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Protracted violence and insecurity: a quantitative analysis of persistent drivers of rising conflict in the Sahel

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Introduction: This paper examines the extent to which NATO's 2011 intervention in Libya contributed to the escalation of violent armed conflict in the Sahel, while accounting for the influence of state fragility, environmental scarcity, population size, and government effectiveness. Although existing scholarship has largely emphasised environmental drivers of Sahelian insecurity, the spillover mechanisms of external interventions remain underexplored.

Methods: Using panel data from 13 Sahelian states covering the period 2012 to 2024, the study applies a two-step System Generalized Method of Moments estimator and Method of Moments Quantile Regression (MMQR) to address endogeneity, capture persistence in conflict, and assess heterogeneity across conflict intensities.

Results: The findings show that NATO-related spillover effects significantly increase violent armed conflict, with stronger impacts in high-intensity contexts. State fragility also emerges consistently as a major driver of escalating violence, whereas environmental stressors do not exhibit a robust direct effect. Government effectiveness shows an unexpected positive association with violence.

Discussion/Conclusion: The study concludes that insecurity in the Sahel is better explained by the interaction between external shocks and entrenched domestic fragilities than by environmental pressures alone.

KEYWORDS

conflict spillover, NATO intervention, Sahel conflict, state fragility, system GMM

1 Introduction

Over the past decade, the Sahel has shifted from a peripheral security concern to one of the world's most volatile and militarised regions [[Armed Conflict Location and Event Data \(ACLED\), 2024](#); [Akinola and Ramontja, 2023](#); [Kazeem, 2024](#)]. Existing scholarship suggests that this escalation may be shaped by state fragility and legitimacy deficits, the expansion of violent extremist groups, climate and livelihood stressors, socio economic marginalisation, and entrenched local grievances ([Chukwudi et al., 2024](#); [Adzavon et al., 2025](#)). While NATO's 2011 intervention in Libya was publicly framed in humanitarian and democratisation terms, the extent studies argue that the post-2011 transition was undermined by the absence of a coherent post-intervention stabilisation and state-building roadmap and rapid external disengagement and fragmented international follow-through

(Gargoum, 2012; Lenshie et al., 2025). These dynamics have converged to create a regional security crisis with profound social, economic, and political consequences.

It must be emphasized that stability of Libya during Gaddafi's era was widely understood as the product of a centralised authoritarian order sustained by oil-funded patronage and elite co-optation (Hove, 2017; Sawani, 2020). By managing tribal and regional alliances, suppressing organised opposition, and distributing resources strategically, the regime constrained the emergence of rival centres of authority and limited large-scale armed mobilization (Pashakhanlou, 2017; Sawani, 2022). Yet, this stability was institutionally shallow because autonomous political institutions and professional security structures were deliberately weakened or subordinated to regime-centred control (Ntaka and Csicsmann, 2021). After the regime's collapse in 2011, these structural vulnerabilities alongside entrenched social and regional fragmentation may have contributed to contested authority and persistent instability.

As the region's security profile has shifted, scholarly debates have intensified regarding the drivers of persistent violence in the Sahel. Existing research is divided between those who emphasise institutional weakness, governance deficits, and socio-economic exclusion (Akinyetun et al., 2024; Okoli, 2024; Ziso and Hamandishe, 2024), and those who highlight geopolitical interventions, especially NATO's Libyan campaign, as critical catalysts for insecurity (Akinola and Ramontja, 2023; Carbone and Casola, 2022; Dan Suleiman et al., 2021; Ethabet, 2025). Much of this latter literature underscores how the collapse of Libya's security architecture enabled the diffusion of armed groups, mercenaries, and Small Arms and Light Weapons (SALWs) across the Sahel, thereby altering the conflict landscape.

Nevertheless, an active body of recent scholarship has tended to focus overwhelmingly on environmental determinism particularly the climate change–resource scarcity–conflict nexus by attributing violence in the Sahel primarily to ecological stressors (Akinyetun et al., 2024; Benjaminsen, 2008; Benjaminsen and Svarstad, 2021; Denisova and Kostelyanets, 2023; Kalilou, 2021; Koren and Schon, 2023; Läderach et al., 2021; Larémont, 2021; Nkiaka et al., 2024). Scholars in this tradition argue that climate-induced scarcity drives food insecurity, poverty, displacement, and violent contestations over land and water, with climate change exacerbating these pressures (Kalilou, 2021). For instance, Denisova and Kostelyanets (2023) link water scarcity to farmer–herder clashes and jihadist mobilization. However, research warns against reducing Sahelian violence to environmental explanations alone. As Kazeem (2024) demonstrates, persistent inequalities, political marginalisation, and historically embedded governance failures are often more consequential in shaping the emergence and persistence of conflict.

What remains inadequately understood and constitutes the core gap this study addresses, is how NATO's intervention in Libya generated specific spillover mechanisms that interact with, and potentially amplify, environmental scarcity and state fragility in the Sahel. Although the post-2011 proliferation of arms and fighters is widely acknowledged, few empirical studies have quantitatively isolated the causal pathways through which the Libyan conflict reverberated across the Sahel, nor have they systematically examined how these effects evolve when controlling for environmental scarcity, population dynamics, government effectiveness, and varying levels of state fragility.

This paper seeks to fill this gap by empirically assessing the extent to which the NATO intervention in Libya contributed to the escalation of violent armed conflict in the Sahel, while simultaneously accounting for other structural drivers. Adopting a quantitative framework,

the paper investigates whether the spillover from Libya remains a robust predictor of violence once key political, demographic, and environmental factors are controlled for. The research is guided by two central questions: (1) What are the factors most strongly associated with the rise of violent armed conflict in the Sahel? (2) Does the impact of these factors vary across Sahelian states? The remainder of this paper proceeds as follows: Section Two provides a critical review of the theoretical perspectives relevant to conflict diffusion, environmental scarcity, and state fragility. Section Three outlines the methodological approach, study population, and data sources. Section Four presents and analyses the empirical findings. Section Five discusses the implications of the results, highlighting policy relevance and study limitations.

2 Theoretical framework: state fragility, insurgency dynamics, and Liberal interventionism

This paper integrates three theoretical perspectives to explain how NATO's intervention in Libya generated spillover effects that contributed to the escalation of violent armed conflict across the Sahel region. The combined use of state fragility, insurgency, and externally driven liberal intervention frameworks offers a coherent lens for analysing why NATO's 2011 operations in Libya produced uneven patterns of violent conflict across Sahelian states. When the logics of state fragility and insurgency theory are merged with the strategic and normative assumptions of liberal interventionism, a dual-level explanatory model emerges: external interventions reshape regional opportunity structures, while domestic institutional capacity determines whether these disruptions translate into sustained insurgency. Understanding the rise of post-Libya conflict in the Sahel therefore requires attention not only to the intentions and normative aspirations behind the intervention, but also to the entrenched institutional weaknesses, security deficits, and governance failures that characterise many states in the region.

State fragility theory, as advanced by Rotberg (2004), conceptualises contexts in which political orders are unable to provide the essential political goods, legitimate authority, territorial control, security, rule of law, and predictable governance. In such environments, the state's monopoly on legitimate violence becomes contested, borders become porous, and non-state armed groups proliferate (Boås, 2017; Ferreira, 2017). Fragility therefore reflects more than administrative weakness; it signifies a structural condition that leaves societies vulnerable to internal violence and transnational shocks. Consistent with this, Carment et al. (2010) argue that states escape fragility only when they demonstrate authority (coercive capability), legitimacy (public acceptance), and capacity (ability to regulate shocks). Boyomo et al. (2025) similarly define fragility as the erosion of authority, legitimacy, and the ability to meet obligations during crises. Fearon and Laitin's (2003) insurgency model extends this logic by arguing that civil war is most likely where insurgency is cheap and sustainable. Factors such as low state capacity, rough terrain, underdevelopment, and large populations jointly reduce the cost of rebel recruitment, concealment, and logistics. These perspectives converge on a critical insight: fragile and institutionally weak states provide fertile ground for insurgencies because they cannot effectively monitor, deter, or suppress organised violence. Within the Sahel, such structural weaknesses were

long-standing (Bøås and Strazzari, 2020; Osland and Erstad, 2020). States such as Mali, Burkina Faso, Niger, Nigeria, and Chad historically struggled to exert authority over peripheral regions where governance vacuums and socioeconomic marginalisation eroded legitimacy (Bøås and Strazzari, 2020). As Iocchi and Baldaro (2024) argue, the region was therefore predisposed to instability even before NATO's intervention in Libya. This baseline vulnerability provides the foundation for understanding how an external intervention, grounded in liberal norms, produced disruptive and largely unintended consequences across the Sahel.

Liberal interventionism rests on the belief that military force, sanctions, or coercive tools may be ethically justified to protect civilians, safeguard human rights, and encourage democratic transitions (Khan and Khan, 2025). Drawing on liberal internationalist thought, the theory assumes that the spread of liberal institutions reduces the likelihood of war (Doyle, 2005). In practice, many interventions invoke humanitarian logics, most prominently the Responsibility to Protect doctrine (RtP), which authorises external action when states fail to protect their populations (Quinton-Brown, 2023). NATO's intervention in Libya was justified precisely on these grounds: to avert imminent mass atrocities in Benghazi and to enforce a United Nations mandate to protect civilians. Thus, when state violence increases in response to external military involvement, neighbouring regions and border communities often experience heightened insecurity as displaced populations, armed groups, and illicit networks move across borders to escape repression or exploit weakened state authority. Even where interventions are justified in protection or democratisation terms, critics argue that liberal interventionism can be crisis-prone because mandate-driven benchmarks and limited local ownership generate unintended consequences and backlash (Baciu et al., 2024). As evidenced in NATO's Kosovo intervention and subsequent regional destabilisation dynamics in Macedonia and Serbia. Also, the failure of liberal state and democracy-building in Afghanistan, which culminated in the 2021 withdrawal further illustrates how liberal interventionism has failed to produce durable peace. These developments criticize the methods used by Western countries to overthrow political regimes they dislike.

The analytical value of merging these theories lies in clarifying the relationship between the external shock generated by NATO's intervention and the internal vulnerabilities of Sahelian states. Liberal interventionists maintain that NATO's actions dismantled Libya's central authority, unleashed vast stockpiles of arms, enabled the circulation of jihadist fighters, and destabilised borderlands (Chávez and Swed, 2024; Shaw, 2013). This dramatically expanded the opportunity structure available to insurgent actors across the Sahel. Where states possessed stronger institutions, cohesive security apparatuses, and greater legitimacy, governments were more capable of mitigating spillover effects through border control, intelligence coordination, and military containment (Bøås and Strazzari, 2020). By contrast, in highly fragile states lacking reach and legitimacy, the same shock escalated into widespread insurgency and intensified violence. Thus, external interventions do not inevitably produce regional conflict; their effects are mediated by domestic structural conditions that shape the feasibility of insurgent mobilisation.

In the Sahel, this pattern was pronounced. Mali, for instance, had limited territorial control and long-standing governance deficits in its northern regions, which were rapidly overwhelmed by returning fighters from Libya and heavily armed insurgent groups (Döring and Herpolsheimer, 2018). Similar dynamics unfolded in Burkina Faso, Niger, and Chad. These differentiated outcomes support (Kuperman's

(2013) argument that liberal interventions generate regional opportunities for insurgency, but only fragile states convert these opportunities into sustained and intense conflict. This integrated framework also informs the variables employed in this paper. The NATO spillover index captures the magnitude of the exogenous shock originating from Libya, whereas state fragility and government effectiveness represent the institutional mediating conditions that determine whether such shocks escalate into violence. Economic development (GDP per capita) and population capture the structural background conditions identified by insurgency theory, shaping the ease of rebel mobilisation. Measures of political freedoms and environmental performance further influence grievance formation and state capacity, though they operate secondary to core institutional strength. The expectation, therefore, is that spillovers from Libya will exert the strongest conflict-intensifying effect where fragility is highest and governance weakest.

In essence, combining state fragility and insurgency models with liberal interventionism generates a nuanced theoretical understanding: external interventions driven by liberal ideals can destabilise regions when they interact with weak institutions, limited state capacity, and contested authority structures. The aftermath of NATO's intervention in Libya illustrates the mutually reinforcing nature of external shocks and domestic vulnerabilities. This integrated approach therefore provides a comprehensive foundation for analysing the rise and persistence of violent conflict in the Sahel and for testing the central hypothesis that NATO's intervention significantly contributed to conflict escalation in fragile neighbouring states.

3 Fragility, governance weakness and the escalation of violent conflict

Previous studies have consistently linked state fragility to the emergence, escalation, and persistence of violent conflict. The central argument is that weak state environments create structural conditions that enable violent and secessionist groups to form, consolidate control over territory, and openly challenge state authority (Ying, 2021). Tonwe and Eke (2013), for instance, examined the evolution of Boko Haram into a terrorist organisation in Nigeria and observed that the state's inability to provide effective public services generated mass unemployment and extreme poverty, which ultimately fuelled the group's insurgency. Similarly, Ibrahim (2020) analysed state fragility in Iraq and found that governance collapse and institutional decay contributed directly to the rise of the Islamic State (IS). More recent empirical evidence shows that the proliferation of jihadist organisations, armed bandit networks, and organised criminal groups in Northwest Nigeria stems from the country's deepening fragility, reflected in declining state capacity, eroding legitimacy, and deteriorating authority structures (Aina, 2025; Nwosu, 2025). As Nigeria advances further toward fragility, markers such as ineffective policing, porous borders, governance deficits, and widespread insecurity have intensified. This environment has allowed violent non-state actors to flourish, thereby aggravating local and regional instability. Additionally, scholars analysing conflict dynamics in the Sahel emphasise long-standing governance deficits and socio-economic vulnerabilities as central drivers of insecurity. Studies by Bøås and Strazzari (2020) and Osland and Erstad (2020) identify state fragility as a critical enabler of the unprecedented surge in violent conflicts across the region. Ranked among the most fragile states in the world, Sahelian countries are often characterised by chronic poverty, weak

bureaucratic capacity, and limited administrative reach (Iocchi and Baldaro, 2024; Osland and Erstad, 2020). The region suffers from an absence of a legitimate monopoly over the use of force, weak social contracts, and governments that struggle to control vast, sparsely populated territories. Similar patterns have emerged in Burkina Faso and Niger, where terrorist groups have exploited governance vacuums to expand their operations and destabilise communities (Bazie and Diallo, 2025; Ziso and Hamandishe, 2024). In contrast, some studies suggest that strengthening state presence may itself stimulate conflict. Ying (2021) demonstrates that increased state penetration can trigger civil conflict, especially in contexts where regional non-state authorities perceive state expansion as a threat to their power. The logic is that attempts to reassert state control in areas dominated by local elites, armed groups, or informal authorities may provoke violent resistance, thereby exacerbating rather than reducing conflict.

4 Conflict diffusion and the unintended consequences of foreign military intervention

Scholarly literature increasingly demonstrates that foreign military interventions, even when framed as peacekeeping, counterterrorism, or state-strengthening missions, often generate unintended consequences that contribute to the escalation, persistence, and regional diffusion of armed conflict. The central logic in this strand of research is that interventions disrupt the domestic balance of power, reshape rebel incentives, and interact with pre-existing state fragilities in ways that may undermine rather than enhance stability. Beehner (2018) argues that external military involvement and state-building efforts frequently produce negative externalities by displacing armed groups across borders, thereby transforming localized conflicts into transnational security threats. This displacement effect not only externalizes internal conflicts but also creates new conflict epicentres in neighboring states that lack the capacity to absorb such pressures. Drawing from a diffusion perspective, Kathman (2011) finds that third-party states typically intervene when the perceived risk of conflict spillover threatens regional or strategic interests. However, he shows that such interventions may unintentionally heighten insecurity by altering the strategic behavior of conflict actors, encouraging escalation, or provoking retaliatory actions. Historical cases reinforce this trajectory. Liotta (2003) demonstrates that the 1999 NATO intervention in Kosovo precipitated renewed instability in Macedonia in 2001 and significantly disrupted Serbia's post-'October Revolution' reconstruction efforts. Similarly, Peksen's (2012) empirical analysis reveals that supportive or neutral foreign military interventions are associated with increased incidences of extrajudicial killings, torture, political imprisonment, and disappearances. Rather than constraining human rights violations, intervention may weaken domestic accountability structures, embolden state forces, or intensify repression against perceived opponents. Cumulatively, these studies suggest that foreign military intervention can inadvertently widen the geographic and political scope of conflict by weakening state resilience, generating forced displacement, eroding governance capacity, and fostering transnational insurgent networks (Akinola and Ramontja, 2023). The Libyan case offers a particularly compelling illustration. Dan Suleiman et al. (2021) show that the 2011 NATO intervention facilitated the

widespread proliferation of Small Arms and Light Weapons (SALWs) across the Sahel and broader Sub-Saharan Africa, thereby exacerbating pre-existing conflicts and enabling the emergence of new armed groups. In fact, the spillover of the Libyan conflict into the Sahel stemmed from Libya's deep political, economic, and socio-cultural ties with Sahelian societies developed over decades (UN Security Council, 2012). Libya's collapse disrupted long-standing patronage networks and triggered the return of Tuareg fighters who had served in Gaddafi's security apparatus, bringing back heavy weapons and combat experience that intensified fragility in Mali and Niger (Lecocq et al., 2013). The sudden loss of remittances from Libyan labour markets further strained Sahelian economies that had depended heavily on migrant income (de Haas, 2008). At the same time, the looting of Libyan arsenals led to massive regional arms proliferation, empowering insurgent and jihadist organisations across porous desert borders (Small Arms Survey, 2019; UNODC, 2022). These dynamics escalated into widespread conflict precisely because Sahelian states were already characterised by weak institutions, limited territorial control, and entrenched governance deficits (OECD, 2020). Thus, the Libyan crisis acted as a catalyst, but pre-existing state fragility determined the scale and severity of the regional spillover. This diffusion of weaponry amplified insurgent capabilities and contributed to the entrenchment of insecurity across Mali, Niger, Burkina Faso, and beyond. In sum, the literature underscores a paradox: while foreign military interventions seek to restore order, they may unintentionally activate regional pathways of conflict diffusion that produce long-term instability. This highlights the need for more nuanced intervention strategies that account for regional spillovers, transnational armed networks, and the structural fragilities of intervention-affected states.

5 Environmental scarcity and conflict

The academic literature on environmental scarcity and violent conflict presents a complex and evolving debate. A notable strand of contemporary research advances the argument that growing scarcities in renewable natural resources—such as water, arable land, and pasture—can heighten the likelihood of conflict. Studies by Ide (2020), Regan and Kim (2020), Wheatley (2024), and Mfarrej (2025) contend that resource depletion, climate variability, and ecological stress can intensify competition among groups dependent on the same environmental goods. From this perspective, scarcities amplify livelihood insecurities, fuel grievances, and create conditions conducive to localised violence and broader instability.

Yet, this scarcity–conflict thesis is far from uncontested. Mahlakeng and Solomon (2023) argue that the relationship between environmental scarcity and conflict is more indirect and contingent than many earlier studies suggest. They maintain that scarcity rarely operates as an autonomous trigger of violence; instead, it interacts with long-standing structural inequalities, political marginalisation, and weak institutions (Akinyetun et al., 2024; Asamoah et al., 2025; Benjaminsen and Svarstad, 2021; Nkiaka et al., 2024). Rather than producing conflict on its own, scarcity tends to aggravate existing tensions, deepen perceptions of injustice, and magnify competition over limited resources. In response, these scholars call for preventive strategies that address the governance and distributional mechanisms underlying demand-induced, supply-induced, and structurally induced scarcities.

This broader perspective is particularly salient in regions like the Sahel, where environmental stress interacts with fragile governance systems and socio-economic vulnerability. Scholars argue that the rise in violence across the Sahel is linked not only to ecological pressures but also to livelihood insecurity, weak state institutions, economic decay, and extreme poverty (Larémont, 2021; Osazuwa et al., 2025). Structural inequalities such as unequal access to fertile land, water points, and grazing areas exacerbate scarcity-driven grievances and reinforce perceptions of marginalisation (Hubert, 2025; Kalilou, 2021). In several cases, communities have turned to insurgency or armed mobilisation when they perceive that resource governance systems exclude them from the benefits of natural wealth or fail to address basic livelihood needs.

6 Data and methodology

6.1 Data sources and measurement of variables

To examine the spillover effect of NATO's intervention in Libyan conflict on the rise in violent armed conflict in the Sahel region by accounting for governance, environmental and socio-economic factors, annual data were compiled from various sources such as the Uppsala Conflict Data Program's (UCDP) Country-Year Dataset and Georeferenced Event Data (GED) on organized violence within Country Borders, *The Fund for Peace, 2025* report, *World Bank's (2025)*, *World Bank (2024)*, and the *International Institute for Democracy and Electoral Assistance (2025)* for the period between 2012 and 2024 due to limited data availability (see *Tables 1, 2* for descriptive statistics and variable summary). A panel of 13 countries was then created. The countries included in the sample are: the Benin republic, Burkina Faso, Cameroun, Chad, Cote d'Ivoire, The Gambia, Guinea, Mali, Mauritania, Niger, Nigeria, Senegal, and Togo.

For the purpose of this study, the Sahel (population of the study) shall be defined as the state of Benin, Burkina Faso, Cabo Verde, Cameroun, Chad, the Gambia, Guinea, Guinea Bissau, Ivory-Cost, Mali, Mauritania, Niger, Nigeria, Senegal, and Togo—that is, the ten (10) countries labelled Sahel states by the UNDP (Burkina Faso, Cameroon, Chad, The Gambia, Guinea, Mali, Mauritania, Niger, Nigeria, and Senegal), plus five (5) other countries (Benin, Cabo Verde, Guinea Bissau, Ivory-Cost and Togo)

which are state members of the CILSS, the Permanent Committee for Drought Control in the Sahel, an international organization established in 1973 to address food security in the region. The sample ($n = 13$) is made up of all countries in the Sahel that have had at least 1 direct fatality at a specific location or time as a consequence of an incident where armed force was used by an organized actor against another organized actor, or against civilians during the time spanning 2012 and 2024. We deemed these countries as ideal for this study because they are all Sahel states that are directly or indirectly affected by the crisis.

6.2 Inclusion and exclusion criteria

Included in the sample of this study were Sahel countries that have experienced a surge in organized violence subsequent to the Libyan 2011 unrest, or an unprecedented lethal incident resulting in at least 1 declared death at a specific location and a specific date during the period spanning 2012 and 2024. Excluded from the study were Cabo Verde and Guinea Bissau, two countries that have experienced less than the threshold of 1 declared fatality.

Our dependent variable is rise in violent armed conflict in the Sahel. The rise in violent armed conflict variable defines a situation where armed force was used by an organized actor against another organized actor or against civilians resulting in at least 1 direct death at a specific location and a specific date (Davies et al., 2025; Höglbladh, 2025). It is measured by the total number of reported deaths (high, low, and best estimates) from lethal events within a given period. Data for this variable was derived from the Uppsala Conflict Data Program's (UCDP) Country-Year Dataset and Georeferenced Event Data (GED) on organized violence within Country Borders (version 25.1). The UCDP dataset provides the most disaggregated information on organized violence, detailing individual events rather than aggregated country-year data. Each event includes its date, precise geographic location, estimated number of fatalities, and the types of actors involved. The dataset covers three categories of violence: state-based conflict, non-state conflict, and one-sided violence, offering a granular view of when, where, and how lethal conflict occurs globally.

To estimate how NATO's intervention in Libya contributed to the rise of violent armed conflict across the Sahel, this study employs the spillover effects of the Libyan conflict as a measure. Following Abdel-Latif et al. (2024), a conflict spillover index (CSI) was constructed using variables that capture conflict intensity, geographic proximity, and temporal variation. This

TABLE 1 Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Rise in violent armed conflict	169	619.882	1444.894	0	10,346
NATO intervention (spillover)	103	0.491	0.256	0	1
Environmental stressors	169	853.207	510.476	92	1,651
State fragility	169	91.422	9.47	71.5	110.1
GDP per capita	156	1205.973	573.18	485.66	3088.72
Government effectiveness	156	-0.844	0.334	-1.61	0.07
Freedom (religion & thought)	169	0.821	0.23	0.33	1
Population size	144	15,434,273	7704335.4	2,043,094	31,200,000

TABLE 2 Data sources and description.

Data	Definition/measurement	Source
The rise of violent armed conflicts (RV)	Total number of reported deaths (high, low, and best estimates) from lethal events within a given period.	Uppsala Conflict Data Program's (UCDP) Country-Year Dataset and Georeferenced Event Data (GED) on organized violence within Country Borders (version 25.1)
NATO's intervention in Libya (NATO)	Conflict spillover index (CSI)	Data constructed by authors using variables that capture conflict intensity, geographic proximity, and temporal variation Abdel-Latif et al. (2024)
State fragility (SF)	Weakened state capacity, where governments struggle to provide security, services, and legitimacy but continue to function.	Fund for Peace (FFP) 2025 report
Environmental stressors (ENVI)	Average annual precipitation	World Bank's (2025)
Per capita GDP (GDP per capita)	National income per person	World Bank (2025)
Population size (POP size)	Total number of inhabitants	World Bank's (2025)
Government effectiveness (GE)	Quality of public service, service provision, policy and decision-making, and government reliability in sustaining these values.	World Bank's (2024)
Freedom of thought, conscience, and religion (freedoms)	The right of citizens to have a religion or change it. Score 0–1 (highest).	International Institute for Democracy and Electoral Assistance's (2025)

multidimensional index provides a robust measure of cross-border conflict diffusion. Drawing on event-level data from the Uppsala Conflict Data Program's (UCDP) Country-Year Dataset and Georeferenced Event Data (GED) on organized violence within Country Borders, conflict intensity (CI_{it}) for each country i at time t was first computed by combining the number of conflict-related fatalities (F_{it}) and incidents (I_{it}). The UCDP data was preferred to its [Armed Conflict Location and Event Data \(ACLED\) \(2025\)](#) counterpart for its scope and event threshold (it focuses strictly on conflict-related deaths with higher inclusive criteria, usually requiring at least 25 battle-related deaths per year for a conflict to be included). More importantly, UCDP data is more reliable for being stable and having stringent coding rules. [Equation 1](#) expresses this intensity measure:

$$CI_{it} = \log(F_{it} \times I_{it}) \tag{1}$$

Where F is the number of fatalities, and I is the number of incidents (cases in organized violence with at least one direct fatality) for country i and time t . This captures both the magnitude and severity of violence within each country. To quantify the spillover effects of Libya's conflict, a weighted average of conflict intensities ($j \neq i$) was calculated. That measure combined the mean of conflict intensities from all the sample countries at time t except the country for which the average is being calculated, and the weight of the country. The CSI_{it} was then computed using the factor of the weighted average ($\sum_{j \neq i} wij$) and conflict intensity (CI_{it}). To calculate the distance (d_{ij}) between point j (in Libya) and point i (in a country within the sample), we employed the Haversine straight-line (geodesic) distance calculator with the latitude and longitude of the countries' geographic centroids as reference point. This calculation uses the shortest-path aerial distance (Haversine), representing the direct geographic separation between two countries. Yet, it gives an approximate measure of the geographic distance with a margin of error of up to 0.5%, and is

significantly different from the road distance which is much longer. This approach reflects the assumption that conflicts in geographically proximate countries exert stronger external effects. [Equation 2](#) specifies the CSI:

$$CSI_{it} = \sum_{j \neq i} wij \times CI_{it} \tag{2}$$

where $j \neq i$ is the mean of intensities from all other countries, different from the country for which the average is being calculated. $wij = 1/d_{ij}$, with d_{ij} denoting the distance between countries i (Sahel countries) and j (Libya). Weighting by geographic proximity incorporates the spatial dimension of conflict dynamics, emphasizing the immediate implications of instability in neighboring states ([Abdel-Latif et al., 2024](#)). Finally, to enhance comparability across countries and over time, the CSI was normalized to range between 0 and 1 using min–max scaling, as shown in [Equation 3](#):

$$\text{Normalized } CSI_{it} = \frac{CSI_{it} - \min(CSI)}{\max(CSI) - \min(CSI)} \tag{3}$$

Where CSI is the conflict spillover index for country i at time t , and $\min(CSI)$ and $\max(CSI)$ represent the lowest and highest conflict intensity indices for all the sample countries. The CSI's multidimensional structure enables it to capture both the scale and severity of conflicts while accounting for spatial interdependence. This makes it more suitable than unidimensional indicators for assessing how Libya's instability permeated borders and intensified violence across the Sahel ([Abdel-Latif et al., 2024](#)). The data and variables involved in the process of the CSI creation can be found in the 'Supplementary material' section of this paper and on external repositories.

To avoid possible omitted variable bias, some standard covariates as observed in the extant literature as influencers of the rise of violent armed conflict are added to the model: weak governance

(proxied with state fragility), economic development (measured with GDP per capita), environmental stressors (average precipitation), freedom of thought, conscience, and religion, government effectiveness, and population size. State fragility reflects weakened state capacity, where governments struggle to provide security, services, and legitimacy but continue to function. Theoretically, fragile states are more prone to violent conflict because weakened institutions reduce the state's ability to deter armed groups, mediate disputes, and maintain order (Fearon and Laitin, 2003; Rotberg, 2004). Fragility is measured using the State Fragility Index (0–120) with countries categorized into 4 major groups: Sustainable (0.0–29.9), Stable (30.0–59.9), Warning (60.0–89.0), Alert (90.0–120). A higher score indicates greater fragility and vulnerability to conflict. This study measures fragility using the State Fragility Index, a score obtained via content analysis of public data with quantitative and qualitative data to assess states' vulnerability. Data is sourced from The Fund for Peace (2025) report. Environmental stressors such as drought, rainfall variability, and land degradation can heighten violent conflict by intensifying competition over scarce resources. In the Sahel, reduced rainfall has been linked to clashes between farmers and pastoralists, often exploited by armed groups (Kalilou, 2021; Larémont, 2021). In this study, environmental stress is measured using average annual precipitation, with data sourced from the World Bank's (2025). GDP per capita is also included as a control variable because low economic development is theoretically linked to higher violent conflict by weakening state capacity and increasing grievances (Collier and Hoeffler, 2004). It is measured as national income per person, sourced from the World Bank (2025). Population size is measured as the total number of inhabitants. Larger populations can heighten violent conflict risk by intensifying competition over scarce resources and straining state capacity (Gleditsch and Urdal, 2002; Goldstone, 2002). Because population levels vary across countries, it is included as a control. Data come from the World Bank (2025). Government effectiveness captures the quality of public services and policy implementation. Weak governance heightens violent conflict risk by limiting state capacity to manage disputes (Fearon and Laitin, 2003). It is measured using the World Bank's (2024), ranging from –2.5 to 2.5. Lastly, Freedom of thought, conscience, and religion protects individuals' rights to hold and practice beliefs. Restrictions on religious freedom can heighten violent conflict by fueling grievances and identity-based mobilization (Basedau et al., 2017). This study measures the variable using International Institute for Democracy and Electoral Assistance's (2025) index, which scores protections and restrictions from 0 to 1.

6.3 Model specification

This paper employs two complementary estimation techniques: System Generalized Method of Moments (system-GMM) and Method of Moments Quantile Regression (MMQR) to examine the spillover effect of NATO's intervention in Libyan conflict on the rise in violent armed conflict in the Sahel region. A dynamic panel approach is appropriate because conflict dynamics exhibit persistence, where past conflict influences current levels. System-GMM incorporates a lagged dependent variable to capture this path dependence while addressing key econometric challenges, including omitted variable bias, measurement error, endogeneity, and unobserved country-specific heterogeneity (Arellano and Bond, 1991; Arellano and Bover, 1995). The

estimator is suitable for panels with many countries and relatively short time periods ($N > T$), which aligns with this study's dataset. Model validity is assessed using the Hansen test of overidentifying restrictions to confirm instrument appropriateness and serial correlation tests to ensure the absence of second-order autocorrelation in the error term. Failure to reject both null hypotheses supports model consistency (Arellano and Bond, 1991; Roodman, 2009). The two-step system-GMM estimator, which offers improved efficiency and robust standard errors, is used following the modifications proposed by Roodman (2009). The dynamic specification is expressed as: The dynamic empirical model specification is given as:

$$RV_{it} = \lambda_1 RV_{it-1} + \lambda_2 NATO_{it} + \lambda_3 SF_{it} + \lambda_4 GE_{it} + \lambda_5 GDP_{it} + \lambda_6 ENV_{it} + \lambda_7 RL_{it} + \lambda_7 POP_{it} + \sum_{h=1}^4 W_h W_{h,i,t-t} + \eta_i + \varepsilon_{it} \quad (4)$$

Where RV_{it} is the dependent variable (rise in violent conflicts) for country i at period t , RV_{it-1} is the lag RV_{it-1} , NATO represents NATO's Spillover Effects, SF is state fragility, GE denotes Government Effectiveness, GDP captures economic conditions (GDP per capita), ENV captures environmental stressors, RL is freedom of thought, conscience and religion while $W_{h,i,t-t}$ is the vector of control variables, η_i is the country-specific effect, W_h are the associated weights and ε_{it} is the error term.

To complement mean-based estimation, the study also employs quantile regression to capture heterogeneity in conflict dynamics across different points of the conditional distribution. Unlike ordinary least squares, which estimates average effects, quantile regression identifies how determinants influence low-violence, median-violence, and high-violence contexts (Koenker and Bassett, 1978). This is particularly relevant for the Sahel, where conflict intensity varies substantially across countries and over time.

We adopt the Method of Moments Quantile Regression (MMQR) with fixed effects developed by Machado and Santos Silva (2019). Traditional quantile regression with non-additive fixed effects is robust to outliers but does not adequately control for unobserved heterogeneity in panel structures (Ike et al., 2020). MMQR overcomes this limitation by modeling both location and scale effects, allowing individual effects to vary across quantiles and thus capturing the full conditional distribution of violent conflict. To estimate the model, the conditional quantiles $Q_\tau(\tau|X)$ for a model of the location-scale variant is operationalized as:

$$Y_{it} = \alpha_i + X_{it}' \beta + (\delta + Z_{it}' \gamma) U_{it} \quad (5)$$

Where the probability, $P\{\delta + Z_{it}' \gamma\} = 1$ and $(\alpha, \beta, \delta, \gamma)$ are parameters to be estimated. Meanwhile (α_i, δ_i) , $i = 1, \dots, n$ denote the individual i fixed effects, and Z is K -vector of known differentiable transformations of the components of X with element l given as:

$$Z_{l=2}(X), l=1, \dots, k \quad (6)$$

From Equation 2, X_{it} is an independent and identical distribution with respect to any fixed i and across time t . The distribution of U_{it} is also independent and identical across individual cross-sections i and

t , orthogonal to x_{it} , and uniquely normalized to meet moment conditions (Machado and Santos Silva, 2019). Hence, Equation 2 suggests the following:

$$Q_y(\tau|X_{it}) = (\alpha_i + \delta_i q(\tau)) + X_{it}'\beta + Z_{it}'\gamma q(\tau) \tag{7}$$

From Equation 7, X_{it} denotes independent variables: NATO's intervention (spillover effects) (NATO) and State fragility (SF). The control variables are Government Effectiveness (GE), GDP per capita (GDP), Environmental stressors (ENV), Freedom of thought, Conscience and Religion (RL), and Population Size (pop). Equation 2 $Q_y(\tau|X_{it})$ designates the quantile distribution of the dependent variable – Rise in violent armed conflict (RV), which depends on the location of independent variables $\alpha_i(\tau) = \alpha_i + \delta_i q(\tau)$ is the scalar coefficient which shows the fixed effect of quantile- t on individual i . Contrary to the usual fixed effects in the least square models, the individual effect does not in any way suggests an intercept shift. In fact, as time-invariant parameters, their heterogenous effects are made to vary through the quantiles based on the conditional distribution of the endogenous factors. Specifically, the parameters are estimated as:

$$\min_q \sum_i \sum_t \rho_\tau \left(\hat{R}_{it} - (\delta_i + Z_{it}'\gamma) \right) \tag{8}$$

Where $\rho_\tau(A) = (\tau - 1) \text{Al}\{A < 0\} + \tau \text{Al}\{A > 0\}$ represents the check-function. Together, system-GMM and MMQR provide a comprehensive framework for analyzing the dynamic and distributional determinants of violent conflict in the Sahel.

7 Empirical results

The paper employs system-GMM and quantile regression to examine the rise of violent armed conflict in the Sahel region. It must be noted that positive signs on the coefficients underscore the potential of the explanatory variables to increase violent armed conflict while negative signs signal the potential to reduce same in the Sahel region. From the system GMM results in Table 3, Models 1–5 indicate that the lagged dependent variable (rise in violent armed conflict) is statistically significant (0.835–0.864) at 1% levels. The high coefficients of the lagged dependent variable capture the temporal persistence of violent conflict, which indicate that past increases in conflict are associated with further increases in the current period. This suggests a path-dependent dynamic in which violence, once escalated, tends to sustain itself rather than quickly dissipating. Given the choice of one lag length, the specification of the second-order Arellano and Bond (1991) autocorrelation test AR (2) results reveal that the system-GMM model does not suffer from second-order serial correlation, and the Hansen J test of overidentification restrictions (OIR) show that the instruments used are not over-identified.

In Model 1, the coefficient for NATO intervention (spillover) is positive and statistically significant at the 5% level. The estimated coefficient ($\lambda = 4.114, p < 0.05$) indicates that NATO-related spillover exerts a stimulating effect on the rise in violent armed conflict in the

Sahel. This suggests that, after controlling for government effectiveness, GDP per capita, and freedom of religion and thought, a one-unit increase in the NATO spillover index is associated with a 4.114-unit rise in violent conflict.

GDP per capita is also positive and significant ($\lambda = 3.301, p < 0.05$). Rather than acting as a simple buffer against conflict, higher income levels appear associated with an increase in violent conflict. This pattern is consistent with arguments that economic growth in weak institutional contexts can intensify distributional struggles over rents, contracts, and strategic resources. It suggests that growth without inclusion or effective conflict-management institutions may coincide with heightened violence. Freedom of religion and thought is negative but statistically insignificant, indicating no clear, independent effect once other economic and security factors are controlled for.

Model 2 expands the specification to include state fragility, environmental stressors, population size, and GDP per capita, while omitting NATO spillover. The lagged dependent variable remains positive and highly significant ($\lambda = 0.873, p < 0.01$), reinforcing the earlier evidence of pronounced conflict persistence. State fragility is positive ($\lambda = 230.8$) but statistically insignificant. The direction of the effect is theoretically consistent as higher fragility is associated with more conflict but the lack of precision suggests that, in this specification and sample, the marginal effect of fragility is not clear-cut. Environmental stressors are negative but wildly imprecise ($\lambda = -23.96$) indicating that the model cannot reliably identify a direct environmental–conflict linkage. This supports a more nuanced view that environmental pressures may be mediated by political and socio-economic structures rather than exerting direct effect. Population size is not statistically significant. This suggests that aggregate population changes do not, on their own, explain short-run fluctuations in violent conflict once fragility, environment, and income are controlled for. GDP per capita is positive but not significant ($\lambda = 1.584$), while freedom of religion and thought remains negative and insignificant. Taken together, Model 2 suggests that when governance and environmental factors are introduced without NATO spillover, only conflict persistence remains a robust driver of current violence.

In the Model 3, state fragility is positive and statistically significant ($\lambda = 324.7, p < 0.05$), implying that more fragile states are more prone to rising violent armed conflict. Thus, after accounting for government effectiveness, environmental stressors, economic development, religious liberties, and population size, a unit increase in state fragility is likely to increase violent armed conflict by 324.7 units. Fragility here captures weak institutions, poor governance, and limited state authority, all of which create permissive conditions for violent armed conflict. The magnitude of the coefficient suggests that deterioration in fragility is associated with a sizeable increase in the rise of violent conflict. This underscores the importance of long-term state-building, institutional reform, and legitimacy-enhancing interventions as central pillars of conflict prevention and peace consolidation. Government effectiveness is also positive and statistically significant ($\lambda = 4.345, p < 0.05$). The plausible reason for this unexpected result is that the current state of governance in Sahel region is not effective enough to exert a positive impact. Environmental stressors exhibit a positive effect ($\lambda \approx 80,306$) but are statistically insignificant. GDP per capita is also positive but not statistically significant ($\lambda = 2.178$). Similarly, the

TABLE 3 System GMM estimations, dependent variable: rise in violent armed conflict.

Variables	(1)	(2)	(3)	(4)	(5)
RV (lagged)	0.835*** (0.0923)	0.873*** (0.200)	0.952*** (0.427)	0.8273** (0.119)	0.864*** (0.182)
NATO (spillover)	4.114** (1.477)			1.799** (659.1)	1.799** (659.1)
SF		230.8 (161.4)	324.7** (134.2)	474.5*** (128.6)	474.5*** (128.6)
GE	-1.952 (1.137)		4.345** (1.757)	4.544*** (1.486)	4.544*** (1.486)
ENVI		-23.955 (140.950)	80.306 (153.403)		-6.200 (27.307)
Pop size		0.000297 (0.000169)	0.000231* (0.000107)		
GDP per capita	3.301** (1.113)	1.584 (3.013)	2.178 (3.144)	3.865*** (0.629)	3.865*** (0.629)
Freedoms	-1.889 (2.076)	-420.0 (5.368)	3.757 (5.176)	-708.1 (1.416)	-708.1 (1.416)
Observations	73	120	120	73	130
Number of instruments	9	9	9	9	8
Number of groups	12	12	12	12	13
AR (1)	0.239	0.854	0.541	0.208	0.655
AR (2)	0.328	0.326	0.664	0.256	0.376
Hanen J test OIR	0.366	0.425	0.882	0.526	0.494
Sargan test OIR	0.128	0.388	0.862	0.472	0.840

Standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Significance at 1, 5 and 10%, respectively.

GMM estimation is done using xtabond2 routine in Stata.

NB: environmental variable was automatically deleted by the Stata software due to multicollinearity.

coefficient for religious liberties or freedom of religion and thought is positive and statistically insignificant ($\lambda = 3,757$), suggesting that variation in religious freedom does not have a significant effect. Nevertheless, population size is positive and statistically significant at the 10% level ($\lambda = 0.000231$, $p < 0.10$).

Similar to the results displayed in the Model 1, the finding in the Model 4 suggests that NATO intervention continues to exert a positive and statistically significant effect ($\lambda = 1.799$, $p < 0.05$). Although the magnitude is smaller, the significance persists even after accounting for the broader set of controls, including state fragility, government effectiveness, GDP per capita, and freedom of religion and thought. This indicates that NATO-related spillover is consistently associated with higher levels of violent conflict in the Sahel, even when accounting for state fragility, government effectiveness, income, and religious freedoms. This finding supports the view that external military engagement, even when intended to stabilize, may generate escalation dynamics or regional diffusion of violence in the Sahel. However, state fragility is now positive and highly significant ($\lambda = 474.5$, $p < 0.01$). This result confirms that more fragile states (weaker institutions, compromised territorial control, and limited legitimacy) are more prone to rising violent conflict. It shifts fragility from an “insignificant” factor in Models 2, 3 to a more critical factor

once NATO interventions and state capacity are jointly modelled. The implication is that external interventions appear inspire conflict in contexts where institutional fragility is already acute. Government effectiveness turns positive and significant ($\lambda = 4.544$, $p < 0.01$). One plausible interpretation is that effectiveness here may be capturing the capacity of the state to project force and intensify military responses in already volatile environments, rather than purely developmental or welfare-enhancing capacity. In other words, states that are “more effective” in organisational terms may simultaneously be more capable of prosecuting wars or engaging in repressive strategies that fuel further violence. GDP per capita is again positive and strongly significant ($\lambda = 3.865$, $p < 0.01$), reinforcing the earlier observation that economic advancement is associated with increased violent conflict in this sample. Freedom of religion and thought remains negative and insignificant ($\lambda = -708.1$), implying that, conditional on other factors, variation in this index does not independently drive violent conflict in the Sahel.

Finally, NATO intervention (spillover) in Model 5 retains a positive and statistically significant coefficient ($\lambda = 1.799$, $p < 0.05$), even after accounting for institutional, economic, and social factors. This implies that, all else being equal, a one-unit increase in the NATO spillover index is associated with a 1.799-unit increase in the rise of

violent armed conflict. The robustness of this effect in such a rich specification suggests that external military engagement is systematically associated with escalation rather than de-escalation of violence in the Sahel. For policy, it underscores the need for conflict-sensitive intervention designs that integrate diplomatic, governance, and peacebuilding components, rather than relying predominantly on hard security instruments. State fragility exerts a strong and positively significant impact ($\lambda = 474.5, p < 0.01$). This reinforces the view that fragile states are more prone to rising violent conflict. Government effectiveness is also positive and highly significant ($\lambda = 4.544, p < 0.01$), implying that the current state of the governance architecture of Sahelian states is conducive for violent conflict. It implies that state-building without parallel improvements in accountability, inclusion, and rule of law may reinforce cycles of organised violence rather than peace.

Environmental stressors display a small negative coefficient ($\lambda = -6.200$) that is not statistically significant, indicating that, within this model, environmental pressures do not exhibit a clear, independent short-run effect on the rise in violent conflict. GDP per capita, by contrast, is positive and highly significant ($\lambda = 3.865, p < 0.01$), suggesting that higher income levels are associated with increases in violent conflict. This finding challenges the conventional assumption that development automatically reduces conflict risk. Instead, it supports a political-economy interpretation in which economic gains in fragile and unequal contexts become objects of contestation and rent-seeking, thereby fuelling violent struggles over control of resources and state power. Freedom of religion and thought carries a negative coefficient ($\lambda = -708.1$) but is statistically insignificant.

Quantile regression was employed to analyse whether the effects of NATO spillover, state fragility, and the other control variables used in the study are heterogeneous across countries in the Sahel,

conditional on their levels of violent armed conflict. As shown in Table 4, the estimated effects are not uniform across the distribution but differ across the quantiles representing low (Q0.10–Q0.25), median (Q0.50), and high (Q0.75–Q0.90) levels of conflict intensity. This indicates considerable heterogeneity in the drivers of violence depending on the severity of conflict within each country. The results reveal that the NATO spillover index is positive and statistically significant across all quantiles. However, the coefficients at the higher quantiles (Q0.75 and Q0.90), which reflect contexts with more intense violent armed conflict, are substantially larger. This suggests that the spillover effects of NATO’s intervention in Libya are more pronounced in countries where conflict intensity is already elevated such as Burkina Faso, Cameroon, Chad, Mali, Niger, and Nigeria compared to relatively low-intensity contexts such as Benin, The Gambia, Mauritania, Senegal, and Togo.

8 Discussion

The study examines the rise of violent armed conflict in the Sahel, while extending existing theoretical and empirical understandings of conflict spillover and state fragility. The results strongly support the central proposition that the 2011 NATO intervention in Libya produced significant regional spillover effects that continue to shape conflict trajectories across the Sahel. Across both the system-GMM and MMQR estimations, NATO-related spillover remains consistently positive and statistically significant with effects intensifying at the upper quantiles of conflict. This reinforces diffusion and liberal interventionist theories, which argue that external military actions despite being justified on humanitarian or security grounds can destabilise neighbouring

TABLE 4 Quantile Regression results.

Variables	0.1	0.25	0.50	0.75	0.90
NATO	650.1** (1,366)	1.162* (608.8)	1.871* (1,102)	2.962*** (2,557)	4.688*** (5,838)
SF	-30.29 (31.24)	-25.34*** (17.22)	-18.49 (32.49)	-7.941*** (76.44)	8.734 (152.2)
GE	-1,017 (935.6)***	-861.9* (514.2)	-646.7 (969.8)	-315.8* (2,282)	207.6 (4,549)
ENVI	0.0665 (0.336)	0.0393 (0.190)	0.00147*** (0.359)	-0.0566 (0.846)	-0.149 (1.667)
GDP per capita	-0.0716 (0.534)	-0.0317 (0.302)	0.0237 (0.571)	0.109 (1.345)	0.243 (2.650)
Freedoms	780.8* (965.1)	855.4 (546.2)	958.8 (1,033)	1,118*** (2,434)	1,369 (4,789)
POP size	4.46e-05 (5.32e-05)	3.25e-05 (2.81e-05)	1.58e-05 (5.25e-05)	-1.00e-05 (0.000123)	-5.08e-05 (0.000252)
Constant	172.4 (2.191)	-74.07 (1.227)	-415.8 (2.317)	-941.3 (5.454)	-1,772 (10,799)
Observations	81	81	81	81	81

Standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

regions by restructuring opportunity spaces for insurgent activity (Kuperman, 2013; Shaw, 2013). The magnitude of coefficients observed at upper quantiles (0.75 and 0.90) indicate that high-intensity conflict contexts are especially sensitive to external shocks, validating the argument that spillover interacts with pre-existing vulnerabilities rather than acting as a uniform determinant of violence. Similarly, the results support state fragility theory, which emerges as one of the most powerful and consistent predictors of rising violence once modelled alongside NATO spillovers and governance factors. This aligns with Rotberg's (2004) and Boås and Strazzari's (2020) conceptualisation of fragility as a structural condition that erodes state authority, weakens territorial control, and enables insurgent mobilisation. The magnitude of the coefficients for fragility particularly in Model 3 through Model 5 show demonstrates that weak institutions tend to amplify conflicts whenever there are external shocks. Thus, the findings confirm the theoretical expectation that fragile states convert exogenous disturbances into sustained and escalatory conflict because they lack the coercive, administrative, and legitimacy-based tools required to neutralise such pressures. This reinforces prior research linking the post-2011 Sahel crisis to institutional weaknesses in Mali, Burkina Faso, Chad, and Niger, where jihadist expansion and armed banditry coincided with governance collapse (Iocchi and Baldaro, 2024; Ziso and Hamandishe, 2024). Nevertheless, government effectiveness is positively associated with violent conflict across multiple models. This contradicts mainstream governance literature, which assumes that stronger institutions reduce the likelihood of conflict (Fearon and Laitin, 2003). The positive sign suggests that government effectiveness in the Sahel may reflect a state's ability to project coercive force rather than its ability to maintain legitimacy, social cohesion, or participatory governance. In contexts where counterterrorism operations are heavily militarised, state effectiveness may manifest as intensified state presence, security offensives, or repression, which can elevate violence in the short run. This aligns with Ying's (2021) argument that increased state penetration can provoke resistance from entrenched non-state authorities, thereby escalating conflict. The study's findings also challenge the dominant environmental determinism in Sahel conflict literature. Environmental stressors, though widely theorised as key drivers of violence, exhibit no statistically significant effect across most models, and their signs are inconsistent. This contradicts studies that posit climate-induced scarcity as a direct trigger of conflict (Denisova and Kostelyanets, 2023; Kalilou, 2021). Rather, the results confirm the view that environmental factors influence conflict only indirectly through governance failures, marginalisation, and livelihood insecurities (Benjaminsen and Svarstad, 2021). The insignificance of environmental stressors in this analysis therefore underscores the primacy of political and institutional variables over ecological ones. Finally, the positive and significant effect of GDP per capita challenges the assumption of development for peace. Rather than reducing conflict, higher income levels appear associated with increased violence, supporting distributional conflict and rent-seeking theories which argue that economic gains in fragile settings fuel competition over resources and state power. In sum, the findings confirm that the Sahel's conflict dynamics are best explained by the interaction of external shocks and entrenched domestic fragilities, contradicting simplistic climate-conflict narratives and refining existing theories on intervention, diffusion, and state failure.

9 Conclusion and policy recommendations

The findings of this study demonstrate that violent armed conflict in the Sahel is primarily shaped by the interaction of external shocks and deep-seated domestic fragilities rather than by environmental pressures alone. The results provide strong and consistent evidence that the spillover effects of NATO's 2011 intervention in Libya significantly intensified conflict across Sahelian states, particularly in countries already experiencing high levels of violence. This supports diffusion-based explanations which argue that foreign interventions can destabilise regions by altering the balance of power, enabling the spread of arms, and empowering transnational armed groups. At the same time, the study highlights state fragility as a powerful and persistent driver of conflict escalation. Fragile states that lack legitimacy, administrative capacity, and territorial control were found to be far more susceptible to the destabilising consequences of the Libyan crisis, thereby converting external disturbances into entrenched cycles of violence. The unexpected finding that government effectiveness is positively associated with rising conflict reveals important nuances in the governance–security relationship. In the Sahel, “effectiveness” may reflect coercive capability or aggressive counterterrorism strategies rather than inclusive governance or social protection. Such militarised responses can intensify resentment and strengthen insurgent recruitment, inadvertently worsening insecurity. Moreover, the analysis shows that neither environmental stressors nor religious freedom exert statistically robust effects on conflict, challenging dominant narratives that attribute Sahelian violence primarily to climate-induced scarcity. Similarly, the positive relationship between GDP per capita and conflict indicates that economic gains in fragile and unequal societies can become objects of “violent contestation,” reinforcing distributional grievances, rent competition, and elite-driven conflicts.

These findings suggest several policy priorities. First, strengthening state legitimacy, administrative capacity, and territorial presence is essential for reducing fragility and weakening insurgent networks. Second, security responses must shift from primarily militarised approaches toward more community-driven, rights-sensitive conflict management strategies that reduce resentment and improve state–society relations. Third, regional bodies such as Economic Community of West African States (ECOWAS) and the African Union (AU) must enhance cross-border cooperation by improving intelligence sharing, harmonising border surveillance, and curbing illicit arms flows from Libya. Finally, at the diplomatic level, stabilising Libya remains a critical security imperative, requiring sustained engagement, support for disarmament initiatives, and collaborative efforts to curb illicit transnational networks. Taken together, these measures emphasise that sustainable peace in the Sahel will depend not only on managing ecological pressures but, more fundamentally, on addressing the institutional weaknesses, governance deficits, and external spillover dynamics that continue to drive insecurity across the region. Nevertheless, the paper is not without limitations. Key constructs, including state fragility, spillover exposure, freedoms, and government effectiveness are operationalised using composite indices that may conceal important sub-dimensions of the spread of violence in the region. Additionally, although a panel of 13 countries is workable for system GMM, a relatively large sample capturing other countries in the Sahel should be considered when data situation improves in the future. Future research should therefore employ quasi-experimental or spatial approaches and incorporate more direct measures of arms trafficking and fighter mobility to estimate spillover effects more precisely, rather than relying primarily on proxy indicators. Moreover, future studies

should employ time series approach to examine the long-term effect of spillover on individual countries.

Data availability statement

Replication files are available on Mendeley Data, V1, doi: <https://doi.org/10.17632/ssbpfyz68m.1>.

Author contributions

HD: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. ZL: Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing, Conceptualization. NJ: Conceptualization, Data curation, Writing – original draft, Writing – review & editing. EO: Conceptualization, Data curation, Writing – original draft, Writing – review & editing.

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Correction note

A correction has been made to this article. Details can be found at: [10.3389/fpos.2026.1835690](https://doi.org/10.3389/fpos.2026.1835690).

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpos.2026.1763275/full#supplementary-material>

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