

CONCEPTUAL FRAMEWORK FOR ANALYSING POLITICAL POLICY, AND GEOGRAPHICAL DRIVERS IN GLOBAL ENERGY AND METAL COMMODITY MARKET

Arjun Kumar K. V.^{1*}, Safika Praveen Sheikh²

¹Alliance University, Chandapura–Anekal Main Road, Anekal, Bengaluru – 562106, Karnataka, India

²Alliance University, Chandapura–Anekal Main Road, Anekal, Bengaluru – 562106, Karnataka, India

Corresponding Author: Arjun Kumar K. V.(Email: 007arjun.akk@gmail.com)

Abstract: An increasingly complex set of political, policy and geographic forces defy conventional economic explanations of supply-demand equilibria in the global energy and metal commodity markets. We propose a unified Conceptual Framework for Analyzing Political, Policy and Geographical Drivers (CFAPPG) in global energy and metal commodities markets. The framework is structured around three analytical pillars, namely (i) geopolitical risk indices and interstate conflict dynamics, (ii) energy transition policy architectures such as carbon pricing, renewable mandates and trade policy, and (iii) geographical endowments such as reserve concentration, infrastructure chokepoints and climate vulnerability, based on Political Economy Theory, Resource Curse Theory, Geographic Determinism and Policy Regime Analysis. The study systematically reviews 147 peer-reviewed studies and institutional reports from 2010-2025 to identify the research gaps that remain. The paper finds that the drivers have been well studied individually, but simultaneous, non-linear interactions and feedback loops are under theorized. The framework is a mixed-methods conceptual synthesis, with illustrative quantitative indicators drawn from Q3 2025 data on crude oil, natural gas, copper, lithium and rare earth elements, and shows that commodity price volatility is best understood through the interaction of multiple drivers rather than through single variable models. Results demonstrate how convergence of geopolitical fragmentation, accelerated energy transition policies and geographical concentration in critical mineral reserves is leading the way to a new paradigm of structural price instability. The paper ends with policy recommendations for producers, consumers and multilateral institutions and a research agenda for empirically validating the CFAPPG framework..

Keywords: Commodity markets, Geopolitical risk, Energy Transition, Critical Minerals, Metal markets, Price Volatility.

1. INTRODUCTION

Classical economics of supply and demand analyses commodity markets in a traditional manner. But the volatility in global energy and metal markets in 2020-25 has exposed the limits of purely economic models. The COVID-19 pandemic disrupted global supply chains, the Russia-Ukraine conflict in 2022 has fundamentally reshaped European energy geopolitics and the accelerating global energy transition has both generated surges in demand for critical metals such as lithium, cobalt, nickel and rare earth elements (REEs) while jeopardizing the long-term demand outlook for fossil fuels.

Political decision making, policy architecture and geographical endowments intersect to characterize 21st century commodity markets. Trade direction is determined by political alliances, while incentives for production are



determined by national industrial policies. Resources are frequently in politically fragile or geographically difficult areas. The location of resources creates supply side risks which cannot be resolved by market mechanisms alone. The central intellectual task of this paper is to understand these drivers as a system of integration rather than as isolated variables.

2. LITERATURE REVIEW

2.1 Political Economy of Commodity Market

The political economy tradition of commodity market research can be traced to the seminal papers of Prebisch (1950) and Singer (1950) and their Prebisch-Singer hypothesis that the commodity terms of trade would trend down in the long run relative to manufactured goods. Resource Curse Theory, developed by later authors like Auty (1993), suggests that economies dependent on commodities are prone to lower growth, weak institutions and authoritarian governments, and has been widely tested and partly corroborated in African and Latin American settings (Sachs & Warner, 1995; Mehlum et al., 2006; van der Ploeg, 2011).

The Arab oil embargo of 1973 sparked a revival of academic interest in the geopolitics of energy. The canonical historical account of how petroleum shaped twentieth-century geopolitics was provided by Yergin (1991) in *The Prize*, and Klare (2001, 2012) theorized a new era of ‘resource wars’ driven by competition over fossil fuels and critical minerals. Recent studies have also dealt with the redefinition of the US geopolitical positioning by the shale revolution (Mead, 2014; Bordoff & O’Sullivan, 2022), and the Belt and Road Initiative of China as a systematic strategy of resource access and leverage of infrastructures (Ferdinand, 2016; Ip, 2023).

2.2 Energy Transition Policy and Commodity Demand

There is a rapidly growing literature since the Paris Agreement (2015) that has focused on the link between climate policy and commodity markets. The energy transition is demonstrated to create both winners (critical mineral producers) and losers (fossil fuel economies) simultaneously (Hein et al., 2021; Manley et al., 2021). The IEA’s Critical Minerals reports (2021, 2023) offer detailed demand projections of 42 times and 21 times the current levels of lithium and cobalt respectively, by 2040 in net-zero scenarios. Baffes and Kabundi (2023) argue that the energy transition policies are already influencing commodity prices of copper and lithium.

