The Dark Side of Diversity: Membership Diversity and Tactical Innovation in Violent Non-State Organizations*

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Abstract

Why do some violent non-state actors (NSA) regularly innovate while others do so rarely? Recent studies suggest variation in affiliation, bureaucratization, support, and competition yield different innovative capabilities. While emphasizing constraints, these studies tend to overlook the importance of internal drivers that make innovation more or less likely. I develop a theory of membership diversity in an NSA as an internal driver of innovation. Using panel data on 187 NSAs (1970 to 2018), I exploit variation in novel exposures to socially-relevant ethnic populations as a diversity treatment in an intent-to-treat design to estimate the relationship between membership composition and tactical innovation. I demonstrate the validity of the empirical strategy using a directed acyclic graph. The analysis finds that the diversity treatment increases both the likelihood and rate of tactical innovation. By treating membership composition as an information problem, the findings underscore the importance of knowing who is in an NSA when evaluating organizational capabilities.

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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. It was the beginning of Boko Haram's experimentation with the bomb. From that moment onward, the group experimented with strapping bombs to bicycles (and tricycles), rickshaws, kiosks, motorcycles, vehicles of different types and sizes, and finally people. They used explosions to ambush military, police, and Civilian Joint Task Force (CJTF) members by detonating bombs, waiting for security personnel to arrive, and attacking first-responders. They planted explosives 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. Even after Boko Haram shifted to rely heavily on suicide bombing in 2014, the group continued to experiment with the method.[1] 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 varied ways.

By contrast, Abu Sayyaf Group (ASG), a similarly affiliated jihadist organization based in the Jolo and Basilan Islands in the Philippines, also employed explosives but in a more limited and redundant way. The group's initial use of explosives revolved around

[1]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.

throwing grenades into crowds and rigging homemade IEDs to target transportation services, businesses, and religious institutions.[2] The group expanded its targets to include government buildings/officials and military patrols/personnel and infrastructure targets, such as bridges, electricity pylons, and water utilities. However, 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 varied in the types of violence it produced.

Why are some violent non-state actors (hereafter "NSA") tactical innovators while others rarely change their tactical behavior? Recent students argue that violent tactical behavior is largely shaped by four factors: organizational affiliations and partnerships with other groups (Horowitz, 2010; Wahedi, 2018; Acosta and Childs, 2013), organizational bureaucracy (Horowitz, 2010), public support (Bakke, 2014; Kalyvas and Sánchez-Cuenca, 2005; Polo and Gleditsch, 2016), and organizational competition (Horowitz et al., 2017). Boko Haram and ASG's use of IEDs is a useful way to view these arguments. 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. IEDs) between these two groups? In theory, both groups should have access to similar types of information, and yet we observe both groups incrementally innovating at different rates.

[2]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.

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.[3] Third, both groups operate in similar settings: they claim to 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.[4] If external competition was the main driver of organizational adaptation, then one would expect ASG to be the more innovative of the two organizations, and not the other way around.

Addressing these theoretical inconsistencies, I develop a theory of membership diversity as an internal driver of an NSA's innovative capacity. The theory argues that organizations with a more diverse labor force will possess a higher underlying innovative capacity than organizations with a homogeneous one (Hong and Page, 2004). Members bring with them past ideas, experiences, and knowledge. These priors inform how individual members respond to the organization's problems. Differences in the types of knowledge located within

[3]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.

[4]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.

a collective determine the potential distribution of responses. The more diverse an organization's membership, the larger the pool of potential solutions from which it draws, increasing the likelihood of tactical innovation.

The main mechanism 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. Other scholars have pointed to the benefits of diversity in organizational innovation (Hong and Page, 2004; Page, 2008). Though prior work has thought carefully about how recruitment potentially shapes organizational behavior (Weinstein, 2006; Cohen, 2013; Eck, 2014; Haer and Böhmelt, 2016), none of these studies fully consider the impact membership diversity has on NSA tactical behavior.

The article outlines an empirical strategy estimating the effect of membership diversity on the likelihood of an incremental tactical innovation. Specifically, I exploit variation in organizational exposure to novel ethnic populations as a diversity treatment in an intent-to-treat design. I demonstrate the validity of the empirical approach using a directed acyclic graph (DAG) (Pearl, 1995, 2009). The key insight from the DAG is that novel exposures only operate through an NSA's selection process to influence membership composition. The research design offers a way of estimating the total effect of novel exposures on tactical innovation, but not the direct effect of membership composition. I show how this strategy yields an unbiased *under*estimate of the treatment effect as not all NSA's in the sample are likely compliers with the diversity treatment.

The analysis finds that exposure to novel populations increases both the likelihood and rate of tactical innovation. Organizations are constrained by the pool of knowledge from which they can draw to solve problems and generate solutions. Members carry valuable information, and the distribution of that information influences the rate of innovation within an NSA. By treating membership composition as an information problem, the findings underscores the importance of know who is in an NSA when evaluating organizational capabilities.

The article proceeds as follows. Section 2 outlines the constraints and drivers of innovative tactical behavior. In section 3, I present a theory on how the level of diversity of an organization's membership can impact the kinds of responses and strategies a NSA is capable of producing. Section 4 outlines the measurement and empirical strategies employed to test the observable implications of the theory. Section 5 presents the main empirical findings and robustness checks. Finally, Section 6 concludes with a discussion of the implications for future research. Along the way, I illustrate the concepts and mechanisms by referring to the Boko Haram and ASG examples.[5]

Constraints and drivers of violent tactical behavior

The literature on violent tactical behavior can be broadly viewed in terms of the "constraints" and "drivers" that emerge both externally and internally to the organization. Table 1 outlines the main contributions to this debate.[6] Arguments regarding the external constraints NSAs face focus on aspects of domestic or international support that constrain the shape violence takes, whereas discussions on external drivers highlight environmental features that

[5]I accept that there are important differences between the illustrative cases. However, using two well known groups helps illustrate aspects of my mechanism. I test the theory using quantitative data.

[6]A full review of the literature can be found in Appendix A.1.

incentivize adaptation and learning. These arguments assume that all organizations are equally capable of innovating and that it is largely the external conditions or internal constraints that shape when and how such innovations occur. However, anecdotal evidence would direct us to question this assumption. Groups like Boko Haram and Abu Sayyaf are situated in similar contexts and yet both groups differ in the degree to which they experiment with similar methods. To understand these *within*-context differences, the internal conditions that motivate innovative behavior need to be considered. However, research focused on internal factors emphasizes constraints, such as resource endowments or organizational structure, while overlooking drivers.

Table 1: Summary of the literature on the constraints and drivers of violent tactical behavior within violent non-state organizations

	Constraints	**Drivers**
External Factors	**Domestic Support** (Bakke, 2014; Polo and Gleditsch, 2016; Kalyvas and SánchezCuenca, 2005) **International Approval** (Stanton, 2016; Keck and Sikkink, 2014)	**Organizational Survival** (Blomberg et al., 2010; Dugan et al., 2005; Wilkinson and Jenkins, 2013) **Competition** (Horowitz et al., 2017; Conrad and Greene 2015; Cunningham et al., 2017) **Network Ties** (Acosta and Childs, 2013; Asal and Rethemeyer, 2008; Horowitz, 2010; Buhaug and Gleditsch, 2006; Wahedi, 2018) **Carriers** (foreign fighters) (Malet, 2013)
Internal Factors	**Resources** (Gates 2002; Weinstein 2006; NyGrid and Weintraub 2015; Wood and Kathman 2015; Cunningham et al. 2017) **Organizational Structure** (Heger et al. 2012) **Specialization** (Horowitz 2010)	**Leadership** (Abrahms and Potter 2015)

Note: *An extended literature review can be found in Appendix A.1*

One potential internal driver of innovative capacity in an NSA lies with the organization's leadership. Leadership decapitation (i.e. the strategic killing of an NSA's leadership) reduces an organization's level of activity and its odds of winning a conflict (Johnston, 2012). Likewise, removing leaders appears to increase the level of indiscriminate violence by an organization (Abrahms and 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 tactical innovation assumes that leaders are the primary source of ideas in an organization. Such an assumption is problematic for two reasons. First, doing so downplays the sheer volume of problems NSAs face on a recurrent basis. If a leader is the architect of all innovations and adaptations, then one should expect *less* innovation 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 is to delegate; however, delegation shifts the potential source of innovation from one to many. This place the theoretical focus onto the members and the delegation process.

Second, focusing on leadership as a source of innovation downplays the importance of principal-agent problems (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 tactical 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 (Johnston, 2008; Shapiro, 2013). Moreover, oversight in these contexts might take the form of fire-alarms (i.e. waiting for infractions to be reported by others) rather than costly policing practices (McCubbins and Schwartz, 1984). If a leader is unable to perfectly monitor an agent, then adaptation and innovation is a potential side-effect of this process of interpreting orders.

It is important to emphasize that competent leadership is vital to an organization's success. Leaders are the main directors of an NSA's extra-institutional efforts (Abrahms and Potter, 2015). However, focusing exclusively on leadership as the internal driver of an organization's innovative capacity assumes a leader can (i) scale in proportion with the volume of problems the organization faces, and (ii) effectively monitor agents. In the next section, I advance a theoretical framework that relaxes these assumptions, by focusing instead on the composition of an organization's membership and the information those members carry with them.

Membership diversity and innovative capacity

I present a theory on how the level of diversity of an organization's membership can impact the kinds of responses and strategies a NSA is capable of producing. I argue that solutions do not emerge exogenously but endogenously when members of the organization encounter problems. As a result, the pool of knowledge from which an organization draws is dependent on the sum of experiences, knowledge, and background of its membership. The argument builds on past work that describes how diversity can trump ability in collective problem solving tasks (Hong and Page, 2004, 2008; Becker et al., 2017).

