Critical Mineral Value Chain Embeddedness and the Production of Local Peace*

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Abstract

Critical mineral extraction is often conflated with traditional resource predation, yet industrial-scale projects function fundamentally differently. Unlike lootable resources that derive value from extraction alone, critical minerals function as "embedded" nodes within highly integrated global value chains, characterized by rigid downstream dependencies and long-term supply obligations. Although the global rush for these strategic assets is frequently assumed to trigger instability in fragile states, this industrial structure generates a different political logic. Why has the critical mineral boom produced pockets of local peace rather than conflict? We develop a theory that integrates global value chain analysis with the political economy of conflict. We argue that value chain embeddedness creates a unique strategic vulnerability for firms: because the realization of economic value depends entirely on uninterrupted integration with downstream processing, local disruption becomes prohibitively costly. Consequently, firms and central governments are compelled to replace coercion with co-optation to secure production. Peace is thus actively produced through the strategic inclusion of potential disruptors. Using an original province-year panel of 529 industrial-scale mining projects across Africa (2001–2020), we find that provinces hosting embedded mines experience a significant decline in armed conflict. Original data on minister-level appointments further indicate that this stability is mediated by the allocation of cabinet portfolios to local elites. These findings demonstrate how the architecture of global production networks endogenously generates political order.

1 Introduction

On the surface, the global scramble for critical raw materials (CRMs)[1] appears to be a repetition of history. These resources, essential for the green energy transition, are overwhelmingly concentrated in developing regions characterized by weak state institutions and histories of political instability (Reich and Simon, 2024; Church and Crawford, 2020; Braunstein and Chuchko, 2025). Classical resource-curse theories therefore predict governance failure and violence, as famously observed in oil- and

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[1]Throughout this paper, the terms *critical raw materials*, *critical minerals*, and *energy-transition minerals* are used interchangeably to denote lithium, cobalt, nickel, and rare earth elements.

gemstone-rich economies (Collier and Hoeffler, 2004; Ross, 2015). Point-source resources typically strengthen authoritarian rentier states and provoke rebellion (Smith, 2004; Fearon and Laitin, 2003), while lootable commodities like alluvial diamonds directly finance insurgencies (Lujala, Gleditsch and Gilmore, 2005; Snyder and Bhavnani, 2005). Yet, empirically, many of the world's CRM-rich areas have largely escaped this fate. In the Democratic Republic of Congo, for example, eastern provinces abundant in lootable gold and coltan have suffered decades of chaotic violence (Laudati, 2013), whereas the southern Copperbelt—home to two-thirds of global cobalt reserves—has experienced relative stability and political integration (Gulley, 2022).

This divergence presents a puzzle: why has the global rush for critical minerals produced pockets of managed stability rather than the conflict predicted by traditional models? Existing scholarship offers partial answers. Emerging studies suggest that stability arises from expanded security protection for foreign-owned mines (Qi, 2024), echoing arguments that regimes militarize to secure extractive enclaves (Enns, Andrews and Grant, 2020). While important, such security-centric accounts overlook the institutional bargains that frequently emerge instead of coercion. They portray local populations merely as threats to be contained, leaving unexplained why many CRM regions exhibit durable political settlements rather than cycles of rebellion and repression.

To understand this, we must recognize that industrial-scale CRM extraction is fundamentally distinct from the extractive models of the past. It functions less like the looting of diamonds and more like a fixed node in a rigid global logistics network. Unlike diffuse or easily lootable resources, critical minerals realize value only through a complex chain of extraction, refining, and manufacturing—stages dominated by a small number of sites, firms, and states (Kalantzakos, 2020; Vivoda, Matthews and Andresen, 2025). This integration creates a condition of value chain embeddedness. These projects require immense, immobile capital investments and are governed by long-term off-take agreements rather than spot-market speculation. The global supply chain for these minerals is characterized by extreme leanness and a lack of redundancy. A disruption at a single major mine can ripple through the supply chain, halting production lines globally. This industrial structure transforms the mine from a "prize" to be seized into a strategic "choke point" to be protected.

We argue that this structural fragility fundamentally rewires the political logic of extraction. Because the realization of value depends entirely on uninterrupted flow, local actors—who sit atop these

strategic choke points—possess a distinct form of disruptive power: the ability to impose outsized costs on governments and investors by blocking access roads, striking, or withholding cooperation. Anticipating these risks, central authorities recognize that large-scale repression is counterproductive; it risks sparking the very instability that the supply chain cannot tolerate. Consequently, states are compelled to substitute coercion with co-optation. To secure the continuous flow of minerals, regimes extend revenue-sharing, representation, and development benefits to potentially disruptive local elites. In short, supply-chain concentration transforms potential conflict zones into arenas of bargaining, creating what we term a commercial peace or pax mineralia—a stability sustained by negotiated inclusion rather than force.

To evaluate this argument, we construct an original province–year panel for Africa (2001–2020) that integrates georeferenced data on 529 industrial mining projects (S&P Global), armed conflict events (UCDP GED), and minister-level elite representation (ACPED). We estimate the causal effects of critical-mineral extraction using the PanelMatch framework (Imai, Kim and Wang, 2023), which rigorously adjusts for staggered adoption and dynamic treatment histories. We benchmark these findings against standard two-way fixed effects (TWFE) models to ensure comparability with the broader literature. Across specifications, the results show that the onset of industrial-scale CRM extraction significantly reduces organized violence. Crucially, we trace the mechanism behind this peace, finding that extraction leads to a significant increase in cabinet-level inclusion for elites from mining provinces. Furthermore, consistent with the logic of disruptive power, this pacifying effect is strongest in provinces with a prior history of non-violent collective action—places where the threat of disruption is most credible.

The remainder of the article proceeds as follows. Section 2 situates our contribution within the evolution of resource-politics scholarship, identifying the limitations of traditional rentier and lootability models. Section 3 conceptualizes the core independent variable—value chain embeddedness—and maps its industrial geography across the African continent. Section 4 establishes the central empirical puzzle by visualizing the temporal divergence in conflict trends between extractive and non-extractive provinces. Section 5 develops a theoretical framework that bridges global value chain analysis with the political economy of conflict, formalizing the logic of "bargains over bullets." Section 6 details the data construction, unit of analysis, and identification strategy. Section 7 presents

the empirical results, leveraging both non-parametric matching and parametric fixed-effects models to test the pacifying effect of extraction and the mechanism of elite co-optation. Section 8 concludes with implications for the geopolitics of supply chains and the future of resource governance.

2 Beyond the Curse: The Evolution of Resource Politics

2.1 The Classic Curse: Rents, Loot, and Conflict

Classic resource-curse theories emphasize two intertwined mechanisms—rents at the national level and loot at the local level. The first is the rentier state model (Beblawi and Luciani, 2015; Omeje, 2021), which posits that when governments derive massive revenues from natural resources like oil, they become detached from their citizens, and accountability erodes (Ross, 2001, 2018). Rulers can rely on these unearned "rents" instead of taxing the public, thereby breaking the fiscal social contract often summarized as "no representation without taxation (Moore, 2004; Mahdavy, 2015)." Empirical work, including Michael Ross's seminal studies, found that petroleum and mineral wealth often correlate with authoritarianism, weak institutions, and slow growth (Ross, 2015, 2012). The mechanism is intuitive: easy resource money enables regimes to fund repressive security forces and patronage networks while lowering incentives to develop a productive, diversified economy or an effective bureaucracy (Karl, 1997; Wantchekon, 2002). As governance priorities shift from production to the distribution of rents, corruption and economic distortions like Dutch Disease tend to follow (Corden and Neary, 1982; Torvik, 2002). In short, unchecked resource windfalls can undermine good governance by freeing elites from the typical constraints and duties of statecraft.

Parallel to this state-centric analysis, another branch of the literature investigated how natural resources fuel internal conflicts, a debate famously framed as "greed vs. grievance." The "greed" argument, exemplified by scholars like Collier and Hoeffler, contends that insurgencies are more likely when rebels have economic opportunities to fund themselves (Collier and Hoeffler, 1998, 2004; Collier, Hoeffler and Söderbom, 2004). Certain resources—especially those that are easily extractable and lootable by small groups, such as alluvial diamonds or gold—lower the startup costs for rebellion by providing a ready source of finance (Lujala, Gleditsch and Gilmore, 2005; Le Billon, 2008; Magazzino, 2024). From this perspective, resource wealth makes rebellion feasible, not just theoretically moti-

vating. Statistical evidence showing a correlation between heavy dependence on primary commodity exports and a higher risk of civil war lends support to this view (Fearon and Laitin, 2003; Ross, 2004; Collier and Hoeffler, 2005). While critics rightly argued that the greed vs. grievance dichotomy was overly simplistic and often ignored legitimate grievances rooted in marginalization and injustice, the core insight of the greed model endures: the physical characteristics of resources create opportunity structures that can directly link natural endowments to the outbreak and duration of violent conflict (Cramer, 2002; Keen, 2012; Lujala, 2010; Humphreys, 2005).

Crucially, these national-level rent-seeking and local-level lootability logics are not independent; they are causally intertwined in a self-reinforcing cycle (Snyder and Bhavnani, 2005; Müller-Koné and Croll, 2014). The rentier state dynamic often sets the stage for the very insurgencies described by the greed model. When states grow fat on external resource rents and neglect broad-based taxation, they frequently fail to extend authority into remote regions, as they have few incentives to invest in administrative capacity there (Sharan, 2022). Such peripheral zones, bereft of state services and a consistent military presence, become fertile ground for insurgent entrepreneurs (Ocakli and Scotch, 2017; Rustad and Binningsbø, 2012). As James Fearon observes, oil-rich states tend to have an unusually weak state apparatus relative to their wealth, making them easy prey for rebellion (Fearon and Laitin, 2003; Basedau and Lay, 2009; De Soysa and Neumayer, 2007). Furthermore, the behavior of rentier elites—marked by massive corruption, arbitrary governance, and neglect of non-resource regions—actively generates the deep public resentment that fuels conflict (Robinson, Torvik and Verdier, 2006, 2014). The availability of lootable resources then provides ambitious rebel leaders with the means to capitalize on these legitimate grievances. Recent scholarship thus recognizes that "greed" and "grievance" are not rival explanations but mutually reinforcing factors locked in a feedback loop, where state rent-seeking begets local rebellion, which in turn gives state actors more incentive to cling to rents to crush challengers (Cruickshank and Fenner, 2007; Lujala and Rustad, 2012).