The US Inflation Reduction Act (IRA, 2022) and the EU Critical Raw Materials Act (CRMA, 2023) have been discussed in the industrial policy literature as reshaping the investment flows and the trade patterns in critical mineral supply chains (Pisani-Ferry, 2023; Evenett et al., 2023). Resource nationalism is the increasing trend of countries to exert greater control over their domestic mineral resources. This is the case in Chile, Indonesia, Zimbabwe and the Democratic Republic of Congo, creating uncertainty on the supply-side (Vivoda, 2021; Lechner, 2022).

2.3 Geographical Drivers and Market structure

Resource reserves are geographically clustered, leading to structural market power asymmetries. Three countries (DR Congo, Australia, Chile) account for over 75% of the world’s lithium reserves, China accounts for about 60% of the global rare earths production and OPEC+ countries possess over 70% of the proven crude oil reserves (USGS, 2024; BP Statistical Review, 2024). The geographical economic theory, grounded on the economic geography framework of Krugman (1991) and the application of Sachs (2003) to natural resources, shows that the spatial agglomeration of resources creates persistent regional price differences and transport cost advantages that establish trade flows.

Infrastructure chokepoints such as the Strait of Hormuz, Strait of Malacca, Suez Canal, and Arctic shipping lanes are physical geographical constraints that increase price volatility when political tensions rise (Rodrigue, 2020). Climate vulnerability is increasingly being included as a driver in the literature on geography of commodity trade: mining operations in high-altitude Andean regions are subject to water stress; Australian iron ore ports are subject to cyclone risk; and Arctic hydrocarbon development is subject to regulatory and logistical complexity (Fischetti, 2023; IPCC, 2022).

2.4 Quantitative Approches to commodity Price Modelling

The econometric literature on modelling commodity prices comprises vector autoregression (VAR) models (Kilian, 2009), dynamic factor models (Stock & Watson, 2002) and, more recently, machine learning approaches such as LSTM neural networks and gradient boosting (Deaton & Laroque, 1996; Herrera et al., 2019). Some commodity price models include indices of geopolitical risk, such as the Geopolitical Risk (GPR) Index of Caldara-Iacoviello

(2022) and document significant and persistent impacts of geopolitical uncertainty on oil prices (Caldara & Iacoviello, 2022; Antonakakis et al., 2017).

Commodity trade networks have been examined with network analysis to detect systemic vulnerabilities and interdependencies (Gephart & Pace, 2015; Rojas-Downing et al., 2017). Most of the quantitative models, however, treat the political, policy and geographic variables as exogenous shocks or binary dummies and ignore their dynamic, endogenous nature. It is this deficiency of methodology which leads to the approach of the conceptual framework used in this paper.

3. RESEARCH GAP

A systematic review of 147 studies highlights several important gaps in the current literature. First, there is significant disciplinary fragmentation, as economic studies of commodity prices seldom treat political risk as an endogenous factor, political science work on resource conflicts seldom investigates price formation mechanisms, and geographical work on resource distribution often neglects policy feedback effects. Second, the focus on one commodity, especially crude oil, limits the transferability of results across commodities, whereas studies on critical minerals are methodologically detached from energy studies. Third, many existing frameworks are based on static analyses and treat political, policy and geographical factors as stable conditions, while the policy environment associated with the global energy transition is changing rapidly. Fourth, there has been insufficient attention to the interaction effects between multiple drivers, despite the fact that major market disruptions, such as the European natural gas crisis in 2022, were driven by the combined impact of several interconnected drivers. Finally, the literature is largely rooted in the perspectives of advanced economies and international institutions with little room for the voice of producer-countries in Africa, Latin America and Southeast Asia, which are highly exposed to transition-related mineral demand pressures and climate-induced production challenges.

4. STATEMENT OF THE PROBLEM

This paper deals with the basic problem of the absence of an integrated conceptual framework to explain the joint, simultaneous and interactive determination of commodity price behaviour by political, policy and geographical drivers. Existing analytical methods are economic, political science or geographical but they are only partial explanations which are not enough for the complexities of the twenty first century commodity market dynamics.

That absence has real-world consequences. Models tend to discount political and geographic risk. Energy and mining companies are long-term investors with horizons of 10-30 years. This is evidenced by the stranded-asset crisis in coal (2015-2020) and supply chain crises in critical minerals (2021-2025). Strategic petroleum reserves, stockpiles of critical minerals, resource diplomacy and other policy interventions are designed with only a limited understanding of how political, policy and geographic factors interact to determine market outcomes.

Scholars do not have a problem with this. The International Monetary Fund (IMF, 2024) warned that under a scenario of persistent trade fragmentation, volatility in commodity prices would increase and global GDP would be reduced by 0.5–1.0% per year. Without coordinated policy frameworks to address gaps in supply of critical minerals needed to achieve net-zero emissions, commodity price shocks of a magnitude similar to the oil crises of the 1970s might occur (World Bank, 2024). Hence, a comprehensive conceptual framework is needed for efficient governance of commodity markets in this age.

5. RESEARCH QUESTION

The primary and secondary research questions addressed in this study are:

RQ1. How do political, policy and geographical drivers interact in shaping price formation and volatility in global energy and metal commodity markets?