NSAs are labor-intensive organizations functionally dependent on human capital (Gates, 2002). When recruited into the group, individual members bring with them past experiences and knowledge. These priors inform how that individual member responds and adjusts to new circumstances. NSAs—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 internally generated, and that as individual members encounter problems, they draw on what they know when devising solutions to those problems.

I assume that each member relies on past knowledge and experiences when dealing with problems. This distribution of information defines the scope and likelihood of the types of solutions that any given member generates. Individual members that originate 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. By contrast, individuals who come from different backgrounds draw from different sets of experiences and knowledge when generating ideas. If each member draws from their past when formulating a solution, then the differences between types of knowledge located within a collective determine the potential distribution of responses. The greater the difference in the makeup of members—specifically the makeup of their knowledge distributions—the more diverse the pool of common experiences.

Solutions emerge when individuals come in contact and interact with the organization's problems, yet the quality of response depends on a 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. 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 within a common subset. However, as the types of problems the organization faces expands, the need for a broader range of potential solutions increases.

The theory assumes that the fundamental unit of analysis in an NSA is the member.[7] Individual members interact with the environment, gather information, and discover problems. Members can pass this information up or down, and problems—both real and imagined—can enter an organization at any level. In essence, NSAs are large sensors where each and every member operates as an independent data-collecting node. If data collection is a collective process, then identifying and resolving problems depends on an internal organizational ecology.

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 one. 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 (Hong and Page, 2004, 2008). As members are exposed to the organization's problems, the likelihood that an individual with an innovative solution will encounter the problem increases.

The theory gives way to the following hypothesis:

[7]NSAs are not assumed to be unitary actors. Past research on violent organizations points to the difficulties underpinning the unitary actor and complete rationality assumptions when theorizing about NSAs (Seymour et al., 2016; Cunningham et al., 2012). The underlying implication is that decision-making outcomes can manifest in multiple ways.

Hypothesis 1 — NSAs with higher levels of knowledge diversity (those with more heterogeneous members) will tactically innovate more often than organizations with lower levels of knowledge diversity (those with more homogeneous members).

Measurement and Empirical Strategy

In this section, I establish the measurement and empirical strategies employed to test the observable implication of the theory. I first outline a strategy for measuring the outcome of interest: tactical innovations. I then outline an intent-to-treat empirical strategy for identifying the key causal relationship by leveraging a structural causal graph. Specifically, I exploit variation in exposure to novel socially-relevant ethnic populations to operate as a diversity treatment.

Measuring Tactical Innovations

I outline a strategy for measuring tactical innovations within NSAs. The measure aims to detect when organizations innovate incrementally. I describe the data and scope conditions that underpin the sample. I then layout how I leverage conflict event data to construct a record of NSA tactical behavior over time. The behavioral record allows for the detection of the novel use of tactics within an organization's lifespan.

In this analysis, I use the Global Terrorism Dataset (GTD) (LaFree and Dugan, 2007). The GTD records event history data on the occurrence of terrorism globally from 1970 to 2018.[8] The motivation for using GTD over other event data projects is three-fold: first, GTD provides a expansive record of tactics and targets employed by violent actors, allowing

[8] Data for 1993 was lost and is not present in the original time series.

the study of tactical behavior over time. Specifically, the temporal scope allows for extended observations of NSAs globally, an important factor when tracking innovations over time. Second, GTD places no exclusion criteria on events or organizations, such as a minimum battle death thresholds (Sundberg and Melander, 2013), capturing a larger spectrum of activity and organizations, even during periods of relative peace. However, it also means the decision boundaries used to define a NSA are less clear. Finally, though the dataset is aimed at capturing terrorism, its inclusion criteria is broad and overlaps prominently with other event datasets, such as the UCDP Geo-referenced Event Dataset (GED) (Sundberg and Melander, 2013) and the Armed Conflict Location and Event Dataset (ACLED) (Raleigh et al., 2010) (see Donnay et al. (2018)). Multiple projects have explored the overlap between civil war and terrorism event data finding that armed actors regularly employ both types of approaches (Fortna, 2015). Moreover, entries are often duplicative across the different event logs (Dunford et al., 2019; Donnay et al., 2018). This is not to say that GTD is a complete reflection of an organization's tactical behavior, rather the data (*a*) provides a useful subset of the NSA's tactical record over time and (*b*) reflects a large population of conflict actors.

For all organizations recorded in the GTD, only organizations that were in operation for a minimum of 6 months in a year for two years are considered. The two year threshold is necessary to ensure the organization has a temporal record of tactical activity. In addition, general actor categories that do not capture a specific organization are also omitted (e.g. "separatists", "rebels", "extremists", etc.). This leaves 187 organizational actors in the data.[9] The unit of analysis is set at the organization-year.

[9] In Table 7 in Appendix A.3, these scope conditions are relaxed to include organizations that did not meet the operational threshold; in addition, I rerun the analysis treating the general actor categories as organizations. Both robustness checks keep with the main findings in the article.

A *violent tactic* is defined as a series of corresponding features that describe both the methods (weapons) and targets used to perpetrate a violent event. This definition departs somewhat from prior work, which focuses primarily on the method used to perpetrate violence (Wilson, 2005; Cohen, 2013; Bloom, 2004; Brym and Araj, 2006; Victor, 2003). I contend that the method is *endogenous to the target*, and as a result, tactics should be measured along both dimensions. Consider a hypothetical group that seeks to destroy an armored truck parked outside military barracks. Shooting at the truck would fail to accomplish the task whereas a rocket-propelled grenade or a well-placed IED might fare better. The target motivates the means and vice versa. Other scholars have incorporated information on both methods and targets together to understand tactical behavior (Polo and Gleditsch, 2016; Asal and Rethemeyer, 2008; Horowitz et al., 2017). However, these studies tend to use broad categories of "soft" (civilians and businesses) or "hard" (military and police) targets. As a further departure, I retain the base categories of target types outlined in the GTD when defining a tactic. Doing so preserves important variation on the heterogeneity in target types.

Figure 1 outlines all weapon-target tactical configurations in the GTD data from 1970 to 2018 for all relevant non-state actors. Each grid cell reflects the number of times a specific tactical configuration was used in the time series. The figure demonstrates that while certain tactical patterns are common for NSAs to employ (e.g. the use of firearms against private citizens), there is considerable variation in the types of tactical combinations and the frequency in which they are used. By leveraging the event history data for the relevant sample of NSAs, I generate a record of the usage of specific tactics over time.

A *tactical innovation*, then, is defined as the novel use of a tactic (weapon-target

Figure 1: Weapon-target tactical configurations in the GTD

Target Types	Chemical	Explosives	Fake Weapons	Firearms	Incendiary	Melee	Sabotage	Vehicle*
Violent Political Party		133		203	9	16	1	
Utilities		3372		101	34	4	17	
Transportation		1466		443	509	9	12	2
Tourists		82		54	5	3		
Terrorists/Non-State Militia	2	559		521	14	26		
Telecommunication		293		71	126		3	
Religious Figures/Institutions		610		337	86	28		1
Private Citizens & Property	38	6174	1	6572	683	690		5
Police	11	4580		5691	154	94	1	2
NGO		65		161	14	2		
Military	23	7016		7873	113	70		4
Maritime		64		76	4	1	1	
Journalists & Media		216		413	29	14	2	
Government	2	3884		3208	318	84	3	2
Food or Water Supply	3	101		23	12	1		
Educational Institution	18	587		322	218	18	2	
Business	3	4266	1	1855	1390	55	8	3
Airports & Aircraft		311		70	18	6		
Abortion Related				1				

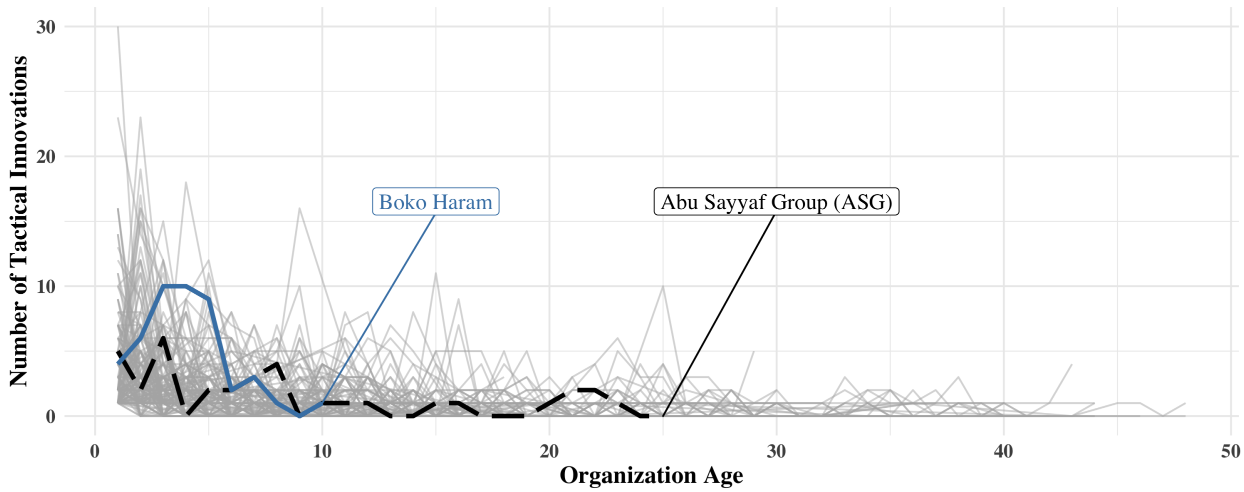
Weapon Types

Violent tactical combinations from 1970 to 2018 for all GTD organizations active for a minimum of 2 years.
Count in each grid-cell reflects the number of GTD entries.
*** not to include vehicle-borne explosives**

combination) by an NSA within its observable time series. The definition emphasizes *incremental* innovations (the expansion of an NSA's tactical repertoire) over *novel* innovations (the introduction of a new tactic to the world stage). Incremental innovation captures experimentation with new tactics *over time*, reflecting an NSA's capacity to both explore and exploit.[10]

[10]Events where weapon and/or target information was not available are excluded from the analysis. By doing this, the measure assumes that novelty increases the probability of coverage, and thus the GTD is more likely to capture innovations — meaning the empirical record correctly reflects the temporal location of an innovation. I explore the implications of deleting these events in Figure 8 in Appendix A.3. Specifically, I randomly impute all missing weapon and/or target entries from the possible set of all tactical combinations available up to time t and then rerun the main analysis. The imputed results keep with the main findings in the article.