2.2 Conditional Curses: Institutions and Commodities

Recognizing this dual pathology, scholars in the 2000s asked why some resource-rich states avoided it, inaugurating a conditionalist turn in the literature (Ploeg, 2011; Rubio and Ulph, 2007; Costello,

2018). This new wave of research identified key factors that mediate the effects of resource wealth, with two refinements proving especially influential (Robinson, Torvik and Verdier, 2006; Boschini, Pettersson and Roine, 2007; Vahabi, 2018; Tatar et al., 2024). The first was the role of domestic institutional quality. A significant body of work demonstrated that robust institutions—characterized by secure property rights, the rule of law, bureaucratic capacity, and checks on corruption—can effectively harness resource revenues for development rather than rent-seeking (Acemoglu, Johnson and Robinson, 2001; Bulte, Damania and Deacon, 2005; Fagbemi and Fajingbesi, 2024). Scholars encapsulated this with the notion of "producer-friendly" versus "grabber-friendly" institutions, finding strong empirical support that resource abundance harms growth only in countries with poor institutions (Mehlum, Moene and Torvik, 2006*a*,*b*). While this raised a chicken-and-egg problem regarding causality—whether resource wealth itself erodes pre-existing institutions—the conditionalist insight remains powerful: policy choices and institutional design are not predetermined by geology (Haber and Menaldo, 2011; Andersen and Aslaksen, 2013; Igwe and Amadi, 2020; Franz, 2025). Prudent management, as seen in Norway or Botswana, can avert the worst outcomes, meaning the curse is conditional, not inevitable (Lambe, 2025; Azubike and Awe, 2024).

A second refinement involved disaggregating "natural resources" into subtypes with distinct political effects (Snyder, 2006; Humphreys, 2005). Arguing that not all resources are created equal, researchers drew distinctions such as "point-source" versus "diffuse" and "lootable" versus "non-lootable." Each category was hypothesized to shape political incentives differently (Le Billon, 2001; Di John, 2007). For example, point-source resources like oil fields or deep-shaft mines are spatially concentrated and capital-intensive, making them easier for a central government to control and tax, which can in turn entrench centralized authoritarian power (Bayramov, 2018). By contrast, diffuse resources like alluvial diamonds are spread over large areas and exploited by many small actors, potentially empowering local warlords and weakening central authority (Lujala, Gleditsch and Gilmore, 2005; Le Billon, 2008). Similarly, the physical properties of a resource condition the nature of conflict; easily lootable resources tend to prolong non-separatist insurgencies, whereas unlootable resources often incentivize rebels to seek control of the state or region itself (Roy, 2018). While scholars noted that these typologies can be imperfect and overlapping, this line of research underscored the critical point that the material properties and geographic context of resources condition their political impact

(Vahabi, 2018).

Despite these important advances, the emerging literature on critical minerals suggests that even these refined typologies miss key features of today's strategic resources (Sholikin, 2025; Braunstein and Chuchko, 2025). Traditional frameworks were developed with commodities like oil and diamonds in mind, where value is realized largely at the extraction point. Critical minerals such as lithium, cobalt, and rare earth elements have fundamentally different economic profiles (Comincioli et al., 2025). Unlike oil or gemstones whose value is realized at extraction, critical raw materials derive worth through their roles in extended global value chains.

First, their value is tightly linked not just to extraction but to their function in complex industrial supply chains (Olaniyi and Odhiambo, 2025; Dou et al., 2023). Lithium ore, for instance, has low value until it undergoes extensive and technologically sophisticated refining, often overseas, to become battery-grade material (Nygaard, 2023). Second, critical minerals force us to redefine "scarcity" as a geopolitical and functional condition rather than a purely geological one(Kalantzakos, 2020). Many of these minerals are not geologically rare, but their processing and refinement are concentrated in one or two countries, creating strategic supply chain bottlenecks (Boafo et al., 2024). For example, the Democratic Republic of Congo (DRC) holds over half the world's cobalt reserves, but China controls over 70% of global cobalt processing capacity (Kim et al., 2021). This dynamic shifts the locus of power from the mine itself to the midstream nodes of the supply chain—the refinery, the trade route, or the high-tech end-use industry(Fang, 2024). The advent of critical minerals thus extends the evolution of resource politics further, demanding an analytical shift from isolated deposits to globalized production networks(Nakanwagi, 2023).

3 What is Value Chain Embeddedness?

To understand the political consequences of the critical mineral boom, we must first rigorously conceptualize the nature of the shock itself. The "green rush" is often discussed in the abstract language of global demand curves and national strategies, but physically, it manifests as a fundamental shift in the industrial organization of mining. This section defines the core independent variable of our study—value chain embeddedness—and maps the specific political geography in which it operates.

3.1 The Subnational Scale of Embeddedness

Global supply chains do not anchor themselves in abstract nation-states; they embed within specific subnational territories. A central conceptual premise of this study is that the political effects of critical mineral extraction are inherently local, yet structurally linked to the center. National-level aggregates, commonly used in traditional resource curse literature, frequently mask the distinct political dynamics of extractive enclaves. For instance, while a national government may be broadly characterized by instability, authoritarianism, or fiscal crisis, specific mineral-rich provinces often operate as distinct "governance pockets" where the imperative of supply chain security fosters different, often more stable, institutional arrangements.

Therefore, the fundamental unit of our analysis is the province-year. We define provincial boundaries using the first-level administrative units (ADM1) from the GADM v3.6 database (Areas, 2012). We prioritize this scale not merely for methodological convenience, but for its profound institutional relevance in the context of African political economy. The province typically serves as the primary arena for center-periphery bargaining, acting as the precise administrative level where political authority, fiscal distribution, and elite mobilization converge.

First, the province is the level at which authority is gate-kept. Governors and provincial assemblies often hold de facto, if not de jure, veto power over land access, labor supply, and operational stability for multinational firms. They are the local sovereigns with whom global capital must negotiate to secure the physical safety of their assets. Second, it is the level where rents are negotiated. The province is the legal entity through which fiscal transfers, royalty sharing mechanisms, and community development funds are channeled from the central treasury or direct corporate payments. Finally, and crucially for our proposed mechanism, the province serves as the constituency base for elite mobilization. It is the geographic container from which local elites draw their legitimacy and leverage to demand co-optation into the national cabinet. By harmonizing these boundaries over time to create a balanced panel, we capture the precise political space where global capital meets local authority. It is within these provincial boundaries that the abstract pressures of the global market are translated into concrete political contestation or cooperation.

3.2 Operationalizing Industrial Capital

What distinguishes a "critical mineral project" from a traditional extractive site? The distinction lies in the industrial logic of production. Traditional conflict literature often focuses on "lootable" resources like alluvial diamonds or artisanal gold, which are labor-intensive, technologically simple, and spatially diffuse (Lujala, 2010). These resources can be extracted with shovels, smuggled in pockets, and monetized in informal markets. In contrast, critical mineral extraction—specifically for battery metals—is capital-intensive, technologically complex, and spatially fixed.

To capture this specific form of embedded capital, we leverage facility-level data fromthe *S&P Global Market Intelligence Metals & Mining* database (formerly SNL Metals & Mining), the most comprehensive commercial source of facility-level information on industrial-scale mining worldwide, narrowing our focus to the core battery metals: cobalt, copper, lithium, and nickel [2]. We operationalize embeddedness not as a static geological endowment, but as the presence of active industrial organization. Using historical ownership and operational status fields, we identify the specific years in which a facility was under active development or production by a verifiable corporate entity.

This distinction is theoretically crucial because an active industrial mine creates a specific condition of structural vulnerability that unexploited deposits or artisanal workings do not. First, industrial CRM mining requires massive sunk costs that create a condition of high asset specificity and immobility. Data from S&P Global reveals that the average capital expenditure for the projects in our sample exceeds $400 million, with development timelines spanning nearly a decade. These investments materialize as immovable infrastructure—open-pit excavations, multi-story processing plants, tailings storage facilities, and dedicated high-voltage power lines—that structurally tether the operator to the territory. Unlike an artisanal miner who can flee violence or relocate operations when tensions rise, an industrial firm faces a "hostage" effect that drastically limits its exit options and increases its incentives to bargain for stability (Vivoda, Matthews and Andresen, 2025).

Furthermore, this vulnerability is compounded by the operational continuity required for critical mineral beneficiation. The production of battery-grade cobalt or copper is rarely a simple digging operation; it is a sophisticated chemical engineering process involving on-site hydrometallurgy (such as acid leaching and electrowinning) that necessitates continuous, uninterrupted flows of chemical

[2] Accessed via S&P Global Market Intelligence platform, https://www.spglobal.com/marketintelligenc.

reagents and massive amounts of electricity (Kalantzakos, 2020). A blockade of a single access road or the sabotage of a power pylon does not merely delay shipment; it can cause the entire industrial process to seize up, damaging expensive equipment and halting output for global supply chains that lack redundancy. Finally, the presence of a listed multinational operator provides a clear, legible target for political action. Unlike opaque informal mining networks, these firms are subject to international regulations, shareholder scrutiny, and reputational risks, making them responsive to "disruptive power" not just physically, but politically and legally. By aggregating these active facilities to the province-year level, we map the extensive margin of this fixed industrial capital, distinguishing the specific dynamics of the green energy transition from the broader noise of the resource sector.

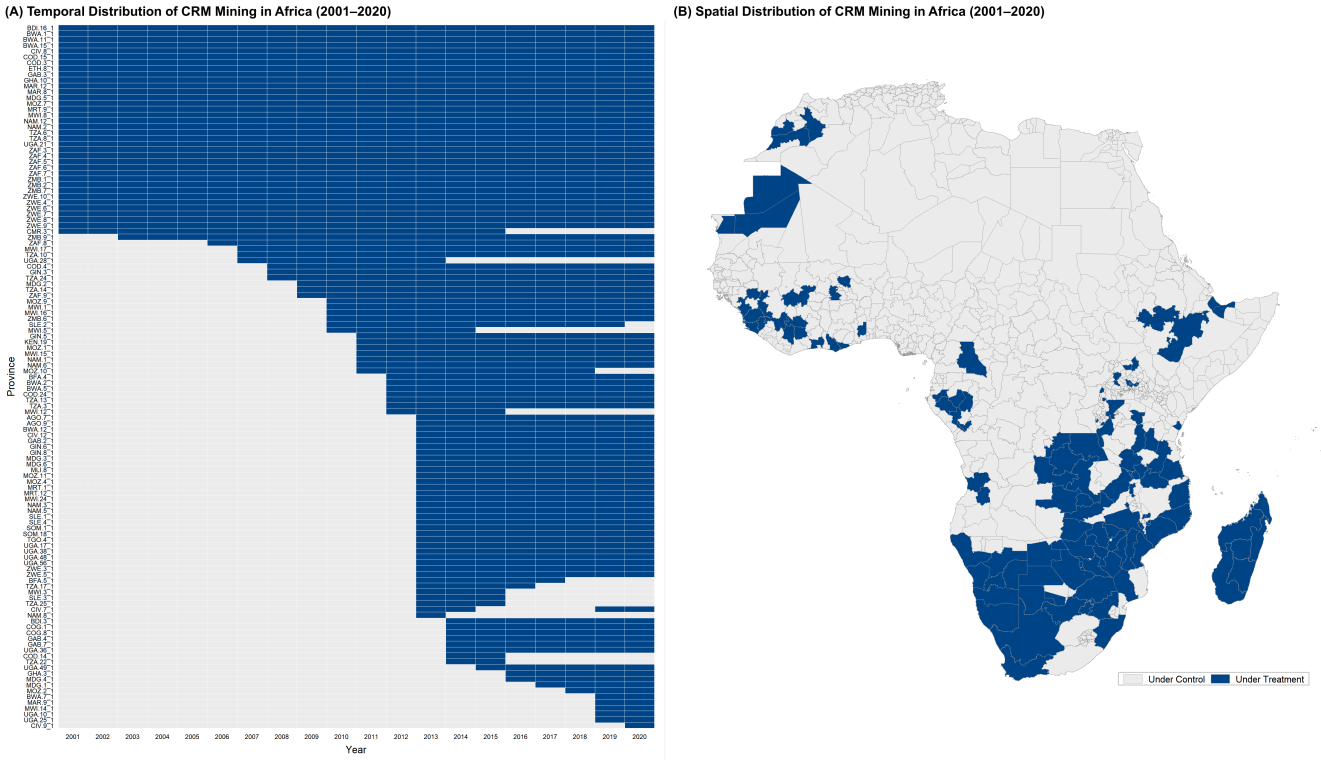

Figure 1: The Industrial Geography of Embeddedness (2001–2020). **(A)** The Staggered Boom: The temporal distribution of provinces entering the global value chain shows a sharp acceleration in the post-2005 era, creating a distinct "shock" of integration. **(B)** The Spatial Cluster: The map reveals the concentrated footprint of industrial capital. Dark blue indicates provinces hosting active industrial CRM projects; light gray indicates provinces without such embedded capital. Data: S&P Global Metals & Mining; Boundaries: GADM v3.6.

The resulting dataset reveals that value chain embeddedness is defined by two structural characteristics: spatial clustering and staggered expansion. Spatially, embeddedness is not distributed

randomly across the continent. As visualized in Figure 1 (Panel B), it is heavily clustered in specific geological belts—most notably the Central African Copperbelt spanning the DRC and Zambia—while emerging nodes appear in the coastal logistics corridors of Mozambique and West Africa. This geographic concentration confirms that the "choke points" of the global energy transition are few, distinct, and politically sensitive.

Temporally, Panel A illustrates the "Green Rush" as a staggered shock. While some provinces have hosted extraction for decades, a significant wave of new territories has been integrated into the global chain only since the mid-2000s, driven by the global battery revolution. The number of active projects in our sample more than doubled between 2005 and 2020. This variation—where different provinces become "embedded" at different times—provides the essential leverage for understanding how the arrival of global capital reshapes local political order.

4 The Green Rush and the Puzzle of Stability

How has the specific form of industrial capital defined in the previous section reshaped the political landscape of the continent? By mapping the expansion of embedded extraction against trends in organized violence, this section establishes the central empirical puzzle of this study: the emergence of a counter-intuitive "commercial peace" in regions historically predicted to be volatile.

4.1 Measuring Organized Violence

Before visualizing the relationship between extraction and stability, we briefly detail our measurement of conflict. Organized violence is operationalized using the Uppsala Conflict Data Program's Georeferenced Event Dataset (GED, version 25.1), which provides spatially precise records of individual conflict events worldwide (Sundberg and Melander, 2013). Unlike country-level aggregates, this dataset allows us to pinpoint violence at the subnational scale. Each record includes the event date, geographic coordinates, acting parties, and estimates of battle-related and civilian fatalities. The dataset covers all major forms of organized political violence—state-based conflict, non-state conflict, and one-sided violence against civilians—offering internally consistent definitions across countries and years.

To align these data with our province–year structure, each conflict event was spatially joined to its corresponding first-level administrative unit (ADM1) based on the event's reported coordinates. This geospatial approach avoids inconsistencies arising from local naming variations or historical boundary changes. From these events, we constructed three dependent variables at the province–year level: (1) a binary indicator of conflict incidence, equal to one if at least one violent event occurred; (2) the total number of conflict events, capturing the frequency and intensity of organized violence; and (3) the total number of fatalities associated with those events, representing the lethality of conflict. These measures provide complementary views of both the presence and scale of armed confrontation.

4.2 The Spatial Disconnect: A "Governance Pocket"

With these measures in place, we first examine the spatial relationship between industrial capital and violence. Conventional wisdom in political economy suggests that the sudden influx of high-value assets into institutionally weak states should act as a magnet for conflict. The "resource curse" literature predicts that contestable rents fuel grievances among displaced communities and fund the greed of insurgent entrepreneurs (Collier and Hoeffler, 2004; Ross, 2015). If this logic held, we would expect the continent's most intense conflict zones to overlap precisely with its most valuable mineral deposits. Yet, the descriptive evidence in Figure 2 reveals a striking spatial disconnect. Panel A establishes the baseline of insecurity, mapping the cumulative density of organized violence across Africa from 2001 to 2020. It highlights a generalized landscape of instability, with intense conflict clusters ("heat zones") dominating the Sahel, the Lake Chad Basin, the Horn of Africa, and the eastern fringes of the DRC.

Panel B provides the critical test of our spatial argument. Here, we overlay the footprint of embedded industrial capital (represented by the dark blue provinces) with conflict hotspots (represented by red bubbles). The map reveals a distinct spatial mismatch. The continent's most significant conflict theaters—such as the Boko Haram insurgency in northeastern Nigeria, the civil wars in South Sudan, or the Islamist insurgency in northern Mozambique—are largely situated in the "grey," non-extractive periphery. Conversely, the primary nodes of the global battery supply chain, specifically the cross-border Copperbelt spanning southern DRC and Zambia, form a visible "governance pocket." Despite hosting billions of dollars in fixed assets (deep blue) and suffering from deep poverty and

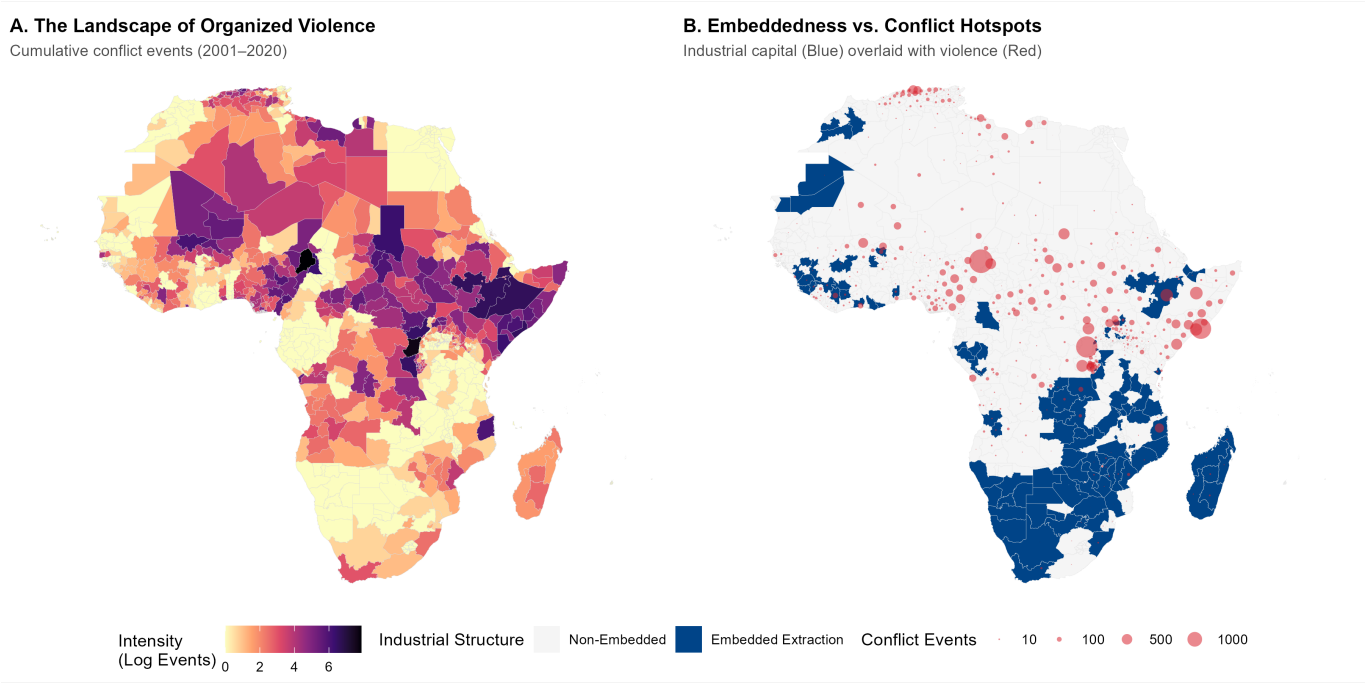

Figure 2: The Spatial Disconnect between Industrial Capital and Organized Violence (2001–2020). Panel A maps the aggregate intensity of organized violence across the continent, revealing a broad "arc of instability" spanning the Sahel, the Lake Chad Basin, and the Horn of Africa. Darker shades indicate a higher cumulative frequency of conflict events (log scale). **Panel B** juxtaposes the geography of *value chain embeddedness* (dark blue regions) against conflict hotspots (red bubbles, sized by event count). The map reveals a striking spatial mismatch: the zones of deepest industrial integration—most notably the Central African Copperbelt—are characterized by a relative scarcity of large-scale violence compared to the non-extractive periphery. This visual evidence contradicts the expectation that high-value resource enclaves serve as primary magnets for conflict. (Data Sources: Mining data from S&P Global Market Intelligence; Conflict data from UCDP GED 25.1)

inequality, these provinces are characterized by a relative scarcity of large-scale violence (small or absent red bubbles). The massive red bubbles of the eastern DRC fade significantly as one moves south into the industrial mining heartland of Katanga. This visualization powerfully suggests that the presence of fixed, industrial capital does not act as an accelerant for chaos, but rather anchors a specific, geographically bounded order.

4.3 The Temporal Divergence: Bifurcation of Local Order

This spatial stability is not static; it is a dynamic outcome that has emerged over time. To capture this, Figure 3 plots the longitudinal trajectory of organized conflict intensity (logged fatalities) from 2001 to 2020, disaggregated by province type. The red line represents the average conflict trajectory for provinces with no industrial critical mineral extraction ("Non-Extractive"), while the blue line represents those provinces hosting embedded projects ("Embedded Extraction").

Two distinct temporal patterns emerge from this visualization, effectively ruling out simple selection effects and illustrating the impact of global value chain integration.

First, prior to the onset of the mining boom in the early 2000s, resource-rich provinces were indistinguishable from—or in some years (e.g., 2001–2002), significantly more violent than—the continental average. This baseline is critical; it confirms that mining firms did not simply "select into" inherently peaceful regions. Rather, they entered territories characterized by significant historical instability and institutional fragility.

Second, and most importantly, a "Bifurcation of Local Order" occurs as value chain integration accelerates. As the global "Green Rush" gains momentum after 2010 (marked by the vertical dashed line), the two trends decouple. While conflict in non-mining provinces trends upward—reflecting broader regional instability in the Sahel and West Africa—provinces hosting embedded extraction exhibit a distinct stabilization trajectory. By the end of the observation period in 2020, a significant gap has opened: despite being high-value targets laden with fixed capital, these extractive enclaves experience significantly lower levels of organized violence relative to the continental counterfactual.

This descriptive divergence poses a fundamental challenge to traditional theories. In regions where grievances over land and pollution are acute, and where the potential rents from extortion are high, why has the presence of vulnerable, high-value capital been accompanied by a relative reduction in

violence? The emergence of this "commercial peace" suggests that the structural pressures of the supply chain may be generating powerful countervailing incentives for order. The following sections develop a theoretical framework to explain this stability not as a natural outcome, but as a political product actively manufactured through strategic co-optation.

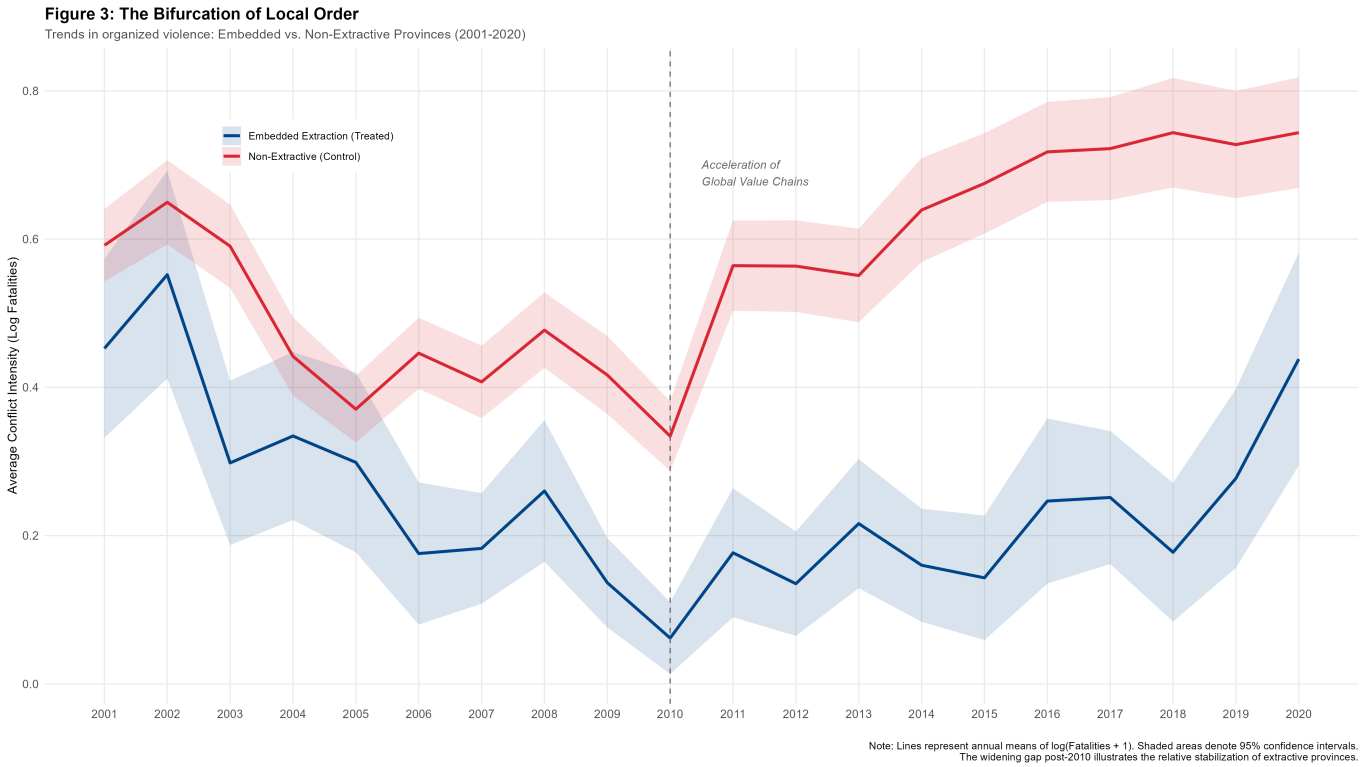

Figure 3: The Bifurcation of Local Order. The figure plots the smoothed average count of organized conflict events (log) for provinces with active industrial CRM extraction (blue solid line) versus those without (red dashed line). The shaded areas represent 95% confidence intervals. Note the distinct decoupling of trends post-2010: while non-extractive regions experience rising instability (red trend), extractive provinces exhibit a relative stabilization (blue trend) despite the rapid influx of capital. This divergence illustrates the core puzzle of the "commercial peace." (Data sources: S&P Global; UCDP GED)

5 Power in the Chain: Global Value Chain Perspective

5.1 The Politics of Extraction

Given the limits of conventional frameworks, a global value chain (GVC) perspective is required, reorienting analysis from the static mineral deposit to the dynamic commodity chain (Pedersen et al., 2019; Mangasini et al., 2025). A resource's political salience emerges not simply from its

existence in the ground, but from its transformation and transit to the market. This perspective immediately highlights a first critical dimension: the politics of extraction (Hilson and Maconachie, 2017; Berman et al., 2017). The mode of production—how a mineral is mined—profoundly shapes political outcomes, creating a stark dichotomy between artisanal and industrial mining. In many developing regions, artisanal and small-scale mining (ASM)—a labor-intensive, low-tech, and often informal process—dominates (Huggins, 2021; HILSON et al., 2022; Huggins, 2023). Politically, ASM carves out gray zones of authority where the state's writ is absent. These sites are often controlled or "taxed" by local strongmen, militias, or rogue military units who establish their own systems of rule and extortion (Katz-Lavigne, 2024). By diverting revenue flows away from the state and toward violent entrepreneurs and corrupt networks, the informality of ASM tends to fragment authority, undermine formal governance, and link resource wealth directly to chronic local insecurity, as has been extensively documented in eastern Congo (Finn, Simon and Newell, 2024).

At the opposite end of the spectrum lies capital-intensive industrial mining, typically undertaken by multinational corporations (Hilson et al., 2024; Radley, 2020). These projects often function as highly productive economic enclaves, integrated with global markets but isolated from the local economy (Narula, 2018*b*). Politically, they can strengthen the central state by providing a concentrated and easily taxable stream of formal revenue through royalties and profit-sharing agreements, thereby bolstering regime finances. However, this very model generates severe political tensions (Bebbington and Bury, 2013; Kirshner and Power, 2015). The benefits—revenue and export earnings—accrue largely to national elites and foreign investors, while the costs—land dispossession, environmental degradation, and labor hazards—are borne by local populations (Gilberthorpe and Rajak, 2019; Soto-Diaz, 2023). This fundamental disparity breeds deep resentment and protest, straining center-local relations and frequently sparking violent conflict, as illustrated by the recurrent community blockades that have crippled Peru's massive Las Bambas copper mine (Arellano-Yanguas, 2011; Bebbington et al., 2018). In reinforcing national rentier dynamics while creating localized grievances, industrial enclaves risk destabilizing the very peripheries they occupy (Narula, 2018*a*; Arias, Atienza and Cademartori, 2014).

5.2 Weaponizing the Supply Chain: Choke Points and Leverage

Beyond the politics at the point of extraction, the second critical dimension of the GVC perspective concerns the commodity's journey and its vulnerabilities (Gereffi, 2018; Yusuf, 2024). Once extracted, critical minerals traverse a complex global chain involving multiple stages of refining, processing, and manufacturing across numerous countries (Righetti and Rizos, 2024). The system's complexity and geographic dispersion create critical nodes whose disruption can halt the entire flow of materials—so-called choke points(Al-Shwaf and Bell, 2025; Siddi, 2023). Geopolitical actors have long understood that controlling these choke points confers immense structural power (Seaman, 2025; Buysse and Essers, 2023). China's strategic dominance over the midstream refining and processing stages for cobalt, lithium, and rare earths is a clear example of this strategy, allowing it to exert leverage over both upstream producers and downstream consumers (Kalantzakos, 2020; Vivoda, Matthews and Andresen, 2025). The 2010 rare earth export restriction crisis powerfully demonstrated how this dependence can be weaponized (Vekasi, 2022; Kalantzakos, 2017).

While much attention focuses on such state-to-state dynamics, the logic of vulnerability extends right down to the local level. Any local or subnational actor capable of disrupting a critical choke point—be it a mine, a port, or a key transport route—gains outsized structural power over the entire system (Arellano-Yanguas, 2011). This provides a new form of leverage for communities, unions, and militias that was largely absent in simpler commodity chains like oil (Klikauer, 2017; Ness, 2015). This dynamic can be understood through political theorist Frances Fox Piven's concept of "disruptive power" (Piven, 1976, 2014): the leverage that marginalized groups derive from their ability to withhold cooperation and "shut things down" in a tightly interdependent system (Cardona Vallès, 2024; Marin and Palazzo, 2024). A community blockade in Peru or political unrest in New Caledonia can remove a significant percentage of global mineral supply from the market, with cascading effects on international prices and industrial production. The local thus becomes deeply strategic (Bebbington et al., 2018; Vivoda, Matthews and Andresen, 2025).

This local leverage is further amplified by the current intensification of great power competition (Vivoda and Matthews, 2024; Müller, 2023). As Western governments pursue "friend-shoring" strategies to build new supply chains outside of China, the operational stability of each new mining project becomes a matter of strategic priority (Vivoda, 2023; Lovely, 2023). A supply interruption

caused by local conflict is no longer just a commercial loss but a strategic setback to geopolitical diversification efforts (Mufungizi and Mpaka, 2025; Çevik, 2024). Consequently, both host governments and their international backers have powerful incentives to prevent or swiftly resolve local disputes (Kalvelage and Tups, 2024; Ufimtseva, Li and Shapiro, 2024). Local communities, aware of this heightened strategic importance, recognize that their grievances, if expressed through disruptive protest, are more likely to command attention at the highest levels (Deberdt, 2024). In effect, local protest leaders can become consequential actors in international politics, courted or coerced by global powers because they hold the keys to a critical choke point in a fragile global system (Zhou, Crochet and Wang, 2025; Maihold, 2022).

6 Theory: Bargains Over Bullets in Critical Minerals

This section formalizes how supply-chain concentration generates incentives for inclusion and the emergence of a commercial peace.

6.1 Beyond Rebels and Victims: The Logic of Local Agency

In the study of resource politics, local populations have long been framed within a restrictive binary. The first narrative, born from early quantitative conflict studies, is that of the "predatory rebel." This perspective models local actors as rational bandits and armed groups as criminal enterprises seeking to maximize profit through violent rent-extraction (Vogel, 2022; Collier and Hoeffler, 2004). In this view, the complex tapestry of local political life is reduced to a market logic of violence. The second, opposing narrative, prominent in human rights and development discourse, casts locals as "passive victims." Here, communities are portrayed as helpless subjects of land grabs, environmental degradation, and state-corporate collusion, their only hope lying in the intervention of external saviors (Martinez-Alier, 2012; Okoi and Nalule, 2023). These powerful but simplistic narratives serve distinct political purposes: the "rebel" frame legitimizes state repression under the guise of counter-insurgency, while the "victim" frame mobilizes international advocacy and fits a clean moral arc for global audiences. Their shared failure, however, is the erasure of local political life, reducing multi-dimensional social actors to one-dimensional objects of either security policy or humanitarian

concern.

To build a more robust theory capable of explaining the distinct political dynamics of critical mineral regions, we must discard these caricatures. Our framework begins with a different foundational assumption: the primacy of the strategic local agent. The arrival of a mining boom is not a simple external shock imposed upon a passive society; it is a political opportunity structure that is actively interpreted, navigated, and shaped by a diverse array of local actors—including traditional authorities, elected officials, youth movements, business elites, and civil society organizations (Colvin, Witt and Lacey, 2015; Sexton, 2020). We conceptualize this agency along three critical dimensions. First, it is cognitive. Local actors possess deep, granular knowledge of the social, political, and physical landscape—an intimate understanding of kinship networks, historical grievances, and territorial boundaries that often renders them "illegible" to the state or corporation. This information asymmetry is a potent source of power. Second, their agency is strategic. Their repertoire of contention is not limited to violence but encompasses a sophisticated array of tactics. This includes "forum shopping," a strategy whereby local groups simultaneously pursue multiple avenues of redress: filing a lawsuit in the corporation's home country, lobbying officials at the national capital, submitting a complaint to an international human rights body, and leaking information to global media outlets. They strategically play different power-holders against one another. Third, this agency is internally contested. The "local community" is not a monolithic entity with a unified will. It is a political arena of competing factions and shifting alliances. The strategic actions we observe are often the messy outcome of internal bargaining, co-optation, and power struggles. A corporation may exploit these divisions, but these same rival factions can also coalesce in the face of a shared external threat, demonstrating a capacity for sophisticated collective action.

This conception of local agency is not merely an abstract ideal; it is empirically grounded. In conflict zones from Colombia to the Philippines, communities have demonstrated remarkable political acumen, negotiating non-aggression pacts with multiple armed groups to establish zones of peace (Mouly, Idler and Garrido, 2015). Ethnographic work in the eastern DRC reveals local chiefs brokering complex, informal contracts with rebel commanders to regulate artisanal mining, creating a semblance of order and a system of taxation where the state is functionally absent (Henn et al., 2024; Matthysen et al., 2020). These examples show that local actors are not simply responding to external

stimuli; they are actively co-creating the very rules that govern their lives. Once we recognize them as strategic players in the game, the crucial question becomes: what unique sources of power do they possess in the age of critical minerals?

6.2 Disruptive Power: Redefining Local Leverage

In classic security studies, power is a function of coercive capacity—measured in soldiers, weapons, and wealth. By this metric, local communities are invariably weak. Their leverage in the context of critical minerals, however, derives not from the ability to project force but from their structural position within the fragile architecture of global value chains (GVCs). The logic of this power is best captured by political theorist Frances Fox Piven's concept of "disruptive power." In her work, Piven argued that the poor and marginalized, though lacking formal power, could nonetheless achieve political victories by collectively withdrawing their cooperation from the tightly interdependent systems—factories, welfare systems, public transit—upon which elites depended (Piven, 1976, 2014). We transpose this logic from the factory floor to the global supply chain, arguing that GVCs represent the quintessential interdependent system of the 21st century.

The contemporary critical mineral supply chain is a system uniquely vulnerable to this form of power. Decades of logistical optimization have produced hyper-efficient, "just-in-time" delivery networks with minimal redundancy. This efficiency comes at the cost of resilience. A small disruption at an upstream node—a single mine or transport route—can trigger a "bullwhip effect," causing massive volatility for downstream manufacturers in Asia, Europe, or North America. This inherent fragility is now magnified by a new geopolitical imperative. With the passage of legislation like the US CHIPS and Science Act and the EU Critical Raw Materials Act, the stable output of a specific cobalt mine in the DRC or a lithium brine in Chile is no longer just a commercial concern; it is a matter of national security for global powers scrambling to de-risk their supply chains from geopolitical rivals.

This context dramatically amplifies the power of local actors to create disruptions at critical choke points. These choke points are not only physical—an access road, a railway, a port—but also social and political. Communities can withdraw their informal "social license to operate," making daily operations impossible through persistent, low-level protests and non-cooperation that bleed a project through a thousand cuts. Furthermore, local actors are no longer isolated. Through transnational

advocacy networks (TANs), they can leverage mobile technology to instantly transmit images of a protest or a security force crackdown to allies in London, New York, or Geneva. These allies, in turn, can activate a new set of choke points within the architecture of global governance and finance. They can pressure Environmental, Social, and Governance (ESG) investors to divest, lobby stock exchanges to delist the company for ethical violations, and trigger review clauses in loans from development banks like the IFC. A blockade thus becomes more than a physical act; it is a powerful communicative act aimed at a global audience of consumers, regulators, and investors, transforming a local grievance into a material risk for global capital.

This disruptive leverage fundamentally rewires the bargaining dynamic. The costs of repression for both the state and the corporation become prohibitively high. For the company, the financial calculus is stark: the millions in lost daily revenue from a production stoppage, coupled with the long-term damage to its stock price from being labeled a high "political risk," can easily outweigh the costs of making concessions. The recurring blockades at Peru's Las Bambas copper mine, which have halted production for over 500 days since 2016 and cost its operator MMG billions in revenue, serve as a dramatic testament to this power (Arellano-Yanguas, 2011; Bebbington et al., 2018). By strategically weaponizing the vulnerabilities of the global system, local groups transform themselves from powerless subjects into pivotal actors who hold a de facto veto over production and must be bargained with.

6.3 State Adaptation: From Bullets to Bargains

Faced with local actors structurally empowered with disruptive leverage, how do central states respond? While the historical reflex to resistance is often coercion, the political economy of critical minerals makes large-scale repression a dangerously counterproductive strategy. A violent crackdown that ignites protracted instability in a strategic mining region does more than quell a protest; it threatens the fiscal lifeblood of the regime itself. It risks alienating international partners and killing the geopolitical goose that lays the golden eggs. This creates a powerful structural incentive for a more pragmatic adaptation: a strategic shift from bullets to bargains.

This logic pushes states to favor co-optation and negotiation as their primary modes of governance in these extractive enclaves. This process is best understood through the theoretical lens of political

settlements, which posits that stability in fragile contexts is achieved not through the application of formal laws, but through ongoing, often informal, pacts among elite groups over the distribution of power and economic rents (Di John, 2007). In critical mineral regions, we witness the formation of dynamic, multi-layered, localized political settlements. These settlements are negotiated between a coalition of actors: central government elites who need revenue, multinational corporations who need stability, and local leaders who control disruptive power. These bargains are brokered by a range of intermediaries—from influential politicians and "fixers" to traditional chiefs—and they manifest in a variety of forms. These include formally legislated revenue-sharing mechanisms; opaque but crucial side-deals that award lucrative service and security contracts to companies owned by local strongmen; corporatist Community Development Agreements (CDAs) that provide visible public goods like schools and clinics; and the granting of enhanced political autonomy and consultation rights to certain groups.

The outcome is the emergence of a pax mineralia—a "mining peace" sustained not by the state's Weberian monopoly on violence, but by a continuously renegotiated alignment of interests. This helps explain the paradox of how capital-intensive extraction thrives in states with notoriously weak formal institutions. The absence of broad state capacity is compensated for by creating highly effective, if narrowly focused, "governance enclaves." However, this transactional peace is both normatively troubling and inherently fragile. It often leads to what scholars term "adverse incorporation," where a select group of local elites is brought into the system of rent distribution, enriching them and strengthening their power at the expense of the broader community and democratic accountability. This creates a form of stabilized inequality. Furthermore, because this peace is based on personalized deals rather than legitimate institutions, it is brittle. It is vulnerable to external shocks, such as a sudden drop in global commodity prices that dries up the patronage funds, and to internal political changes, such as the death of a key chief or the election of a new local leader who refuses to honor the old deal. This inherent fragility means the bargain is constantly being tested, leading not to permanent harmony, but to a cycle of negotiation, stability, breakdown, and renegotiation.

6.4 Testable Hypotheses

Building on this framework, we derive three hypotheses that connect the expansion of industrial-scale critical mineral (CRM) extraction to patterns of conflict and inclusion. Each captures a distinct aspect of our "bargains over bullets" theory: the overall pacifying outcome, the co-optive mechanism that produces it, and the contextual conditions under which it holds.

Hypothesis 1 (Conflict Reduction). Industrial-scale CRM extraction is associated with lower levels of organized armed conflict and fewer conflict-related fatalities.

This expectation follows directly from the logic of co-optation. When the state anticipates that repression would risk costly disruptions to production and investment, it faces stronger incentives to pursue negotiated stability. The emergence of such bargains reduces both the need for large-scale coercion and the economic viability of rebellion.

Hypothesis 2 (Co-optation Incresse). Industrial-scale CRM extraction increases the likelihood of formal power-sharing and benefit-sharing arrangements between central authorities and local elites.

While H1 concerns the observable outcome (reduced conflict), H2 tests the underlying mechanism—whether peace is maintained through inclusion rather than force. If the pacifying effect of CRMs operates through co-optation, we should observe greater incorporation of local actors into cabinet positions, provincial offices, or development councils in extraction regions.

Hypothesis 3 (Conditional Effect of Disruptive Capacity). The pacifying effect of CRM extraction is strongest in provinces where local communities possess credible disruptive capacity, as indicated by prior histories of non-violent collective action such as riots and protests.

This conditional hypothesis probes the theory's core causal logic. Co-optation is a rational state response only when local actors can plausibly threaten disruption. Where such credibility is absent, governments have fewer incentives to share rents or authority, and the pacifying effect of extraction should accordingly weaken.

Together, these hypotheses yield a coherent empirical framework. H1 evaluates whether extraction pacifies conflict; H2 identifies the mechanism of inclusion underlying this relationship; and H3 specifies

the conditions under which this mechanism operates most strongly. The next section describes the data and research design used to test these predictions.

