-correlation. In addition, the models include group and year fixed effects to account for time period and group specific variation.

The second model regresses the number of novel feature activations (i.e. the label activation outlined above) (`Incremental Innovation`) on the adaption score for a violent organization, using the same controls. Lastly, the third model combines both indicators.

Table 7.2: OLS regression of repertoire size and incremental innovations on the level of tactical adaptation of violent organizations

	Tactical Adaptation		
	(1)	(2)	(3)
ln Repertoire Size	0.042***		0.050***
	(0.007)		(0.007)
Incremental Innovation		0.010***	0.012***
		(0.002)	(0.002)
ln No. of Events	−0.025***	−0.025***	−0.027***
	(0.002)	(0.002)	(0.002)
Tactical Adaptation$_{t-1}$	0.295***	0.300***	0.292***
	(0.017)	(0.017)	(0.017)
Tactical Adaptation$_{t-2}$	0.123***	0.125***	0.118***
	(0.017)	(0.017)	(0.017)
Tactical Adaptation$_{t-3}$	0.073***	0.084***	0.071***
	(0.014)	(0.014)	(0.014)
Organization FE	✓	✓	✓
Year FE	✓	✓	✓
Observations	3,337	3,337	3,337
R^2	0.448	0.449	0.456
Adjusted R^2	0.431	0.432	0.440
Residual Std. Error	0.073 (df = 3238)	0.073 (df = 3238)	0.072 (df = 3237)
Unit of analysis:			Organization-Month
Note:			*p<0.1; **p<0.05; ***p<0.01

For all three models, there is a substantively strong and statistically significant effect of both the size of an organization's repertoire and the number of new repertoires introduced within a month on the level of tactical adaptation. Recall that the `Tactical Adaptation` score is grand mean centered around 0 and that positive values denote more adaptive behavior (i.e. events are dissimilar to the events

that came before them) and negative values denote routine behavior (i.e. how similar events are to one another). Both the cumulative size and the introduction of new repertoires are positively associated with more adaptive behavior.

The purpose of Table **??** is to establish the relationship between outcomes such as incremental innovation—of which Chapters 4 and 5 theorize about directly—and the tactical adaptiveness of groups. The models demonstrate that a larger menu of options an organization has to choose from and its propensity to innovate are positively correlated with mixing tactics. As demonstrated in Section 2.4.1, the more adaptive or unpredictable a violent organization is, the more likely it is to achieve negotiations and concessions. Linking adaptation to features of innovation and repertoire size demonstrates how one can decompose adaptation into a range of theoretically important metrics.

7.1.2 Independent Variables

In this section I outline the main independent variables in the analysis. Specifically, the theory makes predictions about membership diversity (H1), the organization's age (H2 and H3), and the level of commitment of the organization's members (H4). I explain how I measure each concept and the logic underpinning each coding decision.

First, in the previous chapter (Ch. 6), I outlined a measurement strategy that proxies for membership diversity by considering the ethnic populations that an organization comes in contact with. I demonstrated that there exists substantial variation in the number of ethnic populations that an organization is plausibly

exposed to.[2] I use this exposure metric to generate two variables. The first metric follows entirely from Chapter 6 and counts the relevant number of ethnic populations that an organization is exposed to over time (`Relevant Exposures`). The metric is cumulative over time and seeks to capture the underlying level of potential diversity in the organization.

The second metric considers the timing of novel exposures to an ethnic population(s). That is, the impact that an new exposure has on one of the three outcomes outlined in the previous subsection. To generate this metric, I use a rolling window that counts the number of exposures that occurred within a specified period. Specifically, I establish three temporal windows at three, six, and nine months. When there is any exposure within the last k number of months, then the `Novel Exposure` variable takes the value of 1 and zero otherwise. One of the implications of the theory is that the introduction of a new knowledge distribution into the organization takes time to yield any positive effects on an organization's innovative capacity. However, the theory is agnostic regarding how long one should expect the effect to emerge. As such, I use these rolling windows to establish that an novel exposure occurred within a specified window.[3] In addition, as the exposure metric is already error-laden, I convert it to a indicator variable rather than a raw count to better isolate the general effects.

[2]As a reminder, how one defines exposure is sensitive to two key tuning parameters. The first concerns the size of the buffer window that is draw around events and the second is the number of time points that an organization has to come in contact with a specific population before considering it an exposure. I establish a 15.92 km radius from an event, which generates a 100km circumference around an event (with the event location at the epicenter). I then count the number of distinct exposures an organization has each month. When an organization has been exposed to the same population for six months, I count this as an exposure.

[3]Note that adjusting the window to three months, nine months, or one year does not change the empirical findings outlined below.

Second, the theory makes prediction that there will exist a concave relationship between the likelihood of observing innovative behavior and an organization's age. Horowitz (2010) argues that as violent organizations age, they are less likely to adopt new tactics as expertise generates incentives to stay with known methods of production. Horowitz finds support for this conclusion, yet only treats the relationship as a linear one. An interesting insight from the simulation in Chapter 5 is that the relationship between an organization's age and its innovative capacity should be curvilinear. Specifically, as members learn from one another, their knowledge distributions begin to converge. Once they converge, the benefits offered by membership diversity begin to diminish as the novel information has been in effect 'consumed' (see Figures 4.2 and 5.4). I include the organization's age and age squared. `Age` is specified as the number of organization-months that a specific violent actor is in the sample. The squared term allows the relationship to be curvilinear. The expectation is that the relationship is concave, thus the coefficient on the squared term should be negative.

Lastly, the theory makes predictions about the level of commitment of each member as an important factor that shapes how members view their participation in the organization, and in turn, their willingness to learn. The argument is that less committed members will view their participation as being more transactional than more committed members who invest in the organization and its mission. Keeping with previous work regarding resource endowments and recruitment (Weinstein, 2005, 2006), I leverage information regarding the potential types of resources that an organization is exposed to as a proxy for the commitment level

of an organization's membership. Specifically, I use data regarding the location of lootable resources (such as diamonds, gold, gems, and drugs) using the PRIO-grid as the geographic unit of analysis. The PRIO grid draws 55kmX55km grids around the world and codes on each grid important geographic, resources, and demographic information (see (Tollefsen, Strand, & Buhaug, 2012)). Among these data is information recorded on the specific location of different types of resources located in a grid cell. The measure `Accumulated Resources` is sum of the total number resource grid cells the group has operated in.[4] The idea is that the higher the number of grid cells, the more resource wealth contained within the organization, which in turn will yield a higher concentration of less committed members (Weinstein, 2006). The expectation then is that as the number of `Accumulated Resources` the likelihood of adaptation or innovation should decrease.