Figure 2: Tactical innovations over time



The figure plots the trajectory of tactical innovations for each NSA in the sample. The x-axis captures the age of the organization (starting at year 1), and the y-axis is the count of the number of innovations. The trajectories of Boko Haram and ASG are highlighted for reference.

Two empirical measures are generated: (i) an indicator variable capturing if an innovation occurred or not in a organization-year, and (ii) a count variable capturing the number of innovations that occurred in a organization-year. The former captures the onset of an innovation, reflecting whether any changes were made to a NSA's tactical repertoire within a given time period, whereas the latter captures innovative capacity more generally, counting the number of total innovations within a given period. Figure 2 plots the number of tactical innovations given an NSA's age. The innovation rate for every organization in the sample is plotted in grey. All NSAs are most innovative in their initial years as they explore and experiment with different tactical arrangements. As NSAs age and begin to specialize, they become less likely to innovate (Horowitz, 2010). The trajectories, however, differ considerably from organization-to-organization. Consider again Boko Haram and ASG: the rate of innovation for both are highlighted in Figure 2. The rate at which each organization innovates varies substantially over time despite their many similarities on other dimensions. Moreover, these differences hold when considering other NSAs that share similar networks (e.g. Al-Qaeda or IS affiliated organizations), highlighting how differences in innovative capacity over time are partly driven by internal rather than external factors.

Empirical Strategy

I use a directed acyclic graph (DAG) to represent the causal associations between the variables theorized to influence an NSAs observed level of tactical innovation to outline the intent-to-treat design proposed to estimate the causal quantity of interest (Pearl, 1995, 2009). The aim of the DAG is to (*i*) establish whether the theoretical assumptions are sufficient for identifying a causal effect from the available observational data, and (*ii*) to isolate the minimum subset of adjustments to satisfy the backdoor criterion (see Pearl (1995)). The value of the DAG lies in its capacity to infer conditional independence from the topology of the graph. At a minimum, the DAG offers a means of mapping the main theoretical assumptions to the empirical strategy used to estimate the effect (Aldrich et al., 2008).

Figure 3 presents the DAG. The target causal pathway is highlighted in bold. Each directed edge on the graph assumes a causal relationships with some nodes being observable (measurable) and others unobservable (latent). Given the constraint that the DAG must be acyclic, feedbacks are presented as time lags (t - 1), where prior states of the variable effect future states. Finally, the graph includes random confounding factors (U_1 and U_2) that are assumed to generate unaccountable dependencies between nodes.[11]

[11] A note on the naming conventions employed in the DAG. "Organization" denotes the organizational structure/institutional makeup of the non-state organization. It reflects the structure, rules, and socialization processes that NSAs utilizes and the processes by which the organization mobilizes its labor force. "Membership" denotes the membership composition of the organization, which is the main concept of inter-

Figure 3: Directed acyclic graph outlining the intent-to-treat research design

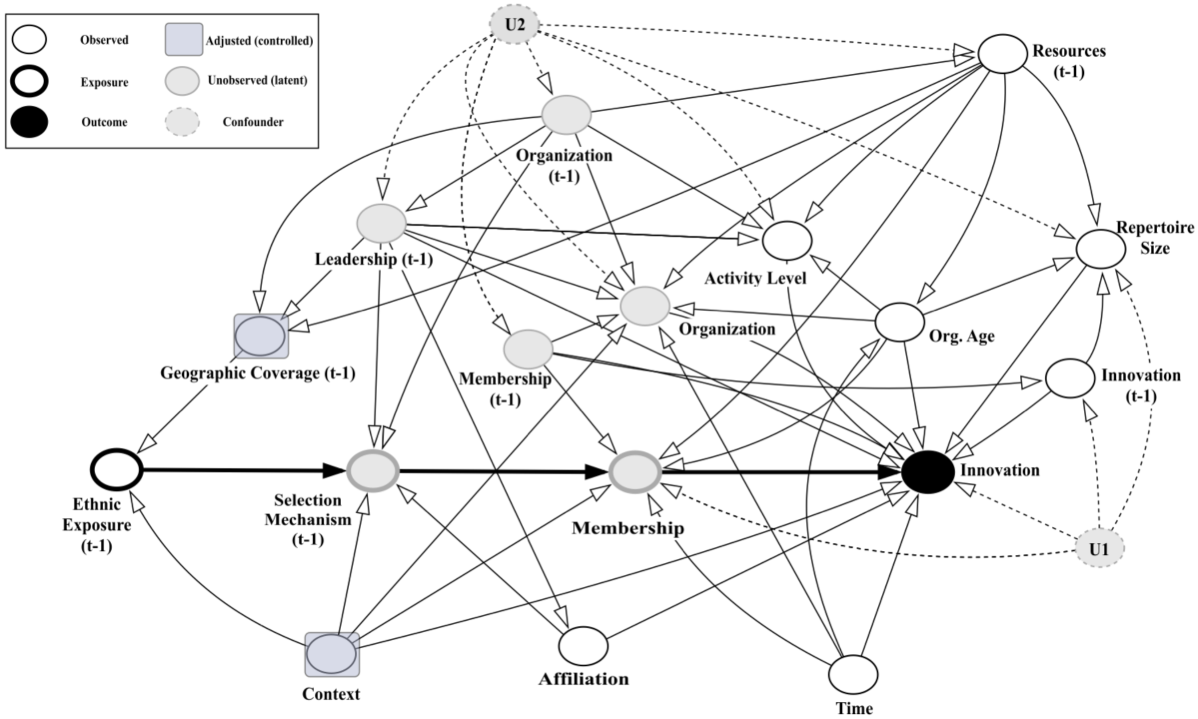


Figure presents a directed acyclic graph (DAG), which aims to capture the structural causal model of the factors assumed to drive tactical innovation in a violent non-state organization. The DAG makes the assumed conditional dependencies explicit. The highlighted pathway $\texttt{Ethnic Exposures}_{t-1} \rightarrow \texttt{Selection Mechanism}_{t-1} \rightarrow \texttt{Membership} \rightarrow \texttt{Innovation}$ captures the proposed Intent-to-Treat research design, where ethnic exposures operates as a treatment that not all NSAs comply with (i.e. not all organizations recruit from the novel population). A complete description of the DAG can be found in Appendix A.2.

The theory argues for the causal link between membership diversity and innovation. Membership composition is not directly observable across a broad set of NSAs, especially over time.[12] Similarly unobservable is an organization's selection process; NSAs are not

est. "Affiliation" denotes network ties with other NSAs. NSAs are argued to pass information and modes of operation through affiliation networks (Acosta and Childs, 2013; Wahedi, 2018). Finally, "Leadership" reflects the subset of members in the organization that drive a majority of the decision making in the organization.

[12]The inner workings of NSAs are notoriously difficult to observe. Qualitative approaches allow for post-hoc accounts, but systematically tracking the movement of ideas and information in an NSA would require real-time observation. Moreover, quantitative data on organizations are largely derived from the news and descriptive accounts, which rarely report on membership demographics in NSAs outside the domain of forcible recruitment or child soldiers, resulting in reporting bias. A notable exception would be the recent reporting

assumed to recruit indiscriminately but rather they put institutions and mechanisms in place to minimize adverse selection (Weinstein, 2005). Membership composition then is assumed to be a function of the selection mechanisms employed by the organization, resource endowments (Weinstein, 2006), organizational age, past levels of membership composition, and contextual (spatial and temporal) factors. The main influence of an organization's leadership on membership composition is assumed to play out through the adjustment of selection institutions and affiliations with other NSAs (assuming that affiliations can shape recruitment decisions).

Given the limitations in observing and measuring membership composition, it is not currently possible to isolate the direct effect of membership diversity on innovations. Rather I propose an intent-to-treat (ITT) design that leverages variation in novel ethnic exposures as a diversity treatment. Specifically, I analyze NSA exposure to novel socially-relevant ethnic populations over time. The key assumptions to the design are that (a) novel exposures only operates through the mediators (selection and membership composition) when influencing the innovation outcome, and (b) ethnic diversity is sufficient (but not necessary) for knowledge diversity. After adjusting for all backdoor pathways, one can exploit the variation in the novel exposures metric to recover an unbiased estimate of the total effect of diversity on innovation within NSAs.

The focus on variation in ethnic diversity over other forms of identity in constructing the instrument is primarily driven by the role of ethnicity as a source of social, cultural, and political differences (Valentino, 2014; Sambanis and Shayo, 2013; Chandra, 2006; Brubaker

on the Islamic State's recruitment pattern in Iraq and Syria (Morris, 2020). In addition, some scholarship has focused more closely on recruitment dynamics as an important mechanism (Eck, 2014; Weinstein, 2006).

and Laitin, 1998; Williams Jr, 1994). Co-ethnicity provides an important source of common information with respect to strategy selection and problem solving (Habyarimana et al., 2007, 2009). Ethnicity offers one potential source of tracking differences in knowledge distributions. The metric aims to isolate variation in the plausible set of populations that an organization could conceivably draw its membership from to approximate one dimension of knowledge diversity within its potential labor pool.

Figure 4 visualizes how the measure is constructed. For each violent event a NSA produces[13], I generate a radial polygon around the event with a circumference of 100 km (total coverage of approximately 796 Sqr Km), and track all ethnic groups that fall within that spatial window.[14] The main assumption is that ethnic populations near where an organization operates have a non-zero probability of being encountered and absorbed by the NSA. As the NSA expands the geographic scope of its operations, it is more likely to encounter diverse populations.