7 Measurement, Data, and Methods

To investigate how industrial mining of critical raw materials (CRMs) shapes subnational political order in Africa, we construct a new province-year panel dataset covering the period from 2001 to 2020. A subnational research design is essential for this inquiry, as resource extraction is a geographically concentrated phenomenon whose political effects are primarily mediated through local and regional administrative institutions. The panel structure, which captures the staggered commissioning of mines across provinces and over time, permits the use of two-way fixed effects estimators. This approach allows us to systematically account for time-invariant provincial characteristics and continent-wide temporal shocks, thereby isolating the effects of mining activity more effectively.

7.1 Elite Inclusion, and Contention

Our empirical analysis draws on three sets of outcome variables that together capture the political consequences of critical-mineral extraction: organized armed conflict, elite political inclusion, and non-violent contention. Each dimension corresponds to one of the mechanisms in our theoretical framework—violent resistance, elite co-optation, and societal bargaining. All measures are harmonized to a balanced province–year panel (ADM1 level, 2001–2020), and non-observed province–years are treated as true zeros to distinguish the absence of events from missing data.

7.1.1 Elite Political Inclusion

The inclusion of local elites in central government is measured using the African Cabinet and Political Elite Data (ACPED), a comprehensive dataset that records the biographical and career information of cabinet ministers across African countries (Raleigh and Wigmore-Shepherd, 2022). ACPED includes each minister's name, year of appointment, portfolio, classification as inner or outer cabinet, and a "regional background" field indicating the minister's province or region of origin. This field enables subnational localization of cabinet representation—a feature not available in most elite datasets—and

allows us to identify the geographic origins of political inclusion.

The key empirical task is to link the regional background text fields in ACPED to contemporary ADM1 units. Because ACPED records are entered in multiple languages and often use historical or colloquial regional names, we implemented a structured harmonization procedure. First, we standardized all region names by removing diacritics, punctuation, and inconsistent capitalization, and we unified directional modifiers. Second, we restricted matching to within-country comparisons using an ISO3-based country lookup table, ensuring that names are only compared within their national context. Third, we separated base names from directional components and searched for their closest ADM1 equivalents using fuzzy string matching with a conservative distance threshold. Manual verification was performed for ambiguous cases, particularly in countries that experienced major administrative reforms such as Ethiopia and the Democratic Republic of Congo. This procedure prioritized precision over coverage to avoid false matches.

Using this harmonized mapping, we aggregated individual ministers to the province–year level and constructed two primary indicators. The first, any cabinet representation, equals one if at least one minister originates from a province in a given year. It captures whether the province is represented at the national executive table. The second, mining-related representation, equals one if at least one minister from the province in that year holds a portfolio related to mining, minerals, natural resources, or extractive industries. The identification of these portfolios relied on a multilingual dictionary covering English, French, Portuguese, and Spanish terms such as "mines," "mineral resources," "hydrocarbons," "petroleum," and "natural resources." This classification allows us to distinguish broad inclusion from sector-specific co-optation. Additional variables, including the number of cabinet members and the presence of inner-cabinet ministers, are used in robustness checks. Unmatched provinces are coded as zero, representing no recorded representation.

These measures operationalize elite co-optation as an observable political process. Appointing ministers from mining provinces indicates attempts by central governments to share benefits or signal inclusion to local elites. Mining-related appointments, in particular, provide direct evidence of targeted incorporation into the resource governance structure, aligning closely with our theoretical mechanism that peace is maintained through negotiated inclusion rather than repression.

7.1.2 Non-Violent Contention

To measure collective action outside the realm of armed violence, we use the Armed Conflict Location and Event Data Project (ACLED), which systematically records political events including demonstrations, strikes, and riots (Raleigh et al., 2010). We extract all events coded as "Protests" or "Riots" for African countries between 2000 and 2024, and aggregate them to the ADM1 level using the same spatial join procedure as for the conflict data. The result is a province–year count of non-violent contentious events.

From these aggregates, we construct two measures: a binary indicator of protest incidence, equal to one if at least one protest or riot occurred in a given province–year, and a count variable capturing the total number of such events. In the analysis, lagged protest incidence is used as a proxy for the credibility of local disruptive capacity—that is, the demonstrated ability of communities to mobilize collectively without resorting to arms. This indicator reflects the non-violent bargaining potential that may encourage governments to pursue co-optation rather than confrontation.

Taken together, these three sets of measures describe the full spectrum of political responses to resource extraction: the occurrence of organized violence, the inclusion of regional elites, and the expression of societal contention. All variables are observed at the same province–year scale, share harmonized spatial boundaries, and are aligned with the timing of mining activity. To capture interdependence across space, we construct a spatial weights matrix based on each province's ten nearest geographic neighbors and compute spatially lagged versions of all outcome variables. These spatial lags measure the average level of conflict, protest, or inclusion in surrounding provinces, allowing us to evaluate whether political processes diffuse geographically—such as conflict spillovers, regional contagion of protest, or coordinated elite appointments. Incorporating these spatial dynamics ensures that our estimates reflect both local and neighboring conditions, yielding a more realistic account of how resource extraction shapes political order in interconnected subnational systems.

7.2 Identification Strategy and Control Variables

Our objective is to estimate the causal effect of industrial-scale critical raw material (CRM) extraction on local political outcomes, including armed conflict and elite inclusion. The primary challenge

for identification is that the placement of mines is not random. Provinces selected for extraction may differ systematically from non-mining provinces in ways that are also correlated with political stability, such as their institutional quality, pre-existing economic potential, or geological endowments. Furthermore, the timing of mine commissioning is staggered across provinces, and the effects of extraction may unfold dynamically over several years.

Traditional two-way fixed effects (TWFE) models are known to produce biased estimates under such conditions of staggered treatment adoption and heterogeneous treatment effects (Goodman-Bacon, 2021; Sun and Abraham, 2021). To address these challenges, our identification strategy employs two state-of-the-art causal inference methods designed for panel data with complex treatment patterns: the matching and weighting framework of `PanelMatch` (Imai, Kim and Wang, 2023).

Our primary estimation strategy utilizes the non-parametric matching framework for panel data developed by Imai, Kim, and Wang, implemented in the R package `PanelMatch` (Imai, Kim and Wang, 2023). This approach generalizes the difference-in-differences design to settings with multiple time periods and staggered treatment adoption by systematically constructing a valid control group for each treated observation. It avoids the functional form assumptions of standard regression models and is robust to the biases that can affect TWFE estimators.

The core of the method is to estimate the Average Treatment Effect on the Treated (ATT) by comparing the observed outcomes of treated units to a weighted average of outcomes from control units. For each province i that begins mining in year g (the treatment "cohort"), we estimate the effect k years after treatment begins. This is done by constructing a matched set, $\mathcal{M}_{i,g+k}$, of control provinces that (1) had not yet been treated by year $g+k$ and (2) exhibit a similar trajectory on pre-treatment outcomes. The matching is performed on the lagged outcome variables for L periods prior to treatment.

Formally, let D_{it} be a binary treatment indicator, where $D_{it} = 1$ if province i has an active CRM mine in year t, and $D_{it} = 0$ otherwise. Let Y_{it} be the outcome of interest (e.g., conflict events). For a unit i treated at time g, the ATT at time $t = g + k$ is estimated by:

$$\hat{\tau}_{ATT}(g,k) = \frac{1}{|\mathcal{T}_g|} \sum_{i \in \mathcal{T}_g} \left\{ Y_{i,g+k} - \sum_{j \in \mathcal{C}_{g,k}} w_{ij} Y_{j,g+k} \right\}$$

where $\mathcal{T}_g$ is the set of provinces first treated at time g, and $\mathcal{C}_{g,k}$ is the set of potential control units that remain untreated up to time $g+k$. The weights w_{ij} are generated to balance the pre-treatment outcome histories between the treated unit i and its matched controls j. This procedure ensures that the comparison is made between units that were on parallel paths before the treatment occurred, thereby satisfying the core identifying assumption of difference-in-differences. By estimating effects for each cohort (g) and time horizon (k) separately, this method flexibly captures dynamic and heterogeneous treatment effects.

As a complementary approach, we employ the Bayesian Panel Causal (`bpCausal`) model developed by Pang, Liu, and Xu (Pang, Liu and Xu, 2022). This method approaches the causal inference problem from a different perspective, treating it as a matrix completion task. It models the counterfactual outcomes for treated units by leveraging a latent factor model structure, which can flexibly capture unobserved confounders that vary across units and over time. This approach is particularly well-suited for situations with complex temporal dynamics and potential spillovers.

The model assumes that the untreated potential outcome, $Y_{it}(0)$, can be decomposed into a combination of unit-specific effects, time-specific effects, and a low-rank structure of unobserved interactive effects:

$$Y_{it}(0) = \mu_i + \lambda_t + \mathbf{F}_t \mathbf{L}_i' + \epsilon_{it}$$

where μ_i is a fixed effect for province i, λ_t is a fixed effect for year t, and ϵ_{it} is idiosyncratic noise. The crucial component is the interactive term $\mathbf{F}_t \mathbf{L}_i'$, where $\mathbf{F}_t$ is a vector of K unobserved time-varying common factors and $\mathbf{L}_i$ is a vector of K province-specific factor loadings. This structure allows the model to learn complex patterns of interdependence and co-movement from the control units in the panel and use this information to predict the counterfactual trajectory for the treated units.

The model is estimated using a Bayesian framework, which provides posterior distributions for the counterfactual outcomes, $Y_{it}(0)$, for all treated province-years. The individual treatment effect for unit i at time t is then calculated as the difference between the observed outcome and the estimated counterfactual:

$$\hat{\tau}_{it} = Y_{it} - \hat{Y}_{it}(0)$$

By aggregating these individual effects, we can estimate the overall ATT and its evolution over time.

The primary advantage of `bpCausal` is its ability to control for unobserved confounders that have heterogeneous effects across units and time, a common feature in political economy data. By testing our hypotheses with both `PanelMatch` and `bpCausal`, we triangulate our findings. The consistency of results across a non-parametric matching method and a parametric factor model would provide strong evidence for the causal claims advanced in this study.

For control variables, we draw on research that links local capacity, exposure, and access to the state and markets with variation in political contention and violence. We include three broad sets of covariates. First, to account for economic activity and population pressure—two factors that shape both opportunities for mobilization and the stakes of redistribution—we include province–year totals of night-time lights and population, constructed from harmonized DMSP/VIIRS (Li et al., 2020) composites and GPW population counts (Center For International Earth Science Information Network-CIESIN-Columbia University, 2018), respectively. From these series we use levels, one-year lags, and simple moving averages. Second, to capture environmental stress and livelihood conditions, we incorporate annual precipitation and five-year anomalies (CHIRPS) (Climate Hazards Center, 2025) and vegetation dynamics via MODIS NDVI (MOD13Q1) (Didan et al., 2015), using levels and lagged changes; these variables proxy shocks to agricultural and pastoral incomes that may alter grievance and opportunity structures. Third, we measure subnational political structure with the count and share of politically excluded groups mapped from EPR/GeoEPR to ADM1 units (Cederman, Wimmer and Min, 2010; Vogt et al., 2015; Wucherpfennig et al., 2011), capturing durable representational deficits that can condition responses to extraction.