7.1.3 Control Variables

In addition to the main dependent and independent variables, I introduce a number of important controls to account for potential confounding factors. The first among these are fixed effects to remove organization and year-specific effects from the outcome.[5] These fixed effects soak up all the between organization and year variation. Thus, only the within organization-year effects are captured. By including an organization fixed effect, I am able to control for organization-specific

[4]Again, by "operated in" I mean that the organization committed a violent event at geographic position that falls within the respective grid cell.

[5]Note that when running an intraclass correlation on the three outcomes, a country grouping variable exhibited no meaningful variation in the dependent variable. Moreover, organization and country fixed effects for some organizations in the sample are perfectly co-linear, as those organizations do not operate in multiple countries.

factors such as ideology. This is vital as most organizational level factors recorded for the organizations in the sample do not vary by month (the temporal unit). More importantly, the theory is not about differences between groups or how they are connected, as is the case with other theories on tactics and adaptation (Horowitz et al., 2017; Wahedi, 2018). Rather, the theory is concerned with the internal drivers of adaptation and innovation *holding organizational and environmental features constant.*

Another important confounding variable concerns the `Geographic Coverage` of the organization. As the ethnic exposure metric leverages where organizations operate in order to make inferences about the internal composition of the group, one could reasonably question if this effect is entirely driven by the organization's capacity to cover territory. Put differently, organizations that are capable of covering more territory are functionally different from those that stay put (Beardsley et al., 2015). In a similar vein, some have argued that the choice between conventional and terrorist-style tactics are driven by an organization's capacity to hold territory (De la Calle & Sánchez-Cuenca, 2015). Thus the observed differences in the adaptive capacity of an organization may be a feature of territorial expansion and not diversity. The important point is that territorial expansion is somewhat included in the ethnic exposure metric. Thus, to parcel out expansion from exposure it is important to include some metric of geographic coverage in the model.

To measure an organization's geographic coverage, I count the total number of level 1 administration units that the organization operated in across the duration of

the sample. Specifically, I track the locations where an organization produced a violent event and isolate the administration unit in which the event occurred. I then sum the total number of locations by month. Thus, the `Geographic Coverage` variable captures the total number of administration units that the group has operated in over time.[6]

Finally, I control for the level of activity by including a measure for the number of events an organization commits within a given month (`N Events`). Violent organizations may be more likely to innovate and experiment given their level of activity. This could be due to two mechanisms: first, more activity increases the number of opportunities for deviations as the rate of production is higher for more active organizations. Alternatively, a higher production rate could potentially be a feature of standardization and expertise. As such, organizations that produce more events are less innovative as they have effectively standardized their production method (think "McDonalds of violence"). The theory is agnostic about the direction and impact of this effect; however, it serves as an important control.

In summary, Table 7.3 offers descriptive statistics for each of the measures outlined in this discussion on data.

[6]Note that I also generate the same measure using the PRIO grid, which draws 55km by 55km grids around the world (see (Tollefsen et al., 2012)). I track activity within different grid cells in precisely the same fashion as the administration units. The use of this measure in place of the one using the administration unit yielded similar findings. I use the administration unit metric in the main analysis as this geographic unit is more widely known.

Table 7.3: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Tactical Adaptation	3,560	−0.015	0.993	−7.732	3.507
Repertoire Size	3,560	76.212	38.359	1	141
Incremental Innovation	3,560	1.733	2.700	0	30
Relevant Exposures	3,560	6.755	8.421	0	42
Novel Exposure (3 Month Window)	3,560	0.265	0.441	0	1
Novel Exposure (6 Month Window)	3,560	0.401	0.490	0	1
Novel Exposure (9 Month Window)	3,560	0.506	0.500	0	1
Organization Age	3,560	81.011	66.182	1	239
Accumulated Resources	3,560	7.292	7.612	1	32
Number of Events	3,560	1.687	0.941	0.693	5.252
Geographic Coverage	3,560	2.474	0.899	0.000	4.143

7.2 Analysis

The empirical implications generated from the computational simulation in Chapter 5 offers important mechanisms regarding why some organizations are more adaptive and innovative than others. As argued, an important driver for innovation lies in membership diversity, or more specifically, knowledge diversity. In addition to membership diversity, two key conditioning factors are also of importance. Specifically, the age of an organization and the level of commitment shapes how organizations learn and absorb information from the fellow participants. In this section, I test the main implications of the theory using a series of regression models. Each empirical model and discussion is cordoned off into its own subsection in an effort to organize the different analyses.

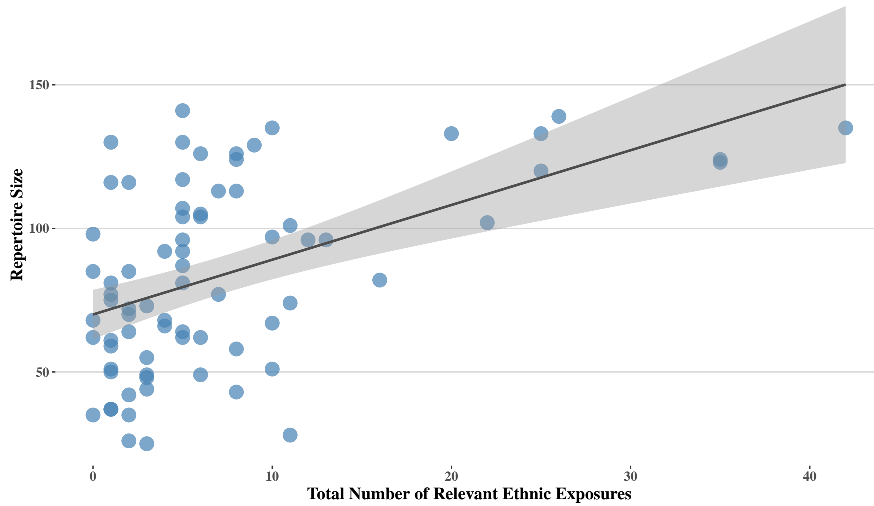
7.2.1 Total number of exposures on the size of a violent organization's tactical repertoire

First, I consider the relationship between the size of an organization's menu of repertoires and the number of population exposures the organizations experience. Put differently, do violent organizations with higher number of ethnic exposures have a larger basket of tactics from which to draw? To examine this question, I aggregated the data to the organization level as the temporal dimension is not immediately relevant. This aggregated probe allows one to assess the between group differences.

