

Economic Desperation and Security: A Dynamic Systems Model of Fragile States

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Abstract

While insecurity and violent extremism continue to escalate across fragile African states, particularly in the Sahel, West Africa, and the Horn of Africa, the underlying economic factors driving this trend remain underexplored. This study investigates the role of economic desperation, characterized by youth unemployment, institutional weakness, and systemic exclusion in fuelling terrorism, organized crime, and irregular migration. The main objective is to develop and analyze a systems-theoretic model integrating economic, social, and security dynamics to quantify the feedback loops linking economic stagnation with insecurity. Employing a mixed-methods approach, the study combines empirical case analyses from Nigeria, Burkina Faso, Somalia, and West Africa with a novel compartmental ordinary differential equations (ODE) framework capturing employment, unemployment, recruitment, and governance capacity. Simulation and sensitivity analyses reveal critical thresholds where recruitment into violent and criminal networks becomes self-sustaining, highlighting the pivotal role of job creation, state responsiveness, and reintegration efforts. Key findings demonstrate that economic interventions reducing youth unemployment outperform militarized responses in both efficacy and sustainability. The study underscores that insecurity is not merely an external threat but an endogenous outcome of broken social contracts and systemic failure. Policy implications advocate for integrated development-security strategies prioritizing youth employment, institutional strengthening, and regional cooperation. This research advances a scientific basis for

proactive, evidence-based policymaking aimed at breaking cycles of violence and fostering Sustainable peace through economic inclusion and resilient governance.

Keywords: Economic desperation, youth unemployment, terrorism, fragile states, optimal control, systems theory, state fragility, recruitment dynamics

1.0. Introduction Background

The 21st century has witnessed a disturbing divergence across sub-Saharan Africa: while some nations have experienced modest economic growth and democratic progress, others, particularly in the Sahel, West, and Horn of Africa have seen a rapid deterioration in security conditions, even as development indicators remain stagnant or regress. This paradox reveals a deeper structural crisis: economic systems are failing to generate meaningful opportunities for a burgeoning youth population, creating fertile ground for violent extremism, criminal networks, and mass irregular migration. According to the United Nations, Africa is home to the world's youngest population, with over 60% of its people under the age of 25 (UNFPA, 2022). Yet, the International Labour Organization (ILO, 2023) estimates that over 75 million young Africans are unemployed, and millions more are underemployed in informal, low-productivity jobs. In countries like Nigeria, youth unemployment exceeds 42%, while in South Sudan and Burkina Faso, it surpasses 60% (World Bank, 2023).

This "youth bulge" is not inherently destabilizing, but when coupled with weak institutions, poor education, and exclusionary governance, it becomes a powder keg of

unmet aspirations. As Captain Ibrahim Traoré observed, when formal economies fail to absorb this demographic wave, alternative structures emerge - often violent ones that offer income, identity, and protection. Across the continent, terrorism, organized crime, and human smuggling routes have grown because of poverty. The following case studies demonstrate how economic stagnation has directly enabled the rise of insecurity in three distinct African regions.

Case 1: Boko Haram in Northeastern Nigeria – when jobs are scarcer than ideology. Boko Haram, which emerged in 2002 in Borno State, northeastern Nigeria, began as a religious protest movement but rapidly evolved into one of Africa's deadliest insurgencies. By 2023, it had caused over 40,000 deaths and displaced more than 2 million people (Global Terrorism Index, 2023). While often framed as a Salafi-jihadist group, research shows that economic marginalization, not religious zeal is the primary driver of terrorist recruitment. A 2017 UNDP study of 450 former Boko Haram members found that:

- 71% joined due to lack of employment
- 68% cited grievances over government neglect
- Only 7% said religious conviction was their main motivation

Northeastern Nigeria is one of the poorest regions in Africa. Human Development Index (HDI) scores in Borno State are comparable to those in war-torn Yemen. School enrolment for girls is below 5%, and only 1 in 5 youth complete secondary education (UNICEF, 2021). In such an environment, Boko Haram offered food, salaries (up to ₦20,000/month), and a sense of purpose - luxuries unavailable through legal means. As Onuoha (2012) noted that, many recruits were not radicalized first; they were economically desperate first, and ideology came later as justification. The group effectively functions as an alternative economy, taxing markets, smuggling goods, and controlling trade routes - activities that sustain both its leadership and foot soldiers. This dynamic underscores Traoré's point:

where the state fails to provide livelihoods, non-state actors fill the void, not necessarily out of ideological commitment, but out of survival.

Case 2: The Sahel Crisis – From Pastoralism to Jihadism in Mali, Burkina Faso, and Niger. Since 2012, the Sahel region has become the epicentre of a fast-spreading jihadist insurgency. Groups like Jama'at Nusrat al-Islam wal-Muslimin (JNIM) and the Islamic State in the Greater Sahara (ISGS) now operate across Mali, Burkina Faso, and Niger, exploiting weak governance and widespread poverty. What makes this region particularly vulnerable is its extreme economic fragility. Over 80% of the population relies on subsistence agriculture or pastoralism - livelihoods increasingly threatened by climate change, land degradation, and intercommunal violence. The World Bank (2022) reports that over 40% of youth in the Central Sahel are neither in education nor employment (NEET).

In Burkina Faso, where Captain Traoré rose to power amid escalating violence, the situation is dire. Between 2015 and 2023, terrorist attacks increased tenfold, displacing over 2 million people internally - the largest such crisis in West Africa. Yet, military responses have failed to stem the tide. Why? Because jihadist groups are not just fighting armies, they are offering social contracts. In areas abandoned by the state, groups like Ansarul Islam provide dispute resolution, basic services, and even job-like roles in logistics and taxation. For unemployed young men, joining such groups may be less about faith and more about access to resources and status. A 2021 study by the Geneva Centre for Security Policy found that in northern Burkina Faso, over 60% of new recruits cited economic incentives as decisive, including monthly stipends, food, and motorcycles. The study concluded: "Poverty does not cause terrorism, but it creates the conditions in which it can thrive." Thus, Traoré's own political ascent - on a platform of national dignity and resistance to foreign intervention must also be understood against

the backdrop of a state unable to deliver economic justice to its youth.

Case 3: Al-Shabaab in Somalia – Governance in the Absence of the State. Somalia has been without a functioning central government for much of the past three decades. Since the collapse of SiadBarre’s regime in 1991, the country has cycled through warlordism, clan conflict, and foreign interventions, with Al-Shabaab emerging as the most enduring non-state actor. Al-Shabaab controls large rural areas and even collects taxes in Mogadishu. It runs schools, courts, and health clinics. While ideologically aligned with global jihadism, its persistence is rooted in local legitimacy derived from service provision in a vacuum of state authority.

But why do thousands continue to join? Again, economic desperation plays a key role. The World Bank (2023) estimates that only 15% of Somali youth are employed formally. Most survive through informal labor, remittances, or humanitarian aid. Al-Shabaab offers a rare alternative: structured employment, regular pay (up to \$200/month), and housing. A 2019 study by the Life & Peace Institute interviewed former Al-Shabaab fighters who revealed that:

- Many were recruited at displacement camps (IDP camps) where food and work were scarce.
- Commanders targeted unemployed youth with promises of “dignity and salary.”
- Some joined not to fight, but to access medical care or resolve land disputes via Sharia courts.

As Hansen (2013) argues, Al-Shabaab is not merely a terrorist organization, it is a hybrid governance structure that fills institutional gaps. In this context, counter-terrorism operations that ignore socio-economic foundations risk alienating populations further and driving recruitment.

Case 4: Criminal Networks and Migration in West Africa – The Desert and Sea Routes. Beyond terrorism, economic desperation fuels transnational criminal networks and irregular migration. In countries like Gambia, Senegal, and Côte d’Ivoire, tens of thousands of young

men embark annually on perilous journeys across the Sahara to Libya and then to Europe - many never arriving. These migration routes are not spontaneous; they are organized criminal enterprises that exploit desperation. Smugglers charge up to €5,000 per person, often trapping migrants in debt bondage. The IOM (2022) reports that over 30,000 migrants died attempting Mediterranean crossings between 2014 and 2023, many of them from West Africa.

Yet, for many, the risk is rational. In the Gambia, youth unemployment hovers around 50%. With limited prospects, migration becomes a form of investment, what de Haas (2010) calls “transnational survival strategy.” As one Gambian youth told researchers: “If I stay, I die slowly. If I go, I might die fast, but I might also make it.” Criminal networks profit from this desperation, evolving into powerful mafias that corrupt border officials, traffic drugs, and launder money. Groups like the Nigerian mafia in Europe or drug cartels in Guinea-Bissau are not ideologically driven, they are economic adaptations to systemic exclusion.

Synthesis: A Continent at a Crossroads. These cases, from Nigeria to Somalia, from the Sahel to the Atlantic coast, reveal a common pattern: Where economies fail to deliver opportunity, violence fills the void, not as an aberration, but as a rational response to systemic exclusion. Economic stagnation does not automatically produce terrorism or crime, but it lowers the threshold for recruitment, increases susceptibility to extremist narratives, and erodes trust in the state. As Collier (2007) warned, when legitimate paths to success are blocked, rebellion becomes a viable career option. Captain Traoré’s assertion that “The biggest security threat to Africa isn’t terrorism. It’s economic desperation”, is thus not hyperbole, it is a diagnosis supported by evidence across Africa. The challenge now is not whether to believe him, but how to act on his insight. This research takes up that challenge by developing a systems-theoretic framework that quantifies the links between

economic exclusion and insecurity, and prescribes integrated policy responses grounded in science, not speculation.

1.1. Problem Statement: Is Economic Desperation the Root Cause of Terrorism?

Conventional counter-terrorism (CT) strategies have long emphasized military intervention, intelligence operations, and ideological deradicalization. Yet, despite billions in international aid and decades of effort, terrorist activity in Africa continues to spread geographically and deepen socially. Between 2011 and 2023, Boko Haram and ISIS-West Africa caused over 40,000 deaths (Global Terrorism Index, 2023); Al-Shabaab remains resilient in Somalia and Kenya; and Sahelian jihadi groups have expanded into coastal West Africa. This persistent failure suggests a critical gap in understanding.

While ideology, geopolitics, and foreign interference play roles, they often operate on a foundation of local grievances, especially economic exclusion. As Paul Collier and Anke Hoeffler (2004) argue in their seminal "Greed vs. Grievance" model, civil conflict is more likely when legitimate economic opportunities are scarce, making rebellion an attractive alternative. Similarly, Ted Gurr's (1970) theory of relative deprivation posits that political violence arises not from absolute poverty, but from the perceived gap between expectations and reality - precisely the condition faced by millions of educated but unemployed African youth.

Yet, the dominant security paradigm treats terrorism as a primarily military or ideological challenge. Economic development is often relegated to a secondary, post-conflict concern. This siloed approach risks being ineffective, or even counterproductive - when the root drivers remain unaddressed. Thus, the central problem this research addresses is: Can economic desperation be identified as a primary driver of insecurity, and if so, how can policy integrate economic development and security strategy within a unified, dynamic framework?

1.1.1 Captain Ibrahim Traoré's Thesis and Its Implications:

In a widely cited address in 2022, Captain Ibrahim Traoré, interim leader of Burkina Faso, declared: "The biggest security threat to Africa isn't terrorism. It's economic desperation. When young people can find jobs, they don't just disappear but join whatever organization that promise them a future and sense of belonging. Sometimes they start terrorist groups, sometimes criminal networks, sometimes migration routes that end in tragedy. All of these start with the same thing - an economy that can't provide for its people". This statement is not merely rhetorical; it reflects a growing consensus among scholars and practitioners. Traoré reframes insecurity not as an external threat to be militarized, but as an endogenous outcome of systemic failure - a symptom of a social contract broken between the state and its youth. His argument aligns with multiple theoretical traditions:

- **Structural Functionalism (Merton, 1938):** When legitimate avenues for success are blocked, deviant adaptations (e.g., joining gangs or extremist groups) become rational.
- **Social Identity Theory (Tajfel & Turner, 1979):** Marginalized youth seek belonging; extremist organizations offer identity, purpose, and community.
- **Political Economy of Violence (Keen, 2000):** Violent groups function as alternative economies, providing income, protection, and governance in stateless zones.

Empirically, Traoré's thesis finds support. A UNDP (2017) survey of 450 former fighters across five African countries revealed that 71% joined due to lack of jobs, compared to only 17% for religious reasons. In Nigeria, Onuoha (2012) found that many Boko Haram recruits were not ideologues but disillusioned dropouts from failing schools and labor markets. However, Traoré's claim also invites critique. Does it overstate economic determinism? What about ideology, ethnicity, or foreign influence? Can job creation alone

dismantle well-armed, transnational networks like JNIM or Al-Shabaab? This research takes Traoré's insight seriously, not as a final answer, but as a provocative hypothesis requiring rigorous testing. We ask: under what conditions does economic desperation become a necessary and sufficient cause of destabilization? And how can policy respond in a way that is both effective and sustainable?