RQ2: How important are political risk, energy transition policy and geographical endowment factors in explaining the variance of commodities prices across different classes of commodities (energy vs metals)?

RQ3: How do geopolitical regime shifts (e.g., Russia-Ukraine conflict, US-China trade wars) propagate through energy and critical mineral supply chains and produce price outcomes?

RQ4: What is the role of national industrial policies (IRA, CRMA, China's Five-Year Plans) as structural drivers of long-term transformation of commodity demand?

RQ5: How does the political risk together with geographic concentration of critical mineral reserves pose supply security challenges to energy transition objectives?

RQ6: What are the most effective institutional mechanisms to address the amplifying interaction between political, policy and geographical drivers of commodity price volatility?

6. RESEARCH OBJECTIVES

The specific objective of this study is:

To systematically review and synthesise the literature on the political, policy and geographic drivers of global energy and metal commodity markets;

To Critically appraise and locate the gaps in the current conceptual and empirical models.

To Developing a Common Conceptual Framework for Analysis of Political, Policy and Geographic Drivers of Global Commodity Markets (CFAPPG);

To Apply the CFAPPG framework to analyze market data for a basket of energy and metal commodities in Q3 2025.

To examine the dynamics of commodity prices about the role of political risk, policy regimes and geographical endowment.

To provide policy implications for the producers, consumers, multinational corporations and multilateral institutions.

To Develop a research agenda to empirically test and extend the CFAPPG framework.

7. RESEARCH METHODOLOGY

7.1 Research Design

The study adopts a conceptual-analytical research design that combines systematic literature review and framework synthesis methodology (Carroll et al., 2011). Since the main aim is to establish a conceptual framework and not to test empiric hypotheses, we synthesize findings across disciplines using a qualitative meta-synthesis approach. The framework is subsequently grounded with illustrative quantitative indicators based on Q3 2025 market data to demonstrate the analytical applicability and empirical relevance.

7.2 Systematic Literature Review

The systematic review of the literature was done following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Databases searched: Web of Science, Scopus, JSTOR, EconLit, SSRN , IMF eLibrary, World Bank Open Knowledge Repository, IEA Publications Database.

Search Terms: (“commodity markets” OR “energy markets” OR “metal markets”) AND (“geopolitical risk” OR “political economy” OR “resource nationalism”) AND (“price volatility” OR “supply chain” OR “energy transition”).

Inclusion Criteria: Peer-reviewed articles, institutional reports and working papers published 2010-2025. Covering at least one of the following six target commodities; . Publications in English.

Exclusion criteria: Studies that focus exclusively on financial derivatives without any physical market participation; studies that are dated prior to the post-2008 commodity supercycle period.

Final sample: 147 sources (89 peer-reviewed journal articles, 31 institutional reports, 18 working papers, 9 book chapters).

7.3 framework Synthesis Methodology

Framework synthesis (Oliver et al., 2005; Carroll et al., 2011) involves the application of an existing theoretical framework or the development of a new one as an analytical lens to systematically map research findings. The CFAPPG framework of this study is inductively developed through four steps: (i) identifying categories of drivers

from literature, (ii) mapping causal mechanisms from drivers to market outcomes, (iii) identifying interaction nodes where multiple drivers converge, and (iv) integrating into a coherent multi-level framework with feedback mechanisms.

7.4 Quantitative Indicator Analysis

For operationalization of the conceptual framework the study considers five categories of quantitative indicators for Q3 2025:

Commodity prices: Brent Crude Oil, European TTF Natural Gas, LME Copper, Lithium Carbonate (China Spot), MREI (Magnetic Rare Earth Index) (Bloomberg Terminal), LME and S&P Platts.

Geopolitical risk indicators: Caldara-Iacoviello GPR index (country and global level), ICRG Political Risk Index, Global Peace Index (Institute for Economics and Peace, 2025).

Policy indicators Carbon prices (EU ETS, UK ETS, California Cap-and-Trade) Critical mineral import dependency ratios (EU, US, Japan). Renewable energy capacity additions rates.

Geographical Indicators: Herfindahl-Hirschman Index (HHI) of reserve concentration; Chokepoint vulnerability scores; Climate risk-adjusted production indices.

7.5 Analytical Framework

The analytic approach is informed by three theoretical traditions, which have been incorporated into the CFAPPG framework. The first is Political Economy Theory (Marx, 1867; North, 1990; Acemoglu & Robinson, 2012) explaining how political institutions organize the distribution of resources. The second is Geographic Determinism and Economic Geography (Sachs, 2003; Krugman, 1991) that tells how the spatial distribution of resources shapes trade and power. A third approach is the Policy Regime Analysis (Hall, 1993; Blyth, 2002) that explains how structural discontinuities in the trajectory of commodity demand are generated by shifts in the policy paradigms.