For data on the location of the various ethnic populations on the ground, I use the geoAMAR (Birnir and Satana, 2020). The geoAMAR tracks all socially-relevant ethnic populations and is the first geo-coded version of the entire AMAR sample frame of 1202 socially relevant ethnic groups described in Birnir et al. (2015). These data are ideal as the selection criteria into the sample is not limited to only "politically relevant" ethnic populations—as is the case with the Ethnic Power Relations (EPR) data (Vogt et al., 2015). The theory places no emphasis on whether an ethnic population is politically activate or not;

[13]As recorded in the GTD.

[14]Only events with precise geo-codes are used to track locations. Imprecisely geo-coded entries are aggregated to administrative and country centroid locations, fixing the location to a point that may not reflect the actual location of the NSA (Dunford et al., 2019).

Figure 4: 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 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 probability that individuals from the exposed population may be recruited into the NSA.

rather, it cares only about the background information that ethnicity provides.[15]

The primary metric generated from this strategy is a categorical variable tracking whether an organization is exposed to no (0), one (1), or multiple (2) novel ethnic population(s) within a given year. The aim of measuring novel exposures is to capture the underlying distribution of recruitment opportunities from novel populations. The assumption is that when an NSA operates within a specific region, there exists a non-zero probability that the organization is based in that locality in some capacity, and by extension, the organization is potentially recruiting from that location. The logic in making the measure ordinal

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

is to capture differences in exposure states, rather than focusing on the marginal effect of exposure to one additional population. The metric is lagged by one period as the effect is not theorized to occur immediately, but only as members interact with an organization's problems.

Figure 5: Novel exposures to socially-relevant ethnic population over time

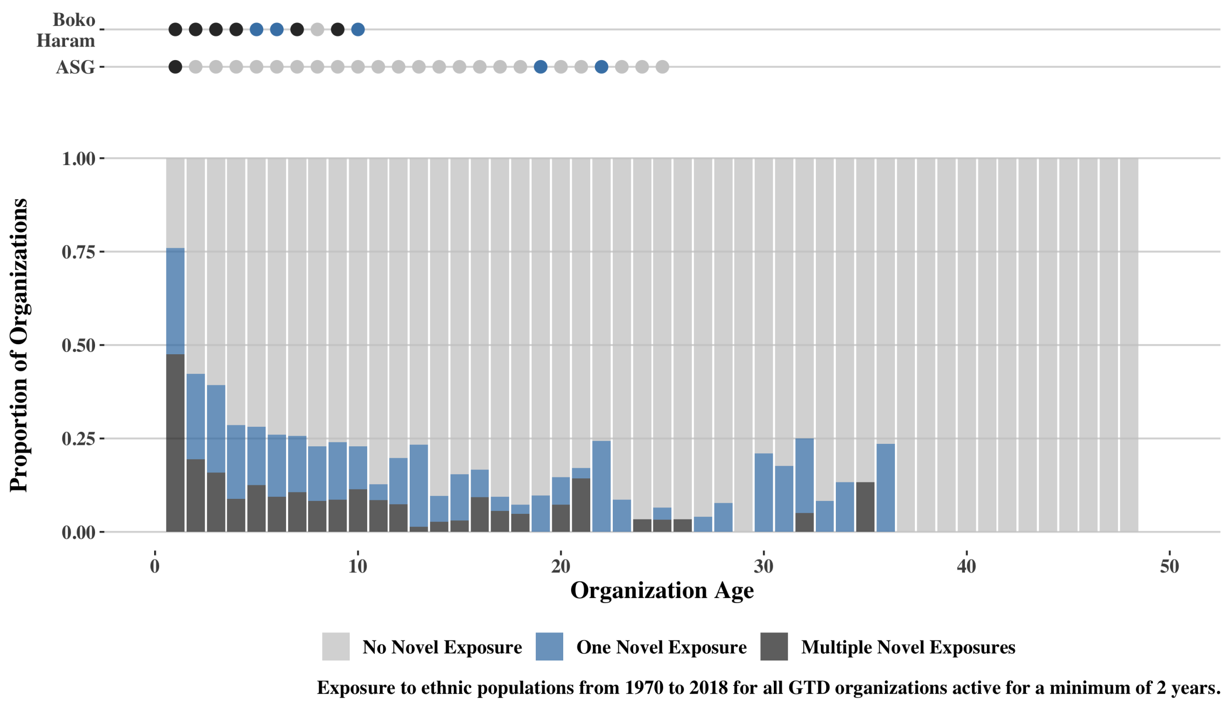


Figure plots the proportion of NSAs that are exposed to novel ethnic populations over the organizations' life time. The top panel highlights two NSAs — Boko Haram and Abu Sayyaf Group — to underscore the variation in exposure pattern across similarly situated organizations. Each point reflects an organization-year and the color corresponds with the exposure record.

Figure 5 plots the proportion of organizations that experience an exposure given their age. The plot demonstrates that novel exposures to new ethnic populations is a rare but regular occurrence for organizations across their lifespan. Note, however, that novel exposures are common for the majority of NSAs within their first year of operation as they all begin their initial operations. Given how the measurement strategy operates, this first year can be thought of as a burn-in for both the exposure and innovation measure, and thus, the first two years of operation for all NSAs in the sample is excluded from the analysis given the measure is lagged by one period in the empirical analysis. Finally, the figure highlights the exposure profiles for Boko Haram and ASG, outlining the differences in the exposure profiles across time. Boko Haram is exposed to novel populations more regularly than ASG.

It is important to emphasize that exposure to a novel ethnic population is mediated by the selection mechanisms the organization has in place (Weinstein, 2005). The more those mechanisms are designed to discriminate, the less likely new populations are to be absorbed into the organization. Put formally, the targeted pathway implies a chain of indirect effects connecting variation in novel exposures to tactical innovation:

$$\overbrace{\texttt{Ethnic Exposures}_{t-1}}^{\text{Diversity Treatment}} \underbrace{\xrightarrow{\pi} \texttt{Selection Mechanism}_{t-1} \xrightarrow{\gamma} \texttt{Membership} \xrightarrow{\phi}}_{\text{Unobserved}} \overbrace{\texttt{Innovation}}^{\text{Outcome}}$$

The estimate of novel exposures on tactical innovation (represented by B_1) is a composite of indirect effects, $\beta_1 = \pi\gamma\phi$. If the effect of the selection mechanism on membership composition is $\gamma < 1$, the NSA discriminates against recruiting members outside a specific target population. By contrast, $\gamma > 1$ would imply a more inclusive organization that recruits across populations. Though γ cannot be estimated directly, it highlights an underlying compliance mechanism in the DAG. Organizations with discriminatory recruitment practices (such as those that only recruit from a particular ethnic group) are less likely to receive the treatment, meaning that at best the ITT estimate can only recover a conditional local average treatment effect (CLATE). If no NSA complies with the treatment — i.e. all NSAs are highly discriminatory — then the effect of novel exposure is blocked by the selection mediator ($\gamma = 0$) and the estimated effect will be zero. The implication is that the ITT strategy yields an underestimate of the treatment effect—especially for groups that discriminate on the basis of ethnicity (Eck, 2014)—but the estimated effect will be unbiased.

To ensure the exclusion criteria, backdoor pathways linking the novel exposures instrument to the outcome must be adjusted. Figure 3 details a minimal sufficient adjustment set containing two variables: context-related confounders and an NSA's geographic coverage. The first captures contextual factors that can shape the probability of an ethnic exposure, such as the total number groups located in the country of operation. Context-specific factors are adjusted for using country fixed effects in the estimation procedure, where the country is determined by the primary country that an NSA operates in for a given year. The other confounding variable concerns the geographic coverage of an NSA. As the ethnic exposure metric leverages where organizations operate, one would expect a high degree of correlation between the coverage and exposure. Moreover, scholars have argued that NSAs that are capable of covering more territory are functionally different from those that stay put (Beardsley et al., 2015). Thus, a NSA's capacity to cover territory might contain information on the NSA's type, which might be related to it its innovative capacity. In the DAG, these relationships are assumed to operate through an NSA's leadership.

To measure an NSA's geographic coverage, I generate three measures. Each captures a unique dimension of the coverage of territory: historic coverage, current coverage, and new territory. For each measure, I track the locations where an organization produced a violent event and isolate the administration unit in which that event occurred. The first metric counts the total `cumulative` number of first administration units that the organization operated in across its observable lifespan. The second metric counts the `discrete` number of administration units the NSA operated in for a given year. Both measures capture the an NSA's capacity to cover territory. The final measure is a dummy variable that takes on the value 1 if an NSA entered a `novel` area (i.e. a previously unvisited administrative unit), 0 otherwise. This measure captures changes that come with entering a new territory, such as new resources and local information. Summary statistics of all variables can be found in Table 4 in Appendix A.3.

Results

I estimate the relationship between ethnic exposures and tactical innovation using the ITT strategy outlined in the previous section. I consider the dependent variable both as a binary and count variable — where the former captures the occurrence of an innovation and the latter captures innovative capacity. I explore different parametric model specifications to generate an estimate of the main effect. I then relax these parametric assumptions using nearest-neighbor matching. The results show support for the theory that a novel exposure results in an increase in an NSA's innovative capacity.