Table 7.4 presents three separate models. Model 1 looks at the relationship between the maximum number of exposures an organization experienced and the total size of its repertoire. Model 2 adds the maximum number of administration units that the organization operated in. Finally, Model 3 incorporates other relevant controls such as the organization's age, the average number of events per month, and the maximum number of grid resource units the organization came in contact with.

To start, I represent the bi-variate relationship in Model 1 graphically in Figure 7.2 with the linear fit represented in gray. The figure shows a clear positive trend between the exposures an organization experiences and the size of its tactical menu. There is a clear positive and statistically significant relationship between the number of ethnic populations an organization is exposed to and the size of its strategic repertoire.

Figure 7.2: Number of ethnic exposures on the size of a violent organizations menu of repertoires



Each point represents one of the 75 organizations in the sample. The gray line describes the best linear fit between the two variables. The gray bands denote the 95% confidence intervals.

Models 2 and 3 in Table 7.4 inject important context into the model. The addition of the Geographic Coverage variable yields a strong substantive effect on the size of an organization's repertoires. This is to be expected as organizations that are more geographically dispersed are shown to employ a wider array of tactics (Beardsley et al., 2015). With that in mind, ethnic exposure still maintains a positive and statistically significant effect. Likewise, the introduction of the main controls reduces the substantive impact of the exposure variable slightly, but the effect still holds. Moreover, note that the average number of events an organization produces is highly related to repertoire size. It would appear when comparing across groups that more active organizations are on average more innovative. Interestingly, organizational age has a positive effect on the size of an organization's repertoire and is not statistically significant at conventional levels, which would

run counter to previous findings (Horowitz, 2010). Finally, resource accumulation is negative as expected but does not exhibit a statistically significant effect.

Table 7.4: OLS regression of ethnic exposure on repertoire size

	Repertoire Size		
	(1)	(2)	(3)
Total Relevant Ethnic Exposures	1.907***	1.101***	0.763***
	(0.384)	(0.291)	(0.284)
Total Geographic Coverage		24.571***	16.654***
		(2.928)	(3.313)
Total Accumulated Resources			−0.141
			(0.242)
Organizational Age			4.072
			(3.760)
Ave. Number of Events			23.237***
			(5.243)
Constant	70.016***	14.875**	−1.626
	(4.314)	(7.261)	(8.051)
Observations	75	75	75
R^2	0.252	0.622	0.711
Adjusted R^2	0.242	0.611	0.690
Residual Std. Error	28.330 (df = 73)	20.284 (df = 72)	18.108 (df = 69)
F Statistic	24.626*** (df = 1; 73)	59.222*** (df = 2; 72)	33.990*** (df = 5; 69)

Note: *p<0.1; **p<0.05; ***p<0.01
All data is aggregated to the organization level for the 75 organizations in the sample.

7.2.2 Diverse exposures on observed levels of tactical adaptation

The model in the above subsection established that the more exposed a violent organization is to a diverse array of ethnic populations, the larger its menu of available tactical repertoires. In this subsection, I will examine if exposure exhibits a similar relationship regarding how adaptive violent organizations are. As demonstrated in Section 2.4.1 in Chapter 2, the more adaptive violent organizations are (i.e. the more they mix their usage of tactics verses utilize the same over and over again), the more successful they tend to be.

I examine the relationship between membership exposure and the capacity for violent organizations to adapt. I run a series of models that look at the ethnic exposure variable in different ways. The first model utilizes the Relevant Exposures variable, which counts the cumulative number of ethnic exposures over time, while Models 2 through 4 offer the novel exposure indicator variable set at different windows. Again, the measure captures if a novel exposure occurred within the set window (e.g. in the last 6 months), 0 otherwise. Showing the estimates across the different windows is important as there is no clear guidance from the theory regarding when one should expect to see the positive benefits of diversity and endogenous learning. Thus, the windows allow a way of specifying a temporal range. Given the potential sensitivity of the results to the way this range is specified, I present three plausible windows: three months, six months, and nine months.

Table 7.5 reports the results from the four OLS models with robust standard errors. The complete model for each configuration is shown. I present the complete model both to save space, but also as an necessity: the main control variables, such as organization fixed effects and the geographic coverage of the organization in a given month, are vital here as they allow for one to isolate and control for the myriad of potential confounders.

The findings from Table 7.4 are illuminating. Keeping with Hypothesis 1, Model 1 shows that organizations that are exposed to more ethnic populations are more tactically adaptive. When looking at the effect of an exposure to a new ethnic population, Models 2 through 4 show that there is a positive boost

Table 7.5: OLS models of exposure metrics on tactical adaptation

	Tactical Adaptation			
	(1)	(2)	(3)	(4)
Cumulative Ethnic Exposures	0.008**			
	(0.041)			
Novel Exposure (3 month window)		0.110***		
		(0.003)		
Novel Exposure (6 month window)			0.105***	
			(0.003)	
Novel Exposure (9 month window)				0.076**
				(0.034)
ln Accumulated Resources	0.008	0.020	0.018	0.016
	(0.826)	(0.569)	(0.621)	(0.650)
Organization Age/100	−1.254***	−1.065**	−1.060**	−1.105**
	(0.009)	(0.027)	(0.028)	(0.021)
Organization Age^2/1000	−0.005	−0.007	−0.008	−0.008
	(0.431)	(0.281)	(0.200)	(0.219)
ln Geographic Coverage	0.235***	0.237***	0.226***	0.226***
	(0.001)	(0.001)	(0.001)	(0.001)
ln Number of Events	−0.327***	−0.336***	−0.336***	−0.332***
	(0.000)	(0.000)	(0.000)	(0.000)
Tactical $Adaptation_{t-1}$	0.189***	0.189***	0.189***	0.189***
	(0.000)	(0.000)	(0.000)	(0.000)
Organization FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	3,485	3,485	3,485	3,485
R^2	0.153	0.154	0.154	0.153
Adjusted R^2	0.128	0.129	0.129	0.128
Residual Std. Error (df = 3384)	0.880	0.879	0.879	0.880
F Statistic (df = 100; 3384)	6.100***	6.150***	6.152***	6.100***

Note: *p<0.1; **p<0.05; ***p<0.01
Unit of analysis set at the organization-month
Robust standard errors reported in parenthesis.

in the level of tactical adaptation regardless of how one specifies the window. This provides support for the theoretical argument that membership diversity can positively impact an organization's innovative capacity.[7]

[7] That said, it is important to re-emphasize that exposure is merely a proxy for the potential demographics in an organization, and thus, these results should be interpreted cautiously.

The control variables also offer some interesting insights. First, the number of events is negatively associated with the adaptiveness of organizations. This runs in contrast to the positive relationship between the average number of events and the size of a violent organization's repertoire presented in Table 7.4. This appears to indicate that higher production rates offer a greater opportunity for expanding an organization's strategic menu. When business is good, there is more room to use resources experimentally. However, the negative relationship in Table 7.4 indicates that higher production rates are also associated with more formulaic productions. That is, organizations are capable of producing events at higher rates precisely because they have standardized production (i.e. they have routines to which they easily return). In essence, more productive organizations are so due to their ability to create routine procedures. What is interesting is that such standardization of productions undermine the ultimate goal of the organization, as predictable organizations tend not to get a seat at the negotiating table (see Section 2.4.1).

Second, as expected, the Geographic Coverage of a violent organization is positively associated with its level of adaptation. This finding holds with prior work. De la Calle and Sánchez-Cuenca (2015) argue that the decision to use terrorism by an organization is shaped by whether the group can hold territory or not. Organizations that cannot do so are forced to employ surprise tactics precisely because the organization is not strong enough to hold its own ground. Beardsley et al. (2015) argue that violent organizations that lack ethnic ties and sufficient military capacity are more likely to be geographically dispersed. Thus,

given these findings, one should expect a positive association between geographic coverage and the ability to mix tactics. For the purposes of this analysis, the Geographic Coverage variable also serves as a vital control as the exposure metrics are all a function of the spatial location of events.

Finally, both organizational age and resource accumulation do not behave as entirely expected by Hypotheses 2 through 4. With regard to resource accumulation, the effect is positive but not statistically significant. Resources intend to serve as a proxy for the level of commitment in the organization. The theory argues that less committed members will have shorter time horizons, view their participation in the organization as transactional, and will be less likely to learn from other members. At least with regard to the adaptiveness of organizations, resources appear to have little effect on a violent organization's propensity to mix strategies.

Organizational age has a strong negative effect on how tactically adaptive organizations are; however, there is little evidence that the shape of the effect is concave (as argued by Hypothesis 3). Rather, the effect is downward sloping, keeping with hypothesis 2 and past explanations — such as Horowitz (2010) who argues that professionalization drives the creation of expertise that reduces novel adoption. That said, the implications from the theoretical simulation presented in Chapter 5 also contends that innovative capacity of organizations will diminish over time, but that this is due to endogenous learning as disparate knowledge distributions converge. It is not surprising that isolating a concave relationship is difficult in this context as the age of an organization itself is not what matters,

but rather *time since* a new knowledge population entered into the organization—which is difficult to isolate with any precision given the current measurement strategy.

Table 7.5 demonstrates support for the theory; however, the observed level of tactical adaptation is a downstream implication of an organization's innovative capacity as shown in Table 7.4. In this regard, it is useful to isolate the specific incremental innovations in an organization's repertoire in order to understand the impact the exposure has on the organization's innovative capacity.

7.2.3 Diverse exposures on the number of incremental innovations

In the last subsection, I show that violent organizations that are exposed to more diverse populations are more adaptive on average. Membership diversity is theorized to increase an organization's adaptive capacity by injecting disparate forms of knowledge into an organized collective. However, as noted, the processes that drive tactical adaptation are both internal (as argued) and external (Horowitz et al., 2017). The motivations that underpin an organization's choice to mix strategies is only partially understood when considering an organization in isolation from the larger context in which it is situated. Acknowledging this fact, this section looks at an violent organization's contentious repertoire and examines when new repertoires are activated. Put differently, when do organizations incrementally add on and innovate their tactical repertoires?

The theory argues that this process of innovation emerges when individuals with disparate types of knowledge interact with the organization's problems. I examine this process more closely by looking at the number of novel incremental innovations that occur in a given organization-month. Again, an incremental innovation is the novel activation of a topic feature. As outlined in detail in Chapter 2, event descriptions are decomposed into relevant topics that are then used to compare events numerically. I treat these features as distinct repertoires and track their activation in an organization's time series. Though imperfect, the metric offers a rough picture of incremental innovations within an organization.

As with the previous table, Table **??** presents four models, each showing the effect of a different exposure metric. Model 1 uses the relevant cumulative ethnic exposures whereas the other three capture a novel exposure given different temporal windows. The table shows some surprising results. First, the impact of cumulative number of ethnic exposures is *negative*, which runs in contrast to the other models, whereas the novel exposures are positive and statistically significant for all three time windows. The implications of the sign flip for the cumulative exposures is discussed in greater detail below. Second, the geographic coverage variable switches signs and is associated with a reduction (rather than an increase) in the number of incremental innovations. Third, the resource accumulation variable now behaves as predicted by Hypothesis 4. That is, more resources reduce an organization's innovative capacity—where again the mechanism has to do with the commitment level of the organization's membership. Fourth, the organization age variable is still decreasing, however, the relationship appears convex. Finally,

Table 7.6: Count models of exposure metrics on the number of incremental innovations

	Incremental Innovation			
	(1)	(2)	(3)	(4)
Cumulative Ethnic Exposures	-0.097^{***} (0.000)			
Novel Exposure (3 month window)		0.155^{**} (0.039)		
Novel Exposure (6 month window)			0.168^{**} (0.029)	
Novel Exposure (9 month window)				0.166^{*} (0.052)
ln Geographic Coverage	-0.081 (0.121)	-0.166^{***} (0.001)	-0.171^{***} (0.001)	-0.171^{***} (0.001)
ln Accumulated Resources	-0.695^{***} (0.000)	-0.738^{***} (0.000)	-0.756^{***} (0.000)	-0.764^{***} (0.000)
Organization Age/100	-4.382^{***} (0.00000)	-4.896^{***} (0.00000)	-5.015^{***} (0.00000)	-5.089^{***} (0.00000)
Organization Age^2/1000	0.110^{***} (0.000)	0.109^{***} (0.000)	0.107^{***} (0.000)	0.108^{***} (0.000)
ln Number of Events	0.641^{***} (0.000)	0.610^{***} (0.000)	0.610^{***} (0.000)	0.614^{***} (0.000)
Organization FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	3,601	3,601	3,601	3,601
Log Likelihood	−2,644.698	−2,701.957	−2,701.918	−2,702.596
Akaike Inf. Crit.	5,489.395	5,603.913	5,603.837	5,605.192

Note: *p<0.1; **p<0.05; ***p<0.01
Unit of analysis set at the organization-month
Robust standard errors reported in parenthesis.

the number of productions is now positively associated with the expected number of incremental innovations.

The results in Table ?? stand in contrast to those in Table 7.5. This is not surprising. Table 7.5 examined the processes that underpin adaptive behavior; however, as noted, the drivers of tactical adaptation are part innovative capacity and part exogenous stimuli. By contrast, Table ?? examines the specific processes that motivate innovation. The results from Models 2 through 4 in Table ?? provide

support for the theory. Organizations exposed to new sources of diversity are more likely to innovate.

At first glance, Model 1 in Table **??** appears to run counter to the theoretical argument in Chapters 4 and 5. However, the results appear to indicate an important limitation to diversity. As organizations become more and more diverse they may inadvertently introduce new organizational challenges, such as creating new barriers to communication and coordination. Likewise, diversity may potentially increase the propensity for factionalism in a violent organizations. Thus, while the introduction of new exposure increases the likelihood of innovating (as seen in Models 2 through 4), the weight of diversity itself may have diminishing benefits. Put differently, the introduction of disparate forms of knowledge may boost how an organization collectively solves problems, yet diversity itself may create roadblocks that hinder cooperation, thus muddying how individual members interact.

This is an interesting implication that lies outside the scope of the current theory but provides an important avenue for future research. When considering the benefits of diversity, apparently there is such a thing as "too much of a good thing." The adverse impact that diversity can have on organizations needs to be explored in greater detail, but at least with regard to the current analysis, the cumulative number of groups appears to retard the number of incremental innovations expected over time.

7.2.4 Unpacking Hypothesis 4: Testing the endogenous learning hypothesis

One of the main mechanisms outlined in Chapters 4 and 5 argues that participation in an organization is an experience unto itself and that members learn endogenously by interacting with other members. The simulation treated three conditions under which learning occurred at low and high rates or not at all. There I argued that learning (which is not immediately observable) could be proxied for by examining the level of commitment in an organization. Past work on rebel recruitment has convincingly argued that violent organizations with high resource endowments tend to attract opportunistic recruits with short time horizons (Gates, 2002; Weinstein, 2006). These recruits treat their participation as transactional, seeking immediate short-term payoffs as compensation for their participation. By contrast, organizations lacking such resources must rely on social endowments. These organizations attract recruits who are more committed to the cause and willing to forfeit pay in the short-term in order to gain the long-term payoffs only accrued when the organization achieves its goals (Gates & Nordas, 2010; Weinstein, 2006).

I argue that the level of resources organizations have access to can offer some insight into the type of member populating its ranks. Specifically, I track the number of resource rich PRIO-grid cells the organization is active in. As shown in the last table, there is a positive and statistically significant relationship between the cumulative number of grid cells and the expected number of incremental innovations. To explore this mechanism more fully, I generate a new variable that

transforms the number of resource grid cells into an indicator variable. If the number of resource grid cells an organization has access to is above the mean for all organizations—meaning that it has on average more resources than the other organizations in the sample—then I mark that organization as having a "high" resource endowment, if not, I consider it "low."

The reason for transforming the cumulative resource variable into a dummy is to (a) acknowledge that this metric is not measured with any level of precision, and as such, the supposed granularity offered by counting up the number of resource grid cells can be misleading. In addition, (b) the use of a indicator variable makes exploring potential interactions between the exposure and resources easier. The idea that learning increases the likelihood of innovation implies an interaction between the members' willingness to learn and the degree of knowledge diversity in the organization. As such, one should expect that more diverse organizations with low resources (and by extension, more committed members) should be more innovative.

To this end, Table **??** mirrors Table **??** but with two important alterations: first, I include the Resources dummy and I interact this dummy with each model's respective exposure metric. The results also mirror those found in Table **??**, especially with regard to the direction and significance of the different metrics. The interaction between the level of resource endowments and the effect of exposure is significant for only two of the four models. It is significant when interacted with the cumulative exposures variable and when interacted with the six month window for the novel exposures metric. Understanding the effects of an interaction term

Table 7.7: Count models of the interaction of exposure and resource endowments on the number of incremental innovations

	Incremental Innovation			
	(1)	(2)	(3)	(4)
Cumulative Ethnic Exposures	-0.059^{***}			
	(0.000)			
Novel Exposure (3 month window)		0.109^{*}		
		(0.051)		
Novel Exposure (6 month window)			0.157^{***}	
			(0.006)	
Novel Exposure (9 month window)				0.157^{***}
				(0.009)
Resources	-0.349^{***}	-0.334^{***}	-0.238^{***}	-0.295^{***}
	(0.00001)	(0.00004)	(0.007)	(0.004)
ln Geographic Coverage	-0.335^{***}	-0.344^{***}	-0.354^{***}	-0.365^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
Organization Age/100	-3.153^{***}	-3.706^{***}	-3.765^{***}	-3.722^{***}
	(0.00000)	(0.000)	(0.000)	(0.000)
Organization Age^2/1000	0.066^{***}	0.067^{***}	0.065^{***}	0.064^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
ln Number of Events	0.711^{***}	0.684^{***}	0.686^{***}	0.684^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
Relevant Ethnic Exposures * Resources	0.016^{*}			
	(0.054)			
Novel Exposure (3 month window) * Resources		−0.061		
		(0.526)		
Novel Exposure (6 month window) * Resources			-0.209^{**}	
			(0.021)	
Novel Exposure (9 month window) * Resources				−0.100
				(0.308)
Observations	3,601	3,601	3,601	3,601
Log Likelihood	−5,712.302	−5,816.110	−5,811.128	−5,813.195
Akaike Inf. Crit.	11,626.600	11,834.220	11,824.250	11,828.390

Note: *p<0.1; **p<0.05; ***p<0.01
Unit of analysis set at the organization-month
Robust standard errors reported in parenthesis.

in a generalized linear model is difficult from the coefficients alone. Thus, I plot these effects graphically.