We further include a set of accessibility and international-presence controls that shape the costs of coercion and the returns to cooperation. Transport connectivity is measured by ADM1-level road and rail line-length density derived from OSM via the ohsome API (OpenStreetMap contributors, 2023); we screen implausible year-over-year jumps, apply a short rolling median smoother, and retain smoothed levels and lags. Geographic frictions and market access are captured with terrain roughness (TRI from GMTED) (Danielson and Gesch, 2011), administrative area, great-circle distance from the provincial centroid to the national capital, and distance to the nearest seaport (Natural Earth) (Natural Earth, 2023). The presence of UN peacekeeping (Cil et al., 2020) is coded from mission-year point data and aggregated to ADM1 as the number of missions, total average troops, and a presence

dummy, each with one-year lags. Finally, to absorb national-level institutional and macroeconomic shocks common to provinces within a state, we merge country-year indicators from the Worldwide Governance Indicators (PV, GE, RQ, RL, CC, VA) (Kaufmann, Kraay and Mastruzzi, 2011) and the World Development Indicators (GDP per capita, growth, inflation, unemployment, FDI, exports, investment) (World Bank, 2023), using conservative within-country interpolation and then one-year lags in the province panel. Continuous covariates enter in levels (standardized in preferred specifications); binary and counts are kept in levels, with log or IHS transforms used in robustness. Table A in the online appendix details definitions, coding rules, and data sources for all variables.

8 Empirical Findings

Our empirical analysis unfolds in three stages, designed to rigorously test the theoretical framework. We begin by assessing the baseline relationship between industrial CRM extraction and organized violence (H1). To ensure our estimates are robust to complex treatment dynamics, we employ non-parametric matching alongside standard parametric fixed-effects models. Next, we turn to the mechanism of co-optation (H2), investigating whether mining activity systematically predicts the inclusion of local elites into the national cabinet. Finally, we explore the conditional nature of this peace (H3), verifying whether the pacifying effect is, as theorized, concentrated in provinces with a credible capacity for collective action.

8.1 The Peace Effect of Embeddedness

Does the onset of industrial mining reduce conflict? To answer this, we first estimate standard Two-Way Fixed Effects (TWFE) models, which control for unobserved time-invariant provincial characteristics and common temporal shocks. Table 1 presents the results across seven specifications, progressively introducing covariates to test the stability of the coefficient.

Across all models—from the parsimonious baseline (Column 1) to the fully saturated specification (Column 4)—the coefficient for active industrial mining remains negative. This consistency suggests that the relationship is not driven by omitted variable bias. Notably, Column 4 represents a particularly stringent test: by controlling for the spatial lag of conflict, peacekeeping deployments, and

Table 1: The Effect of Critical Mineral Embedded Extraction on Conflict Intensity and Severity (TWFE Estimates)

	Conflict Intensity *(Dependent Variable: Log Conflict Events)*				**Conflict Severity** *(Dependent Variable: Log Fatalities)*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Embedded Mining (Active)	-0.0794*	-0.1015**	-0.0864**	-0.0451	-0.1237**	-0.1181**	-0.1076*
	(0.0464)	(0.0410)	(0.0409)	(0.0424)	(0.0542)	(0.0546)	(0.0574)
Controls							
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Controls	No	Yes	Yes	Yes	Yes	Yes	Yes
National Context	No	No	Yes	Yes	No	Yes	Yes
Security Dynamics	No	No	No	Yes	No	No	Yes
Observations	16,740	13,221	13,211	12,435	13,221	13,211	12,435
R^2	0.529	0.547	0.549	0.531	0.420	0.421	0.407
Within R^2	0.001	0.005	0.012	0.018	0.003	0.005	0.009

Notes: The table reports coefficients from two-way fixed effects (TWFE) regression models. The dependent variable in Columns 1–4 is *Conflict Intensity*, measured as log count of organized conflict events. The dependent variable in Columns 5–7 is *Conflict Severity*, measured as log battle-related fatalities. The main independent variable, *Embedded Mining (Active)*, is a binary indicator equal to 1 if the province hosts at least one active industrial-scale critical mineral mine in a given year. **Local Controls** include population (log), night-time lights (log), rainfall anomalies, vegetation index (NDVI), and transport infrastructure density. **National Context** controls for GDP per capita, GDP growth, FDI inflows, and V-Dem indicators for democracy and corruption. **Security Dynamics** includes the spatial lag of conflict from neighboring provinces, the presence of UN peacekeeping troops, and excluded ethnic groups. Standard errors clustered at the province level are reported in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

excluded groups, we isolate the localized effect of extraction from broader regional instability. While the inclusion of these powerful security controls naturally attenuates the coefficient magnitude, the direction of the effect remains consistent. Furthermore, Columns 5–7 demonstrate that this pacifying effect holds not only for the frequency of conflict (intensity) but also for its lethality (severity), measured by log fatalities. The results provide strong parametric support for Hypothesis 1: embedded extraction effectively dampens organized violence.

While the TWFE results confirm the direction of the effect, standard regression models may mask heterogeneous treatment dynamics or fail to account for the selection process into mining. To address this, we leverage the `PanelMatch` estimator, which allows us to match treated provinces with valid counterfactuals based on their precise pre-treatment history. We specify a four-period window ($K = 4$) and use propensity-score weighting to ensure covariate balance (see Appendix for diagnostics).

Figure 4 displays the dynamic Average Treatment Effect on the Treated (ATT). The results reveal a temporal pattern that is theoretically illuminating but obscured in static regressions. In the immediate aftermath of a mine's commissioning (t+1 to t+3), the effect on conflict is statistically

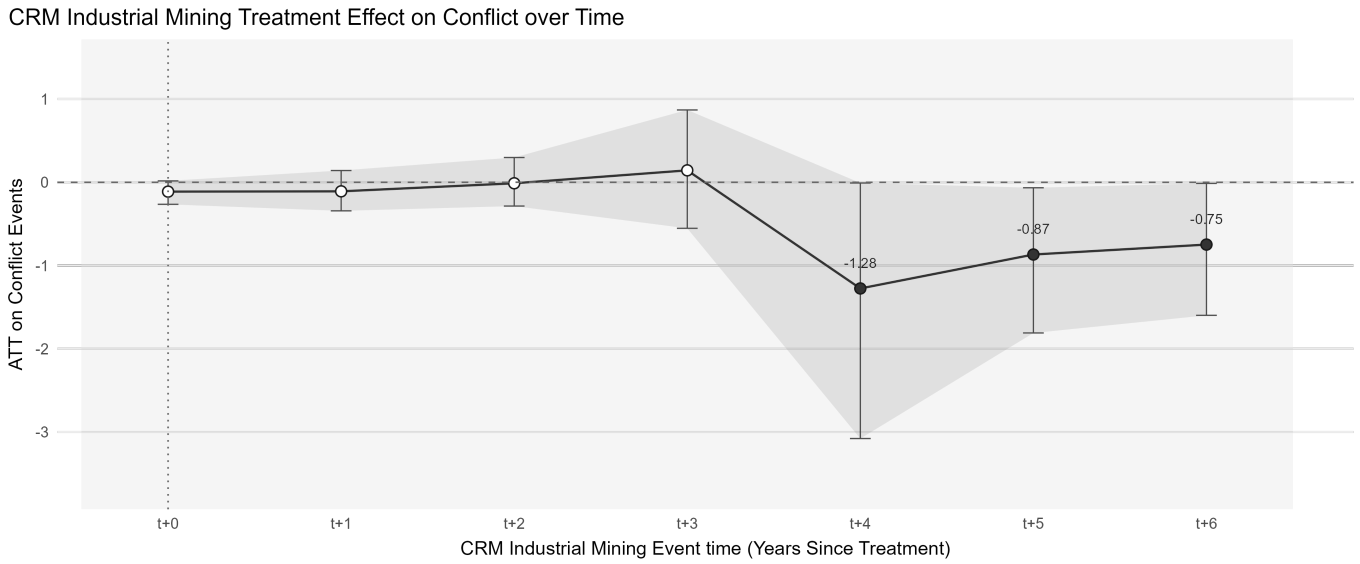

Figure 4: The Dynamic Effect of Industrial Mining on Organized Violence (PanelMatch). Notes: The figure plots the Event-time Average Treatment Effect on the Treated (ATT) with 90% confidence intervals. The shaded region marks the post-treatment period ($t \geq 0$). Estimates are based on `PanelMatch` with a four-period history ($K = 4$) and propensity-score refinement (`ps.weight`). The trend shows a significant reduction in conflict emerging approximately four years after the onset of extraction.

indistinguishable from zero. This null effect likely reflects the friction of initial operations and the time required to establish new governance arrangements. However, a clear decline materializes from period t+4 onward. By the fifth year of operation, the presence of embedded capital is associated with a reduction of approximately 0.87 conflict events per year relative to the counterfactual. This delayed but durable pacification supports the interpretation that stability is not an automatic byproduct of wealth, but the result of a gradual consolidation of political order—a process of bargaining and co-optation that takes time to institutionalize.

8.2 The Mechanism: Buying Peace with Cabinet Positions

Having established the outcome, we turn to the mechanism: is this peace purchased through elite co-optation? We test Hypothesis 2 by examining whether mining activity predicts the appointment of local elites to the national cabinet.

Figure 5 visualizes the dynamic treatment effect on the probability of cabinet representation. The trajectory closely mirrors the conflict reduction timeline seen in Figure 4: following the onset of extraction, the probability of a province securing a cabinet seat trends upward, peaking at

Table 2: The Timing of Co-optation: Effect of Mining on Sectoral Cabinet Appointments

	Dependent Variable: Mining Portfolio (Dummy)			
Lag Structure	Current (t)	Lag ($t-1$)	Lag ($t-2$)	Lag ($t-3$)
	(1)	(2)	(3)	(4)
Industrial Mining	0.0166	0.0427**	0.0538**	0.0519*
	(0.0183)	(0.0212)	(0.0232)	(0.0286)
Fixed Effects				
Province FE	Yes	Yes	Yes	Yes
Country × Year FE	Yes	Yes	Yes	Yes
Controls				
Local Capacity	Yes	Yes	Yes	Yes
Security Dynamics	Yes	Yes	Yes	Yes
Observations	12,445	12,435	12,425	11,679
R^2	0.390	0.389	0.389	0.400

Notes: Linear Probability Models (LPM) estimated using OLS. The dependent variable is a binary indicator equal to 1 if the province holds a mining-related cabinet portfolio in a given year. The independent variable is the presence of active industrial mining, entered with varying lag structures from t (current year) to $t-3$ (three-year lag) across columns. All models include **Province Fixed Effects** to account for time-invariant local characteristics and **Country × Year Fixed Effects** to rigorously absorb all time-varying national-level shocks. Standard errors are clustered at the country level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

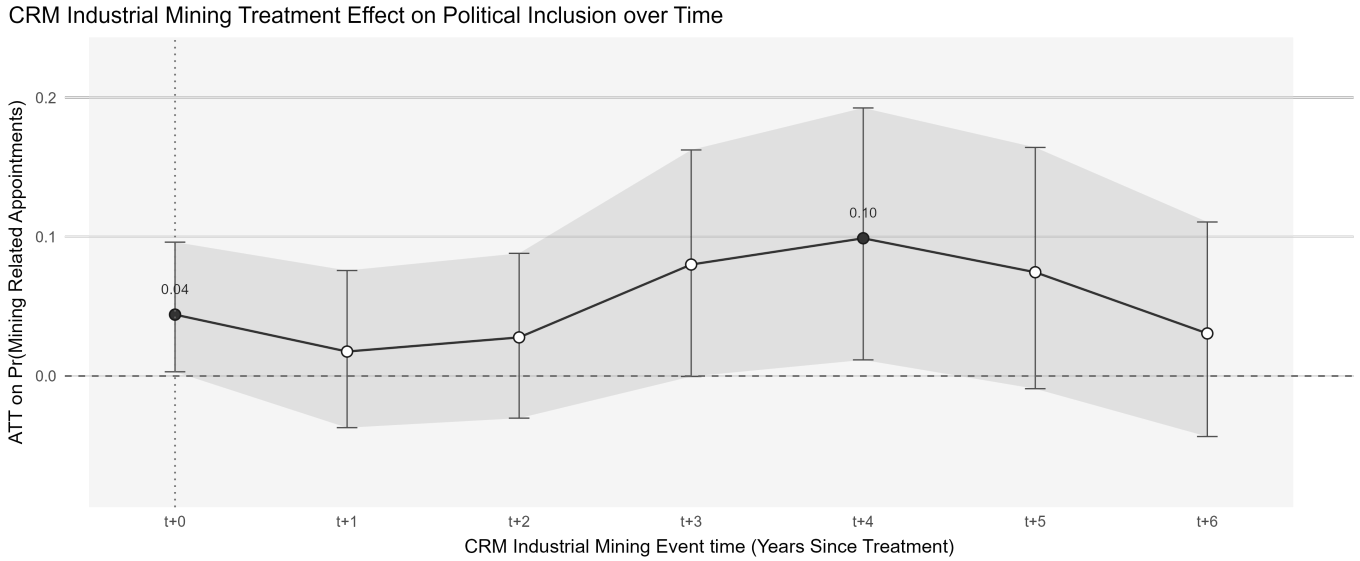

Figure 5: The Effect of Mining on Elite Inclusion (ACPED). Notes: Dynamic ATT on the probability that a province has any cabinet representation; 90% CIs shown. Design identical to Fig. 4 ($K = 4$, `ps.weight`, all $|SMD| < 0.2$). The series rises gradually and peaks around t+4, coinciding with the stabilization period.

approximately $t+4$. This temporal alignment—where political inclusion rises precisely as conflict falls—strongly suggests that the two processes are causally linked. The state appears to respond to the strategic value of the province by integrating its elites into the center.

To rigorously test the specificity and timing of this mechanism, Table 2 utilizes linear probability models with stringent Country $\times$ Year Fixed Effects. This design is critical as it absorbs all national-level political shocks (e.g., elections, regime changes), isolating only the within-country variation between mining and non-mining provinces. The results confirm that active mining is a significant predictor of holding a mining-related portfolio—a targeted form of co-optation. Crucially, this effect is driven by the lagged terms ($t-2$ and $t-3$), confirming that the political bargain takes time to negotiate. The data thus supports the view that central governments actively integrate local gatekeepers into the resource governance structure to secure the supply chain.

8.3 The Condition of Disruptive Capacity

Finally, we test the core logic of our bargaining theory: does co-optation occur only when the threat of disruption is credible? Hypothesis 3 posits that the pacifying effect should be conditional on local capacity for collective action.

Figure 6 tests this by splitting the sample into provinces with high versus low pre-treatment histories of non-violent protest. The divergence is stark. In provinces with a demonstrated capacity for mobilization (High Protest), the onset of mining is followed by a sharp and significant reduction in conflict (blue line). In contrast, for provinces lacking this history (Low Protest), the effect of mining is statistically indistinguishable from zero (gold dashed line).

This finding rules out alternative explanations based on simple economic modernization or unconditional state repression. If mining reduced conflict simply by providing jobs or by saturating the region with security forces, we would expect the effect to be universal across all provinces. Instead, the fact that pacification is specific to high-capacity regions confirms that peace is a *negotiated outcome*. The state offers inclusion and stability primarily to those communities that possess the credible power to disrupt the value chain, effectively purchasing their cooperation to maintain the flow of critical minerals.

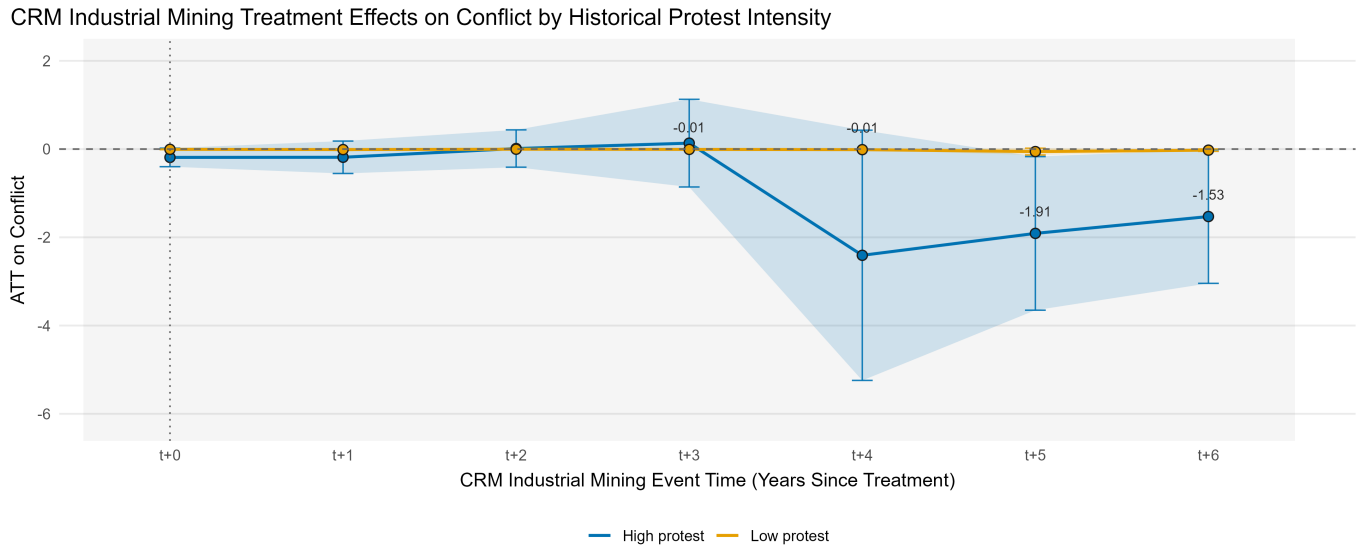

Figure 6: Conditional Effect of Mining by Local Disruptive Capacity. Notes: Event-time ATTs estimated separately for provinces with *high* (blue) vs. *low* (gold) pre-treatment protest frequency. Blue solid line: high-protest; gold dashed line: low-protest; bands denote 90% CIs. Design as in Fig. 4 ($K = 4$, `ps.weight`, all $|SMD| < 0.2$). Only the high-protest stratum shows large, statistically discernible declines, confirming H3.

9 Conclusion

As the global energy transition accelerates, the geopolitical spotlight has shifted to the extraction of critical raw materials. Policy debates in Washington and Brussels often frame this "Green Rush" through the binary lenses of interstate competition or local predation, anticipating that the scramble for African minerals will inevitably reproduce the violent pathologies of the resource curse. This study offers a different, counter-intuitive finding: in the era of tightly integrated global value chains, the strategic imperative of supply security creates powerful incentives for local stability.

Using a novel province-year dataset covering two decades of industrial mining across Africa, we documented a distinct "bifurcation of local order." While the non-extractive periphery of the continent has faced rising instability, provinces hosting industrial-scale critical mineral projects have experienced a relative pacification. We argued that this stability is not a natural endowment but a political product, actively manufactured through a logic of value chain embeddedness. Because industrial mining creates massive, immobile assets that function as strategic choke points, the costs of local disruption become prohibitive for both firms and central governments. Consequently, the state is compelled to abandon the coercive tactics often used in other sectors and instead pursue

a strategy of co-optation. Our empirical results rigorously support this mechanism: the onset of extraction significantly predicts the appointment of local elites to the national cabinet, effectively purchasing peace through the distribution of political power.

These findings have broad implications for the political economy of development and conflict. First, they challenge the monolithic treatment of "natural resources" in civil war literature. We demonstrate that the political effects of extraction are determined not just by the price of the commodity, but by its industrial organization. The shift from "lootable" alluvial diamonds to "embedded" battery metals fundamentally alters the strategic terrain: it transforms rebels from potential rent-seekers into spoilers who must be bought off, and it transforms the state from a distant predator into a necessary partner in maintaining flow security.

Second, this study contributes to the emerging literature on the geopolitics of supply chains. We show that the structural power of global production networks extends beyond state-to-state coercion; it penetrates deep into the domestic politics of producer nations. The vulnerability of the global chain endogenously generates local political settlements. In this sense, supply chain dependence acts as a functional substitute for state capacity—imposing order in regions where the state's monopoly on violence is otherwise weak.

However, this "commercial peace" should not be romanticized. The stability we observe is transactional, not institutional. It relies on the co-optation of specific local elites—what scholars term "adverse incorporation"—rather than the strengthening of democratic accountability or the broad redistribution of wealth. By channeling dissent into cabinet portfolios rather than public goods, this mechanism may stabilize the mine while entrenching inequality and corruption in the surrounding community. Furthermore, our heterogeneity analysis suggests that this peace is conditional on the credible threat of disruption. The state bargains only with those strong enough to threaten the chain. This leaves marginalized communities without disruptive capacity—or those living in the shadow of less strategic resources—doubly excluded: they suffer the externalities of extraction without the leverage to demand inclusion.

Future research should examine the durability of these settlements. Can this "mining peace" survive a collapse in commodity prices, or will the withdrawal of co-optation funds trigger a resurgence of violence? Additionally, as Western powers push for "friend-shoring" and higher ESG standards, it

remains to be seen whether external pressure will reinforce these elite bargains or force a move toward more inclusive, democratic governance. For now, our findings suggest that the green energy transition is rewriting the social contract in the African periphery—replacing the chaos of the resource curse with the rigid, unequal, yet stable order of the supply chain.

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