8. THE CFAPPG FRAMEWORK: CONCEPTUAL; ARCHITECTURE

8.1 Framework Overview

The Conceptual Framework for Analyzing Political, Policy and Geographical Drivers (CFAPPG) divides the determinants of commodity market outcomes into three main pillars, four interaction mechanisms and two feedback loops. The framework works at three levels of analysis: macro (global geopolitical architecture); meso (national policy frameworks and regional geographical conditions); and micro (individual commodity market dynamics) shown in table-1.

Table-1: Framework Overview

Pillar	Key Drivers	Primary Mechanisms	Market Outcome
I. Political	Geopolitical risk; interstate conflict; resource nationalism; sanctions; alliances	Supply disruption; trade diversion; risk premium inflation; investment deterrence	Price volatility; supply concentration; trade fragmentation
II. Policy	Energy transition mandates; carbon pricing; industrial policy; trade tariffs; strategic reserves	Demand transformation; substitution effects; investment signals; supply chain reshaping	Structural demand shifts; price decoupling; new market creation
III. Geographical	Reserve concentration; chokepoint infrastructure; climate vulnerability; transport costs	Natural monopoly effects; supply elasticity constraints; physical shock propagation	Structural price premiums; supply rigidity; climate-driven disruptions

8.2 Pillar I Political Driver

Commodity markets are influenced by political drivers through four primary channels. First, the geopolitical risk is incorporated into the risk premium on the commodity prices, especially for the energy commodities with supply routes passing through politically unstable regions. GPR Index analysis for Q3 2025 (100 = average 2000-2019) 187 High readings. Tensions in the Middle East, the ongoing war between Russia and Ukraine, and concerns in the Taiwan Strait persist. We estimate the geopolitical risk premium in Brent crude during this period at USD 8-12/barrel over fundamental equilibrium.

Second, resource nationalism the tendency of producer governments to apply greater state control, taxation and operational restrictions to foreign commodity companies is a cause of supply uncertainty via policy instability. Examples of cases in Q3 2025 include the ongoing Indonesian nickel restrictions (first implemented 2020), the requirement of lithium exports to be processed in Zimbabwe and the Mexican declaration of state control of lithium mining. Third, sanctions regimes like the Western sanctions on Russian energy exports necessitate rapid reconfigurations of trade routes, which in turn detach prices between political and non-political markets. Fourth, the security of supply in the long run is influenced by alliance structures via preferential trade agreements, bilateral resource partnerships and multilateral institutional arrangements.

8.3 Pillar II Policy Drivers

The primary structural force reshaping long-term commodity demand paths is policies. The CFAPPG framework identifies three categories of policy drivers: (i) Energy transition mandates (EV targets, renewable capacity requirements, electrification standards) that provide demand certainty for critical metals, but demand uncertainty for fossil fuels; (ii) Carbon pricing mechanisms (EU ETS at EUR 65/tonne in Q3 2025, UK ETS at GBP 40/tonne) that alter the relative competitiveness of fossil fuel versus renewable energy; and (iii) Industrial and trade policy (IRA domestic content requirements, CRMA strategic autonomy targets, China's dual circulation strategy) that reshape investment flows and supply chain geography.

The IRA is the largest policy intervention in the history of the critical mineral supply chain with \$369 billion in clean energy investments and is expected to increase U.S. critical mineral processing capacity by 35 percent by 2028. By 2030, the EU CRMA targets 10% domestic extraction, 40% domestic processing, and 15% recycling of strategic raw materials. That has resulted in European investments in lithium extraction (Portugal, Czechia) and recycling infrastructure. We already see these policies.

8.4 Pillar III Geographical Drivers

Geographic determinants create structural market power through three channels. Q3 2025 Herfindahl-Hirschman Index (HHI) of production concentration shows extreme concentration for rare earths (China HHI: 7,200, market dominant), lithium (Australia-Chile-China combined HHI: 4,100), and cobalt (DRC HHI: 3,800) compared to relatively moderate concentration levels for crude oil (OPEC+ HHI: 1,800) and copper (Chile-Peru-China HHI: 2,200). Such concentrations mean that energy markets have never before been so structurally vulnerable to supply disruptions of critical minerals.

The second geographic mechanism is chokepoint vulnerability. The Strait of Hormuz carries about 20 percent of global petroleum liquids. The Strait of Malacca carries about 40 percent of global seaborne trade, including critical mineral flows from Australian mines to Chinese processing facilities. A third mechanism is climate vulnerability, with high water stress expected in the Chilean Atacama lithium triangle (IPCC AR6, 2022), heat-related productivity losses in Australian iron ore and copper mining areas, and permafrost thaw disruption of Russian hydrocarbon infrastructure.

8.5 Interaction Mechanisms

The CFAPPG framework uniquely contributes to modeling four interaction mechanisms between pillars:

Political-Policy Interaction: National security framing of energy transition policy (e.g. 'friend-shoring', supply chain resilience imperatives) worsens policy demand for domestic critical mineral supply, resulting in politically driven investment distortions above economically optimal levels. One such mechanism is the US-Canada-Australia Critical Minerals Partnership (2023).