Figure 7.3 plots the expected counts for each of the models, varying the exposure and resource variables while holding all other variables in the model at their observed values (Hanmer and Kalkan 2010). The standard errors are generated via bootstrapping with the variance-covariance matrix. The simulated parame-

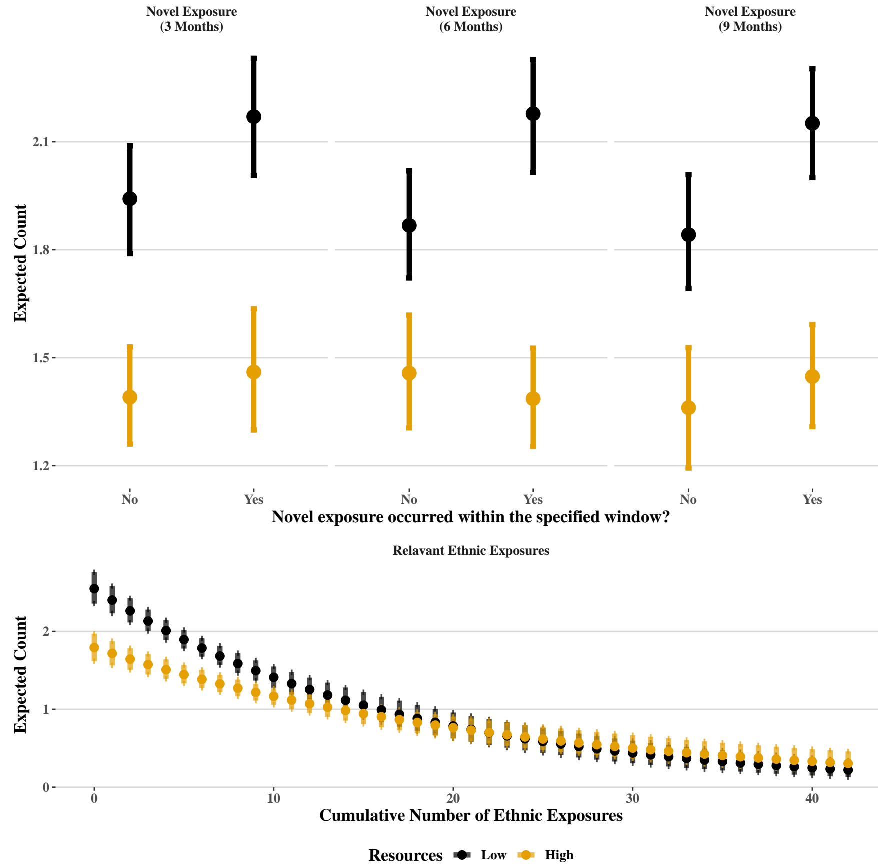
ters are adjusted to yield robust standard errors. Each plot panel is titled by its respective exposure metric.

The figure shows a stark difference between organizations with high access to resources and those without. Organizations with low levels of resources are by far more likely to generate incremental innovations than organizations that are resource endowed. This difference stands out most starkly for the six month window of the Novel Exposure metric. Organizations with more committed members (i.e. low resource endowments) are far more likely to benefit from exposure to a new population than groups will when commitment is low (i.e. resources endowments are high, thus attracting more opportunistic recruits). The results provide support for Hypothesis 4.

Interestingly, when examining the interaction of the cumulative number of ethnic exposures, one once again sees the downward sloping effect. However, the difference between low and high resource endowments appears to impact the rate of change differently, at least prior to 20 cumulative exposures. Groups with more committed members are more likely to innovate than groups with less committed members. Yet the impact of an additional group reduces the expected number of innovations more quickly in the low resource groups than in the high resource group. This occurs until the two populations converge around 20 cumulative exposures.

The main take-away from this figure is that there is a notable difference between organizations with resources and those without. The theory argues that violent organizations with limited access to resources attract committed members

Figure 7.3: Expected number of incremental innovations when interacting exposure and resources



which translates into higher levels of learning. Thus, member diversity matters most in organizational contexts where members are willing to learn from one another. When members are unwilling to learn from one another the potential impact of membership diversity is diminished.

7.3 Discussion

In this chapter, I tested the main theoretical implications of the dissertation's theory by generating novel metrics for the main concepts of interest and then testing them empirically. I have found broad support for the argument that knowledge

diversity in collective groups increases its innovative capacity. Put differently, organizations with more diverse members will (a) be less predictable, (b) have a larger menu of tactical productions from which to select, and (c) be more innovative. The implications of the theory are that *who* is in the organization matters when assessing *what* an organization is capable of doing. The theory and the empirics support thinking about an organization's innovative capacity and the internal processes that drive it.

That said, diversity appears to have its limits. As show above, though exposure to a new population increases the expectation of incremental innovations, the number of disparate groups in an organization can generate new challenges. Thus, the benefits associated with diversity come with costs. In the previous sections, I considered briefly why this is, considering potential breakdowns in communication and coordination as potential explanations. Differences between different populations could generate new transaction costs that reduce rather than boost the organization's capacity to innovate. Thus, random interaction of members might be slowed when groups become too diverse. Moreover, there might emerge political dynamics that create barriers between groups. For example, the Islamic State, which operated in Iraq and Syria, was reportedly forced to separate Chechen fighters in its ranks because they were forming a clique and not working effectively with other groups. This all points to an potentially interesting negative externality to membership diversity.

The empirical strategy pursued here is not without its limitations. At best, I can only claim that there exists a correlation between violent organizations that

come in contact with more diverse populations and the level of adaptation and innovation observed. However, to establish causation, one would need to approach the puzzle differently than I have done here. As I argue in Chapter 6, an experimental design is implausible given the treatment of interest. Moreover, I argued that a process tracing approach was also infeasible given that the narrative surrounding attribution of new and novel ideas in an organization is impossible to reliably recompose. Thus, a data-driven and econometric approach—as pursued here—is the best way to move forward when investigating a topic such as this.

All in all, the empirical analysis supports the theory's conclusions and encourages scholars of conflict to think about membership as an important component when assessing the lethality and strength of violent organizations. Likewise, it pushes scholars to not treat these types of organizations as unitary actors but rather to consider in greater detail the plausible implications of many actors behaving at random toward the same goal. This sort of a framework generates new avenues of research as we better treat violent non-state actors as the collectives that they are.

Chapter 8

Conclusion

Let's return to the puzzle that motivated this project at the onset and apply what was learned. In Chapter 1, I described two violent non-state organizations—Boko Haram in Nigeria and Abu Sayyaf (ASG) in the Philippines—that are similar in more ways than not. Both organizations are similarly aligned with major transnational jihadi organizations/networks, such as Al Qaeda and the Islamic State. Both are situated in weak states where the government's capacity to project power is limited by geography and/or resources. Both operate in the proximity of their respective countries. Both have been in operation for a similar duration, and finally, both are cut from a similar ideological cloth: proclaiming an extremist Islamic ideology geared toward a predominantly Muslim population.

Despite these similarities, real differences exist in how the two organizations produce violence. Where Boko Haram is adaptive, ASG is inclined to repeat the same modes of production. Where Boko Haram is inclined to experiment with new methods and targets—mixing them into new combinations and expanding

the organization's menu of violence—ASG is restrained, focusing on a few types of methods and targets but rarely expanding beyond its domain of expertise. When put side-by-side, the distinction is clear: the two organizations appear to experiment, innovate, and adapt at different rates.

But why is this? Existing theory in political conflict would encourage us to look at the resources available to the group (Weinstein, 2005, 2006), the information networks that they are capable of tapping (Acosta & Childs, 2013; Horowitz, 2010; Wahedi, 2018), the domestic conditions that constrain the boundaries of acceptable behavior (Bakke, 2014; S. Kalyvas & Sánchez-Cuenca, 2005), environmental conditions that shape the level of competition each organization faces (Cunningham & Sawyer, 2017; Horowitz et al., 2017), or the age of the organization and its level of bureaucratic capacity (Horowitz, 2010). However, along all these dimensions, there is little differentiating Boko Haram from ASG. In many respects, they share the same advantages and challenges, and yet express different adaptive capacities.

The limitations in the current state of knowledge in explaining why Boko Haram is more innovative and adaptive than ASG is problematic for a number of reasons. First, understanding the factors that shape violent organizational behavior has been one of the focus areas of empirical conflict research for the last twenty years, so in some respects, this limitation speaks to a potential blind spot regarding how these violent organizations are evaluated in the literature. Second, how adaptive violent organizations are is associated with outcomes that matter to conflict researchers — mainly whether non-state groups will enter into negotia-

tions and gain concessions from the state — which means tactical adaptation as a concept matters to the process of conflict itself. Finally, from a policy perspective, the state's ability to predict a violent organization's behavior is one of its primary tools in its counter terrorism toolkit (Atran, 2003). The less governments are able to anticipate militant behavior, the less effective the state will be at dampening insurgent activity.

In this dissertation, I have argued that the key difference between organizations like Boko Haram and ASG lies not in external factors (such as resource flow, affiliation networks, or environmental conditions) but rather in an important internal resource: their human capital. Tactical innovations in the production of violence emerge when a diverse population of members interact with the organization's problems. Individual members from diverse backgrounds bring with them disparate forms of knowledge that increase the probability of an innovation as individuals draw from their respective knowledge to resolve the multitude of problems the organization faces. Moreover, members observe and learn from one another, resulting in a mixing of knowledge that contributes to more innovative outcomes.

Boko Haram is adaptive precisely because it absorbs a diverse array of members. The key finding from a 2016 Mercy Corp survey and report on former young Boko Haram combatants is to this point. "There is no demographic profile of a Boko Haram member," the report states. "Members we spoke to came from diverse backgrounds. Some had jobs, and others did not. Some had attended secular school, others Islamic school, and others had dropped out. Profiling in youth

interventions based on demographics is unlikely to be successful" ("Motivations and Empty Promises: Voices of Former Boko Haram Combatants and Nigerian Youth", 2016, pg. 2). Boko Haram is able to draw from multiple ethnic and social strata in no small part thanks to its early days operating as a religious community organization that provided small loans to entrepreneurs, trapping individuals and family in debt to the organization ("Gifts and Graft: How Boko Haram Uses Financial Services for Recruitment and Support", 2016). As a result, the organization is heterogeneous where it counts, allowing for the possibility of different vantage points and perspectives to interact.

By contrast, the members of ASG fall into a more homogeneous demographic profile. The organization draws from demographically impoverished individuals from the Moro ethnic group. Moreover, the group recruits slowly through kinship ties. They intermarry and absorb new members through dowries to poor Moro farmers (Alindogan, n.d.). The kinship network reduces the Philippine government's ability to infiltrate the group, but it also prevents the introduction of new ideas. As a result, the organization is locked in its own echo chamber, devoid of different perspectives and information.

The causal factor at play is knowledge diversity: the disparate sources of knowledge within an organization, and how that knowledge is revealed, leveraged, and learned as individual members at all levels in the organization interact with the organization's problems. The theoretical framework outlined in Chapters 4 and 5 remains agnostic about the exact structure of any organization, rather it emphasizes both the stochastic nature underpinning how members interact and the

nature of information itself—that is, ideas move around in pieces, not as a complete whole easily attributed to a singular source.

The main difference between Boko Haram and ASG lies in the diversity of its members: where one absorbs members more broadly, the other does not. These differences in demographics translate into a more diverse pool of collective knowledge. Members draw from what he or she knows when formulating responses to problems both big and small. The differences between knowledge distributions located within a collective group of individuals matter when determining the potential distribution of responses. For example, say to devise some operation, one were to randomly draw three members from Boko Haram and from ASG, the odds are that there would be a more diverse collection of perspectives in the former than the latter. Membership diversity is a key factor that shapes how Boko Haram and ASG produce violence. Differences in knowledge allow for the collective re-imagining of how to approach the wide array of challenges that an organization locked in a life or death struggle with the government face. Without it, a violent organization lacks the vision to see new ways of doing old things.

Moreover, given that members can observe and learn from one another, knowledge diversity can have an aggregate impact on all members. When a Kanuri fighter from a slum in Maiduguri interacts with a Ibo business man from Bauchi, both gather new types of information from the exchange. As argued in Section 4.3 in Chapter 4, one's willingness to learn is shaped by how he or she views their participation in the organization (i.e. temporary and transactional verses long-term and committed); however, the point remains, participation in organization's like

Boko Haram and ASG is an experience unto itself, and each and every participant is drawing something from the experience in observing his or her fellow participants. The main difference lies in the information being observed: is it a new idea or more of the same? I contend that when different sources of knowledge mix, they generate new kinds of ideas that increase the probability of an innovation. Put simply, when the Kanuri and Ibo fighter interact and observe one another, they are likely learning something new.

It is important to re-emphasize that the effect of membership diversity on organizations like Boko Haram or ASG's innovative capacity is not theorized to be dependent on the structure of the organization or members being in positions of authority. The theory emphasizes the stochastic nature in which information moves while remaining agnostic about the structure of the organization itself. One could say that the most diverse members are the least capable of airing their ideas, especially if they are systematically excluded from positions of authority. Yet this overlooks the reality that ideas can be commandeered and attribution can be stolen. Members in positions of power at all levels likely have an incentive to steal and re-brand good ideas as their own, especially when dispute-resolving institutions are weak, non-existent or the potential of a superior retaliating comes at the edge of a knife.

Moreover, the idea that only ranking members in an organization matter devalues the fact that learning is a dynamic process. Members learn over time through repeated interaction with other members, and components of new ideas can emerge from any number of sources—especially as members are shaped and re-

shaped by repeated experiences with one another. As noted, information moves in small indistinguishable pieces of data which are difficult, if not impossible, to trace back to a single source. This reality complicates the nature of attribution both in the retelling (through firsthand accounts) and in the systematic process-tracing of ideas from inception to production.[1] Ultimately, this problem of attribution is the primary motivation for using an aggregate-level quantitative empirical design. As such, the relationship between the diversity of an organization's members and the adaptive/innovative productions observed in the empirical can best be teased out through statistical probing.

In summary, why do we observe such differences between Boko Haram and ASG in their level of tactical experimentation and adaptation? The diversity of their members. When individuals with different types of knowledge join a violent organization, the organization has greater innovative capacity. That is, diversity increases the *possibility* for tactical innovations.

8.1 Contributions

This dissertation project directs the analytical focus on *who* is in a violent organization and argues that the answer to this question can shape (*a*) the ultimate outcome of a civil conflict, (*b*) how analysts assess the military capabilities of an armed group, (*c*) other arenas for innovation, such as rebel governance or institution building, and (*d*) the underlying severity of the conflict. Though prior work has thought carefully about how recruitment potentially shapes organiza-

[1] I outline these challenges in greater depth in Chapter 6.

tional behavior (D. K. Cohen, 2013; Eck, 2014; Haer & Bhmelt, 2016; Weinstein, 2006), none of these studies fully consider the impact diversity has on violent organizational behavior.

This project has taken a first step in bridging this gap. First, the theoretical framework advanced here atomizes the individual and thinks carefully about the information he or she possesses and how such information can operate contagiously in a closed system. Second, the theory generates a framework whereby individual-level interactions and outcomes contribute to larger organization-level outcomes that we observe. Rather than treating the internal clockwork of a violent organization as a black box, the theory proposes that the processes that dictate how individuals meet in an organization are susceptible to the stochastic realities of the world, and such randomness is opportunity generating. Finally, the theory reduces the concept of diversity down to its most basic element: information. This allows one to think about the impact of membership diversity more formally and to treat it as another resource that a violent organization has available to it.

In addition to these theoretical contributions, the dissertation offers novel advancements in how to measure concepts like tactical adaptation and membership diversity. With respect to the former, I present a novel measurement strategy for assessing when militant organizations mix their violent repertoires. The metric advanced in Chapter 2 measures similarities and dissimilarities in the violent productions organizations produce, offering insights into when violent non-state organizations are mixing repertoires and when they fall into tactical routines. I reduce textual descriptions of violent events down into a distinct number of relevant

topics. I then use the resulting weights vectors from these topics models—which describe how individual events load onto the relevant topics—to examine the similarity between events. The metric situates activity in its respective history record and offers a strategy for measuring and understanding the sequencing of repertoires across organizations and time. This measure of adaptation helps push the field forward in its use of event history data by introducing a way of using event history records more completely rather than throwing information away by simply counting the number of events — which is common practice in the field at time of writing.

Ultimately, the project encourages further research in how membership diversity can both create and constrain opportunities. This project has focused on the positive effects of diversity on innovation; however, the empirical analysis in Chapter 7 indicates that there are limitations to diversity. Specifically, the results found that as the number of different populations in an organization increase, the probability of observing an incremental innovation *decreases*. This indicates that there is some optimal range in which the benefits born from membership diversity are realized, after which other factors (such as increases communication costs and factionalism) begin to override. Understanding where and when diversity is a gain for violent organizations is an important and vital research agenda for conflict scholars seeking to better understand the factors that drive violent organizational behavior.

Likewise, improving upon the metrics generated here, this project demonstrates how event history data can be used more thoughtfully than counting event occur-

rences. The unstructured text in which event data is built off of is an important source of information regarding what violent organizations do and how they go about doing it. Moreover, with the boom in machine learning and data analytic techniques, never before has it been easier to probe the unstructured features of these data to better understand the broad array of violent products organizations produce.

This project encourages scholars to disaggregate thoughtfully and to use an expanded toolkit when studying conflict processes. First, it promotes the use of machine learning and other analytic methods—not solely for the purposes of predicting conflict occurrence—but in classification of conflict itself and the processes that underpin it. Unstructured accounts of violent events are opportunities that have been grossly underutilized in conflict research to date. Second, it emphasizes the use of quantitative case studies, where aggregate level phenomena are explored through the lens of a particular case. Finally, the project demonstrates how computational simulation can be leveraged as a theory generating tool. The comparative statics from the computational model are easy to interpret, comprehend, and test when the system from which they emerged is anything but. This emphasis on using computational methods to generate theory falls in line with a renewed focus on what simulation can tell us as scholars and practitioners (Siegel, 2018).

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