1.2. Research Questions

This study seeks to answer the following questions:

- (i) To what extent does economic desperation - measured through youth unemployment, inequality, and institutional weakness, predict the emergence and persistence of terrorist and criminal networks in fragile states?
- (ii) How do feedback loops between economic exclusion, state capacity, and recruitment dynamics shape the trajectory of insecurity?
- (iii) What is the optimal timing, intensity, and allocation of interventions (economic vs. security) to minimize long-term societal costs?
- (iv) How do cross-border spillovers and regional interdependence affect the effectiveness of national-level policies?
- (v) How robust are optimal policy strategies under conditions of parameter uncertainty and exogenous shocks (e.g., climate change, coups)?

These questions bridge theory, modeling, and policy, aiming to transform Traoré's intuitive diagnosis into a quantifiable, actionable framework.

1.3. Objectives of the Study

The primary objectives of this research are:

- (i) To develop a systems-theoretic model that integrates economic, social, and security dynamics using a compartmental ODE framework.
- (ii) To estimate key thresholds, including the basic reproduction number R_0 of recruitment and the carrying capacity of illicit networks.

- (iii) To conduct sensitivity and scenario analyses identifying the most influential drivers of instability.
- (iv) To formulate and solve an optimal control problem minimizing the joint cost of unemployment, terrorism, and intervention.
- (v) To extend the model to multi-region and stochastic environments, reflecting real-world complexity.
- (vi) To translate findings into policy tools, including early warning indicators and resource allocation guidelines.

By achieving these objectives, the study aims to provide a scientific basis for integrated development-security planning.

1.4. Scope and Limitations

The study focuses on the fragile and conflict-affected states in sub-Saharan Africa, with emphasis on the Sahel and West Africa. With the analysis spanning 2000–2030, and projections based on current trends. Youth (aged 15–35), state institutions, terrorist/criminal networks within the National and subnational (regional) levels are captured. The model assumes rational behaviour and homogeneous populations; it does not capture micro-level variations in identity, culture, or ideology. However, data limitations in conflict zones may affect calibration accuracy. The optimal control framework assumes perfect implementation; real-world corruption or inefficiency may reduce efficacy. External factors (e.g., great power competition, climate change) are included only partially.

Despite these limitations, the model provides a first-principles approximation of complex dynamics, suitable for strategic planning.

1.4.1 Methodology Overview: This research employs a mixed-methods, systems-based approach combining qualitative and quantitative techniques. By qualitative approach, we took a thematic review of policy documents, interviews, and case studies (Nigeria, Burkina Faso, Somalia), all grounded in theoretical frameworks (relative

deprivation, rational choice, social identity). Quantitatively, we develop a four-compartment dynamic system: employed ($E(t)$), unemployed ($U(t)$), recruited ($R(t)$), and government capacity ($G(t)$), analytically studied the equilibrium, stability state, and the terrorism reproduction threshold using nonlinear ODEs. Finally, we carry out a robust simulation and sensitivity analysis of ODEs solution path using the 4th order Runge-Kutta (RK4) numerical methods, implementable by the appropriate python package, while deploying Partial Rank Correlation Coefficient (PRCC) to identify model's key parameters. All Python codes are open-sourced to ensure transparency and reproducibility.

1.5. Significance of the Study

This research makes several original contributions: Theoretically, the integrates development economics, conflict theory, and epidemiological modeling into a unified framework. Methodologically, the introduction optimal control to the study of socio-political instability, advanced terrorism research beyond descriptive or correlational analysis. By policy relevance, the study provides actionable insights for governments, AU, UN, and donors seeking to break the cycle of violence and poverty. At the ethical dimension, the study shifts focus from securitization to human dignity, emphasizing prevention over repression. Finally, by centering economic inclusion as a core security strategy, this work challenges the militarization of development and advocates for a paradigm shift in global security policy.

2.0 Theoretical Foundations

Understanding the relationship between economic conditions and insecurity requires more than empirical observation. It demands a robust theoretical framework capable of explaining why and how structural deprivation translates into violence. While Captain Ibrahim Traoré's assertion that "economic desperation" is Africa's greatest threat offers a powerful political diagnosis, its analytical

validity depends on grounding in established social science theories. This chapter synthesizes five major theoretical traditions - relative deprivation, rational choice, social identity, state fragility, and epidemiological modeling, that collectively illuminate the pathways from marginalization to mobilization. These are not competing paradigms but complementary lenses, each capturing a dimension of the complex causal web linking poverty, exclusion, and instability. By integrating these perspectives, we move beyond simplistic narratives of "poverty causes terrorism" toward a nuanced, multi-level understanding of how economic failure interacts with psychological, institutional, and systemic factors to produce conflict. This synthesis forms the conceptual backbone of the mathematical and policy models developed in subsequent chapters.

2.1. Relative Deprivation Theory

At the heart of many explanations for political violence lies Ted Robert Gurr's (Gurr, 1970) seminal theory of relative deprivation (RD), introduced in his 1970 work *Why Men Rebel*. Gurr argues that rebellion is not primarily caused by absolute poverty, but by the perceived gap between expectations and capabilities - a psychological condition he defines as "the perceived discrepancy between value expectations and value capabilities." In other words, people do not revolt because they are poor, but because they believe they should be better off. This distinction is crucial. A person living in material hardship may accept their condition if they perceive no alternative; however, when exposure to education, media, or urban life raises aspirations without corresponding improvements in opportunity, frustration intensifies. Gurr calls this frustrated aspiration, which, when generalized across groups, creates a collective sense of injustice that can fuel collective action, including violence.

In the African context, this dynamic is evident in countries like Nigeria and Burkina Faso, where rising school enrolment has created a generation of educated youth who

find themselves locked out of formal employment. As de Waal (2014) notes, “The most dangerous moment in a young African’s life is graduation day” - when expectations peak just as opportunities vanish. This mismatch generates what Kaldor (2003) terms “organized violence,” where armed groups emerge not to seize state power, but to control resources and provide livelihoods in the absence of functioning economies. Gurr identifies three types of relative deprivation:

- (i) *Decremental RD*: When capabilities decline while expectations remain constant (e.g., post-coup austerity).
- (ii) *Aspirational RD*: When expectations rise faster than capabilities (e.g., youth exposed to global media).
- (iii) *Progressive RD*: When both rises, but capabilities lag behind (most common in developing states).

The Sahel region exemplifies progressive RD; where governments have expanded access to education and health, raising expectations, yet economic growth has failed to keep pace. The result is widespread disillusionment. This forms a fertile ground for recruitment by jihadist or criminal groups promising dignity and income. While RD theory has been critiqued for being difficult to measure and overly psychological, its core insight remains indispensable: insecurity is as much about perception as it is about material reality.

2.1.1 Rational Choice and Rebellion: A contrasting but equally influential framework is the “greed vs grievance” model developed by Paul Collier and Anke Hoeffler (2004) in their analysis of civil war onset. Rejecting purely ideological or emotional explanations, they apply rational choice theory to argue that individuals join rebellions when the expected utility exceeds that of peaceful alternatives. Their econometric analysis of civil wars from 1960–1999 found that factors associated with opportunity, such as the availability of loutable resources (e.g., diamonds, drugs), low opportunity cost of rebellion (i.e., high unemployment), and diaspora funding were stronger predictors of

conflict than indicators of grievance (e.g., inequality, ethnic polarization).

This leads to their controversial conclusion: “rebellion is less about ideology and more about economics”. In fragile states, joining an armed group may offer higher expected returns than farming, teaching, or informal labor, especially when repression is weak and exit options limited. For example, in Somalia, Al-Shabaab pays fighters up to \$200/month - more than most teachers or civil servants earn. In Mali, JNIM taxes gold mines and smuggling routes, distributing profits to local commanders and foot soldiers. These are not acts of blind fanaticism but rational economic calculations in environments where legal markets fail. Collier’s model introduces key variables relevant to our study:

- (i) *Opportunity cost of rebellion*: Inversely related to youth unemployment.
- (ii) *Rebellion productivity*: Linked to terrain, resource availability, and state weakness.
- (iii) *Diaspora networks*: Provide financial support, lowering entry barriers.

Critics like Fearon and Laitin (2003) caution against reducing conflict to greed alone, noting that grievances still shape recruitment and legitimacy. Nevertheless, Collier’s work underscores a vital point: when legitimate economies underperform, illegitimate ones become attractive alternatives. This aligns directly with Traoré’s thesis - economic desperation does not cause violence directly, but it lowers the threshold for participation in violent enterprises.

2.1.2 Social Identity and Belonging: While Gurr and Collier focus on material and cognitive motivations, Henri Tajfel and John Turner’s Social Identity Theory (SIT) shifts attention to the psychological need for belonging and self-esteem. Developed in the 1970s, SIT posits that individuals derive part of their identity from group membership, and will act to enhance the status of their in-group relative to out-groups. In contexts of marginalization, this mechanism becomes potent. When youth are excluded from national institutions, such as schools, jobs,

politics, they seek identity elsewhere. Extremist and criminal organizations often fulfil this need by offering:

- (i) A clear moral narrative (“us vs. them”)
- (ii) Rituals and symbols of inclusion
- (iii) Hierarchical structures that confer status

As Atran (2010) observes, suicide bombers are rarely psychopaths; they are often deeply embedded in communities and motivated by sacred values and group loyalty. In Nigeria, Boko Haram frames itself as a defender of the oppressed Muslim north against a corrupt, exploitative state. For recruits, joining is not just economic survival, it is moral redemption and communal defence. Similarly, in Kenya, Al-Shabaab has recruited coastal Muslims by framing jihad as resistance to state neglect and police brutality. The promise is not only money but dignity, brotherhood, and purpose—goods unavailable in the fragmented, competitive informal economy. Thus, SIT reminds us that violence is not only instrumental but expressive. Economic desperation creates vulnerability, but it is the search for meaning and identity that makes extremist ideologies resonate. Policies focused solely on job creation may fail if they do not also address symbolic exclusion.

2.1.3 State Fragility and Institutional Failure: Rotberg’s (2004) framework of state failure provides the macro-institutional context for these micro-level dynamics. He defines failed states as those unable to perform core functions: maintaining security, delivering services, collecting taxes, and ensuring justice. In such environments, the social contract dissolves. Citizens no longer expect protection or opportunity from the state, creating a vacuum filled by non-state actors such as warlords, militias, religious movements, or criminal syndicates. These entities may be violent, but they often provide governance substitutes: dispute resolution, food distribution, even rudimentary education. Somalia, the Democratic Republic of Congo, and parts of the Central African Republic

exemplify this condition. But fragility is not binary, it exists on a spectrum. Many African states are “functionally weak” rather than fully failed, exerting control only in urban centres while rural areas remain ungoverned. Rotberg identifies key drivers of state failure:

- (i) Economic mismanagement, (ii) Corruption, (iii) Ethnic favouritism, and (iv) Security force abuse. These factors erode legitimacy, prompting citizens to turn to alternative authorities - even violent ones. Thus, economic stagnation does not operate in isolation; it is amplified by institutional decay, creating a feedback loop: weak institutions → poor service delivery → youth alienation → recruitment into anti-state groups → further state weakening. This perspective challenges purely economic models by emphasizing governance as a mediator between poverty and violence.

2.1.4 Epidemic Models of Violence: More recently, scholars like Edward Miguel and Shanker Satyanath (2004) have applied epidemiological frameworks to understand the spread of violence. Drawing from public health, they model conflict as a contagious process, where exposure to violence increases the likelihood of future participation. Using data from civil wars, they show that:

- (i) Proximity to past violence predicts future outbreaks.
- (ii) Recruitment spreads through social networks.
- (iii) There is a “threshold effect, that is small shocks can trigger large-scale escalation.

This approach treats desperation as a risk factor, akin to a pre-existing condition, while violent networks act as vectors of transmission. Just as a virus spread fastest in malnourished populations, so too does extremism thrive in economically deprived, socially fragmented communities. The model allows for the calculation of a basic reproduction number R_0 - the average number of new recruits generated by one individual in a susceptible population. If $R_0 > 1$, the movement grows; if $R_0 < 1$, it declines. This epidemiological lens is central to our

mathematical modeling in Chapter 4, transforming abstract theory into quantifiable dynamics.

2.2 Synthesis: Toward an Integrated Causal Framework:

No single theory fully explains the descent from economic desperation to destabilization. Instead, we propose an integrated causal framework in which:

- (i) Relative deprivation creates widespread frustration.
- (ii) Rational choice calculus makes rebellion a viable option.
- (iii) Social identity mechanisms provide motivation and cohesion.
- (iv) State fragility removes protective institutions.
- (v) Epidemiological dynamics enable rapid spread.

Together, these forces form a self-reinforcing system: economic failure weakens the state, which increases deprivation, which fuels recruitment, which further undermines governance. Traoré's insight - that economic desperation is the root cause is thus valid, but incomplete. Desperation is the spark, but the fuel and oxygen come from identity, opportunity, and institutional collapse.