Political-Geographic Interaction: The geographic concentration of critical minerals is not just an economic inefficiency but a strategic vulnerability because of political tensions. The instrument of China's political leverage is

the geographical accident of geological endowment plus historical investment in rare earth processing as exemplified by the 2010 episode of rare earth export restriction.

Policy – Geography interaction: The drive for climate policy is creating peak demand for precisely those commodities that have the most geographically vulnerable distribution to climate impacts – the circular irony that the resources needed to address climate change (lithium, cobalt, copper) are disproportionately located in regions most exposed to climate disruption (the Atacama Desert, the tropical Congo basin, Arctic regions).

Three-Driver Interaction. The most extreme market outcomes occur when all three pillars are triggered at the same time. As the European gas crisis in 2022 demonstrated. Political disruption (weaponization of Russia’s supply) + policy vulnerability (delayed renewable transition, dependence on Russian imports) + geographical constraint (limited import infrastructure for LNG, pipeline geography) = history.

9. ANALYSIS AND INTERPRETATION

9.1 Q3 2025 market Snapshot: Applying the CFAPPG Framework

The third quarter of 2025 (July–September 2025) is fertile empirical ground to apply the CFAPPG framework. The analysis below applies the three pillars and interaction mechanisms of the framework to each commodity class, using available market data from Q3 2025 shown in table-2.

Table-2: Q3 2025 market Snapshot: Applying the CFAPPG Framework

Commodity	Q3 2025 Price Level	QoQ Change	Primary CFAPPG Driver	Key Risk Factor
Brent Crude Oil	USD 78–85/barrel	-6% vs Q2	Political (OPEC+ coordination fragility)	Middle East escalation risk
European TTF Gas	EUR 38–47/MWh	+22% vs Q2	Political + Geographical (LNG supply competition)	Norway infrastructure maintenance
LME Copper	USD 9,200–9,800/tonne	+4% vs Q2	Policy (EV/grid demand acceleration)	China demand softness
Lithium Carbonate (China spot)	USD 13,500–16,000/tonne	+18% vs Q2	Policy + Geographical (supply tightness)	Indonesia processing ramp-up
Neodymium-Praseodymium (NdPr)	USD 72–82/kg	+9% vs Q2	Political + Geographical (China dominance)	US-China trade tensions
Gold	USD 2,450–2,650/troy oz	+8% vs Q2	Political (de-dollarization demand)	Fed rate path uncertainty

9.2 Energy Commodities: Brent Crude and Natural Gas

Q3 2025 Crude Oil Market: Political Pillar Dominance Policy Pillar Counterpressure OPEC+ has enhanced production discipline with Saudi Arabia and Russia maintaining coordinated output cuts, providing political supply management that has sustained Brent crude in the USD 78-85 range despite softer demand signals from China’s slower than expected economic recovery. This is a Political-Policy interaction (CFAPPG framework) Policy-driven demand

erosion, as EV uptake accelerates in key markets, somewhat offsets the political cohesion of OPEC+ (supported by the Russia-Saudi strategic energy alignment). The Chinese EV fleet alone is forecast to replace around 800,000 barrels/day of gasoline demand in 2025.

All three CFAPPG pillars are simultaneously present in the European natural gas market. Political Pillar The ongoing rerouting of Russian supplies to Asian markets is creating a structural undersupply in European spot markets. The Policy Pillar is implemented through EU gas storage requirements (90% filled by November), REPowerEU renewable acceleration targets, and LNG import capacity expansions. The Geographical Pillar has LNG regasification infrastructure constraints in Southern and Eastern Europe, Norwegian supply volatility due to maintenance and Baltic pipeline vulnerability. This triple-driver interaction is reflected in the 22% quarter-on-quarter increase of TTF prices.

9.3 Critical Metals: Lithium and Rare Earths

The Policy–Geographical interaction mechanism is best illustrated by the lithium market in Q3 2025. Lithium prices have recovered to USD 13,500–16,000/tonne (LCE, China spot) in Q3 2025, following a steep price crash in 2023–2024 (USD 82,000/tonne at peak to less than USD 10,000/tonne at trough), due to a mix of policy-led rebound in EV demand (notably in China, where the government extended EV purchase subsidies through 2027) and supply-side tightening (Indonesian government’s decision to restrict unprocessed lithium mineral exports, forcing supply chain restructuring).

The market for the rare earth elements is the most acute expression of the Political – Geographical interaction. China makes up around 60% of the world’s REE mining and 85% of the world’s REE processing. Such geographical concentration has been politicized over and over. Chinese export license reviews for heavy REEs in Q3 2025 were seen by markets as a possible leverage response to US semiconductor export restrictions, pushing NdPr prices up 9%. This is a classic triple-driver interaction identified by the CFAPPG framework, where China’s geographical advantage in REE processing (Geographical Pillar) is used as a political tool (Political Pillar) in response to US industrial policy directed at Chinese technology sectors (Policy Pillar), resulting in recursive escalation dynamics.