Table 2 summarizes a suite of OLS and GLM model specification for both measures of tactical innovation. The first two models fit the binary outcome whereas latter two fit the count outcome. Model 1 is a linear probability model, 2 is a logistic regression model, 3 is a ordinary least squares regression, and 4 is a negative binomial count model. All four models control for geographic coverage and country fixed effects. The standard errors are clustered by organization and country. The models tell a consistent story across the different specifications. A novel exposure to a novel ethnic population in time t corresponds

Table 2: Linear specifications estimating the effect exposure to a novel ethnic population on a NSA generating a tactical innovation

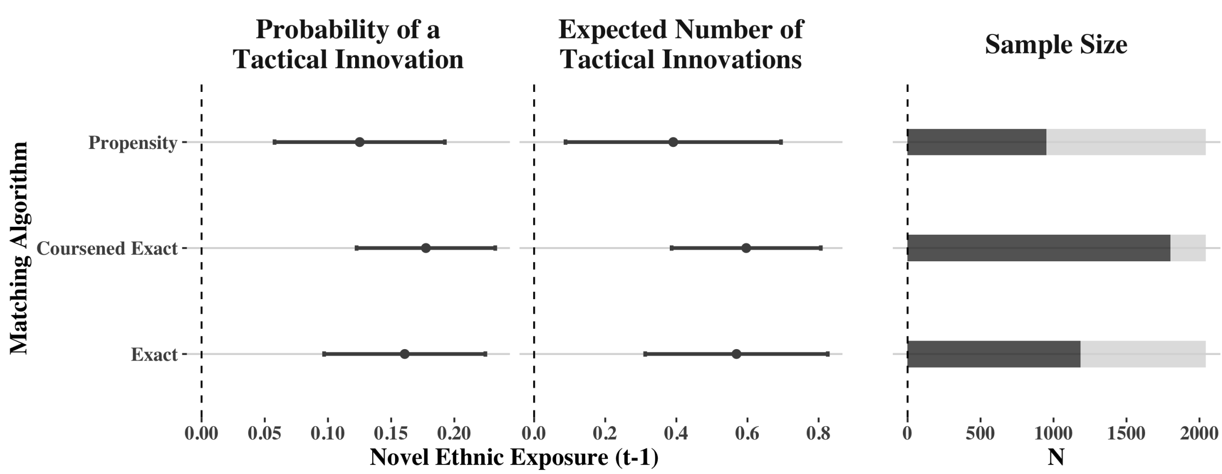
	Pr(Tactical Innovation = 1)		$E[N$ Tactical Innovations]	
	1	2	3	4
	LPM	Logit	OLS	Neg. Bin.
Novel Exposure$_{t-1}$	0.075	0.375	0.316	0.172
	(0.019)	(0.100)	(0.086)	(0.050)
Cumulative Geo. Coverage$_{t-1}$	-0.012	-0.065	-0.045	-0.051
	(0.002)	(0.013)	(0.008)	(0.012)
Discrete Geo. Coverage$_{t-1}$	0.076	0.318	0.379	0.305
	(0.026)	(0.117)	(0.107)	(0.083)
Novel Geo. Coverage$_{t-1}$	0.020	0.110	0.062	0.070
	(0.003)	(0.021)	(0.011)	(0.013)
Overdispersion				1.4467
Fit statistics				
Observations	2,042	2,008	2,042	2,027
Squared Correlation	0.147	0.142	0.176	0.17
Pseudo R^2	0.11055	0.108	0.04709	0.0696
BIC	3,977.30	3,471.49	9,356.06	7,090.16

Country fixed effects were applied to all models.
Two-way (Organization & Country) standard-errors in parentheses
Difference in sample size due to country observations being censored due to lack of variation on the dependent variables.

with a statistically significant increase in both the probability of observing an innovation and the expected number of innovations. Specifically, being exposed to a single new ethnic populations corresponds with a 7.5% increase in the odds of an innovation, and a 15% increase if the organization is exposed to more than one population. Likewise, the number of innovations that group is expected to generate in a given year goes from 1.16 to 1.47 if exposed to a novel population and 1.79 if exposed to more than one population.

The models in Table 2 all assume a linear relationship between the variables of interest. One concern lies with model dependency — that is, different functional form specification might yield different estimates (King and Zeng, 2006). To reduce these concerns, I use a range of different nearest neighbor matching algorithms to generate comparable treatment and control units to estimate the difference in the expected count and probability of a tactical innovation (Ho et al., 2007). Specifically, I use propensity, course exact matching, and exact matching to match NSAs that experienced an exposure in the prior year to those that did not using the geographic coverage measures to match on. To generate the match, I collapse the categorical measure of novel exposures down to a binary measure, where 1 corresponds with at least one exposure, 0 otherwise. I then match the data on the probability of receiving an exposure. The aim is to find comparable counterfactuals within these data (whether that is two groups operating in the same country, or the same group at different time points). The matched data is both pruned and re-weighted so that the distributions of the treatment and control group are similar. Finally, country-fixed effects are again used to remove all between group variation and close the context-specific backdoor path.[16]

Figure 6: Matching results of exposure to a novel ethnic population on tactical innovation



The figure presents a coefficient and bar plot. The coefficient plot reflects the specific matching algorithm on the y-axis and the estimate on the x-axis. The point denotes the estimate and the bars the 95% confidence intervals. Each matching algorithm prunes the data differently; the bar plot reflects the relative sample size in dark grey and the full sample size is shadowed in light grey. A dashed line highlights the location of 0.

[16]See Table 5 in Appendix A.3 for the balance statistics.

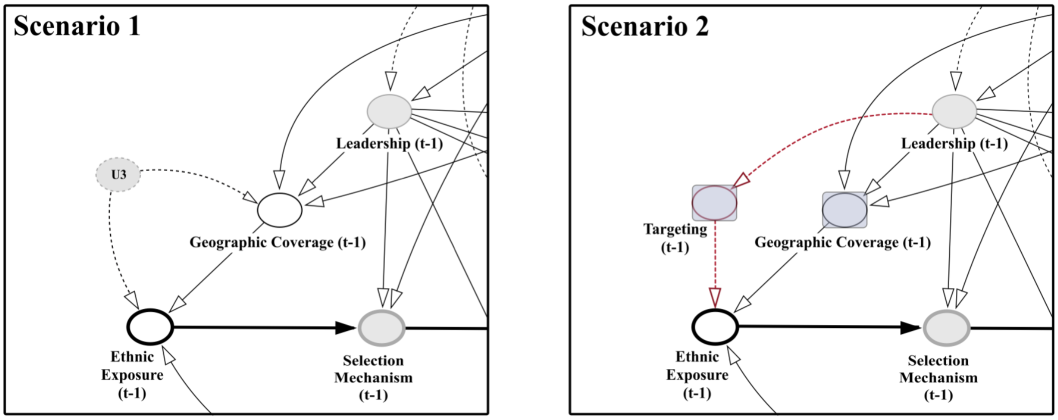
Figure 6 presents the difference in the expected means between the matched treatment and control units. The figure compares the estimates from the different matching algorithms. Since each algorithm prunes the data differently, a bar plot is added to show the reduction in the sample size for the matched data. The effects are presented as a coefficient plot where the point location denotes the estimated mean and the bars the 95% confidence intervals. The figure falls in line with the parametric models presented in Table 2: a novel exposure in the prior year corresponds with an increased probability of observing a tactical innovation. Likewise, the expected number of tactical innovations is estimated to increase given a novel exposure in the previous period.

Robustness

The empirical results lend support to the argument that membership diversity increases an NSA's innovative capacity. The theoretical assumptions outlined by the DAG offer a strategy for estimating a CLATE of novel exposures on an NSA's likelihood of innovating. However, confidence that the models effectively capture the CLATE pivots on the assumption that the DAG is a realistic approximation of the data-generating process. In this section, I consider two potential confounding scenarios that build off the DAG presented in Figure 3. I outline both scenarios and present alternative estimation strategies. I then outline a series of robustness checks that target model sensitivity to specific measurement decisions.

Figure 7 presents two confounding scenarios to the main DAG presented in Figure 3. Each DAG is presented as a subgraph with the unobserved portions of the DAG operating the same as in Figure 3. Scenario 1 in Figure 7 assumes that geographic coverage and ethnic exposure are potentially confounded by an unobservable factor U_3, such as the climate. The

Figure 7: Confounding scenarios



The figure presents two panels containing subgraphs to the main DAG presented in Figure 3. The first panel describes a scenarios where an unobserved factor confounds both geographic coverage and exposure. The second panel describes a scenarios where leadership confounds ethnic exposure through a targeting mediator. Both scenarios present adjustment strategies: in panel 1, geographic coverage is a collider; in panel 2, targeting is observable and adjusted for. Refer to Figure 3 larger components of the DAG and legend.

concern is that factors that diminish a NSA's capacity to travel would in turn reduce the probability of a novel exposure. In this scenario, $\texttt{Geographic Coverage}_{t-1}$ operates as a collider and should not be adjusted. Doing so opens up the backdoor pathway $\texttt{Ethnic Exposures}_{t-1} \leftarrow \texttt{Geographic Coverage}_{t-1} \leftarrow \texttt{Leadership}_{t-1} \rightarrow \texttt{Innovation}$, violating the exclusion condition. In this scenario the minimal adjustment set reduces to include only contextual factors. I rerun the linear parametric models presented in Table 2, controlling for only country fixed effects. The results presented in Table 6 in Appendix A.3 keep with the main findings reported in Table 2.

Scenario 2 in Figure 7 considers a potential confounder from $\texttt{Leadership}_{t-1} \rightarrow \texttt{Ethnic Exposures}_{t-1}$. The concern is that exposures are not completely independent from the decision to enter a new territory (e.g. leaders select to go into a new territory with the explicit purpose of targeting a novel ethnic population). In this scenario, a backdoor pathway remains open linking exposures to innovations via leadership, violating the exclusion condition and biasing the CLATE estimate. To deal with this potential confounder, Scenario 2 considers a new variable — `Targeting` — that takes on the value of 1 if an attack occurred within the novel ethnic group's polygon, 0 otherwise. The idea is that by conditioning on the decision to target one can effectively block the confounding backdoor path. The measure aims to partial out targeting decisions from exposures to novel populations. Like the novel exposure measure, targeting is lagged by one period for temporal correspondence. Table 3 again re-estimates the models in Table 2 but with the targeting variable included. The results show that even after adjusting for the targeting confounder, the effect of novel exposure on tactical innovation still holds.[17]

In addition to the two confounding scenarios, I run a number of robustness checks that explore sensitivity of the estimated effect to specific measurement decisions. Table 7 in Appendix A.3 consider the implications of relaxing the inclusion conditions for the relevant organization sample to include all NSAs. Table 8 in Appendix A.3 restricts the relevant time period of the sample to 1990-2018, 2000-2018, and 2010-2018. The table addresses the concern that the ethnic populations identified by geoAMAR are fixed over time, and thus the population polygons may not accurately reflect the spatial distribution of the relevant populations for earlier periods (1970/1980). Restricting the sample offers a way to explore sensitivity to the specific temporal window used to estimate the model. Finally, Figure 8 in Appendix A.3 considers the implications associated with dropping all event entries where tac-

[17]Note that for the binary outcome models the coefficient of novel exposure is not statistically significant at conventional levels ($p \leq .05$) but is at the 90% confidence level ($p \leq .1$). The increase in the size of the standard errors is a result of multicollinearity as the targeting and exposure measure are highly correlated (.663, $p \leq .001$).

Table 3: Replication of Table 2 adjusting for the targeting confounder

	Pr(Tactical Innovation = 1)		$E[N$ Tactical Innovations$]$	
	1	2	3	4
	LPM	Logit	OLS	Neg. Bin.
Novel Exposure$_{t-1}$	0.044	0.233	0.308	0.159
	(0.026)	(0.130)	(0.115)	(0.064)
Targeting$_{t-1}$	0.048	0.241	-0.008	0.010
	(0.034)	(0.167)	(0.181)	(0.105)
Cumulative Geo. Coverage$_{t-1}$	-0.012	-0.070	-0.048	-0.049
	(0.002)	(0.014)	(0.008)	(0.011)
Novel Geo. Coverage$_{t-1}$	0.055	0.227	0.369	0.271
	(0.034)	(0.156)	(0.130)	(0.104)
Discrete Geo. Coverage$_{t-1}$	0.021	0.120	0.069	0.069
	(0.003)	(0.023)	(0.012)	(0.013)
Overdispersion				1.5933
Fit statistics				
Observations	1,614	1,578	1,614	1,605
Squared Correlation	0.156	0.147	0.203	0.159
Pseudo R^2	0.11819	0.11495	0.05538	0.07414
BIC	3,228.76	2,759.74	7,442.56	5,755.10

Country fixed effects were applied to all models.
Two-way (Organization & Country) standard-errors in parentheses
Difference in sample size due to country observations being censored due to lack of variation on the dependent variables.

tical information is missing. Non-random deletion of event entries may be a potential source of bias as mis-measuring the timing of innovations may be driving the effect of interest. To address this concern, I randomly impute tactical information for all missing weapon/target entries selecting from a plausible set of tactics used by all organizations in that sample up to time t. The main models are then re-estimated and stored 100 times using the imputed version of the dependent variable. For all the robustness checks reported above, the main findings reported in Table 2 hold.

Discussion

When comparing differences in tactical behavior between Boko Haram and ASG, existing theory would encourage us to look at their available resources (Weinstein, 2005, 2006), their information networks (Horowitz, 2010; Wahedi, 2018; Acosta and Childs, 2013), domestic conditions that constrain the boundaries of acceptable behavior (Bakke, 2014; Kalyvas and Sánchez-Cuenca, 2005), environmental conditions that shape the level of competition (Horowitz et al., 2017; Cunningham and Sawyer, 2017), and/or the age of the organization and its level of bureaucratic capacity (Horowitz, 2010). However, along all these dimensions, little differentiates Boko Haram from ASG. In many respects, they share the same advantages and challenges, and yet the organizations innovate at different rates.

In this article, 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: membership. Tactical innovation emerges 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 knowledge to resolve the multitude of problems an organization faces.

Boko Haram experiments tactically 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" (Corps, 2016b, 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 (Corps, 2016a). As a result, the NSA 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 NSA draws from 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, 2016). 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 NSA is locked in its own echo chamber, devoid of different perspectives and information.

The theory reduces the concept of diversity down to its most basic element: information. Moreover, the theory generates a framework whereby individual-level interactions contribute to larger organization-level outcomes. This allows one to think about the impact of membership diversity as another resource available to violent organizations. The policy implications for counter insurgency and conflict scholars is that the membership composition can potentially influence how adaptive and resilient a NSA is, potentially motivating different types of counterinsurgency responses given different compositions.

Membership diversity can potentially increase the lethality of NSAs as groups innovate and experiment with new forms of violence. Further research needs to be done establishing a link between incremental innovations and increased fatalities. Moreover, NSAs that are capable of regularly innovating are potentially better able to stay relevant, instill greater levels of fear within target populations, and generate greater pressure to push the state to negotiate and compromise. Scholars of violent tactical behavior should continue to explore the repercussions of varying, adapting, and innovating tactics on conflict processes. Finally, a more complete understanding of how NSA members interact with organizational structures and institutions may better elucidate structural conditions that make it easier for membership diversity to be utilized. Highly centralized and decentralized organizational structures may enhance or inhibit the ability of individual members to interact with the organization's problems.

The ITT design advanced in this paper leverages variation in novel exposures to socially-relevant ethnic populations as a diversity treatment. However, the strategy only allows for the estimation of the total effect of exposure on innovation, not the direct effect of interest. The empirical strategy yields an underestimates of the true effect as not all NSAs in the sample are assumed to comply with the treatment when ethnic affiliations are strong. As data on NSAs becomes more granular and information on membership composition is measure with increased accuracy, it may be possible to estimate the direct effect of membership composition on tactical innovation.

Finally, this paper advances the usefulness of causal graphs in making theoretical assumptions more explicit (Pearl, 1995, 2009). The importance of clear specifications when dealing with purely observable data requires a better marriage of theory and empirics (Aldrich et al., 2008). The internal processes that shape observed outcomes within violent organizations do not always fit within a randomized identification strategy. Causal graphs offer a way to clarify relationships in order to make causal identification possible. This paper takes a step in that direction through careful specification of how existing theoretical knowledge and researcher assumptions fit together.

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A Appendix

A.1 Extended Literature Review

I survey the literature on the factors that underpin theories on tactical innovation and diversification within NSAs. I outline a gap in the literature on violent tactics where little if any weight is placed on the internal dynamics of violent organizations. This section is intended as a supplement to the discussing in Section 2 in the main manuscript. In particular, Table 1 summarizes the prominent debates in the literature. This appendix delves into those discussions more thoroughly and explores assignment of each class of literature to the specific quadrant of Table 1.

A.1.1 External Constraints & Drivers

NSAs 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 NSAs that rely on civilian communities for support and resources are less likely to abuse non-combatant populations (Weinstein, 2006), roam (Beardsley et al., 2015), and adopt tactical methods that are not locally popular (Stanton, 2013; Bakke, 2014; Polo and Gleditsch, 2016). 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, 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, NSAs 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 in NSAs 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 et al., 2010). Violent organizations have incentives to operate in ways that avoid detection and effective targeting (Beardsley et al., 2015; Parkinson, 2013).[18] Likewise, the state seeks out ways to undermine a violent organization's efforts through its own process of adaptation and innovation (Wilkinson and Jenkins, 2013; Dugan et al., 2005). Thus, violent organizations and the state engage in "tactical interactions" 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 (Tarrow, 2011; Bloom, 2005; Conrad and Greene, 2015).[19] Moreover, the ability for the state to anticipate an violent challenger's behavior increases its capacity to target them (Beardsley et al., 2015; Toft and Zhukov, 2015). 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 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

[18] 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.

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

hijackings.[20] It was a costly and ultimately detrimental exercise for the group. However, the majority of 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 of conflict (Buhaug and Gleditsch, 2006; Danneman and Ritter, 2014; Jervis and 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 (Horowitz, 2010; Acosta and Childs, 2013; Wahedi, 2018; Asal and Rethemeyer, 2008).[21] 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 innovation. 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 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.

[20] 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).

[21] 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.

A.1.2 Internal Constraints & Drivers

The internal conditions that shape an NSAs'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 NSAs concerns resources. Resources shape how NSAs mobilize (McCarthy and Zald, 1977), recruit (Weinstein, 2006; Gates, 2002; Gates and Nordas, 2010), bargain (Nygård and Weintraub, 2015), and compete (Wood and 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 and 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, NSAs cannot implement methodologies that extend beyond their resource capabilities.[22] 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 innovative 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; 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 NSA's 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 et al., 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 innovative capacity (Gill et al., 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

[22] 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.

ideas in favor for their preferred method, reducing the likelihood of innovation.[23]

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 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.

A.2 Compositional assumptions underpinning the directed acyclic graph presented in Figure 3

The following list outlines the explicit assumptions being made in the main empirical DAG presented in Figure 3. Each directed arrow denotes a causal relationship.

- **Activity Level → Innovation**: More active NSAs, i.e. NSAs that generate more violent events, are more likely to be innovative. The assumption is that the baseline opportunity to innovate increases as the number of events increase.
- **Affiliation (t-1) → Selection Mechanism (t-1)**: NSAs locked into affiliation networks are assumed to select recruits in a manner that conforms with the norms generated by that partnerships.
- **Affiliation (t-1) → Innovation**: NSAs learn new tactics through affiliations with other NSAs (Buhaug and Gleditsch, 2006; Danneman and Ritter, 2014; Jervis and Snyder, 1991; Acosta and Childs, 2013; Asal and Rethemeyer, 2008).
- **Ethnic Exposure (t-1) → Selection Mechanism (t-1)**: Main theoretical pathway discussed in Section 4 in the manuscript.
- **Selection Mechanism (t-1) → Membership**: Main theoretical pathway discussed in Section 4 in the manuscript.
- **Membership → Innovation**: Main theoretical pathway discussed in Section 4 in the manuscript.

[23] 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.

- **Geographic Coverage (t-1) → Ethnic Exposure (t-1)**: Confounder pathway discussed in Section 4 in the manuscript.
- **Innovation (t-1) → Repertoire Size**: An innovation in the prior period increases the size of an NSA's tactical repertoire in the current period by definition.
- **Innovation (t-1) → Innovation**: An innovation in the prior period increases the likelihood of an innovation in the current period. Innovation is temporally dependent.
- **Leadership (t-1) → Activity Level**: NSA leaders are assumed to influence the number of violent events the organization produces each year. The lag denotes that plans and circumstances in the previous period influence the level of activity in the current period.
- **Leadership (t-1) → Affiliation (t-1)**: NSA leaders influence, in part, the types affiliations the organization enters into (Christia, 2012).
- **Leadership (t-1) → Geographic Coverage (t-1)**: An NSA's leadership is assumed to influence where the organization operates and how much territory the organization covers in a given period.
- **Leadership (t-1) → Selection Mechanism (t-1)**: An NSA's leadership is assumed to influence the institutions used to select new members.
- **Leadership (t-1) → Innovation**: Decisions made by the organization's leadership in the prior period are assumed to influence the likelihood of an innovation in the current period. Section 2 in the manuscript outlines the importance of leadership on innovation but underscores limitations to assuming that leadership is the sole pathway through which innovations occur.
- **Leadership (t-1) → Organization**: Decisions made by an NSA's leadership in the prior period are assumed to influence the organization's structures and institutions in the current period.
- **Membership (t-1) → Innovation (t-1)**: Membership composition in the prior period is argued to influence tactical innovations in the prior period. This pathway reflects the lagged representation of the main argument in Section 3 in the manuscript.
- **Membership (t-1) → Innovation**: Membership composition in the prior period is assumed, via the main theoretical mechanism, to impact the likelihood of an innovation in the current period. The idea is that the impact of membership composition on an organization's innovative capacity is temporally dependent, in part, on the composition of the organization in prior periods.
- **Membership (t-1) → Membership**: Membership composition in the prior period is assumed to influence membership composition in the current period.

- **Membership (t-1) → Organization**: Membership composition in the prior period is assumed to influence the organization's structure and institutions in the current period.
- **Org. Age → Activity Level**: The number of events an organization generates in a given period is assumed to be influenced by the age of the organization. NSAs may become less (more) active as they age.
- **Org. Age → Repertoire Size**: As NSA's age, their repertoires of contention are assumed to grow. That is, an older NSA is assumed to have a larger tactical repertoire than a younger organization.
- **Org. Age → Innovation**: As NSA's age, the likelihood of an innovation or adopting an innovative tactic decreases (Horowitz, 2010).
- **Org. Age → Membership**: The age of an NSA is assumed to influence its membership composition. Horowitz (2010) argues that bureaucratization and specialization may inhibit innovation. Likewise, I assume that these processes may begin to influence what populations are recruited into the group.
- **Org. Age → Organization**: As NSA's age, the organizational structure and institutions are assumed to change.
- **Organization (t-1) → Activity Level**: The prior state of the organization (structure/institutions) is assumed to influence the activity level of the NSA in the current period. The assumption is that organizations that are disorganized and/or dysfunctional in the previous period will be less capable of organizing and producing violence due to the mismanagement and mis-allocation of organizational resources.
- **Organization (t-1) → Geographic Coverage (t-1)**: The state of the organization is assumed to influence the organization's ability to cover territory. The assumption is that organizations that are disorganized and/or dysfunctional are less capable of covering territory due to the mismanagement and mis-allocation of organizational resources.
- **Organization (t-1) → Leadership (t-1)**: The state of the organizational structure and institutions are assumed to shape leadership capabilities.
- **Organization (t-1) → Resources (t-1)**: The state of the organizational structure and institutions are assumed to shape its capacity to extract resources either externally from an patron, or internally from lootable wealth.
- **Organization (t-1) → Selection Mechanism (t-1)**: An NSA's institutions and structures is assumed to shape its selection institutions. For example, more hierarchical organizations are assumed to have standardized mechanisms for recruiting, selecting, and socializing than decentralized organizations that operate as cells.
- **Organization (t-1) → Organization**: Organizational structure is assumed to be temporally dependent.

- **Repertoire Size → Innovation**: NSAs with larger tactical repertoires are more likely to innovate than organization's with smaller tactical repertoires. The assumption is that incremental tactical innovations compound.

- **Resources (t-1) → Activity Level**: The level of resources NSA has is assumed shape its capacity to mobilize (McCarthy and Zald, 1977) and compete (Wood, 2014).

- **Resources (t-1) → Geographic Coverage (t-1)**: Resource availability may incentivize NSAs to cover more territory either to extract resources from local populations or because the NSA is not dependent on local populations for resources (Beardsley et al., 2015).

- **Resources (t-1) → Org. Age**: NSAs with resources are assumed to survive longer than NSA without them.

- **Resources (t-1) → Repertoire Size**: NSAs with resources are assumed to develop and use a larger array of tactics than organizations that lack resources.

- **Resources (t-1) → Membership**: Resource endowments are assumed to shape membership composition (Weinstein, 2006).

- **Resources (t-1) → Organization**: Resources endowments in the prior period are assumed to influence organizational structure and institutions in the current period.

- **Context → Innovation**: The likelihood of developing and/or adopting a new tactic is related to local support and approval (Kalyvas and Sánchez-Cuenca, 2005; Bakke, 2014; Polo and Gleditsch, 2016).

- **Context → Ethnic Exposures (t-1)**: Confounder pathway discussed in Section 4 in the manuscript.

- **Context → Selection Mechanism (t-1)**: Forney (2015) argues that NSAs leverage civilian information networks (i.e. local contextual knowledge) to vet and select recruits.

- **Context → Membership**: Contextual factors are assumed to influence supply-side factors that shape membership composition. For example, limited economic opportunities may incentivize participation in an NSA, increasing the supply of potential recruits.

- **Time → Innovation**: Temporal factors are assumed to influence the likelihood of an innovation. The assumption is that NSAs can observe and learn from one another (Linebarger, 2016).

- **Time → Membership**: Temporal factors are assumed to influence membership composition.

- **Time → Org. Age**: Time increases age by definition.

- **Time → Organization**: Temporal factors are assumed to influence an NSAs organizational structure and institutions.

- U_1 **and** U_2 **Confounders**: Confounding factors generating unobserved and unacknowledged correlations between variables.

A.3 Empirical Section Extended

The following section offers additional empirical support to the main analysis presented in Section 4 in the manuscript. Note that all relevant tables are directly referenced in the manuscript.

Table 4 reports the summary statistics for the main variables used in the empirical strategy outline in Section 4.

Table 4: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Tactical Innovations (count)	2,042	1.3	1.9	0	18
Tactical Innovation (binary)	2,042	0.5	0.5	0	1
Novel Exposures	2,042	0.3	0.6	0	2
Geographic Coverage (Cummulative)	2,042	14.0	14.5	1	95
Geographic Coverage (Discrete)	2,042	4.3	5.5	1	50
Geographic Coverage (Novel)	2,042	0.4	0.5	0	1

Years: 1970 to 2018 (48); N Organizations: 187

Table 5 presents balance statistics for the geographic coverage measures used to match organization-years where a novel exposure occurred to organizational-years where no exposure occurred. Matching is employed in the manuscript to reduce concerns over model dependency (Ho et al., 2007). Moreover, since the DAG presented in Figure 3 makes no specific parametric assumptions, matching allows for a non-parametric estimation strategy. Three different matching algorithms are explored in Figure 6. The balance statistics show that on average, the two distributions are generally equivalent. Note that country-specific factors are still adjusted for in Figure 6 using country-fixed effects.

Table 6 addresses the first confounder scenario in the robustness section in the manuscript where geographic coverage and ethnic exposure are confounded by an unobservable confounding factor. The presence of a confounder results in geographic coverage operating as a collider. As a result, Table 6 excludes the coverage metrics from the model. The results align with the main finding reported in Table 2 with an increased effect size.

Table 7 considers the implications of relaxing the inclusion conditions for the relevant sample of non-state actors in the manuscript. For the main analysis, only organizations that were in operation for 6 months a year for a minimum or two years were included in the sample. In addition, generically named actors — such as “Extremists” or “Separatists” — were dropped from the sample. Table 7 reruns the main parametric analysis presented in Table 2 but without imposing any inclusion criteria. That is, all actors in the GTD are

Table 5: Balance statistics for the matching algorithms used to generate Figure 6

Algorithm	Dimension	Novel Exposure$_{t-1}$ = 0	Novel Exposure$_{t-1}$ = 1
Propensity	Cum. Geographic Coverage$_{t-1}$	11.75 (11.82)	11.94 (13.11)
	Discrete Geographic Coverage$_{t-1}$	5.18 (5.25)	5.59 (6.43)
	Novel Geographic Coverage$_{t-1}$	0.87 (0.33)	0.87 (0.33)
Coursened Exact	Cum. Geographic Coverage$_{t-1}$	11.39 (30.2)	10.81 (10.16)
	Discrete Geographic Coverage$_{t-1}$	5.34 (16.57)	5.26 (5.87)
	Novel Geographic Coverage$_{t-1}$	0.87 (1.37)	0.87 (0.34)
Exact	Cum. Geographic Coverage$_{t-1}$	7.54 (14.23)	7.54 (6.44)
	Discrete Geographic Coverage$_{t-1}$	3.69 (7.69)	3.69 (3.09)
	Novel Geographic Coverage$_{t-1}$	0.85 (1.61)	0.85 (0.36)

Table 6: Adjustment for confounder scenario 1

	Pr(Tactical Innovation = 1)		$E[N$ Tactical Innovations$]$	
	1	2	3	4
	LPM	Logit	OLS	Neg. Bin.
Novel Exposure$_{t-1}$	0.133	0.609	0.550	0.365
	(0.021)	(0.104)	(0.083)	(0.050)
Overdispersion				1.075
Fixed-Effects				
country	✓	✓	✓	✓
Fit statistics				
Observations	2,042	2,008	2,042	2,027
Squared Correlation	0.081	0.067	0.109	0.106
Pseudo R^2	0.05886	0.05075	0.02796	0.03312
BIC	4,083.86	3,584.24	9,470.97	7,274.70

Two-way (group & country) standard-errors in parentheses

included in the analysis. The table demonstrates the main findings in the paper are not sensitive to the specific inclusion criteria decisions.

Table 8 explores restricting the relevant time period to 1990 onward, 2000 onward, and 2010 onward, respectively. One concern lies with the polygons used to track the location of socially-relevant ethnic populations in the geoAMAR (Birnir and Satana, 2020). The data treats these populations as fixed over time; however, the population locations geoAMAR are not guaranteed to be accurate at earlier periods. To address this concern, Table 8 subset the data to only consider more recent slices of the GTD time series. In all three tables, the results keep with the main findings in the manuscript.

The final robustness check considers the implications associated with dropping all event entries with "Unknown" tactical information for the weapon, target, or both. The concern is that for those organization-years where tactical information is missing, an innovation could have occurred but was not reported on, potentially altering the conditional relationship of interest. For example, one might observe tactic X_t at time t and code it as an incremental innovation having not observed that tactic's use prior to that point. However, tactic X_t may have been used in a prior period at time $t-1$, but was miscoded due to

Table 7: Replication of Table 2 with no inclusion criteria restrictions on the relevant sample

	Pr(Tactical Innovation = 1)		$E[N$ Tactical Innovations]	
	1	2	3	4
	LPM	Logit	OLS	Neg. Bin.
Novel Exposure$_{t-1}$	0.063	0.303	0.286	0.159
	(0.020)	(0.096)	(0.079)	(0.046)
Cumulative Geo. Coverage$_{t-1}$	-0.011	-0.055	-0.038	-0.047
	(0.003)	(0.015)	(0.010)	(0.014)
Novel Geo. Coverage$_{t-1}$	0.082	0.351	0.370	0.300
	(0.024)	(0.108)	(0.096)	(0.074)
Discrete Geo. Coverage$_{t-1}$	0.019	0.101	0.065	0.073
	(0.003)	(0.020)	(0.011)	(0.013)
Overdispersion				1.4363
Fit statistics				
Observations	2,472	2,428	2,472	2,458
Squared Correlation	0.132	0.122	0.143	0.16
Pseudo R^2	0.09842	0.09255	0.03781	0.0599
BIC	4,784.97	4,166.76	11,272.44	8,572.08

Country fixed effects were applied to all models.
Two-way (Organization & Country) standard-errors in parentheses
Difference in sample size due to country observations being censored due to lack of variation on the dependent variables.

missing information.

To address this problem, I randomly impute tactical information for all missing weapon/target entries in the relevant GTD time series. Selecting from the set of all plausible tactics used by all organizations in the sample at time t, I randomly draw weapon and/or target information to fill in the values for event entries missing tactical information. I then re-calculate an NSA's innovation record using these imputed tactical data. This allows for a plausible tactic to emerge in an organization's time series prior to the empirical record where these missing entries are ignored. Given that the imputed entries are randomly selected, I repeat this process 100 times re-estimate the main model, retaining the coefficient and the standard error for the novel exposure metric. The empirical exercise aims to capture the sensitivity of the results to potential missingness in the data.

Figure 2 reports the coefficient estimates for the novel exposure metric for all 100 iterations of the randomly imputed tactical information used to generate the tactical innovation measure. The distributions capture the point estimates from each re-estimation of the the parametric models reported in Table 2. Only the coefficient estimates for the main variable of interest — novel exposures$_{t-1}$ — are reported. The solid red lines in the figure denote the location of the point estimates reported in Table 2.

The figure shows the sensitivity of the main result to measurement error — specifically missingness in GTD's tactical record. For models 1 and 2, where the dependent variable is binary, the imputed results show a slight *reduction* in the magnitude of the effect. The results are still positive and statistically significant. For models 3 and 4, where the dependent variable is a count, the estimated coefficients appear larger on average (model 3) or around the same magnitude (model 4) to the findings reported in Table 2. The exercise supports the

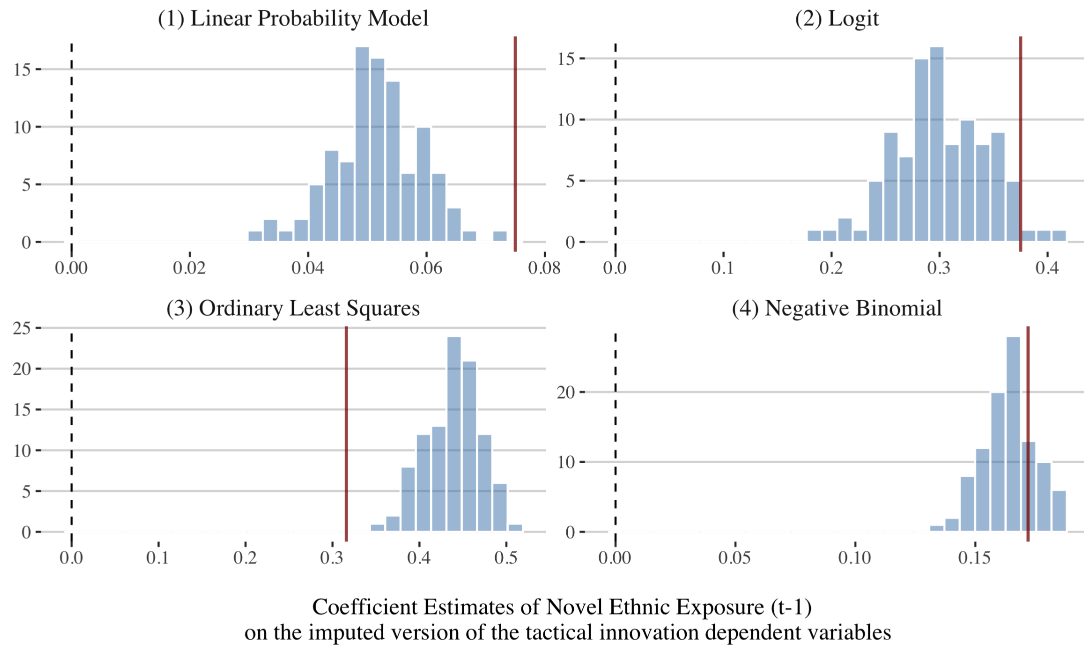
Table 8: Replication of Table 2 with restricted temporal samples

	Pr(Tactical Innovation = 1)		$E[N$ Tactical Innovations]	
	1	2	3	4
	LPM	Logit	OLS	Neg. Bin.
		Sample: **1990 onward**		
Novel Exposure$_{t-1}$	0.086	0.418	0.450	0.237
	(0.022)	(0.113)	(0.101)	(0.055)
Cumulative Geo. Coverage$_{t-1}$	-0.010	-0.053	-0.039	-0.043
	(0.001)	(0.009)	(0.007)	(0.007)
Novel Geo. Coverage$_{t-1}$	0.048	0.193	0.186	0.215
	(0.024)	(0.111)	(0.113)	(0.096)
Discrete Geo. Coverage$_{t-1}$	0.017	0.097	0.060	0.063
	(0.002)	(0.016)	(0.008)	(0.009)
Overdispersion				1.4131
Observations	1,435	1,408	1,435	1,423
		Sample: **2000 onward**		
Novel Exposure$_{t-1}$	0.067	0.315	0.500	0.254
	(0.026)	(0.131)	(0.124)	(0.058)
Cumulative Geo. Coverage$_{t-1}$	-0.011	-0.057	-0.038	-0.049
	(0.002)	(0.013)	(0.008)	(0.011)
Novel Geo. Coverage$_{t-1}$	0.047	0.201	0.205	0.205
	(0.034)	(0.160)	(0.149)	(0.122)
Discrete Geo. Coverage$_{t-1}$	0.020	0.105	0.062	0.074
	(0.002)	(0.017)	(0.011)	(0.012)
Overdispersion				1.469
Observations	1,035	1,009	1,035	1,022
		Sample: **2010 onward**		
Novel Exposure$_{t-1}$	0.072	0.368	0.420	0.205
	(0.030)	(0.161)	(0.164)	(0.075)
Cumulative Geo. Coverage$_{t-1}$	-0.054	-0.060	-0.060	
	(0.003)	(0.018)	(0.014)	(0.012)
Novel Geo. Coverage$_{t-1}$	0.079	0.370	0.404	0.309
	(0.045)	(0.220)	(0.153)	(0.122)
Discrete Geo. Coverage$_{t-1}$	0.023	0.108	0.101	0.097
	(0.005)	(0.029)	(0.022)	(0.017)
Overdispersion				1.9589
Observations	611	564	611	587

Country fixed effects were applied to all models.
Two-way (Organization & Country) standard-errors in parentheses
Difference in sample size due to country observations being censored
due to lack of variation on the dependent variables.

proposition that the *direction* of the estimated effect is not sensitive to non-random deletion of missing tactical information in the GTD entries.

Figure 8: Estimate sensitivity to missingness in the tactical record



The reports re-estimation of the main results reported in Table 2 with missing tactical information randomly imputed when generating the dependent variable. Missing tactical information in the GTD event record is randomly imputed 100 times. The blue histograms capture the point estimates of novel exposures on the imputed tactical innovation measure for all 100 iterations. The solid red line denotes the location of the point estimates reported in Table 2. The black dashed line highlights the location of 0.