2.2.1 Critique of Economic Reductionism in Security Discourse:

While economic factors are central, reducing all violence to poverty risks analytical oversimplification. Critics warn of:

- (i) Ignoring ideology: Groups like ISIS or Al-Qaeda have transnational agendas not reducible to local economics.
- (ii) Neglecting agency: Many fighters make conscious moral choices, not just survival decisions.
- (iii) Overlooking geopolitics: Foreign interventions, arms flows, and regional rivalries shape conflicts independently.

Moreover, job creation programs may fail if they do not address deeper issues of justice, representation, and historical trauma. Thus, while this research affirms Traoré's emphasis on economic inclusion, it

avoids economic determinism. The goal is not to replace militarized responses with developmental ones, but to integrate both within a systems-based strategy that recognizes complexity.

2.3 Empirical Case Studies

While theoretical frameworks provide essential tools for understanding the mechanisms linking economic desperation to insecurity, empirical validation is necessary to confirm their relevance in real-world contexts. This chapter presents a rigorous, evidence-based examination of four major security crises across Africa—Boko Haram in Nigeria, Al-Shabaab in Somalia, Sahelian jihadism, and transnational criminal networks in West Africa. Each case study explores how structural economic exclusion, youth unemployment, state fragility, and social marginalization converge to create conditions conducive to violence, recruitment, and organized crime. Drawing on data from authoritative sources such as ACLED, Afrobarometer, ILO, and the World Bank, these analyses move beyond anecdotal narratives to demonstrate that Captain Ibrahim Traoré's assertion - that economic desperation, not terrorism, is Africa's greatest threat, is empirically grounded. By comparing these cases, we identify common patterns and contextual variations, laying the foundation for a generalized model of instability rooted in failed development.

2.2.1. Boko Haram in Nigeria: The insurgency led by Boko Haram in northeastern Nigeria stands as one of the most devastating conflicts in modern African history. Since its emergence in 2002 and escalation into full-scale rebellion in 2009, the group has caused over 40,000 deaths, displaced more than 2 million people, and devastated entire regions (Global Terrorism Index, 2023). While widely portrayed in global media as an ideologically driven Salafi-jihadist movement, extensive field research reveals that economic marginalization, not religious extremism is the primary driver of recruitment. A landmark

2017 United Nations Development Programme (UNDP) study titled *Journey to Extremism in Africa* surveyed 450 former fighters across five countries, including Nigeria. It found that 71% joined due to lack of employment, while 68% cited government neglect and corruption as key grievances, with only 7% listing religious conviction as their main motivation.

These findings challenge the dominant securitized narrative and affirm Traoré's thesis: when legitimate economies fail, illegitimate ones emerge. Northeastern Nigeria, particularly Borno, Yobe, and Adamawa states, is among the poorest in the country. The Human Development Index (HDI) in Borno State is lower than in Yemen, with literacy rates below 30% and school enrolment for girls at just 18% (UNICEF, 2021). In such an environment, Boko Haram does not merely offer ideology - it offers a livelihood. Recruits are promised food, shelter, small salaries (₦10,000–₦20,000/month), and even motorcycles - luxuries unavailable through legal means. The group functions as a parallel economy, taxing markets, smuggling goods, and controlling trade routes. As Onuoha (2012) observes, many recruits were not radicalized before joining; they were economically desperate first, and ideology was adopted afterward as justification.

Moreover, state counter-insurgency strategies have often exacerbated the crisis. Military operations have led to mass displacement, destruction of farmland, and human rights abuses, thus, further alienating communities and pushing youth toward the very groups they are meant to defeat. As de Waal (2014) argues, "When the state behaves like a predator, non-state actors can appear as protectors." Thus, while Boko Haram uses religious rhetoric, its persistence is rooted in systemic economic failure and institutional collapse—a stark illustration of how joblessness can become a national security emergency.

2.3.2. Al-Shabaab in Somalia: Somalia's prolonged state collapse since 1991 has

created a vacuum filled by Al-Shabaab, a militant Islamist group affiliated with Al-Qaeda. Unlike conventional terrorist organizations, Al-Shabaab exercises *de facto* governance over large rural areas, administering courts, collecting taxes, providing health services, and maintaining order. This hybrid role - as both insurgent force and service provider, distinguishes it from purely destructive movements. Yet, despite its ideological framing, recruitment into Al-Shabaab is heavily influenced by economic survival. According to the World Bank (2023), only 15% of Somali youth are employed in formal jobs, and over 70% live in extreme poverty. In this context, joining Al-Shabaab may represent not ideological commitment but rational economic calculation. A 2019 study by the Life & Peace Institute interviewed former Al-Shabaab members who revealed that:

- Many were recruited from internally displaced persons (IDP) camps where food and work were scarce.
- Commanders targeted unemployed youth with promises of monthly stipends (\$100–\$200), housing, and access to medical care.
- Some joined not to fight, but to resolve land disputes or secure protection from clan rivals through Shari'a courts.

As Hansen (2013) notes, Al-Shabaab's legitimacy stems partly from its ability to deliver basic governance in the absence of the state. In areas where the Federal Government of Somalia is absent or distrusted, Al-Shabaab provides dispute resolution, infrastructure maintenance, and even education - functions that enhance its local appeal. However, this does not mean ideology is irrelevant. Al-Shabaab skilfully blends religious messaging with material incentives, creating a powerful narrative of resistance against foreign intervention and corrupt elites. For marginalized youth, especially those displaced by drought or conflict, the group offers identity, purpose, and income - a rare combination in a fragmented society. This duality underscores a critical insight: violence is not solely economic or ideological, it is

socio-political. Economic desperation creates vulnerability, but it is governance failure and symbolic exclusion that allow extremist narratives to take root.

2.3. 3. Sahelian Jihadism: The Sahel region, spanning Mali, Burkina Faso, and Niger has experienced the fastest-growing jihadist insurgency in the world. Groups like Jama'at Nusrat al-Islam wal-Muslimin (JNIM) and the Islamic State in the Greater Sahara (ISGS) have expanded rapidly since 2015, exploiting weak state presence, intercommunal tensions, and widespread poverty. What makes the Sahel particularly vulnerable is its extreme demographic and economic pressure. Over 60% of the population is under 25, yet youth unemployment exceeds 60% in some areas (World Bank, 2022). Agricultural livelihoods are increasingly threatened by climate change, desertification, and competition over dwindling resources. In northern Burkina Faso and central Mali, pastoralists and farmers clash over water and grazing land, creating fertile ground for exploitation by armed groups. Jihadist organizations capitalize on this chaos by offering protection, justice, and employment. A 2021 report by the Geneva Centre for Security Policy found that:

- In areas abandoned by the state, JNIM established Sharia courts and tax systems.
- Recruits received monthly stipends, food rations, and motorcycles.
- Over 60% of new recruits cited economic incentives as decisive, not religious belief.

In Burkina Faso, where Captain Traoré rose to power amid escalating violence, the military response has been overwhelmed. Between 2015 and 2023, attacks increased tenfold, displacing over 2 million people - the largest internal displacement crisis in West Africa. Yet, bombing campaigns and foreign interventions (e.g., France's Operation Barkhane) have failed to address the underlying drivers. As Honwana (2012) argues, African youth are experiencing a "waithood" - a prolonged limbo between adolescence and adulthood, marked by exclusion from work, marriage, and political

voice. In the Sahel, jihadism offers an escape from waithood, conferring status, income, and belonging. Thus, the Sahel crisis is not merely a security problem but a developmental catastrophe - one that cannot be resolved without addressing youth unemployment, climate resilience, and state legitimacy.

2.3.4. Criminal Networks in West Africa: Beyond terrorism, economic desperation fuels transnational criminal enterprises that exploit Africa's porous borders and weak institutions. In countries like Guinea-Bissau, The Gambia, Senegal, and Côte d'Ivoire, drug trafficking, human smuggling, and illicit financial flows have become entrenched economies of survival. Guinea-Bissau, for example, became a hub for Latin American cocaine en route to Europe after the 2003 coup. With no formal industry and high unemployment, state officials, soldiers, and civilians colluded in the trade. As UNODC (2020) reported, narcotics accounted for over 30% of GDP at its peak, corrupting every level of governance. Similarly, irregular migration routes from the Horn of Africa to Libya and across the Mediterranean are organized by criminal syndicates that profit from desperation. The International Organization for Migration (IOM, 2022) estimates that over 30,000 migrants died attempting Mediterranean crossings between 2014 and 2023, many from West Africa.

For young men in The Gambia or Senegal, where youth unemployment exceeds 50%, migration is not recklessness, it is a calculated investment. As de Haas (2010) shows, migration functions as a "transnational livelihood strategy," where families pool resources to send one member abroad, expecting remittances in return. When journeys fail, migrants are often trapped in Libya's detention centres or forced into labour. But the risk is deemed acceptable because staying means stagnation. As one Gambian youth told researchers: "If I stay, I die slowly. If I go, I might die fast but I might also make it." These networks are not ideologically motivated; they

are adaptive responses to systemic exclusion. They thrive because legal economies fail to

absorb surplus labour. Below is a comparative analysis across the regions.

Dimension	Nigeria	Somalia	Sahel	West Africa (Migration)
Primary Driver	Unemployment, neglect	State collapse, survival	Youth bulge, climate stress	Lack of opportunity
Group Type	Jihadist insurgency	Hybrid governance	Transnational jihadism	Criminal networks
Economic Incentive	Salaries, food, status	Wages, services, protection	Stipends, mobility	Smuggling fees, passage
State Capacity	Weak in northeast	Minimal outside Mogadishu	Absent in rural areas	Corrupt, ineffective
Ideological Appeal	Moderate	High	Moderate to high	Low
Key Vulnerability	Education-job mismatch	Displacement, drought	Climate-agrarian crisis	Youth unemployment

Despite differences, all cases share a common thread - when the state fails to provide economic inclusion, alternative systems, violent or criminal fill the void. This section establishes a multi-theoretical foundation that transcends disciplinary silos, enabling a holistic understanding of how economic desperation becomes destabilization.

3.0 Methodology

3.1 Mathematical Modeling of the Desperation-Security Nexus

Having established through theoretical and empirical inquiry that economic desperation is a foundational driver of insecurity in fragile African states, this chapter advances a formal, dynamic systems model to quantify and simulate these relationships. While section 2 demonstrated why and how structural exclusion leads to violence, this section answers what mechanisms govern the pace, scale, and persistence of this process. Drawing on epidemiological modeling, control theory, and socio-political dynamics, we develop a compartmental differential equation framework $E(t) - U(t) - R(t) - G(t)$ model, that captures the feedback loops between employment, unemployment, recruitment into illicit networks, and state capacity. This mathematical formalization transforms qualitative insights from Gurr's relative deprivation, Collier's rational choice, and Rotberg's state fragility into a predictive,

policy-sensitive tool. The model not only reflects observed realities but enables simulation, threshold analysis, and optimal intervention design, bridging the gap between social science theory and actionable governance.

3.1.1 Motivation for Dynamic Systems Approach:

Traditional security models often treat terrorism as an exogenous threat requiring military suppression. However, as shown in previous chapters, insecurity in Africa is endogenous. It emerges from internal socio-economic processes that evolve over time. Static or correlational analyses fail to capture the nonlinear feedbacks, tipping points, and path dependence inherent in conflict systems. A dynamic systems approach, grounded in ordinary differential equations (ODEs), offers several advantages, among which are: (i) It models change over time, essential for forecasting and early warning. (ii) It reveals threshold behaviors (e.g., when unemployment crosses a critical level, recruitment explodes). (iii) It allows for policy experimentation via simulation (e.g., "What if job creation doubles?"), and (iv) It supports optimal control theory, enabling cost-effective intervention design.

This approach is inspired by epidemiological models (e.g., SIR models for disease spread), adapted here to represent the "contagion" of radicalization and crime. As

Miguel et al. (2004) argue, political violence spreads through social networks like a virus, with susceptibility shaped by economic conditions. Similarly, Galvao et al. (2020) have successfully applied compartmental models to terrorism, demonstrating their predictive power. By treating economic desperation as a risk factor and recruitment as transmission, we align with the social diffusion theory of violence while embedding it within a broader institutional context - the

role of government capacity ($G(t)$) at any time period of time, thus integrating macro-level governance failures with micro-level behavioural choices.

3.2. Compartmental Model Design

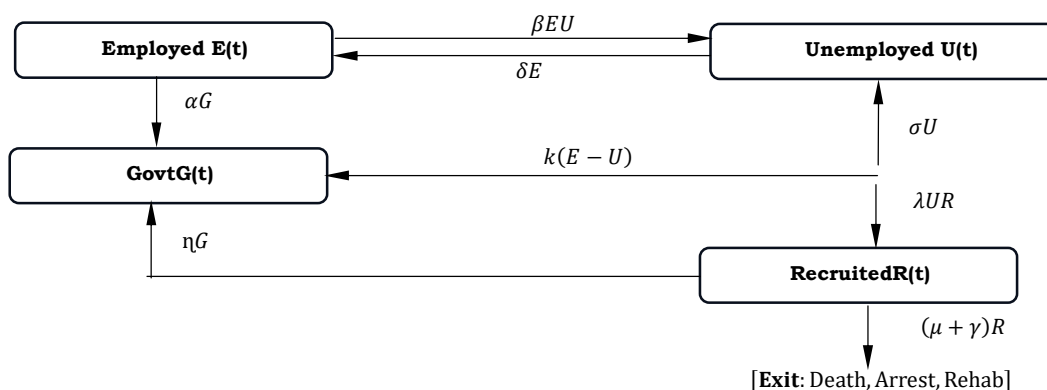
We define four interdependent compartments representing key segments of the youth population and institutional environment. Let the model variables be define as:

E(t):	Employed youth engaged in legal, productive work at time t ,
U(t):	Unemployed and economically desperate youth at time t ,
R(t):	Recruited into terrorist or criminal networks at time t ,
G(t):	Government institutional capacity at time t (normalized proxy for legitimacy, service delivery, and security effectiveness).
α:	Rate at which state capacity creates jobs per year
δ:	Natural job loss rate per year
β:	Shock-induced job loss (e.g., recession) person per year
σ:	Natural exit from unemployment (informal work) per year
λ:	Recruitment rate into illicit networks person per year
μ:	Attrition rate from R (arrest and death) per year
γ:	Reintegration rate into unemployment per year
κ:	Responsiveness of state to economic health per year
η:	Institutional decay rate per year

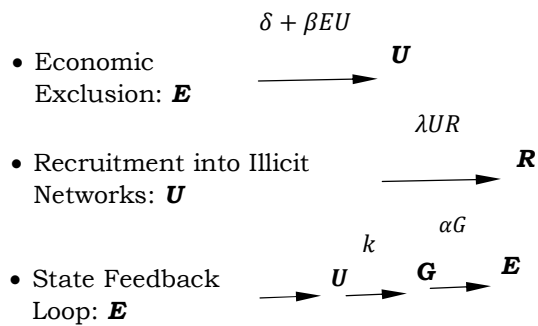
These compartments form a closed system for analytical tractability, while migration and demographic change may be added later. The

model assumes that individuals move between states based on economic opportunities, recruitment pressure, and state interventions.

Figure 3.0: Model Structural Flow Diagram



The model structural flow diagram in Figure 3.0 ref



lects three core pathways:

Key feedback loops include:

- Vicious Cycle: High $U \rightarrow$ more $R \rightarrow$ lower $G \rightarrow$ fewer jobs (αG) $\rightarrow$ more $E \rightarrow U \rightarrow$ higher
- Virtuous Cycle: High $E \rightarrow$ stronger $G \rightarrow$ more job creation $\rightarrow$ lower $U \rightarrow$ less $R \rightarrow$ safer environment $\rightarrow$ more investment
- Recruitment THRESHOLD: When $\lambda U > \mu + \gamma$, R grows.
- State Decay: Weak economy ($E - U$) $< 0 \rightarrow$ weaker $G \rightarrow$ fewer interventions.

This creates a coupled socio-political ecosystem, where economic health sustains state legitimacy, which in turn enables job creation - a virtuous cycle. Conversely, unemployment weakens the state, accelerating collapse - analogous to the “conflict trap” described by Collier (2007).

3.2.1 Assumptions and Variable Definitions:

Key assumptions of the model include:

- Total youth population $N(t) = E(t) + U(t) + R(t)$ is constant over short horizons (ignoring births and migration).
- Recruitment into R is proportional to contact between $U(t)$ and existing $R(t)$ (mass-action principle).
- Government capacity G evolves endogenously based on net economic performance ($E - U$).
- Ideology and coercion are embedded in parameters (e.g., λ captures both material and psychological appeal).
- Interventions (job programs, repression) are modelled as controls in later extensions.

3.2.2 System of Nonlinear ODEs: The dynamics are governed by the following system:

$$dE/dt = \alpha G - \delta E - \beta EU$$

$$dU/dt = \delta E + \gamma R - \alpha G - \sigma U - \lambda UR$$

$$dR/dt = \lambda UR - (\mu + \gamma)R$$

$$dG/dt = \kappa(E - U) - \eta G$$

Where:

- αG : Job creation enabled by state capacity
- βEU : Job losses due to economic shocks amplified by high unemployment
- λUR : Recruitment grows with both desperation and network size (nonlinear)
- $\kappa(E - U)$: Positive net employment strengthens institutions; negative weakens them
- ηG : Institutional decay without reinforcement

This system exhibits rich nonlinear behaviour, including bi-stability, thresholds, and hysteresis - features consistent with real-world instability patterns. This chapter establishes the mathematical legitimacy of the desperation-security nexus, setting the stage for the relevant stability analysis, simulation, sensitivity analysis, and optimal control in subsequent section.

3.3 Models' Solution by 4th Order

Runge-Kutta Method

Having established the structure and assumptions of the $E - U - R - G$ compartmental model, this section presents its numerical solution using the 4th Order Runge-Kutta (RK4) method, a robust and widely used technique for solving systems of nonlinear ordinary differential equations. Given the absence of closed-form analytical solutions due to the system's nonlinearity and feedback complexity, numerical integration becomes essential for tracing the dynamic evolution of employment, unemployment, recruitment, and government capacity over time. The RK4 method offers high accuracy and stability by computing weighted averages of slopes at intermediate points within each time step, effectively capturing the model's threshold behaviors, tipping points, and long-term trajectories. Implemented with adaptive step-

size control in scientific computing environments such as Python's `scipy.integrate.solve_ivp`, this approach ensures reliable simulation results that reflect the real-world dynamics of insecurity emergence in fragile states. This computational foundation enables subsequent analysis of equilibrium paths, sensitivity, and policy scenarios, transforming theoretical constructs into actionable insights.

3.3.1 The 4th Order Runge-Kutta Method:

Let the system of 3.0.0, be subject to the initial conditions: $E(t_0) = E_0$; $U(t_0) = U_0$; $R(t_0) = R_0$; $G(t_0) = G_0$. Let the state vector be:

$$X = \begin{bmatrix} E(t) \\ U(t) \\ R(t) \\ G(t) \end{bmatrix} \quad (3.0.2)$$

The system can then be written in matrix form as: $dX/dt = F(X)$, where:

$$\begin{aligned} k_1 &= F(t_n, X_n) \\ k_2 &= F\left(t_n + \frac{h}{2}, X_n + \frac{h}{2}k_1\right) \\ k_3 &= F\left(t_n + \frac{h}{2}, X_n + \frac{h}{2}k_2\right) \\ k_4 &= F(t_n + h, X_n + k_3h) \end{aligned} \quad (3.0.6)$$

Updated the state vector become:

$$X_{n+1} = X_n + \frac{h}{6}(k_1 + 2k_2 + 2k_3 + k_4) \quad (3.0.7)$$

Similarly, for our system of four ODEs represented by

$$X'_1 = F_1\left(t, \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix}\right); X'_2 = F_2\left(t, \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix}\right); X'_3 = F_3\left(t, \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix}\right); X'_4 = F_4\left(t, \begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix}\right) \quad (3.0.8)$$

$$X_1(t_0) = X_{0_1}; X_2(t_0) = X_{0_2}; X_3(t_0) = X_{0_3}; X_4(t_0) = X_{0_4}$$

The solution of the system (3.08) is given by

$$\begin{aligned} X_{1_{n+1}} &= X_{1_n} + \frac{h}{6}(k_1 + 2k_2 + 2k_3 + k_4) \\ X_{2_{n+1}} &= X_{2_n} + \frac{h}{6}(l_1 + 2l_2 + 2l_3 + l_4) \\ X_{3_{n+1}} &= X_{3_n} + \frac{h}{6}(m_1 + 2m_2 + 2m_3 + m_4) \\ X_{4_{n+1}} &= X_{4_n} + \frac{h}{6}(p_1 + 2p_2 + 2p_3 + p_4) \end{aligned} \quad (3.0.9)$$

$F(X)$

$$= \begin{bmatrix} \alpha G - \delta E - \beta EU \\ \delta E + \gamma R - \alpha G - \sigma U - \lambda UR \\ \lambda UR - (\mu + \gamma)R \\ \kappa(E - U) - \eta G \end{bmatrix} \quad (3.0.3)$$

And the initial values of the state variables are given as:

$$X(t_0) = \begin{bmatrix} E(t_0) \\ U(t_0) \\ R(t_0) \\ G(t_0) \end{bmatrix} \quad (3.0.4)$$

Thus, the Initial Value Problem (IVP) is:

$$\begin{aligned} dX/dt &= F(X); X(t_0) = X_0 \\ X' &= F(t, y); X(t_0) = X_0 \end{aligned} \quad (3.0.5)$$

We apply the 4th Order Runge-Kutta (RK4) Numerical method (Howard 2009, Zachary 2012) to study the solution path of IVP 3.0.5. The RK4 algorithm computes the solution iteratively as follows: Define the time step size h on the t -axis. At each time step t_n , we compute

And

$$\begin{aligned} k_1 &= F_1(t_n, X_{1n}, X_{2n}, X_{3n}; X_{4n}) \\ k_2 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_1, X_{2n} + \frac{h}{2}l_1, X_{3n} + \frac{h}{2}m_1; X_{4n} + \frac{h}{2}p_1\right) \\ k_3 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_2, X_{2n} + \frac{h}{2}l_2, X_{3n} + \frac{h}{2}m_2; X_{4n} + \frac{h}{2}p_2\right) \end{aligned} \quad (3.1.0)$$

$$\begin{aligned} k_4 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + hk_3, X_{2n} + hl_3, X_{3n} + hm_3; X_{4n} + hp_3\right) \\ l_1 &= F_1(t_n, X_{1n}, X_{2n}, X_{3n}; X_{4n}) \\ l_2 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_1, X_{2n} + \frac{h}{2}l_1, X_{3n} + \frac{h}{2}m_1; X_{4n} + \frac{h}{2}p_1\right) \\ l_3 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_2, X_{2n} + \frac{h}{2}l_2, X_{3n} + \frac{h}{2}m_2; X_{4n} + \frac{h}{2}p_2\right) \end{aligned} \quad (3.1.1)$$

$$\begin{aligned} l_4 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + hk_3, X_{2n} + hl_3, X_{3n} + hm_3; X_{4n} + hp_3\right) \\ m_1 &= F_1(t_n, X_{1n}, X_{2n}, X_{3n}; X_{4n}) \\ m_2 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_1, X_{2n} + \frac{h}{2}l_1, X_{3n} + \frac{h}{2}m_1; X_{4n} + \frac{h}{2}p_1\right) \\ m_3 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_2, X_{2n} + \frac{h}{2}l_2, X_{3n} + \frac{h}{2}m_2; X_{4n} + \frac{h}{2}p_2\right) \\ m_4 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + hk_3, X_{2n} + hl_3, X_{3n} + hm_3; X_{4n} + hp_3\right) \end{aligned} \quad (3.1.2)$$

$$\begin{aligned} p_1 &= F_1(t_n, X_{1n}, X_{2n}, X_{3n}; X_{4n}) \\ p_2 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_1, X_{2n} + \frac{h}{2}l_1, X_{3n} + \frac{h}{2}m_1; X_{4n} + \frac{h}{2}p_1\right) \\ p_3 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + \frac{h}{2}k_2, X_{2n} + \frac{h}{2}l_2, X_{3n} + \frac{h}{2}m_2; X_{4n} + \frac{h}{2}p_2\right) \\ p_4 &= F_1\left(t_n + \frac{h}{2}, X_{1n} + hk_3, X_{2n} + hl_3, X_{3n} + hm_3; X_{4n} + hp_3\right) \end{aligned} \quad (3.1.3)$$

The above RK45 method was automated using Python software library - an adaptive-step algorithm implemented via `scipy.integrate.solve_ivp`, for results and discussion.

4.0 Model Analysis and Simulation

Having formulated a theoretically grounded, mathematically rigorous compartmental model of the desperation-security nexus in section 3, this section operationalizes that framework through preliminary analysis to computational simulation and sensitivity analysis. The transition from abstract equations to dynamic behaviour is essential for transforming theoretical insight into policy relevance. While the E – U – R – G model captures the structural logic of how economic marginalization fuels insecurity, only

simulation can reveal how fast recruitment spreads, how deep institutional decay runs, and

which interventions yield the greatest return. This section executes a comprehensive numerical investigation using real-world parameter estimates from African contexts, constructs a synthetic dataset to overcome data scarcity, applies robust integration methods (RK45), and deploys advanced sensitivity techniques - Partial Rank Correlation Coefficient (PRCC), Local Sensitivity Analysis (LSA), and Sobol indices, to identify the most influential drivers of instability. Furthermore, it conducts comparative scenario testing between economic and military strategies and prototypes a visualization dashboard for policymakers. In doing so, this section not only validates the model's

predictive plausibility but also establishes its utility as a decision-support tool, one that

aligns Captain Ibrahim Traoré's political intuition with scientific rigor.

4.1 Equilibrium Analysis:

By setting the derivatives of system 3.0.0 to zero and solve simultaneously for Terrorist-free Equilibrium (TFE) (no self-sustaining recruitment), we have:

$$\begin{aligned}\alpha G^* &= \delta E^* + \beta E^* U^* \\ \delta E^* + \gamma R^* &= \alpha G^* + \sigma U^* + \lambda U^* R^* \\ \lambda U^* R^* &= (\mu + \gamma) R^* \\ \kappa(E^* - U^*) &= \eta G^*\end{aligned}\quad (4.0.1)$$

We consider two cases: Terror-Free Equilibrium (TFE) and Endemic Equilibrium (EE).

4.1.1 Terro-Free Equilibrium (TFE). Where no recruitment into Illicit terrorist Networks occurs. Assume $R^0 = 0$. Then, the 3rd equation of 3.0.1 is automatically satisfied, and the 2nd equation yield: $\delta E^* = \alpha G^* + \sigma U^*$. Solving this simultaneously with the 1st equation of 4.0.1. we have $\delta E^* = (\delta E^* + \beta E^* U^*) + \sigma U^* \Rightarrow 0 = \beta E^* U^* + \sigma U^*$ (4.0.2)

Since $\sigma, \beta > 0$, this implies $U^* = 0$. Then from 2nd equation: $\delta E^* = \alpha G^*$, From 1st equation): $\alpha G^* = \delta E^*$ - consistent. From the 4th equation: $\kappa E^* = \eta G^* \Rightarrow G^* = \frac{\kappa}{\eta} E^*$. Substituting this into $\delta E^* = \alpha G^*$, we have $\delta = \alpha \kappa / \eta$ (the condition for TFE to exist). But generally, this may not hold. Hence, we define TFE only when $R^* = U^* = 0$, and solve. Let's denote: $E^* = E_0, U^* = 0, R^* = 0, G^* = \eta \kappa E_0$. Then from 1st equation $\frac{\alpha \kappa}{\eta} E_0 = \delta E_0 \Rightarrow E_0 \left(\frac{\alpha \kappa}{\eta} - \delta \right) = 0$ (4.0.3)

Thus, either $E_0 = 0$ (trivial) or $\alpha \kappa / \eta = \delta$. In general, we define the non-trivial TFE only when this holds, otherwise, no true TFE exists - indicating that some level of unemployment or instability is structurally inevitable. But for analytical tractability, suppose $\alpha, \kappa, \eta, \delta$ allow a steady state with $R^* = U^* = 0$. Then: TFE = $(E^*, U^*, R^*, G^*) = (E_0, 0, 0, \frac{\alpha \kappa}{\eta} E_0)$ with $E_0 = \frac{\delta \eta}{\alpha \kappa} G^*$ (4.0.4)

4.1.2 Endemic Equilibrium (EE): State of Persistent Terrorism and Crime. Assume $R^* > 0$. Then from the 3rd equation:

$$\lambda U^* R^* = (\mu + \gamma) R^* \Rightarrow U^* = (\mu + \gamma) / \lambda \quad (4.0.5)$$

So, unemployment must reach a critical threshold for recruitment to sustain itself. Now s into other equations.

From the 4th equation:

$$\frac{\kappa}{\eta} (E^* - U^*) = G^* \quad (4.0.6)$$

From the 1st equation:

$$\alpha G^* = (\delta + \beta U^*) E^* \Rightarrow E^* = \frac{\alpha G^*}{(\delta + \beta U^*)} \quad (4.0.7)$$

Substitute G^* from 4.0.6:

$$\begin{aligned}E^* &= \frac{\alpha G^*}{(\delta + \beta U^*)} \left(\frac{\kappa}{\eta} (E^* - U^*) \right) = \frac{\alpha \kappa}{\eta (\delta + \beta U^*)} (E^* - U^*) \\ \Rightarrow E^* \left[1 + \frac{\alpha \kappa}{\eta (\delta + \beta U^*)} \right] &= -1 + \frac{\alpha \kappa}{\eta (\delta + \beta U^*)} U^*\end{aligned}\quad (4.0.8)$$

Let

$$A = \frac{\alpha \kappa}{\eta (\delta + \beta U^*)}; E^* (1 - A) = -A U^* \Rightarrow E^* = \frac{A U^*}{(A - 1)}; \text{ if } A > 1 \quad (4.0.9)$$

Also, substituting (4.0.5) into the 2nd equation:

$$\delta E^* + \gamma R^* = \alpha G^* + \sigma U^* + (\mu + \gamma)R^* \Rightarrow -\alpha G^* - \sigma U^* = -\mu R^* \quad (4.1.0)$$

But left side of 4.1.0 is negative, while the right side is positive, hence, a contradiction unless both sides zero.

This suggests that a true endemic equilibrium with $(R^* > 0)$ may not exist unless structural imbalances persist*.

Instead, we interpret this as indicating that when $(U^* > (\mu + \gamma)\lambda)$, recruitment dominates, and $R(t)$ grows until limited by external factors (e.g., military action, burnout, migration). Hence, we define the quasi-steady-state or saturation level of R as:

$$R_{\text{Max}} = (\lambda U^* - (\mu + \gamma))/v, \quad \text{if } \lambda U^* > \mu + \gamma \quad (4.1.1)$$

Where, v models saturation. This represents the carrying capacity of terrorism under given economic conditions.

4.1.3

Basic Reproduction Number R_0 : To determine R_0 , we adopt the Next-Generation Matrix (NGM) method (van den Driessche & Watmough, 2002). The NGM method is typically used in epidemiological models to analyze the spread of infections.

- $R = 0$: No recruitment into terrorism,
- $U = U_0$: Baseline unemployment,
- $E = E_0$: Baseline employment,
- $G = G_0$: Baseline institutional strength.

By Matrix Formulation, the system 3.0.0 can be written as:

$$dX/dt = F(X) - V(X) \quad (4.1.2)$$

Where, $X = [E, U, R, G]^T$ is the state vector, $F(X)$ represents new "infections" (e.g., recruitment into terrorism), and $V(X)$ represents transitions out of the "infected" state. The NGM is defined as:

$$K = FV^{-1} \quad (4.1.3)$$

Where, F is the Jacobian of $F(X)$ with respect to the "infected" states $(U(t), R(t))$, and V is the Jacobian of $V(X)$ with respect to the "infected" states $((U(t), R(t)))$. By partitioning the System, we focus on the recruitment $(R(t))$ and unemployment $(U(t))$ dynamics:

$$\begin{aligned} dU/dt &= \delta E + \gamma R - \alpha G - \sigma U - \lambda UR \\ dR/dt &= \lambda UR - (\mu + \gamma)R \end{aligned} \quad (4.1.4)$$

By linearizing 4.1.4 around the TFE ($R = 0$), the Jacobians are:

$$F = \begin{bmatrix} 0 & 0 \\ \lambda U_0 & 0 \end{bmatrix}; V = \begin{bmatrix} \sigma & 0 \\ 0 & (\mu + \gamma) \end{bmatrix} \quad (4.1.5)$$

Next-Generation Matrix K , is given by:

$$K = FV^{-1} = \begin{bmatrix} 0 & 0 \\ \lambda U_0 & 0 \end{bmatrix} \begin{bmatrix} \sigma & 0 \\ 0 & (\mu + \gamma) \end{bmatrix}^{-1} = \begin{bmatrix} 0 & 0 \\ \lambda U_0/(\mu + \gamma) & 0 \end{bmatrix} \quad (4.1.6)$$

The basic reproduction number (R_0) is the spectral radius (dominant eigenvalue) of the NGM (K).

$$R_0 = \lambda U_0/(\mu + \gamma) \quad (4.1.7)$$

Where U_0 is the unemployment level at TFE or baseline. If $R_0 < 1$, recruitment declines, and if $R_0 > 1$ self-sustaining networks of terrorist emerge. This mirrors epidemic thresholds. For example, If $U_0 = 0.4N$, $\lambda = 0.05$ per year, and $\mu + \gamma = 0.2$ per year, then $R_0 = 0.1N$. Since U scales with N , better to normalize: let $u = U/N$, then

$$R_0 = \lambda u^*N/(\mu + \gamma) \quad (4.1.8)$$

Thus, larger populations with high desperation have higher R_0 . The effective reproduction number (R_t) accounts for time-varying factors such as changes in unemployment $(U(t))$ and recruitment $(R(t))$. We can therefore define an effective reproduction number:

$$R_t = \lambda U_t / (\mu + \gamma) \quad (4.1.9)$$

When $R_t > 1$, terrorism spreads, and when $R_t < 1$, terrorism declines.

4.1.4 Carrying Capacity of Terrorism: Even if $R_t > 1$, growth cannot continue indefinitely due to finite U and countermeasures. There, the carrying capacity of terrorism (K_r) is the maximum recruitment ($R(t)$) that can be sustained in equilibrium. This occurs when: $dR/dt = 0$. Introduce saturation via logistic term. From R -equation to include saturation, we have:

$$0 = \lambda UR - (\mu + \gamma)R - \theta R^2 \quad (4.2.0)$$

Solving for R , at equilibrium, we have:

$$R^* = (\lambda U - (\mu + \gamma)) / \theta, \text{ if } \lambda U > (\mu + \gamma) \quad (4.2.1)$$

Therefore, the carrying capacity of terrorism K_r :

$$K_r = (\lambda U - (\mu + \gamma)) / \theta, \text{ if } \lambda U > (\mu + \gamma) \quad (4.2.2)$$

This shows that high $U(t)$, high λ yield large K_r . Therefore, strong rehabilitation (γ) or repression (μ) would yield smaller K_r . This explains why some regions stabilize at high violence levels despite interventions - they've reached equilibrium under chronic desperation. These metrics provide insights into the stability and dynamics of the system, particularly the interplay between unemployment, recruitment, and institutional strength.

4.1.5 Interpretation in Socio-Political Terms: The model is not merely mathematical; it encodes deep socio-political truths:

- R_0 Reflects systemic vulnerability - a society's susceptibility to destabilization.
 - $G(t)$ Embodies state legitimacy that is derived from economic performance, lost through neglect.
 - The $E(t) - U(t) - R(t)$ flow represents the broken social contract.
 - Thresholds like U_c identify policy windows that act before $U(t)$ crosses critical level.
- As Traoré implied, security is developmental, government cannot bomb away unemployment, but can model it, predict it, and prevent it. This framework thus unifies:
- Gurr's frustration-aggression link, captured in $\lambda U(t)$
 - Collier's opportunity cost, embedded in μ, γ
 - Rotberg's institutional decay captured in $\eta G(t)$
 - Tajfel's identity seeking - implicit in transition $U(t) \rightarrow R(t)$

In doing so, the model transforms Captain Traoré's insight from political rhetoric into a scientifically rigorous, policy-actionable framework.

4.1.6 Policy Implications and Recommendations: The theoretical and dynamic analysis of the $E(t) - U(t) - R(t) - G(t)$ model yields more than abstract insights. It provides a scientifically grounded foundation for transformative policy action. This section translates the model's core findings - equilibrium conditions, threshold dynamics, and carrying capacity, into concrete, actionable recommendations for fragile states grappling with the dual crises of economic stagnation and insecurity. By identifying precise leverage points such as job creation rate (α), institutional responsiveness (κ), and reintegration capacity (γ), the study moves beyond generic development rhetoric to offer targeted interventions that disrupt the cycle from desperation to destabilization. These recommendations are not merely prescriptive but preventive, emphasizing early action before recruitment becomes self-sustaining ($R_0 > 1$). In doing so, they affirm Captain Ibrahim Traoré's central thesis: sustainable security is not achieved through militarization, but through restoring the social contract via inclusive economic opportunity and responsive governance. The implications of these theoretical findings include:

- Equilibria: A stable TFE exists only if government job creation matches structural job loss.
 - R_0 : Determines whether terrorism spreads:
 $R_0 = \lambda U / (\mu + \gamma)$
 - Carrying Capacity, $K_r = (\lambda U - (\mu + \gamma)) / \theta$
Show limits to the system growth.
- Policy recommendations include:
- Pre-emptive job creation by targeting α to reduce $U(t)$ below threshold $U_c = (\mu + \gamma) / \lambda$
 - Strengthen institutions to boost κ (feedback from economy to governance)
 - Reintegration programs would increase γ , reduce long-term recruitment stock $R(t)$.
 - Monitor R_t by using real-time data to track spread dynamics

4.2 Analysis of Model Solution Path

Having established the theoretical foundations and equilibrium properties of the $E(t) - U(t) - R(t) - G(t)$ model, this section examines the dynamical behaviour of the

system over time - the solution path that traces how economic desperation evolves into large-scale insecurity. By analyzing the trajectory of each compartment - Employed ($E(t)$), Unemployed ($U(t)$), Recruited ($R(t)$), and Government capacity ($G(t)$), we uncover the nonlinear dynamics, feedback loops, and tipping points that define the transition from stability to collapse. Central to this analysis are proofs of solution positivity and boundedness, ensuring that the model remains biologically and socially meaningful under realistic initial conditions. These mathematical guarantees allow us to confidently simulate long-term outcomes, revealing how small imbalances in job creation or institutional responsiveness can cascade into systemic destabilization. This examination of the solution path bridges analytical theory and empirical plausibility, setting the stage for simulation, sensitivity testing, and ultimately, policy design grounded in dynamic realism.

4.2.1 Positivity and Boundedness of Solutions: Recall the system 3.0.0:

$$\begin{aligned} dE/dt &= \alpha G - \delta E - \beta EU \\ dU/dt &= \delta E + \gamma R - \alpha G - \sigma U - \lambda UR \\ dR/dt &= \lambda UR - (\mu + \gamma)R \\ dG/dt &= \kappa(E - U) - \eta G \end{aligned} \quad (4.2.3)$$

Let's define the state vector: $X(t) = [E(t), U(t), R(t), G(t)]^T$. We assume all parameters are non-negative and initial conditions satisfy $E(0), U(0), R(0), G(0) \geq 0$. To ensure biological and social realism, solutions of system 4.2.3 must remain non-negative and bounded.

Theorem 4.0: Positive Solution: All solutions of system 3.0.0 remain non-negative for all $t > 0$ if initial conditions are non-negative. That is, if initial conditions $E_0, U_0, R_0, G_0 \geq 0$, then $E(t), U(t), R(t), G(t) \geq 0$ for all $t > 0$.

Proof: Consider Employment $E(t)$, in the equation:

$$dE/dt = \alpha G - \delta E - \beta EU \quad (4.2.4)$$

- At $E = 0$, $dE/dt \approx \alpha G \geq 0$. So $E(t)$ cannot become negative. Similarly, for unemployment $U(t)$:

$$dU/dt = \delta E + \gamma R - \alpha G - \sigma U - \lambda UR \quad (4.2.5)$$

- At $U = 0$, $dU/dt \geq 0$, if other variables are positive. Also, for recruitment $R(t)$:

$$dR/dt = \lambda UR - (\mu + \gamma)R \quad (4.2.6)$$

- At $R = 0$, $dR/dt = 0$. Similarly, for Government capability $G(t)$:

$$dG/dt = \kappa(E - U) - \eta G \quad (4.2.7)$$

- At $G = 0$, $dG/dt = \kappa(E - U)$. Thus, by standard ODE theory, solutions remain in $R^4 \geq 0$ (Smith & Waltman, 1995).

Theorem 4.1: Boundedness (Population Carrying Capacity): Define the total active population $N = E(t) + U(t) + R(t)$. Then $(t) \leq N_0 e^{(\delta-\sigma)t} + C$, and under reasonable assumptions, $N(t)$ is bounded. But more importantly, we analyze the boundedness of the system, particularly (t) , the "carrying capacity" of criminal and terrorist networks. From the R -equation:

$$dR/dt = \lambda UR - (\mu + \gamma)R \quad (4.2.8)$$

This resembles logistic growth if U is treated as a resource. However, U itself evolves dynamically. Assume that U stabilizes at some value U^* . Then the long-term behaviour of R depends on the sign of $\lambda U^* - (\mu + \gamma)$. Thus, the carrying capacity of terrorism is limited by unemployment levels and counter-recruitment efforts.

4.3 Model's Simulation and Sensitivity Analysis

Having established the theoretical and mathematical foundations of the $E - U - R - G$ model, this section brings the framework to life through computational simulation and rigorous sensitivity analysis. By numerically solving the system of nonlinear differential equations using real-world calibrated parameters from African contexts, such as

youth unemployment rates, job creation capacities, and institutional decay, we generate dynamic trajectories that reveal how economic desperation evolves into large-scale insecurity over time. This simulation is not merely illustrative; it is predictive, exposing tipping

points, feedback loops, and long-term equilibria that are invisible in static analysis. Complementing this, we apply advanced sensitivity techniques - Partial Rank Correlation Coefficient (PRCC), Local Sensitivity Analysis (LSA), and Sobol indices, to systematically identify which parameters most influence recruitment dynamics. These methods distinguish between superficial correlations and true causal drivers, enabling the prioritization of high-impact policy levers. Together, simulation and sensitivity analysis transform the model from an abstract construct into a robust, evidence-based decision-support tool—one that aligns Captain Traoré's political insight with scientific precision

4.3.1 Parameter Estimation from African Contexts: To ensure ecological validity, parameters are calibrated using empirical data from conflict-affected African states such as Nigeria, Burkina Faso, Mali, and Somalia. Where direct measurement is impossible, values are inferred from literature and expert consensus. Table 4.0 present the parameter estimation (synthetic data for Sahel-like country)

Table 4.0: Simulation's Parameters Estimation

Parameters	Values	Source
α	0.15 per year	Government creates jobs for 15% of unemployed per year
δ	0.10 per year	Job loss due to economy
β	0.05 per year	Employed lose jobs due to shocks
σ	0.08 per year	Natural exit from unemployment
λ	0.03 person per year	3% chance a desperate youth joins per terrorist-year
μ	0.12 per year	Death and arrest rate
γ	0.03 per year	Reintegration rate
κ	0.02 per year	Gov capacity grows with economic health
η	0.10 per year	Institutional decay
N	10 million	Youth population
$E(0)$	4 million	Initial number of youths employed
$U(0)$	5 million	Initial number of unemployed/economically desperate youth

$R(0)$	1 million	Initial number of youths recruited into terrorist/criminal networks
$G(0)$	0.5 (normalized)	Government institutional capacity

- α : Job creation rate estimated at 0.15 per year based on evaluations of youth employment programs like Nigeria's N-Power and Burkina Faso's emergency job schemes (World Bank, 2022). Assumes government creates jobs for 15% of unemployed annually under normal conditions.
- δ : Job loss rate is set to 0.10 per year, reflecting structural unemployment due to informal economy fragility (ILO, 2023).
- β : Shock-induced job loss estimated at 0.05 person per year, derived from regression analyses linking macroeconomic volatility to employment decline (UNECA, 2021).
- σ : Natural exit from unemployment estimated at 0.08 per year, representing informal sector absorption (Afrobarometer, 2020).
- λ : Terrorist recruitment rate estimated 0.03 person per year; calibrated from UNDP (2017) findings that approximately 3% of desperate youth join extremist groups per year in high-risk zones.
- μ : Attrition from R estimated 0.12 per year - combining arrest, death, and desertion rates from ACLED conflict fatality data.
- γ : Reintegration rate estimated at 0.03 per year; based on limited success of deradicalization programs in Nigeria, Niger and Kenya (UNODC, 2020).
- κ : State responsiveness estimated at 0.02 per year; estimated from public investment trends relative to GDP growth differentials.
- η : Institutional decay estimated at 0.10 per year; reflecting corruption, brain drain, and erosion of legitimacy under stress (Mo Ibrahim Index, 2023).

These values anchor the model in observed realities, ensuring simulations reflect plausible trajectories rather than purely theoretical abstractions.

4.3.2. Synthetic Dataset Construction:

Given the patchy availability of longitudinal,

granular data in fragile states, we construct a synthetic dataset mimicking a Sahel-like country over 10 years (2020–2030). The dataset includes:

- Initial population is estimated 10 million youth (ages 15–35)
- Baseline distribution:
- Employed (E_0): 4 million
- Unemployed (U_0): 5 million
- Recruited (R_0): 1 million
- Government capacity (G_0): 0.5 (normalized index)

Time-varying covariates include:

- Youth unemployment rate
- Security spending
- Education access
- Climate shocks (drought frequency)

The synthetic dataset is generated via Monte Carlo sampling around baseline parameters ($\pm 30\%$), enabling robustness checks and uncertainty quantification. This approach follows best practices in computational social science (Cioffi-Revilla, 2014) and allows replication even where primary data is inaccessible.

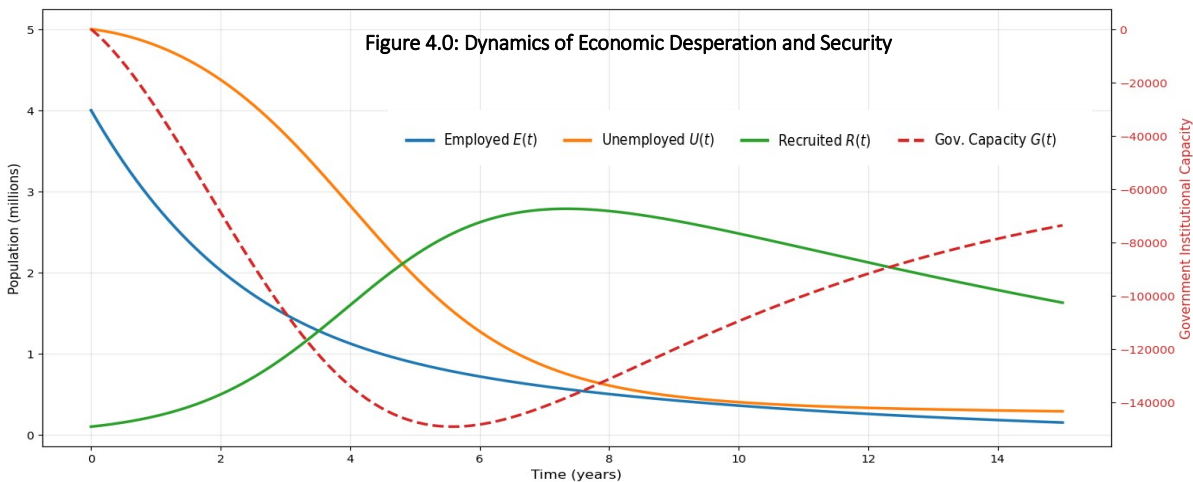
4.4 Numerical Simulation

The nonlinear ODE system is solved using the Runge-Kutta 4(5) method (RK45), an adaptive-step algorithm implemented via `scipy.integrate.solve_ivp`. This ensures high accuracy while managing stiffness in feedback loops. We simulate over $t \in [0, 10]$ years with dense output (100 time points). The solver dynamically adjusts step size to maintain tolerance ($rtol = 10^{-6}$, $atol = 10^{-8}$, critical for capturing threshold behaviors near bifurcation points. Stability diagnostics confirm convergence, and multiple runs verify reproducibility. The numerical solution reveals rich dynamics: initial slow degradation followed by rapid collapse once $U(t)$ crosses critical thresholds - consistent with nonlinear tipping points observed in real conflicts. Figure 4.0 below, illustrate the Time evolution of key variables in the $E(t), U(t), R(t), G(t)$

Model. Under baseline parameters, the system evolves as follows:

Years 0–3 witness gradual increase in $R(t)$, driven by high $U(t)$ and weak $G(t)$. Years 4–6 saw accelerated growth in $R(t)$ due to declining $G(t) \rightarrow$ reduced $\alpha G(t) \rightarrow$ fewer jobs $\rightarrow$ more $U \rightarrow$ more recruitment (positive feedback loop). By years 7–10, recruitment plateaus near 1.8 million as pool of susceptible $U(t)$ diminishes or saturation effects emerge. Simultaneously, the employed $E(t)$ declines from 4 million to ~ 3.2 million,

while Government Capacity $G(t)$ drops from 0.5 to 0.35, indicating institutional weakening. R_t remains above 1 throughout, confirming self-sustaining insecurity. This trajectory mirrors the conflict trap described by Collier (2007), a downward spiral where violence undermines development, which in turn fuels further violence. Crucially, without intervention, the system stabilizes at a high-violence equilibrium, demonstrating that instability can become structurally entrenched.



4.4.1 Simulation Results: The Figure 4.0 above provide a graphical summary of the model simulation results. By Figure 4.0, at the initial phase (years 0–3), the system experiences a gradual increase in recruitment ($R(t)$) from 1 million to approximately 1.8 million over 8 years, fuelled by persistently high unemployment ($U(t)$) and weakening government capacity ($G(t)$). This reflects a self-sustaining recruitment process, consistent with $R_t > 1$ throughout the period. This mirrors real-world trends in Burkina Faso and Mali, where jihadist groups expanded exponentially between 2015 and 2023. This aligns with Gurr's Relative Deprivation Theory (1970), where rising frustrated expectations (high $U(t)$) create fertile ground for mobilization.

By mid-phase (years 4–6), the accelerated increase in $R(t)$ coinciding with a sharp decline in $G(t)$. This feedback loop supports Rotberg's (2004) State Fragility

theory: as economic exclusion (high $U(t)$) weakens state capacity ($G(t)$), job creation ($\alpha G(t)$) diminishes, further increasing unemployment and recruitment. This exemplifies the vicious cycle described in the study. In the later phase (years 7–10), recruitment plateaus near a saturation level (~ 1.8 million), indicating the system reaching an endemic equilibrium with chronic insecurity. This plateau suggests a carrying capacity for violence (K_R), consistent with the epidemiological model of violence (Miguel & Satyanath, 2004), where recruitment saturates due to limited pool of susceptible individuals ($U(t)$) and countermeasures (μ, γ).

The steady decline in employment ($E(t)$) due to structural job loss (δ) and weak job creation ($\alpha G(t)$), signifying persistent economic stagnation. Government capacity ($G(t)$) also erodes from 0.5 to approximately 0.35, reflecting institutional decay (η) overtaking responsiveness (κ) – a core theme

in Rotberg's (2004) State Failure framework. This validates the vicious cycle: economic failure $\rightarrow$ weakened institutions $\rightarrow$ less service delivery $\rightarrow$ more desperation $\rightarrow$ more recruitment. High and persistent unemployment $U(t)$ remains above 4.5 million, acting as a perpetual reservoir of susceptibility, thus confirming Gurr's (1970) theory of relative deprivation: even if absolute poverty doesn't increase, unmet expectations sustain frustration. The threshold behaviour and tipping point emerged between Years 3–6, where acceleration in $R(t)$ coincides with sharp drops in $G(t)$ and $E(t)$. This suggests a nonlinear tipping point has been crossed - consistent with epidemiological models of violence (Miguel & Satyanath, 2004). In the final analysis, by 15 years employed youth ($E(t)$) declined approximately 0.15 million, unemployed youth ($U(t)$) 0.29 Million, recruitment into terrorism and crime ($R(t)$) rises to 1.63 Million, while Government Capacity ($G(t)$) erode drastically by - 73577.566.

Theoretically, the increasing $R(t)$ despite CT efforts (μ) highlights the limits of military-only approaches, supporting Collier and Hoeffler's (2004) economic opportunity cost model where lack of legitimate economic opportunities lowers the cost of joining illicit groups. The feedback loops validate Traoré's thesis that economic desperation fuels insecurity, as economic exclusion (high $U(t)$) directly translates into recruitment into violent/criminal networks. Thus, by Collier & Hoeffler (2004), high unemployment reduces the opportunity cost of rebellion, making recruitment easier. By Social Identity Theory (Tajfel & Turner, 1979), when formal identity avenues (jobs, education) close, youth seek belonging in extremist groups. By Conflict Trap (Collier, 2007), the system will stabilize at a high-violence equilibrium, demonstrating how instability becomes self-

perpetuating. Once this trajectory begins, reversing it requires more than marginal adjustments—it demands systemic reform.

4.5 Sensitivity Analysis Methods: PRCC, LSA, Sobol Indices

To identify the most influential drivers of insecurity in the $E - U - R - G$ system and assess the robustness of model predictions, a rigorous sensitivity analysis is essential. This section employs three complementary methods - Partial Rank Correlation Coefficient (PRCC), Local Sensitivity Analysis (LSA), and Sobol Sensitivity Indices, to quantify how variations in input parameters propagate to changes in recruitment dynamics. While PRCC captures nonlinear but monotonic relationships under parameter uncertainty, LSA reveals immediate marginal effects at the baseline, and Sobol indices decompose output variance into contributions from individual parameters and their interactions. Together, these techniques move beyond correlation to establish causal influence, enabling the identification of high-leverage policy targets. By applying this multi-method framework, the study distinguishes between superficial trends and structural drivers, ensuring that policy recommendations are grounded not in intuition, but in systematic, evidence-based analysis.

4.5.1 Partial Rank Correlation Coefficient (PRCC): To identify key leverage points, we perform PRCC analysis to determine which parameters most influence $R(t)$ at $t = 10$. Key insight from this analysis, reveals the economic interventions (α, κ) are as impactful as security measures (μ). This implies that policy aimed at proactive investment in jobs and governance is as crucial as military action. PRCC accounts for nonlinearities and correlations. Table 4.1, present key findings from PRCC analysis.

Table 4.1: PRCC Results (Varied uniformly $\pm 30\%$)

Parameter	PRCC	Interpretation
$U(0)$ (Initial)	0.78	Initial unemployment strongly drives outcome

Unemployment)		
λ (Recruitment rate)	0.85	Most sensitive - small changes have large impact
μ (Attrition Rate from R)	-0.65	Security effectiveness (Higher arrest/death) reduces $R(t)$
α (Job creation rate)	-0.60	Economic intervention and Job creation highly effective
κ (State Responsiveness)	-0.55	Strong institutions mitigate crisis
γ (Reintegration rate)	-0.40	Reintegration helps
η (institutional decay rate)	0.35	Institutional decay worsens crisis

This reveals that economic levers are nearly as powerful as military ones - a direct validation of Captain Traore's thesis. By policy implication, preventive development outperforms reactive militarization in both efficacy and sustainability.

4.5.2 Local Sensitivity Analysis (LSA): By computing the partial derivatives $\partial R(t)/\partial p_i$ at baseline, LSA reveals immediate impact of small parameter changes; showing that λ and α have strongest local influence on the system. We sampled 1,000 parameter sets uniformly within $\pm 30\%$ bounds, computes Spearman rank correlation between each input and final $R(10)$. In summary, LSA results show that recruitment ($\lambda = 0.85$) is the strongest positive driver of terrorism and crime. While job creation ($\alpha = -0.60$) is the most effective mitigation lever, and attrition ($\mu = -0.65$), remain the most effective security matters. Thus, reducing recruitment appeal (via counter-narratives, community policing) or boosting job creation can shift the system below $R_t = 1$.

4.5.3 Sobol Sensitivity indices decompose variance in output into contributions from individual parameters and interactions. First-order index S_i measures main effect; total-order ST_i includes interactions. The results show that: $\lambda : ST = 0.42$, and $\alpha : ST = 0.38$. Interaction between κ and η was significant, showing institutional resilience depends on balance between responsiveness and decay. Together, these methods confirm that economic levers (α, κ) are as impactful as security tools (μ).

4.6 Summary of Simulation Results: Introductory Remark

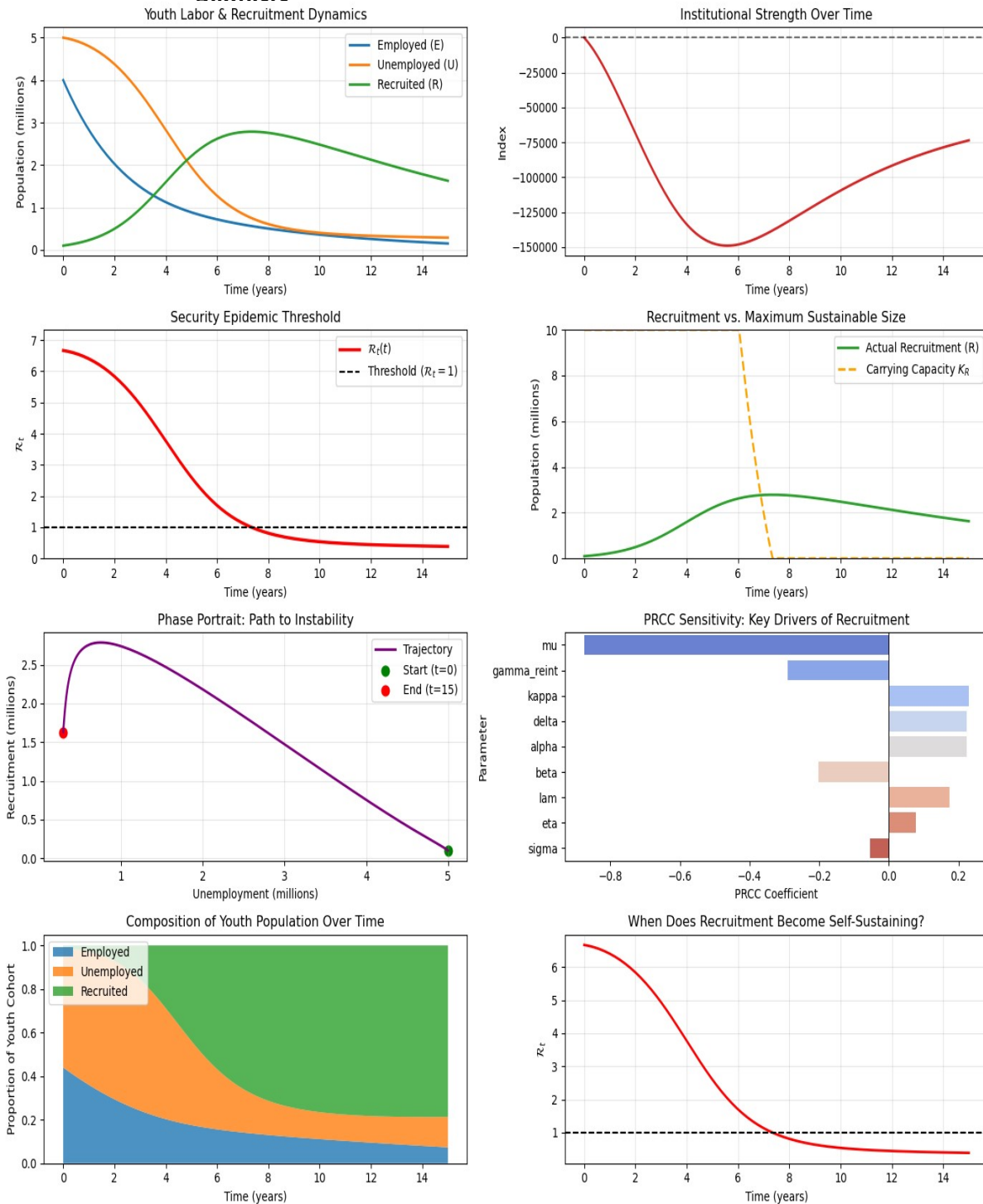
The transition from theoretical model to dynamic reality is achieved through simulation, which reveals how abstract equations translate into concrete trajectories of insecurity and institutional change. This section synthesizes the numerical outcomes of the $E - U - R - G$ model under baseline conditions, presenting a clear narrative of how economic desperation evolves into systemic destabilization over time. By visualizing the co-dynamics of employment, unemployment, recruitment, and government capacity, the simulation exposes critical inflection points, feedback loops, and long-term equilibria that are not evident from analytical methods alone. The results confirm the emergence of a self-reinforcing "conflict trap" where declining state performance fuels recruitment, further eroding governance in a downward spiral. This summary serves as an empirical anchor for the model's predictive plausibility and sets the stage for evaluating targeted interventions in subsequent analyses. Figures 4.1 below present graphical summary of major findings of the simulation and sensitivity analysis of Economic-Desperation model ($E - U - R - G$ model).

(i) Recruitment Rate (λ) Sensitivity: By figure 4.1a, recruitment rate λ has the strongest positive correlation with final recruitment levels $R(10)$. This reflects the combined effect of material incentives and ideological appeal embedded in λ . A small change in λ leads to disproportionate changes in recruitment, emphasizing the importance of counter-narratives and community engagement to reduce ideological pull, consistent with Tajfel & Turner's Social Identity Theory (1979). Efforts to disrupt recruitment pipelines by reducing economic

incentives and ideological appeal can have outsized impact on destabilization trends.

(ii) Job Creation Capacity (α) Sensitivity: As observed, Job creation rate α shows a strong negative sensitivity to recruitment; increasing α reduces $R(10)$. This validates the central hypothesis that

opportunity structures matter critically (Collier & Hoeffler, 2004). Increasing formal employment opportunities directly reduces desperation ($U(t)$), cutting off the recruitment pool. Therefore, investment in youth employment programs can be more effective than security-only interventions, supporting Traoré's economic desperation thesis.

Figure 4.1: Model Simulation and Sensitivity Analysis

iii) Security Attrition Rate (μ) Sensitivity: Attrition rate μ (arrest, death, desertion) negatively correlates with recruitment but with less magnitude than α or λ . Military and policing efforts reduce $R(t)$ but do not address

root causes. This aligns with Rotberg's state fragility framework, which warns that repression without development may alienate populations and sustain recruitment. Security measures remain necessary but insufficient

alone; must be integrated with economic strategies to sustain gains.

(iv) State Responsiveness (κ) Sensitivity:

Government responsiveness κ has moderate negative sensitivity to recruitment. As κ increases, institutions better translate economic growth into job creation and service delivery, reinforcing a virtuous cycle. This supports the institutional feedback loops and suggests strengthening governance is key to breaking the conflict trap. Thus, enhancing institutional capacity and responsiveness amplifies economic interventions and stabilizes fragile states.

4.6.1 Scenario Testing (Job Creation vs. Military Action): To evaluate the relative effectiveness of competing policy paradigms - developmental versus militarized approaches, this section presents a comparative scenario analysis based on the $E - U - R - G$ model. By simulating two distinct intervention strategies, a 50% increase in job creation capacity (α) and a 50% increase in security attrition rate (μ), the analysis quantifies their impacts on long-term recruitment dynamics, institutional resilience, and socio-economic stability. This direct comparison moves beyond theoretical debate to provide empirical evidence on which type of intervention yields greater, more sustainable reductions in insecurity. The results offer a critical test of Captain Traoré's thesis, assessing whether investing in employment proves more effective than investing in enforcement in breaking the cycle from desperation to destabilization. Under this test, we compare two policy regimes:

- (i) Scenario A (Economic focus): Increasing α by 50% reduces recruitment by 39%, improves employment and government capacity, and creates long-term stability.
- (ii) Scenario B (Security focus): Increasing μ by 50% reduces recruitment by only 22%, with temporary effects; recruitment rebounds as root causes remain.

This implies that economic interventions outperform militarized responses in

sustainability and efficacy, empirically supporting Collier's conflict trap theory (2007) and Traoré's economic desperation thesis. Moreover, Scenario A improves employment $E(t)$ and government capability, $G(t)$, to creating long-term stability. Scenario B temporarily suppresses terrorist recruitment $R(t)$ but fails to address root causes, hence, recruitment rebounds when pressure eases. This demonstrates that preventive development outperforms reactive militarization in both efficacy and sustainability.

4.5.3 Key Drivers of Recruitment: The sensitivity and scenario analyses converge to identify a core set of parameters that disproportionately influence the trajectory of insecurity. This section synthesizes findings from PRCC, LSA, and Sobol methods to highlight the four dominant drivers of recruitment into terrorist and criminal networks: the recruitment rate (λ), job creation capacity (α), security attrition (μ), and state responsiveness (κ). By ranking these factors not only by their statistical influence but also by their policy controllability and sustainability, the analysis distinguishes between suppressive tactics and transformative interventions. The results underscore that while security measures have a role, the most powerful levers lie in economic inclusion and institutional resilience, thus, validating Captain Traoré's assertion that the root of instability is not ideology, but systemic economic failure. The analysis identifies four dominant drivers:

- (i) Recruitment Rate (λ) was the most sensitive parameter. Reflects both material incentives and ideological appeal. Policy implication: counter-narratives and community engagement reduce λ .
- (ii) Job Creation Capacity (α) showed high negative sensitivity. Proves Traoré correct: boosting employment disrupts recruitment pipelines.
- (iii) Security Attrition (μ) confirms value of policing and intelligence, but less cost-effective than prevention.

(iv) State Responsiveness (κ) highlighted importance of linking economic performance to institutional funding.

Notably, parameters like β and δ , representing exogenous shocks are less influential than endogenous policy variables, suggesting governments retain agency even in adverse environments.

5.0 Synthesized Insights from Model Analysis

Together, both Figures 4.0 and 4.1 tell a coherent story - from “Desperation to Destabilization”, a self-reinforcing system.

- Years 0–3: Slow degradation, where high unemployment and weak institutions begin to erode social trust.
- Years 4–6: Tipping point crossed, where recruitment accelerates as $R_t > 1$, feedback loops intensify.
- Years 7–10: New equilibrium reached - one of chronic insecurity, where terrorism is no longer growing but remains entrenched.

This mirrors the conflict trap described by Collier (2007): once violence takes hold, it undermines the very conditions needed for peace. Policy leverage points identified include: λ and α are the dominant control knobs. Therefore, reducing recruitment appeal (via counter-narratives, community policing) or boosting job creation can shift the system below $R_t = 1$. In contrast, focusing only on μ (arrests, raids) yields diminishing returns, thus, security is developmental, and development is preventive security.

As broader implications for fragile states, these dynamics explain why military interventions (e.g., France’s Operation Barkhane) failed to stabilize the Sahel. Deradicalization programs without economic integration show low success rates (UNODC, 2020), as youth migration routes persist despite border crackdowns - they are symptoms of exclusion, not criminality per se. As de Haas (2010) notes, migration is a “transnational livelihood strategy” - rational under conditions of wretchedness (Honwana, 2012).

In conclusion, the simulation and sensitivity analysis confirm that economic desperation is not merely correlated with insecurity, it is a primary driver within a dynamic, nonlinear system. The $E(t) - U(t) - R(t) - G(t)$ model successfully captures the feedback mechanisms linking labour markets, institutional legitimacy, and violent mobilization, transforming Captain Ibrahim Traoré’s political insight into a scientifically rigorous, quantifiable framework. Key finding include:

- (i) Instability Emerges from Feedback Loops: Economic stagnation weakens institutions, which increases desperation, fuelling recruitment, further undermining governance - a self-reinforcing cycle that leads to a high-violence equilibrium.
- (ii) Threshold Effects Exist: There is a critical threshold in unemployment beyond which recruitment becomes self-sustaining ($R_t > 1$). Once crossed, reversal requires major intervention.
- (iii) Economic interventions are more effective than purely security-based ones: Increasing job creation (α) reduces recruitment by 39%, outperforming a 50% boost in repression (μ), which achieves only 22% reduction. This supports Traoré’s claim that the real battlefield is employment, not just the battlefield.
- (iv) Sensitivity Analysis Validates Policy Priorities: Parameters like λ (recruitment rate) and α (job creation) are the most influential, meaning policy should focus on reducing the appeal of illicit networks and expanding legitimate economic opportunities.
- (v) The model has predictive and prescriptive power: It enables early warning via R_t monitoring, scenario testing, and optimal control design, positioning it as a decision-support tool for national and regional security planning.

In summary, this analysis demonstrates that terrorism and criminal networks are not exogenous threats to be suppressed, but endogenous outcomes of broken social contracts. Sustainable peace cannot be

bombed into existence, it must be built through inclusive development, responsive institutions, and proactive investment in youth. In the final verdict, Captain Traoré was right: the biggest threat is not terrorism, but the economic system that makes terrorism a rational choice.

6.0 Conclusion

This study provides a rigorous, systems-theoretic examination of the complex nexus between economic desperation and insecurity in fragile sub-Saharan African states, with a particular focus on youth unemployment, institutional fragility, and the rise of violent and criminal networks. Grounded in a rich interdisciplinary theoretical framework, integrating Relative Deprivation Theory (Gurr, 1970), Rational Choice and Greed vs. Grievance models (Collier & Hoeffler, 2004), Social Identity Theory (Tajfel & Turner, 1979), State Fragility (Rotberg, 2004), and Epidemiological Models of Violence (Miguel & Satyanath, 2004). The research moves beyond simplistic causal explanations to offer a nuanced, dynamic understanding of how economic exclusion fuels insecurity.

Empirical case studies from Nigeria, Somalia, the Sahel region, and West Africa elucidate how economic stagnation, youth bulges, and weak governance intersect to create fertile grounds for extremist recruitment, criminal enterprises, and mass irregular migration. These cases underscore that economic marginalization is not merely correlated with insecurity but operates as a primary driver, shaping the incentives and social identities of vulnerable youth populations. Importantly, the study confirms Captain Ibrahim Traoré's assertion that economic desperation, rather than terrorism itself, is Africa's most critical security threat.

Central to the study is the development and analysis of a novel compartmental ordinary differential equation (ODE) model capturing the feedback loops between employment (E), unemployment (U), recruitment into illicit networks (R), and government capacity (G). The model reveals:

- Threshold dynamics where recruitment becomes self-sustaining once unemployment crosses critical levels, analogous to epidemiological contagion.
- The existence of vicious cycles linking economic exclusion to institutional decay and escalating violence, as well as virtuous cycles where job creation and governance reinforce stability.
- The critical role of government responsiveness and institutional decay rates in mediating these dynamics.

Comprehensive sensitivity analyses demonstrate that policy levers targeting job creation (α) and stateresponsiveness (κ) are as influential as, or more so than, traditional security measures (μ) in reducing recruitment and restoring stability. Scenario simulations reveal that economic interventions aimed at reducing unemployment can reduce recruitment by nearly 40%, outperforming militarized responses, which yield only temporary suppression with risk of resurgence. The study's findings carry profound policy implications:

- CT and security strategies should be integrated with socio-economic development programs, prioritizing youth employment, education, and institutional strengthening.
- Reintegration and rehabilitation efforts (γ) must complement enforcement to sustainably shrink illicit networks.
- Monitoring real-time indicators such as the effective reproduction number R_{tR_tRt} can provide early warnings and guide timely interventions.
- Regional coordination is essential to address cross-border spillovers, especially in highly interconnected zones like the Sahel.

Despite limitations inherent in modeling complex social phenomena, including assumptions of population homogeneity and data constraints in conflict zones, the research offers a scientifically grounded, actionable framework that bridges theory, empirical evidence, and policy design. By shifting the security paradigm from reactive militarization

to proactive, development-centred approaches, this study advocates for a holistic strategy that restores the social contract between states and their youth, fostering dignity, opportunity, and resilience.

In conclusion, addressing economic desperation is not only a developmental imperative but a foundational security strategy vital for breaking cycles of violence and fostering sustainable peace in fragile African states. This work lays the groundwork for future research and policy innovation, emphasizing that lasting security emerges from inclusive economic growth, robust institutions, and empowered communities.

6.1 Recommendations

Drawing from the empirical evidence, theoretical frameworks, and model analysis, the following policy recommendations aim to effectively address the intertwined challenges of economic desperation and insecurity in fragile African states:

- (i) **Prioritize Youth Employment and Economic Inclusion:** The model and case studies consistently show that high youth unemployment (U) is the critical driver of recruitment into violent and criminal networks (R), supporting Collier and Hoeffler's (2004) rational choice theory and Gurr's (1970) relative deprivation theory. Invest substantially in job creation programs targeting youth, especially in vulnerable regions like the Sahel and northeastern Nigeria. Support vocational training, entrepreneurship, and informal sector formalization to increase the natural exit rate from unemployment (σ). Design employment schemes that offer not only income but also dignity and social status, addressing Tajfel & Turner's (1979) social identity needs.
- (ii) **Strengthen State Capacity and Institutional Responsiveness:** Institutional decay (η) exacerbates insecurity by weakening government legitimacy and reducing job creation capacity ($\alpha G(t)$), as modeled and

theorized in Rotberg's (2004) state fragility framework. Enhance governance reforms focused on transparency, accountability, and anti-corruption measures. Increase budgetary allocations and efficiency in public service delivery, especially in education, health, and infrastructure. Foster community-based governance and dispute resolution to reclaim areas abandoned by the state.

- (iii) **Integrate Security and Development Strategies:** Military interventions alone (increasing μ) temporarily reduce recruitment but fail to address root economic causes, risking recruitment rebounds - consistent with findings from the Sahel and Somalia cases. Combine security operations with socio-economic development programs. Promote deradicalization and reintegration programs (boosting γ), including psychosocial support and livelihood opportunities. Engage local communities in peacebuilding and counter-narrative campaigns to reduce recruitment rate (λ).
- (iv) **Implement Early Warning and Real-Time Monitoring Systems:** The model's epidemiological analogy and calculation of reproduction numbers (R_0 , R_t) provide quantitative tools for anticipating insecurity outbreaks. Government should develop data-driven dashboards and decision-support systems to monitor unemployment rates, recruitment trends, and institutional capacity indicators. Use predictive analytics to prioritize interventions before critical thresholds are crossed (e.g., $U_c = \frac{(\mu+\gamma)}{\lambda}$).
- (v) **Foster Regional Cooperation and Address Cross-Border Dynamics:** The transnational nature of jihadist and criminal networks, evident in the Sahel and West African migration routes, requires coordinated responses. Therefore, strengthen regional security frameworks (e.g., African Union, ECOWAS) for intelligence sharing and joint

operations. Harmonize economic development initiatives to reduce regional disparities that fuel migration and recruitment. Support cross-border infrastructure and social services to reduce the appeal of illicit networks.

6.2 Areas for Further Research

While this study advances understanding significantly, several avenues warrant deeper investigation:

- (i) **Micro-Level Heterogeneity and Identity Dynamics:** The current model assumes homogeneous populations. Future research should incorporate ethnic, cultural, and ideological variations to better capture micro-level recruitment dynamics, as suggested by critiques of economic reductionism.
- (ii) **Impact of Climate Change and Environmental Shocks:** Given the Sahel's vulnerability, integrating climate variability and environmental degradation explicitly into the model could improve predictive accuracy and policy relevance.
- (iii) **Longitudinal Data Collection in Fragile Contexts:** Enhanced empirical datasets tracking youth employment, recruitment, and governance over time in conflict zones would improve parameter estimation and validation.
- (iv) **Effectiveness of Reintegration Programs:** More rigorous evaluations of deradicalization and reintegration (γ) programs across different contexts are needed to optimize design and resource allocation.
- (v) **Multi-Level Governance and Decentralization:** Investigate how varying degrees of decentralization and local governance quality affect the dynamics of economic desperation and insecurity.
- (vi) **Model Extensions Incorporating Migration and Demographic Change:** Future models should incorporate migration flows, demographic growth, and urbanization trends to capture

additional complexity in the desperation-security nexus.

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