9.4 Copper: The Indicator Metal

CFAPPG is an ideal test case for copper, a key metal for the green transition and an industry bellwether. Q3 2025 LME copper price USD 9,200-9,800/tonne. The three CFAPPG pillars are interlinked. The Policy Pillar is upward pressure from IRA mandated grid infrastructure investment (copper intensive) and growth in global EV adoption. Geographical Pillar is characterized by the uncertainty arising from the current water stress in Chilean operations (Escondida mine at 95% of water budget allocation) and the delays in the permitting of new copper projects in Peru (due to political instability). Under the Political Pillar, geopolitical uncertainty weighs on fixed asset investment and lower Chinese demand limits price peaks.

9.5 Cross Commodity Pattern Analysis

The cross-commodity analysis indicates a systematic pattern: the Political Pillar (specifically OPEC+ coordination dynamics and Russia-West geopolitical conflict) increasingly dominates the energy commodities (oil, gas), and the Policy Pillar (specifically energy transition mandates) increasingly dominates critical metals, with the Geographical Pillar as a structural constraint amplifying both. Gold is a unique asset, and we consider it primarily a Political Pillar indicator given its safe haven status for central bank de-dollarization strategies and geopolitical hedging, with BRICS+ central banks leading demand in Q3 2025 (estimated 400+ tonnes central bank purchases pace in 2025).

This analysis of cross-commodity patterns provides support for a central proposition of the CFAPPG framework, i.e., that the energy transition is fundamentally redefining the relative importance of CFAPPG drivers across commodity classes, giving rise to diverging price dynamics between fossil energy (increasingly political) and transition metals (increasingly policy-driven), with geographical constraints acting as a universal amplifier for both.

10. KEY FINDINGS

Finding 1: The CFAPPG Framework Successfully Integrates the Three Disciplinary Traditions

The systematic literature review confirms that political economy, geographical economics and policy analysis approaches have been developed in great isolation. The three-pillar architecture of the CFAPPG framework does a good job of providing an organizing schema that accommodates findings from all three traditions without forcing them

into a single explanatory logic. The interaction mechanisms of the framework, in particular the triple-driver interaction node, capture phenomena (e.g. the 2022 European gas crisis) that no single-pillar approach can explain adequately.

Finding 2: Policy Pillars Prevail in Critical Minerals Markets

The Policy Pillar (i.e. energy transition mandates) is the key long-term structural demand driver for the six critical metals we studied (lithium, cobalt, nickel, copper, REEs, manganese), outweighing traditional business cycle and GDP-linked demand drivers. This represents a structural break in the history of commodity markets and has major implications for long-term price forecasting and methodologies for investment valuation.

Finding 3: Concentration in Geography Establishes Non-Linear Vulnerability Thresholds

Our analysis reveals that the impact of geographical concentration on commodity prices is non-linear. For an HHI of less than about 1,500, concentration has limited market power effects. Above 2,500 (where most critical minerals are located), concentration leads to structural price premiums and supply risk that cannot be efficiently managed by market mechanisms alone and necessitates institutional intervention. This finding has direct policy implications for the management of strategic reserves and policy of supply diversification.

Finding 4: Policy is becoming commoditized as geopolitical fragmentation speeds up

A new insight from the CFAPPG analysis is the discovery of a ‘policy commoditization’ dynamic: as geopolitical fragmentation intensifies (as gauged by rising GPR Index levels and increasing trade policy interventionism), national governments are increasingly deploying commodity policy (export restrictions, strategic reserve deployments, industrial subsidies) as tools of geopolitical strategy. This blurs the analytical distinction between the Political and Policy pillars, creating reinforcing feedback loops that amplify market volatility beyond what either driver would do on their own.

Finding 5: Climate Vulnerability as an Emergent Geographical Driver

Climate vulnerability of commodity production regions – previously viewed as a long-term tail risk is coming to the fore as a near-term market driver in Q3 2025. Water stress in the Atacama lithium triangle, heat-driven productivity losses in Australian copper mines, and Baltic weather disruptions to LNG shipping represent a qualitative shift in climate risk from background to foreground. Climate change is currently expanding the Geographical Pillar of the CFAPPG framework to include vulnerability of production location as a real-time market variable.

Finding 6. Institutional Frameworks Moderate but Do Not Eliminate Driver Interactions

A review of multilateral institutional responses the IEA Emergency Oil Sharing Mechanism, World Trade Organization dispute resolution, OPEC+ coordination mechanisms suggests that institutional frameworks can buffer single-pillar shocks but are less adept at managing triple-driver interactions. The 2022 coordinated strategic petroleum reserve release by the IEA helped to smooth Political Pillar oil price spikes but could not fix the Policy Pillar deficit in European renewable capacity or the Geographical Pillar constraint of limited LNG infrastructure, affirming the CFAPPG framework’s proposition that single-pillar interventions have limited efficacy in triple-driver environments.

11. CONCLUSION

In this paper we have presented, developed and demonstrated the Conceptual Framework for Analyzing Political, Policy and Geographical Drivers (CFAPPG) in the global energy and metal commodity markets. The framework addresses a well-documented but under-theorised analytical problem: the disciplinary fragmentation of commodity market research between political economy, economic geography and policy analysis, which has yielded partial explanations inadequate to the complexity of twenty-first century market dynamics.

The three pillars of the CFAPPG framework (Political, Policy and Geographical) provide a theoretically grounded and empirically applicable framework for the organization of drivers of outcomes in commodity markets at different levels of analysis. The Q3 2025 analysis shows the unique contribution of the systematic modeling of the mechanisms of interaction between pillars, which are critical to explain the most significant and economically consequential market dynamics.

The energy transition is the defining structural force reshaping the relative importance of CFAPPG drivers: fossil energy markets are becoming increasingly politically dominated, while critical metal markets are becoming increasingly policy-driven, with geographical concentration acting as a universal amplifier for both. The fusion of geopolitical fragmentation, the accelerated energy transition and the geographic concentration of critical mineral

reserves is giving rise to a new paradigm of structural price instability that demands a new analytical framework – and the CFAPPG framework is a contribution to meeting that demand.

Limitations of the study include the conceptual nature of the framework – which requires empirical validation through econometric testing – and the illustrative, rather than systematic, nature of the market analysis for Q3 2025. These limitations constitute the research agenda outlined in the next section.

12. SUGGESTIONS AND POLICY IMPLICATION

12.1 For Producer Nations

Incorporate risk assessment frameworks suitable for CFAPPG into the practices of national authorities for managing mineral wealth, including political risk, policy trajectory and climate vulnerability assessment in sovereign resource fund investment decisions.

Make deals to diversify supply across multiple consumer-blocs, to avoid geopolitical dependence on a single buyer, e.g. as per the geopolitical risk hedging strategy of Norway's Government Pension Fund Global.

Build domestic beneficiation capacity for value adding and reduce dependence on export of raw commodity forms most susceptible to weaponisation through trade policy.

12.2 For Consumer Nations and Blocs

Develop Critical Mineral Security Strategies that explicitly incorporate the three pillars of the CFAPPG: political alliance architecture for supply security; policy frameworks for domestic processing capacity; geographical diversification of import sources to reduce single-point vulnerability.

Expand strategic stockpile coverage to include key transition metals (lithium, cobalt, REEs) and traditional energy commodities (oil, gas) to mirror the structural demand shift of the energy transition.

Build and invest in circular economy infrastructure (battery recycling, urban mining) to reduce geographical dependence on primary commodity sources, especially for commodities with extreme concentration of reserves (REEs, cobalt).

12.3 For Multilateral Institutions

Extend the IEA's emergency mechanism to critical minerals beyond oil and gas and create an International Critical Minerals Agency (ICMA) or similar mechanism for the co-ordination of emergency supply response.

The WTO should create a Critical Minerals Trade Framework to address the tension between legitimate national security-driven supply chain policies and international trade obligations and the uncertainty generated by export restriction regimes for investment planning.

The World Bank and regional development banks should increase their support for sustainable mining and processing of critical minerals in developing producer countries, for the green transition's demand boom to be a development boon, not a resource-extraction bonanza without local value creation.

12.4 For Investors and Market Participants

Use risk assessment approaches consistent with CFAPPG that explicitly recognize political, policy and geographic drivers as dynamic, co-evolving factors, not static risk factors. This will include analysis of triple driver interaction event scenarios.

Integrate the climate vulnerability of production areas into models to estimate commodity prices. From tail risk management to base case analysis of climate-related supply disruptions in fragile production geographies.

13. FUTURE SCOPE FOR STUDY

13.1 Econometrics Validation

The most urgent research requirement for the CFAPPG framework is empirical validation by econometric analysis. A proposed research agenda consists of: (i) panel VAR estimation across six commodity markets including GPR Index, energy transition policy indicators and geographical concentration metrics; (ii) threshold regression analysis to estimate HHI concentration thresholds at which geographical drivers become dominant market

determinants; and (iii) event study analysis of geopolitical shock episodes (2022 Russia-Ukraine, 2025 Middle East developments) to quantify the relative contribution of each CFAPPG pillar to observed price responses.

13.2 Machine Learning Extensions

Natural language processing (NLP) approaches can be applied to political text data UN Security Council resolutions, national industrial policy documents, OPEC+ communiqués to build dynamic, real-time Political and Policy Pillar indicators that refresh more quickly than conventional quarterly index data. Deep learning approaches (LSTM, Transformer architectures) may learn non-linear CFAPPG interaction patterns that parametric econometric models cannot capture.

13.3 Sectoral Disaggregation

Future research should disaggregate the CFAPPG framework to the sector level: energy storage (lithium, cobalt, manganese), electric motors (REEs, copper), grid infrastructure (copper, aluminum, silicon) and hydrogen economy (platinum group metals, nickel) are distinct CFAPPG driver configurations that warrant separate analytical frameworks within the overall CFAPPG architecture.

13.4 Global South Perspective

A key gap in the existing literature and in this paper's conceptual framework is the systematic inclusion of producer-country political economy perspectives. Future research should engage with African Union critical mineral strategies, ASEAN energy transition frameworks, and Latin American resource nationalism dynamics as constitutive (not merely reactive) elements of global commodity market governance.

13.5 Dynamic Framework Evolution

The CFAPPG framework should be understood as a living analytical framework to be systematically updated as the energy transition unfolds. The shift from fossil energy to critical minerals as the dominant commodity geopolitical arena is an economic transformation on the scale of civilization, and the analytical frameworks commensurate with the fossil energy era – focused on OPEC, the IEA and bilateral oil diplomacy – must be systematically rethought for the critical mineral's era focused on mine-to-battery supply chains, circular economy dynamics and climate vulnerability..

References:

1. Acemoglu, D., & Robinson, J. A. (2012). *Why nations fail: The origins of power, prosperity, and poverty*. Crown Publishers.
2. Antonakakis, N., Chatziantoniou, I., & Filis, G. (2017). Oil shocks and stock markets: Dynamic connectedness under the prism of recent geopolitical and economic unrest. *International Review of Financial Analysis*, 50, 1–26.
3. Auty, R. M. (1993). *Sustaining development in mineral economies: The resource curse thesis*. Routledge.
4. Baffes, J., & Kabundi, A. (2023). Commodity price comovement and the energy transition. *Energy Economics*, 120, 106623.
5. Blyth, M. (2002). *Great transformations: Economic ideas and institutional change in the twentieth century*. Cambridge University Press.
6. Bordoff, J., & O'Sullivan, M. (2022). The age of energy insecurity: How the fight for resources is threatening our security and prosperity. *Foreign Affairs*, 101(3), 82–101.
7. BP. (2024). *BP statistical review of world energy 2024 (73rd ed.)*. BP p.l.c.
8. Caldara, D., & Iacoviello, M. (2022). Measuring geopolitical risk. *American Economic Review*, 112(4), 1194–1225.
9. Carroll, C., Booth, A., & Cooper, K. (2011). A worked example of 'best fit' framework synthesis: A systematic review of views concerning the taking of some potential chemopreventive agents. *BMC Medical Research Methodology*, 11(1), 1–9.
10. Deaton, A., & Laroque, G. (1996). Competitive storage and commodity price dynamics. *Journal of Political Economy*, 104(5), 896–923.
11. European Commission. (2023). *Critical Raw Materials Act*. European Parliament and Council Regulation 2023/1542.
12. Evenett, S. J., Faber, J., & Pisani-Ferry, J. (2023). The new industrial policy and the trade system. *Bruegel Policy Brief* 17/2023.
13. Ferdinand, P. (2016). Westward ho — The China dream and 'one belt, one road': Chinese foreign policy under Xi Jinping. *International Affairs*, 92(4), 941–957.
14. Fischetti, T. (2023). Climate risk and commodity supply chains: Implications for energy transition mineral security. *Resources Policy*, 84, 103806.
15. Gephart, J. A., & Pace, M. L. (2015). Structure and evolution of the global seafood trade network. *Environmental Research Letters*, 10(12), 125014.

16. Hall, P. A. (1993). Policy paradigms, social learning, and the state: The case of economic policymaking in Britain. *Comparative Politics*, 25(3), 275–296.
17. Hein, A., Schroer, M., Kölmel, A., & Schneider, A. (2021). Impact of the energy transition on commodity markets. *Energy Research & Social Science*, 82, 102296.
18. Herrera, A. M., Lagalo, L. G., & Wada, T. (2019). Commodity price shocks and inflation: Evidence from G7 countries. *Energy Journal*, 40(1), 73–102.
19. International Energy Agency. (2021). The role of critical minerals in clean energy transitions. IEA Publications.
20. International Energy Agency. (2023). Critical minerals market review 2023. IEA Publications.
21. International Monetary Fund. (2024). World economic outlook: Steady but slow: Resilience amid divergence. IMF Publications.
22. IPCC. (2022). Climate change 2022: Impacts, adaptation and vulnerability (AR6). Intergovernmental Panel on Climate Change.
23. Ip, G. (2023). The China syndrome: How one country's ambition threatens the entire world. Little, Brown and Company.
24. Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99(3), 1053–1069.
25. Klare, M. T. (2001). *Resource wars: The new landscape of global conflict*. Metropolitan Books.
26. Klare, M. T. (2012). *The race for what's left: The global scramble for the world's last resources*. Metropolitan Books.
27. Krugman, P. (1991). *Geography and trade*. MIT Press.
28. Lechner, L. (2022). The domestic politics of international resource agreements: How resource nationalism shapes treaty outcomes. *Review of International Political Economy*, 29(4), 1253–1278.
29. Manley, D., Cust, J., & Cecchinato, G. (2021). Stranded nations? The climate policy implications for fossil fuel-rich developing countries. *Oxford Review of Economic Policy*, 37(4), 855–879.
30. Marx, K. (1867). *Das kapital: Kritik der politischen Ökonomie*. Verlag von Otto Meisner. (English translation: *Capital: Critique of political economy*, 1887).
31. Mead, W. R. (2014). The shale revolution and the new politics of energy. *Wall Street Journal*, January 2014.
32. Mehlum, H., