Bachelor Project

The effect of changes in counterinsurgency pressure on dark networks

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1 Introduction

Counterinsurgency withdrawals have become a recurring feature of contemporary conflict. In recent years, Western militaries have exited major interventions without achieving their stated stabilization goals, leaving behind security vacuums that insurgent groups are often quick to exploit. France's departure from the Sahel in 2022, the U.S. withdrawal from Afghanistan in 2021, and similar episodes elsewhere were not merely tactical drawdowns. They marked abrupt shifts in the strategic environments in which insurgent organizations operate. For these groups, the sudden reduction of external pressure can force difficult choices about how to organize, govern territory, and project violence.

Despite how common such withdrawals have become, we know surprisingly little about their organizational consequences. Research on terrorism and insurgency has richly documented how clandestine groups adapt when pressure increases. Al-Qaeda's evolution from a relatively centralized hierarchy into a looser constellation of semi-autonomous cells after the U.S. invasion of Afghanistan is a canonical example (Jackson, 2006, p. 250). What happens in the opposite scenario, however, remains underexplored. When capable counterinsurgent forces leave, do insurgent organizations recentralize to recover coordination and efficiency? Or do other dynamics, such as territorial expansion, internal politics, or competition with rival groups, push organizational change in different directions?

This study addresses that gap by examining organizational adaptation in the wake of counterinsurgency withdrawal using spatial network analysis. It applies spatio-temporal clustering techniques to patterns of violent events in order to infer operational cells and track how their structure changes across distinct counterinsurgency phases. By focusing on what happens when pressure decreases rather than intensifies, the analysis shifts attention to an understudied moment in insurgent life cycles. In doing so, it contributes both theoretically, by probing the mechanisms that shape organizational adaptation, and methodologically, by demonstrating how observable violence can be used to study otherwise opaque networks.

The policy implications are equally significant. Counterinsurgency strategies are often tailored to the organizational form of the adversary. Fragmented networks of autonomous cells demand different intelligence methods, targeting priorities, and resource allocations than centralized hierarchies. Understanding how insurgent organizations behave during and after withdrawal phases can therefore inform more effective transition and handoff strategies when international forces exit conflict zones.

This research contributes to terrorism studies by bringing together theories of dark network trade-offs with spatial analytical tools. Organizational theory has long emphasized the tension insurgent and terrorist groups face between efficiency and security when selecting structural arrangements. Empirical work, however, has largely examined these trade-offs under conditions of escalating pressure (Zech & Gabbay, 2016). By extending this analytical lens to periods of counterinsurgency withdrawal, and by employing spatial network methods adapted from recent advances in the study of covert groups through violence data, this study broadens our understanding of how insurgent organizations evolve when the battlefield and the balance of pressure change.

2 Literature Review

2.1 Dark Networks and Their Organizational Dilemma

Terrorism studies often conceptualize insurgent organizations as "dark networks", entities that operate both illegally and covertly, striving for maximum invisibility while pursuing strategic objectives (Milward & Raab, 2006, p. 334). Those conditions require this type of groups to make trade-offs in their structure and operations. On one hand, dark networks need sufficient communication and coordination to carry out operations effectively. On the other hand, too much communication produces intelligence signatures that make them vulnerable to counterterrorism measures (Milward & Raab, 2006, pp. 334-335). Similarly, while hierarchical authority enables direction of resources toward strategic priorities, concentrated leadership creates high-value targets, whose removal can significantly disrupt the organization. The delicate balance between operational effectiveness and survival under threat shapes the organizational structures these groups adopt.

Research identifies the centralization-decentralization continuum as the key dimension along which dark networks navigate structural choices (Bakker et al., 2012, p. 52). In essence, these organizations face an optimization problem: centralization enhances the capacity to act efficiently, while decentralization strengthens resilience and the ability to survive under pressure.

Centralized structures concentrate decision-making authority within core leadership groups, maintaining direct hierarchical control over subordinate units. Chuang and D'Orsogna (2019) demonstrate through network modeling that centralization facilitates efficient resource allocation and ideological coherence. Yet, these advantages come with significant vulnerabilities: concentrated leadership presents high-value targets, increased communication generates intelligence opportunities, and hierarchical arrangements are more easily mapped by adversaries. Price's (2019) historical analysis reinforces these trade-offs, showing that while centralized phases allowed sophisticated coordination, they also magnified losses when key leaders were removed.

In contrast, decentralized structures distribute authority across semi-autonomous cells, limiting inter-cell communication. This configuration prioritizes resilience through what Bakker, Raab, and Milward (2012, pp. 50-52) term "networked capability": the ability to replace disrupted nodes and maintain functionality. Reduced communication minimizes intelligence signatures, and individual cells can continue operations even when other nodes are compromised (Everton, 2012). However, decentralization is not without cost: coordination becomes more difficult, resource distribution grows less efficient, and strategic coherence suffers when autonomous cells pursue divergent local agendas. The tension illustrates the enduring trade-off between integration, which enables coordinated action, and differentiation, which enhances survival (Milward & Raab, 2006, pp. 343-345).

2.2 Organizational Adaptation Under Pressure

A substantial body of research explores how dark networks adapt their structures in response to changing external pressures. Al-Qaeda's evolution following September 11 stands as the canonical example. Raab and Milward (2003) analyzed how intensive U.S. counterterrorism efforts pushed the organization from relative centralization toward a highly decentralized network of semi-autonomous cells. Sageman (2008) documents the emergence of a "leaderless jihad" model, where local cells operated with minimal central coordination. Bakker et al. (2012, pp. 52-54) further demonstrate that centralization moderates vulnerability: highly centralized structures suffer amplified disruption under counterterrorism pressure, as the removal of key nodes destabilizes entire organizations.

Yet, much scholarship has focused almost exclusively on adaptation under increasing pressure. The reverse scenario: what happens when capable counterinsurgent forces withdraw, intelligence capabilities wane, or surveillance infrastructure diminishes, remains largely unexplored. Do dark networks then recapture efficiency by recentralizing? This question is increasingly pressing, given the growing frequency of counterinsurgency withdrawals in contemporary conflicts. Western interventions in Afghanistan, Iraq, the Sahel, and elsewhere have shifted the strategic landscape for insurgent organizations, yet systematic research into structural adaptation under declining external pressure remains scarce.

2.3 Research Gap and Contribution

This review highlights a gap at the intersection of theory on dark network adaptation and empirical analysis of counterinsurgency withdrawal. Theoretically, research establishes that dark networks navigate trade-offs along the centralization-decentralization continuum and adapt in response to external pressure. Yet, these insights have not been fully integrated to examine how insurgent organizations respond when counterinsurgent capabilities decline.

Counterinsurgency withdrawals create natural experiments for studying adaptation. These shifts alter the optimization problem for dark networks, potentially triggering structural adaptations as they recalibrate centralization-decentralization trade-offs. Examples include the U.S. withdrawal from Afghanistan in 2021 and the French exit from the Sahel between 2021 and 2023, where professional militaries with significant intelligence assets were suddenly a factor that dark network no longer had to consider when planning their operations.

This research addresses the gap by applying spatial network analysis across counterinsurgency phases to detect structural adaptation following major withdrawals. By integrating theoretical frameworks on dark network trade-offs with spatial analytical methods, the approach examines whether patterns of observable violence reveal organizational responses to reduced external pressure. Tracking structural changes over time allows testing of whether dark networks recentralize when counterinsurgency capabilities diminish, contributing both theoretical insights into adaptation mechanisms and empirical knowledge about insurgent exploitation of withdrawal transitions.

3 Theoretical Framework

Dark networks navigate a persistent organizational dilemma that dictates their organizational structure. These groups must balance the need for operational security against the requirement to coordinate complex activities across expansive territories (Everton, 2012). This tension exists as a trade-off between two distinct organizational architectures, each presenting unique benefits and liabilities. Studying this balance provides a lens for studying how insurgent groups pivot when counterinsurgency pressure fluctuates.

3.1 The Centralization-Decentralization Trade-off

Centralized structures anchor decision-making power within a core leadership hub that exerts hierarchical control over subordinate cells. For a covert group, this model offers clear perks. Centralized command permits fluid resource allocation, funneling funds, hardware, and personnel toward high-priority strategic goals (Chuang & D'Orsogna, 2019, pp. 445-448). It enables the synchronization of attacks across various fronts to achieve a combined strategic impact. Furthermore, centralization preserves ideological and tactical unity, ensuring that local actions remain tethered to the group's primary mission.

However, this concentration of power invites danger under heavy counterterrorism pressure. High-level leaders become "high-value targets" whose removal can cripple the entire organization. Centralization also demands frequent communication between the core and the periphery, creating a trail for intelligence and increasing the risk of infiltration. Because these networks are easier for security forces to map, they are more susceptible to targeted dismantling (Everton, 2012).

In contrast, decentralized structures scatter authority among semi-autonomous cells that share minimal information. This design prioritizes survival and stealth. Because communication is sparse, these networks leave smaller intelligence footprints and are harder to track. If one node is destroyed or a leader is captured, other cells continue their operations unaffected. Al-Qaeda's shift after 2001 serves as an example of this adaptation, as it moved toward a model of loosely linked affiliates acting with little central oversight (Raab & Milward, 2003; Sageman, 2008).

Decentralization also certain comes with costs. Coordinating between isolated cells is difficult, which hampers the ability to launch complex, multi-front campaigns. Resource sharing becomes clunky, as cells cannot easily trade weapons or intelligence. Strategic focus may also blur if autonomous units begin pursuing local interests that clash with the broader cause. For dark networks, structure is an optimization puzzle: they must weigh the efficiency of centralization against the security of decentralization, depending on the severity of the external threat (Chuang & D'Orsogna, 2019).

3.2 From Trade-offs to Testable Predictions

This framework allows us to forecast how organizations adapt when the environment shifts. While scholars have often noted how groups decentralize to survive intense pressure, the opposite reaction, what happens when pressure lifted, is less explored. When a capable counterinsurgent force withdraws, do these networks centralize to regain their lost efficiency?

When an adversary with high-tech surveillance and strike capabilities leaves, the security costs that once mandated decentralization drop. The risk of detection falls and the threat to leadership fades. As counterinsurgency pressure drops, maintaining a fragmented structure becomes less logical. Under these lighter conditions, groups may consolidate their cells to sharpen coordination and execute more ambitious strategies.

Therefore, military withdrawals create favorable conditions for centralization. We expect organizational structures to slide along the centralization-decentralization spectrum, adjusting as the balance between the need for safety and the desire for efficiency shifts.

Therefore, this research addresses the following research question:

How does a decrease in counterinsurgency pressure affect the structure of insurgencies?

Hypothesis: The rate of new cell formation will decrease following counterinsurgency withdrawal compared to periods of sustained pressure, resulting in organizational stabilization rather than continued decentralization.

3.3 Scope Conditions

This theoretical framework applies under two primary scope conditions. First, the framework applies to dark networks: organizations operating both illegally and covertly that face threats of detection and disruption. Organizations not subject to counterinsurgency pressure may not exhibit the centralization-decentralization trade-offs central to this analysis.

Second, the predictions depend on significant decreases in counterinsurgency pressure rather than marginal fluctuations. Minor variations in adversary capabilities or force levels may not trigger observable organizational adaptation. The framework therefore applies most clearly to substantial transitions such as complete military withdrawals.

4 Methods

This research uses a single-case longitudinal study design to assess how insurgencies adjust their operational structure following shifts in counterinsurgency pressure. A single-case longitudinal design enables tracking organizational structure continuously before and after a discrete change in counterinsurgency pressure, allowing the research to isolate the effects of that specific change while holding other case-specific factors constant.

4.1 Case

Jama'at Nusrat ul-Islam wa al-Muslimin is a suitable case as it fulfills this study's case selection criteria while also offering significant policy relevance as JNIM operates in the Sahel, which accounts for over half of global terrorism-related deaths (UN, 2025).

Firstly, a suitable insurgency to study would need to experience clear variation in its counterinsurgency environment. JNIM experienced precisely such variation as Western counterinsurgency forces, including French Operation Barkhane and European Task Force Takuba, withdrew in November 2022, followed by the departure of UN peacekeepers (MINUSMA) in 2023, and the arrival of Russian Wagner Group mercenaries (later replaced by Africa Corps). Secondly, the organization must operate as a dark network, i.e. covert and illegal, concealing its structure and activities to evade counterinsurgency operations. This criterion ensures the research examines organizational adaptation specific to covert networks, as bright network, i.e. legal and overt, face different constraints (Bakker et al., 2012, p. 48). JNIM meets this requirement as a terrorist organization that must operate clandestinely to survive. Thirdly, the organization should be situated within established research and theories on network adaptation. This criterion provides methodological leverage: by selecting a case where existing theory generates clear predictions, the research can rigorously test whether observed patterns align with theoretical expectations. Existing research demonstrates that dark networks like Al-Qaeda decentralize under increasing counterinsurgency pressure, as documented following post-9/11 operations (Brinton Milward & Raab, 2006, pp. 338-339). By examining an Al-Qaeda affiliate like JNIM during a period of decreasing pressure, this research can test the reverse prediction: do networks recentralize when external threats diminish? Studying JNIM thus allows for theory-testing rather than purely exploratory analysis.

4.2 Data

This research relies on data from the Armed Conflict Location and Event Dataset (ACLED) (Raleigh et al., 2010). The analysis examines 15,724 conflict events attributed to JNIM between March 2, 2017 and November 2025. Events are discrete incidents involving designated political actors at specific locations and times, including acts of political violence (the use of force by groups with political purposes), demonstrations, and strategic developments such as organizational changes or agreements (ACLED, 2024). Each event record includes the date, precise geographic coordinates (latitude and longitude), event type and sub-type, actors involved, and contextual information, enabling the reconstruction of JNIM's spatial and temporal activity patterns across the Sahel.

The dataset begins with JNIM's formation on March 2, 2017, when Ansar Dine, al-Mourabitoun, and AQIM announced their merger into Jama'at Nusrat al-Islam wal Muslimeen. For this analysis, all events listing JNIM as either the primary or associated actor were included. Strategic developments unrelated to operational activity (arrests of JNIM militants, agreements, organizational announcements) were excluded to focus on events reflecting operational actions, without further filtering by event type, target, or fatality threshold.

4.3 Operationalization of Variables

To assess whether JNIM shifts organizationally in response to changing counterinsurgency pressure, I must operationalize two key variables: organizational structure (the dependent variable) and time periods reflecting distinct counterinsurgency environments (the independent variable).

4.3.1 Dependent variable: Organizational Structure

The study of clandestine groups is challenging due to the deliberate effort by these groups to conceal their internal structure, making methods that rely on direct observation difficult to apply reliably. This research addresses this challenge by operationalizing organizational structure through spatial patterns of group activity. This research addresses this challenge by operationalizing organizational structure through geographical patterns of violence. Geographic space serves as a window into latent organizational structure. I measure this through the number of active cells derived from a spatio-temporal clustering algorithm. This approach produces event networks: spatially defined representations of cells derived from clustering patterns in event data. These networks are not direct observations of JNIM's actual cell structure, but rather analytical constructs that approximate organizational structure.

Prieto Curiel et al. (2020) developed a spatial-temporal clustering methodology to overcome these limitations by inferring organizational structure from observable violence patterns rather than requiring direct access to the organization. Their methodology was used to analyze Boko Haram's organizational fragmentation by tracking how violent events cluster geographically and move across the region over time. The key insight is that terrorist cells face physical mobility constraints, i.e. they cannot instantly travel unlimited distances between attacks. By modeling these spatiotemporal constraints, they identify distinct operational cells through patterns in the data. They defined active cells as "the ones that are still active at a certain time t" to track how organizational structure evolved (Prieto Curiel et al., 2020, p. 8). Like Boko Haram, JNIM must balance operational reach against mobility limitations in challenging terrain with limited infrastructure. The method requires only publicly available event data rather than privileged access to internal documents, making it particularly suitable for analyzing a clandestine organization like JNIM. Higher cell counts indicate greater organizational fragmentation and decentralization, while lower counts suggest consolidation toward centralized control.

Following Prieto Curiel et al. (2020) methodology, I use an agent-based model to identify operational cells from the spatiotemporal distribution of attacks. Rather than assuming cells can appear anywhere at any time, the algorithm respects realistic mobility limitations. The algorithm processes events sequentially, assigning each attack to either an existing cell or creating a new cell based on spatiotemporal feasibility. For each event, the algorithm calculates whether any previously identified cell could have traveled to the attack location given elapsed time and mobility parameters. The model operates through three parameters: v (daily cell speed in km/day), μ (maximum distance between consecutive attacks in km), and τ (inactivity threshold in days after which cells are considered dormant). A cell's potential location expands daily according to its speed v until reaching the maximum operational radius μ, after which it maintains that coverage area. When an event occurs, if no existing cell falls within feasible travel distance given elapsed time, the algorithm assigns the event to a newly identified cell. I adopt this approach for JNIM but adjust the parameter ranges to reflect documented differences in operational mobility. JNIM extensively uses motorcycles for rapid mobility across the Sahel's challenging terrain and limited road infrastructure, suggesting potentially higher mobility than Boko Haram. To ensure robust results, I test 651 parameter combinations across a wide range of mobility scenarios: v ranges from 0 to 200 km/day (in 10 km/day increments) and μ ranges from 0 to 300 km (in 10 km increments). For all scenarios, I maintain $\tau = 365$ days as the inactivity threshold. This comprehensive parameter sweep allows me to assess whether substantive findings regarding organizational structure changes persist across different mobility assumptions. Convergent results across parameter combinations strengthen confidence in detected patterns and ensure findings are not attributable to specific parameter choices.

4.3.2 Independent variable: Counterinsurgency pressure

The independent variable is counterinsurgency pressure, operationalized through two distinct time periods. The first period (March 2017 – November 2022) represents sustained Western counterinsurgency presence, characterized by French Operation Barkhane, European Task Force Takuba, and UN MINUSMA peacekeeping forces. The second period (December 2022 – November 2025) represents the post-withdrawal environment, following French departure in November 2022 and subsequent MINUSMA withdrawal in 2023. While Wagner Group mercenaries arrived in December 2021, the November 2022 French withdrawal marks the clearest structural break in counterinsurgency capability and thus serves as the analytical cutpoint.

4.4 Interrupted Time Series Regression Analysis

Interrupted time series (ITS) regression analysis is used to test whether JNIM's organizational structure changed following the November 2022 French withdrawal. This approach quantifies whether observed changes in cell counts represent genuine structural breaks coinciding with the withdrawal, rather than continuation of pre-existing trends.

ITS regression is appropriate for this analysis based on three design requirements (Bernal et al., 2017, pp. 349-350). First, the intervention has a clearly defined temporal boundary: French forces completed their withdrawal in November 2022, providing unambiguous differentiation between pre-intervention and post-intervention periods. Second, the outcome can respond relatively quickly to changes in counterinsurgency pressure, unlike slowly developing outcomes such as life expectancy or demographic shifts. Third, the data provide sufficient observations to detect trend changes as the analysis spans 105 monthly observations from JNIM's formation in March 2017 through November 2025, with 69 pre-withdrawal observations and 36 post-withdrawal observations.

4.4.1 Model Design

I use the following segmented regression model:

$$Y_t = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 T X_t + \varepsilon_t$$

where Y_t represents the number of active cells at time t, T represents months elapsed since March 2017, and X_t is a binary indicator (0 = pre-withdrawal, 1 = post-withdrawal). The coefficient β_0 represents baseline cell count at JNIM's formation, β_1 captures the pre-intervention trend in cell formation, β_2 estimates the immediate level change in cell count following withdrawal, and β_3

measures the change in trend (slope) after withdrawal. Based on the theoretical expectation that reduced counterinsurgency pressure enables slowing or halting organizational decentralization, I hypothesize a slope change: the coefficient β_3 should be negative, indicating a decrease in the rate of decentralization following the French withdrawal (Bernal et al., 2017, p. 351, Figure 2b). This represents organizational stabilization, meaning a slowdown in cell count increase, rather than continued fragmentation. I estimate this model using ordinary least squares regression.

Time series data requires addressing potential autocorrelation, where observations at consecutive time points are more similar than those further apart (Bernal et al., 2017, pp. 353–354). I test for autocorrelation by examining residual plots and the partial autocorrelation function. To address any detected autocorrelation, I employ Newey-West heteroskedasticity and autocorrelation consistent (HAC) standard errors, which provide robust inference without requiring specific modeling of the autocorrelation structure.

Cell detection depends on mobility parameters (daily speed v and maximum distance μ) that define spatiotemporal clustering thresholds. To ensure findings are not artifacts of arbitrary parameter choices, I conduct robustness analysis across 651 parameter combinations: v ranging from 0 to 200 km/day in 10 km/day increments and μ ranging from 0 to 300 km in 10 km increments. The analysis focuses on the plausible parameter range, excluding highly constrained mobility scenarios ($v < 50$ km/day or $\mu < 50$ km). This restriction is justified by JNIM's documented operational behavior: the organization extensively uses motorcycles for rapid movement across the Sahel's challenging terrain, enabling mobility that far exceeds these lower thresholds (GITOC, 2023, pp. 27-28). Parameter combinations below 50 km/day or 50 km are therefore inconsistent with empirical evidence of JNIM's capabilities. Results are presented as heatmaps displaying the coefficient β_3 and its statistical significance across all parameter combinations, allowing assessment of whether the core finding holds under varying methodological assumptions.

5 Analysis

5.1 Background Information

Jama'at Nusrat al-Islam wal-Muslimin (JNIM) emerged on March 2, 2017 through the merger of four Al-Qaeda-affiliated jihadist groups operating in Mali: Ansar Dine, the Macina Liberation Front, al-Mourabitoun, and the Sahara branch of Al-Qaeda in the Islamic Maghreb (AQIM) (Mostert et al., 2025). In a video announcing the coalition's formation, JNIM's emir Iyad ag Ghali, an ethnic Tuareg from Mali's northern Kidal region, pledged allegiance to AQIM leader Abdelmalek Droukdel and Al-Qaeda emir Ayman al-Zawahiri. The merger formalized operational cooperation among groups that had previously maintained distinct identities and territorial focuses, representing a strategic consolidation of Al-Qaeda's presence in the Sahel under unified command. JNIM operates through a three-tiered hierarchical structure consisting of a central shura council, regional commanders (manatiq emirs), and area commanders (markaz emirs) at the local level (Global Initiative Against Transnational Organized Crime [GITOC], 2023, p. 18). The central shura council determines overall strategic direction and ensures cohesion among constituent factions, while regional commands maintain significant operational autonomy in day-to-day activities (GITOC, 2023, p. 18). This organizational design allows JNIM to balance strategic coherence with tactical adaptation across the diverse contexts of Mali, Burkina Faso, and Niger.

The counterinsurgency environment against JNIM has undergone transformation since the organization's formation. Operation Barkhane, launched by France in August 2014 as the successor to Operation Serval, maintained approximately 4,500-5,100 troops across the Sahel region with permanent bases in Chad, Mali, Burkina Faso, and Niger. The operation focused primarily on counterterrorism through direct pursuit of armed groups, conducting joint operations alongside G5 Sahel forces and targeting senior JNIM leadership. Despite tactical successes, including the elimination of two of JNIM's five founding leaders, Operation Barkhane faced mounting casualties, escalating insurgent violence, and deteriorating relations with Mali's military junta following coups in August 2020 and May 2021. On November 9, 2022, French President Emmanuel Macron announced Operation Barkhane's formal conclusion, with the last French troops withdrawing from Mali in August 2022 after nine years of sustained operations (France Calls Time on Anti-Jihadist

Operation Barkhane in Sahel, 2022). This withdrawal represented a shift in counterinsurgency pressure against JNIM. With France's departure, Russia-backed Wagner Group mercenaries arrived in Mali beginning in December 2021, establishing bases in Bamako and subsequently deploying to central Mali cities including Ségou and Timbuktu (Thompson et al., 2022). These Russian mercenary forces brought different operational capacities and objectives compared to their French predecessors, marking a transition from Western-led multinational counterinsurgency to Russian proxy forces. This November 2022 juncture thus provides an opportunity to analyze how changes in counterinsurgency pressure affect insurgent operational structure, with distinct operational environments before and after French withdrawal. While JNIM's formal command structure is increasingly understood, operational details remain unclear. Scholars lack reliable estimates of how many active cells exist and where they operate, limiting understanding of how organizational structure translates into observable violence patterns.

5.2 The Dependent Variable: Cell Count

Having established the methodology for detecting cells through spatio-temporal clustering, this section applies it to JNIM's conflict event data to measure the dependent variable: active cell counts over time. Recall that "cells" here represent analytical constructs. They are spatial clusters of violent activity that approximate operational units, not directly observed organizational entities. Because JNIM's true mobility capabilities cannot be directly observed, the algorithm is tested across 651 different parameter combinations: daily speed v ranging from 0 to 200 km/day (in 10 km/day increments) and maximum distance μ ranging from 0 to 300 km (in 10 km increments), with τ maintained at 365 days as the inactivity threshold. This parameter space exploration addresses the uncertainty of how quickly JNIM cells move and how far they operate between attacks. What matters for the analysis is whether temporal patterns persist across different mobility assumptions. If organizational changes appear only under specific parameters, they might be methodological artifacts. If they appear universally, they likely reflect change in organizational structure.

Figure 1 displays how active cell counts vary systematically across the parameter space, i.e. different combinations for v and μ. Panel (a) shows the relationship between mobility parameters and detected cell counts as of November 2025. The contour lines reveal an inverse relationship: lower

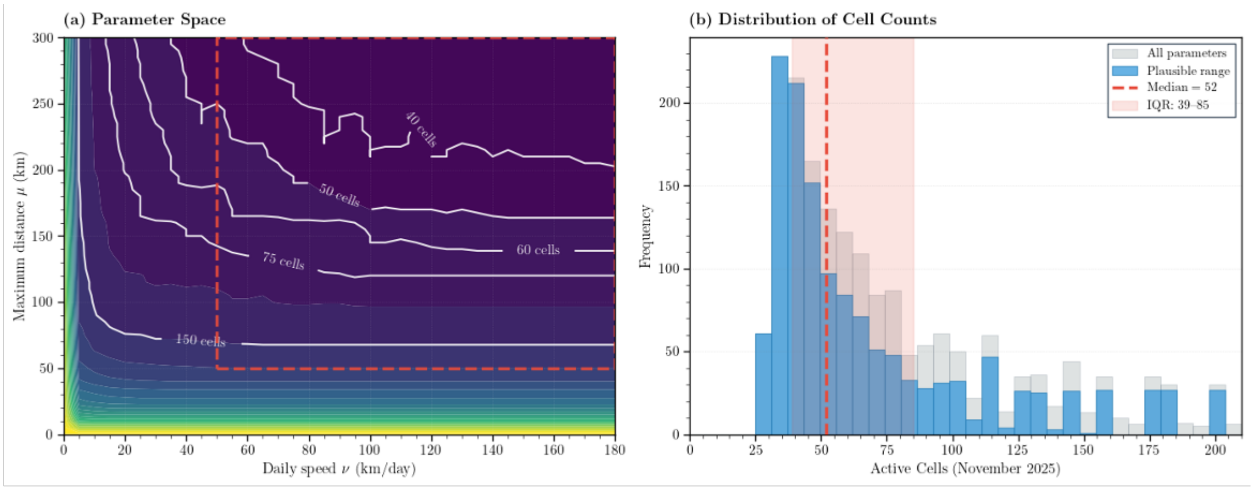

Figure 1: Parameter space exploration

mobility parameters produce higher cell counts, as geographically dispersed attacks are interpreted as evidence of more distinct operational units. For instance, scenarios with highly constrained mobility (ν around 50 km/day and μ around 60 km) detect approximately 150 cells, while scenarios allowing greater movement (ν around 150 km/day and μ around 250 km) identify closer to 40 cells. This sensitivity shows that without direct knowledge of JNIM's actual mobility, different assumptions yield different estimates of organizational structure. The red dashed box in panel (a) delineates the plausible parameter range, excluding scenarios where $\nu < 50$ km/day or $\mu < 50$ km. As established in the methodology section, these highly constrained scenarios are inconsistent with JNIM's documented use of motorcycles for rapid movement. Focusing on this plausible range substantially narrows the variability in cell count estimates. Panel (b) illustrates this narrowing effect through a histogram of active cell counts for November 2025, based on the results that different parameter combinations output. The gray bars represent the frequency distribution across all 651 parameter combinations, showing that active cell counts range from approximately 10 to over 200 cells when the full parameter range is plotted. The blue bars, by contrast, show the distribution when restricting analysis to the plausible parameter range. Within this restricted space, active cell counts span from 39 to 85 cells (interquartile range, shaded in red), with a median of 52 cells. While this range still shows significant variation, it represents a considerably tighter distribution than the full parameter space suggests.

The following analysis focuses on four representative mobility scenarios to illustrate how JNIM's organizational structure evolved between March 2017 and November 2025. These scenarios span the plausible range of JNIM operational capabilities given their documented use of motorcycles for rapid movement across the Sahel's challenging terrain (GITOC, 2023, p. 27-28): low mobility ($v = 90$ km/day, $\mu = 100$ km), medium mobility ($v = 120$ km/day, $\mu = 150$ km), medium-high mobility ($v = 150$ km/day, $\mu = 250$ km), and high mobility ($v = 200$ km/day, $\mu = 300$ km). Before examining the results, two methodological points require clarification. First, following Prieto Curiel et al.'s (2020, p. 8) approach, the analysis distinguishes between total cells (all cells that have existed up to a given time, shown in pink) and active cells (cells still conducting operations, shown in orange). Cells with no activity after one year are considered dormant and excluded from active counts. Second, while absolute cell counts vary with mobility assumptions, the temporal patterns described below persist across all parameter combinations. This consistency suggests that detected organizational changes reflect genuine structural evolution rather than methodological artifacts.

Figure 2 displays the evolution of JNIM's cell structure across the four mobility scenarios. Each panel shows a similar temporal pattern despite different absolute numbers. Look first at the orange line representing active cells in each scenario. In the low mobility scenario (top left), active cells climb steadily from about 10 in 2017 to approximately 60 by late 2022. The medium mobility scenario (top right) shows similar growth, rising from roughly 10 to 55 active cells. Even under high mobility assumptions (bottom right), which consolidate geographically dispersed attacks into fewer operational units, active cells expand from approximately 10 to 35. This consistent upward trajectory across all parameter specifications indicates that JNIM progressively fragmented its operations geographically during the period of French counterinsurgency operations. The temporal trends reveal a stabilization in organizational structure following French withdrawal in November 2022 (indicated by a green vertical line in Figure 2). After sustained growth through late 2022, active cell counts plateaued across all mobility scenarios rather than continuing their previous upward trend. This stabilization persisted through November 2025, suggesting that the counterinsurgency environment shift following French departure corresponded with a stop to further decentralization. The pink line showing total cells continues rising slightly in some scenarios, indicating that new cells occasionally form. However, the stable active cell counts mean that new formations are offset by existing cells going dormant. JNIM's organizational structure reached a new equilibrium after

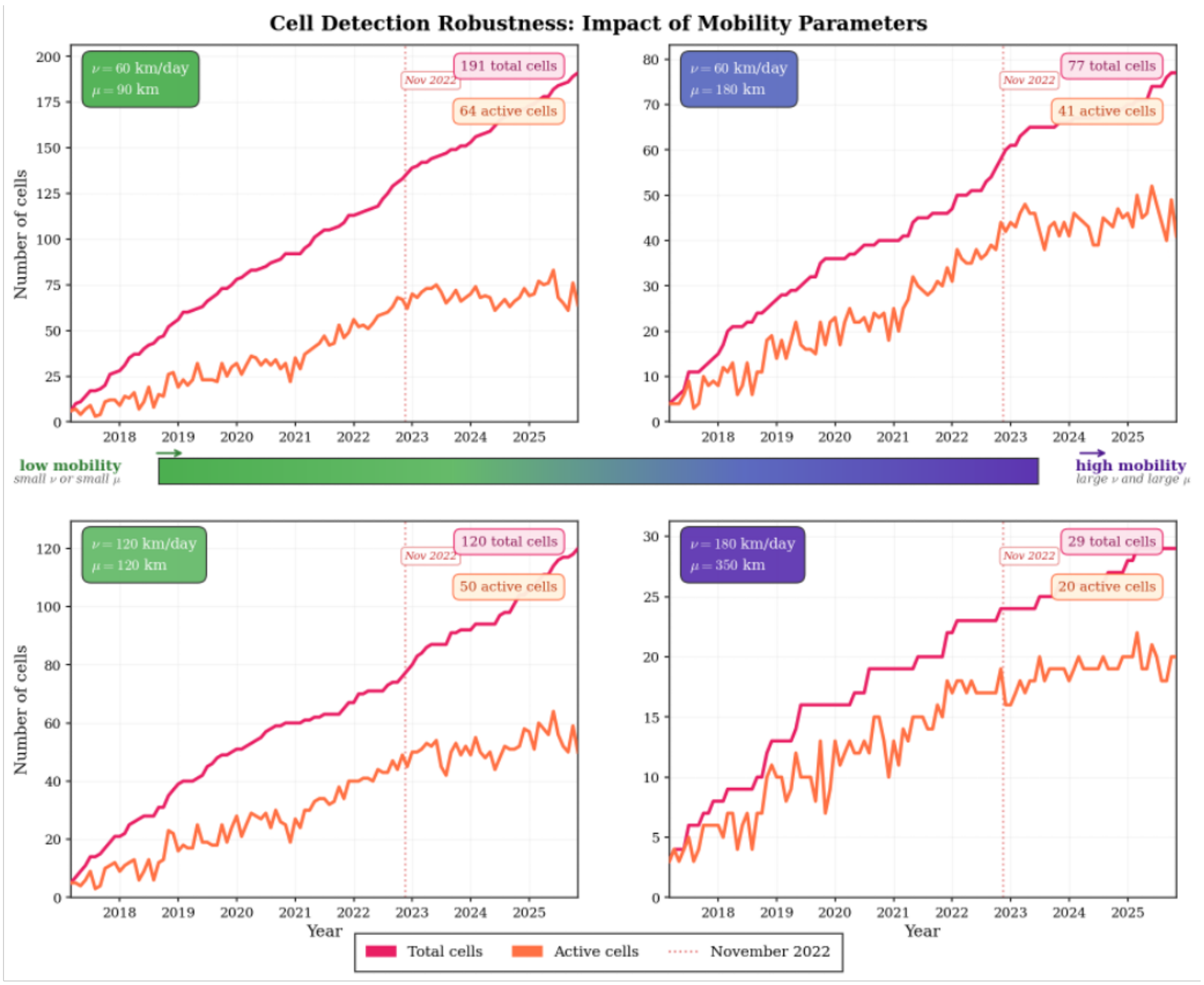

Figure 2: Cell count with different mobility scenarios

November 2022, fundamentally different from the sustained expansion that characterized the 2017-2022 period. The ratio between total identified cells and currently active cells provides additional insight into organizational dynamics. Prieto Curiel et al. (2020, p. 19) observed that for Boko Haram, this ratio ranged between 40-80% depending on mobility parameters, reflecting cell attrition through counterinsurgency pressure. For JNIM, comparable patterns emerge: under medium mobility assumptions ($\nu = 120$ km/day, $\mu = 150$ km), approximately 50% of historically identified cells remained active as of November 2025, suggesting that while new cells formed during the study period, others ceased operations either through successful counterinsurgency targeting or organizational consolidation. These temporal patterns in active cell counts provide the dependent variable for subsequent interrupted time series analysis examining how the November 2022 French withdrawal affected JNIM's organizational structure.

5.3 Relationship Between Dependent and Independent Variable

To test whether the November 2022 French withdrawal affected JNIM's organizational trajectory, I employ interrupted time series (ITS) analysis using ordinary least squares regression with Newey-West heteroskedasticity and autocorrelation consistent (HAC) standard errors. The ITS model estimates three key parameters: the pre-intervention trend (β_1), which measures the rate of organizational change before French withdrawal; the immediate level change at the intervention point (β_2), which captures any abrupt shift in cell counts; and the slope change following intervention (β_3), which reveals whether the trajectory of organizational evolution altered after withdrawal. Following Bernal et al.'s (2017, p. 351) framework for ITS analysis, the regression equation takes the form:

$$Y_t = \beta_0 + \beta_1 Time_t + \beta_2 Post_t + \beta_3 (Time_t \times Post_t) + \varepsilon_t$$

where $Time_t$ is a continuous variable counting months from March 2017 ($t = 1, 2, \ldots, 105$), $Post_t$ is a binary indicator (0 before November 2022, 1 thereafter), and $Time_t \times Post_t$ captures the interaction between time and the post-withdrawal period. The analysis spans 105 monthly observations from JNIM's formation in March 2017 through November 2025, with 69 pre-withdrawal observations and 36 post-withdrawal observations. Results are presented for the medium mobility scenario ($\nu = 120$ km/day, $\mu = 150$ km), which falls in the center of the plausible parameter range. Robustness across all 651 parameter combinations is examined subsequently.

For the medium mobility scenario ($\nu = 120$ km/day, $\mu = 150$ km), the regression results demonstrate a break in the trend at the intervention point (Figure 3). The coefficient for Time ($\beta_1 = 0.366$, SE = 0.018, $p < 0.001$) indicates that before French withdrawal, JNIM added approximately 0.37 active cells per month on average. This translates to roughly one new operational cell every three months. Over the 69-month pre-withdrawal period from March 2017 to November 2022, this sustained expansion meant JNIM grew from approximately 20 active cells to 50 active cells. The group progressively fragmented its operations geographically during the period of French counterinsurgency operations, consistent with the visual pattern observed in Figure 2. The level shift coefficient appears large ($\beta_2 = 29.59$, SE = 1.587, $p < 0.001$), but this reflects a technical feature of interrupted time series models rather than sudden organizational expansion. Because cells increased by 0.7 per month over 69 months, JNIM had accumulated substantial growth by November 2022. The regression must account for this cumulative expansion when modeling the transition to the post-withdrawal period. The coefficient represents a statistical adjustment that captures the accumulated pre-intervention trend, not an indication that 29.59 new cells suddenly appeared in November 2022.

The slope change coefficient captures the shift in organizational trajectory following French withdrawal. The estimate ($\beta_3 = -0.373$, SE = 0.027, $p < 0.001$) indicates that JNIM's monthly growth rate decreased by 0.373 cells per month relative to the pre-withdrawal trend. This represents a near-complete halt to the decentralization process. The post-withdrawal slope can be calculated as: 0.366 (pre-withdrawal growth) $-$ 0.373 (slope change) ≈ -0.007 cells per month. This value near zero indicates organizational stabilization rather than continued expansion. JNIM stopped fragmenting into additional cells after French departure.

Diagnostic tests confirm the regression model meets key assumptions for valid inference. Residuals satisfy normality (Shapiro-Wilk $p = 0.354$) and homoscedasticity (Breusch-Pagan $p = 0.538$) requirements. Autocorrelation is addressed through Newey-West HAC standard errors, which provide robust estimates even when observations exhibit temporal dependence. High variance in-

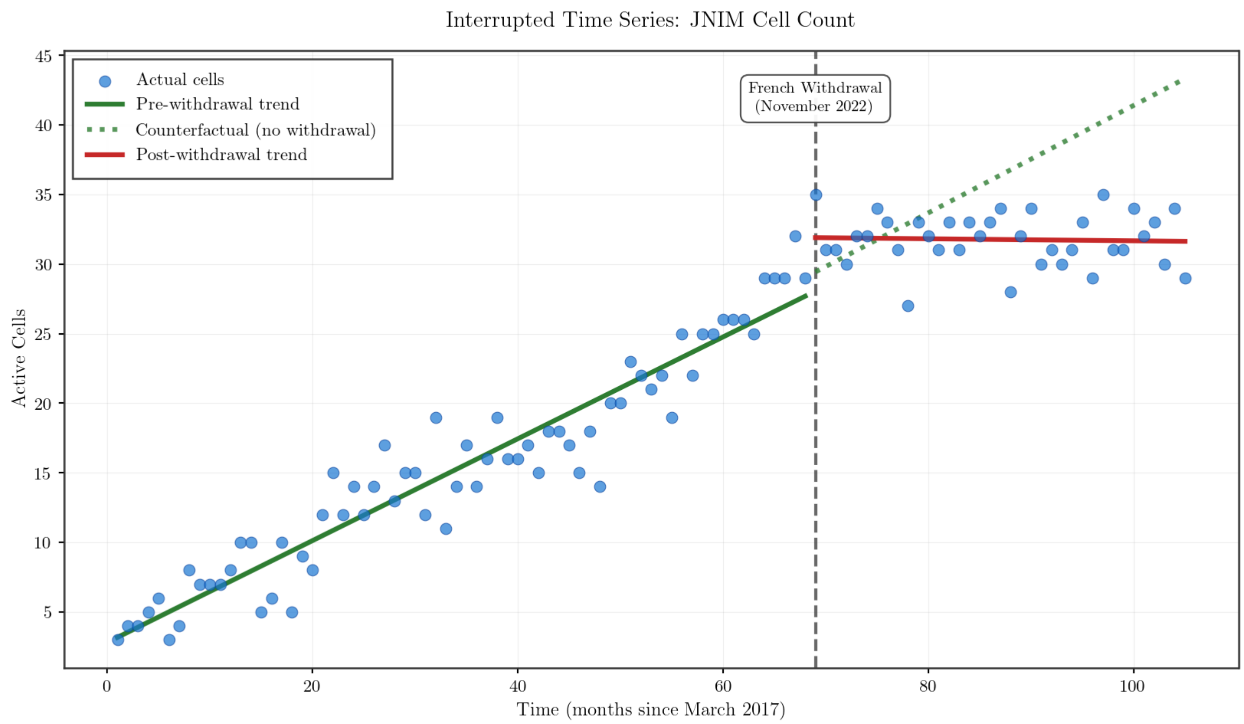

Figure 3: Linear regression

flation factors for the post-withdrawal indicator and time-post interaction (VIF = 45.1 and 51.1) reflect the mathematical structure of models containing interaction terms. As Francoeur (2011) notes in his discussion of moderated regression, components of interaction terms naturally create correlations with their constituent variables, and these correlations are inherent to the model specification rather than indicating problematic multicollinearity. The robustness analysis evaluates 651 parameter combinations spanning $\nu \in [0, 200]$ km/day and $\mu \in [0, 300]$ km. Filtering to plausible mobility assumptions ($\nu, \mu > 50$ km) yields 375 specifications, all of which produce statistically significant negative β_3 coefficients ($p < 0.01$), with values ranging from -0.122 to -1.293 (median = -0.328).

Figure 4 visualizes the relationship between mobility parameters and regression results through complementary 2D heatmaps (top panels) and 3D surface plots (bottom panels). Panel (a) shows that slope change coefficients become more negative (stronger deceleration) under lower mobility assumptions—constrained movement produces more fragmented cell structures, amplifying the observable organizational shift. Panel (b) confirms universal statistical significance across parameter space, with $-\log_{10}(p)$ values exceeding 6 throughout ($p < 10^{-6}$).

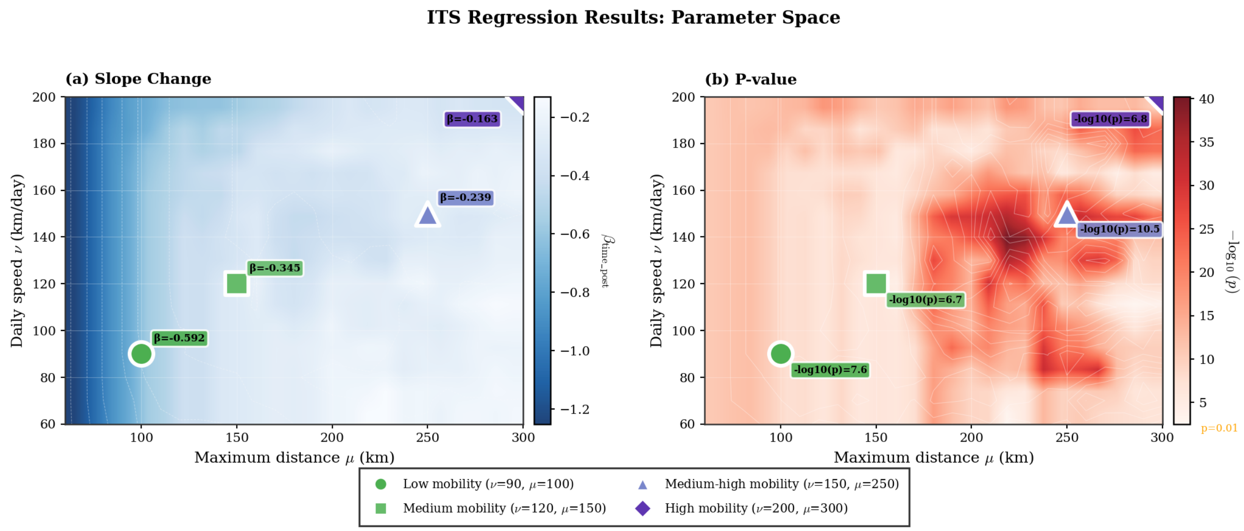

Figure 4: Parameter space heatmap

The 3D visualization reveals smooth gradients across the parameter surface, with no discontinuities or unstable regions. Four representative scenarios are highlighted: low mobility ($\nu = 90$, $\mu = 100$, $\beta = -0.592$), medium mobility ($\nu = 120$, $\mu = 150$, $\beta = -0.345$), medium-high mobility ($\nu = 150$, $\mu = 250$, $\beta = -0.239$), and high mobility ($\nu = 200$, $\mu = 300$, $\beta = -0.163$). While coefficient magnitudes vary across this range, the finding remains that all 375 scenarios show deceleration in organizational expansion following French withdrawal in November 2022.

This universal consistency across parameter space provides strong evidence that the observed structural break represents a genuine organizational shift rather than an artifact of methodological assumptions. The withdrawal of Western counterinsurgency forces coincides with the cessation of JNIM's sustained organizational fragmentation, suggesting that changes in counterinsurgency composition affect insurgent organizational dynamics.

5.4 Discussion

Prior to the French withdrawal, JNIM expanded steadily, adding roughly one new cell every three months. Its network grew from around 20 cells in March 2017 to roughly 50 by late 2022. After the withdrawal, however, that expansion effectively stalled. Across all 375 parameter combinations, the statistically significant change in slope shows that the monthly growth rate fell to nearly zero. JNIM preserved its decentralized architecture rather than collapsing it inward, suggesting that post-

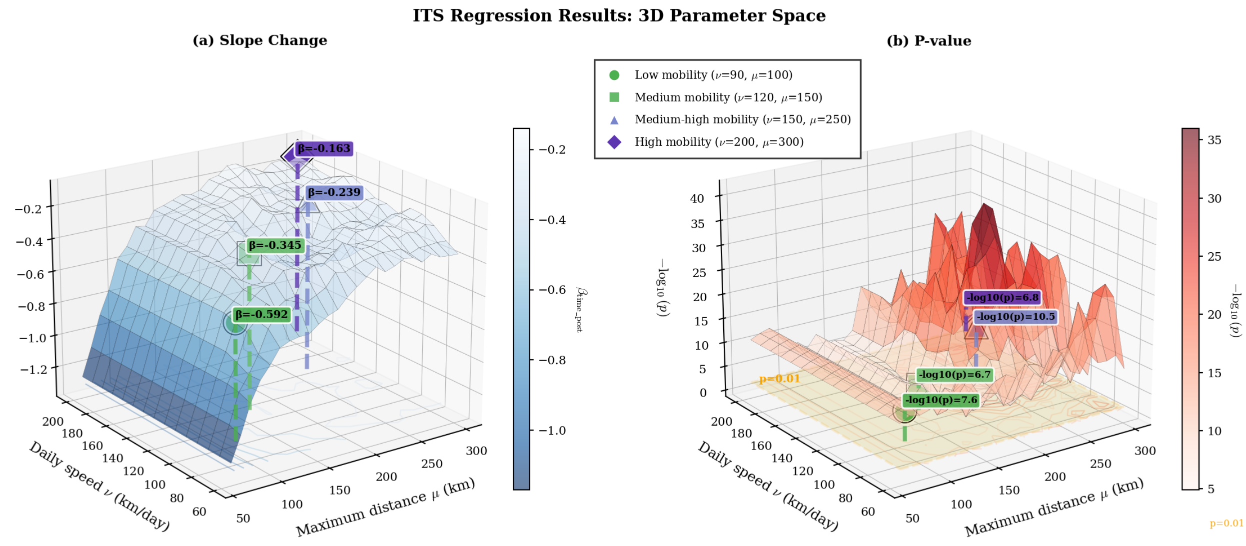

Figure 5: Parameter space heatmap

2022 stabilization displays neither fragmentation nor recentralization, but something in between.

Abrahms' (2018) work on organizational structure helps clarify why this shift matters. He shows that centralized groups allow leaders to "communicate tactical instructions to the rank-and-file, discipline disobedient members for attacking civilians, and vet out members prone to hurting the political cause" (p. 141). It's not clear whether the steady fragmentation into event cells observed from 2017 to 2022 is a strategic expansion policy or a tactical necessity in order to evade counterinsurgency operations. Under intense counterterrorism pressure, breaking into smaller units reduces visibility and limits the damage of leadership targeting.

One partial answer lies in the gap between the total number of cells ever identified and the subset that remains active. Using Prieto Curiel et al.'s (2020) methodology which found that between 40 and 80 percent of Boko Haram's historically identified cells remained active depending on mobility assumptions (p. 19) and a similar pattern emerges for JNIM. Under medium mobility assumptions, only about half of all historically identified JNIM cells were still active as of November 2025. This implies constant churn beneath the surface: new cells were formed, while others disappeared, whether due to counterinsurgency targeting or internal decision-making to cease operations in a certain region.

This dynamic aligns with what Bakker et al. (2012) identify as core capabilities of resilient covert networks. The first is “replacing nodes”, i.e. the ability to keep members flowing through systems of recruitment, training, and deployment even as others are “killed, captured, or desert the cause” (p. 49). During the French operations from 2017 to 2022, JNIM clearly possessed this capacity. The steady pre-withdrawal growth rate in cells shows that the organization could continuously generate new operational units despite sustained pressure, pointing to institutionalized mechanisms for regeneration and recruitment.

The second capability Bakker et al. (2012) highlight is “balancing differentiation and integration”: finding the right mix between specialization of tasks and skills and the means to reintegrate them to create operational activity under the conditions of covertness and illegality (p. 51). This balance is inherently unstable. Specialization and coordination improve effectiveness, but “the more complex the integration mechanisms have to be… the more susceptible dark networks will be to attack” (p. 49). Every additional communication link raises the risk of exposure, forcing organizations to accept redundancies that “weaken functional differentiation and are less efficient” in exchange for survival (p. 49). The post-withdrawal plateau suggests JNIM may have settled into a balance along this trade-off.

Here, the GITOC report offers an interesting insight. When senior commanders are killed, they are successively replaced, ensuring continuity in leadership and guidance (p. 17). More importantly, JNIM deploys experienced commanders, who contribute functional specialization skills to various regions, allowing the group to maintain coordination without constant top-down communication (p. 17). This approach enables JNIM to “maintain stronger central control, which guarantees that local units stay aligned with the group’s overarching objectives while still enjoying a certain level of autonomy” (p. 17). Rather than forcing all cells to communicate directly with a central leadership which is precisely the vulnerability Bakker et al. (2012) warn against, JNIM relies on embedded regional commanders who coordinate locally while reinforcing strategic alignment. This organizational logic helps explain why JNIM stopped fragmenting but did not consolidate. By systematically deploying experienced commanders to regional cells, the group appears to have offset the efficiency losses of decentralization while retaining its security benefits. Cells remain autonomous enough to blunt targeting, yet regional command structures prevent drift and fragmentation. Stabilization rather than continued proliferation or contraction may reflect the sustainable upper limit of this model. Under the altered threat environment shaped by the Wagner Group and later the Russian Africa Corps, JNIM no longer needed to keep splitting to survive, but its decentralized–regional command system worked well enough that recentralization offered no clear advantage.

5.5 Alternative Explanations

While the interrupted time series analysis demonstrates that JNIM's organizational stabilization coincided with the November 2022 French withdrawal, alternative explanations should be considered. The observed pattern could reflect internal organizational dynamics rather than responses to changing counterinsurgency pressure.

Firstly, internal reforms may explain stabilization independent of external pressure. JNIM undertook "structural reforms and command chain restructuring" between 2019-2020 "in response to growing tensions with Islamic State West Africa Province and to counter internal dissent and defections," which "successfully consolidated JNIM's ranks" (GITOC, 2023, p. 13). The post-2022 stabilization could represent successful implementation of these reforms.

Secondly, the cell detection methodology infers organizational structure from spatial patterns of violence, which may not fully capture organizational changes. Shifts in attack frequency or geographic distribution could reflect tactical adaptations, target availability, or seasonal factors rather than fundamental restructuring. The stabilization in active cell counts might indicate operational consolidation in contested territories rather than organizational centralization.

6 Conclusion

This research examined how insurgent organizations adapt when counterinsurgency pressure decreases. Using spatial network analysis of JNIM's conflict events from 2017 to 2025, the study tracked organizational structure across a major withdrawal transition. The findings challenge straightforward predictions about recentralization following reduced external pressure.

JNIM fragmented steadily during French operations, adding approximately one new operational cell every three months between 2017 and 2022. After French withdrawal in November 2022, this expansion halted abruptly. The organization stabilized rather than recentralizing, maintaining its decentralized structure through November 2025. This pattern held universally across 375 plausible parameter combinations, demonstrating robustness to methodological assumptions.

The stabilization suggests that organizational responses to changing pressure are more nuanced than simple centralization-decentralization dynamics predict. JNIM appears to have reached an equilibrium where regional command structures provide coordination benefits without creating the communication vulnerabilities that centralized hierarchies produce. The group no longer needed to fragment for survival, yet recentralization offered no compelling advantage under altered threat conditions.

For counterinsurgency policy, these findings carry important implications. Withdrawal transitions create opportunities for insurgent organizations to consolidate gains and optimize structures for new operational environments. Security strategies must anticipate not just territorial expansion but organizational adaptation that may enhance long-term resilience. The stabilization pattern observed here suggests that effective handoff planning requires understanding how adversaries will restructure once capable forces depart.

Future research should examine whether this stabilization pattern generalizes across other withdrawal cases. Does organizational equilibrium following reduced pressure represent a broader phenomenon, or does it reflect factors specific to JNIM's regional context and command architecture? Comparative analysis across Afghanistan, Iraq, and other withdrawal scenarios could reveal whether the mechanisms identified here operate systematically or contingently. Understanding organizational adaptation during transitions remains essential for developing counterinsurgency approaches that account for adversary flexibility across different pressure environments.

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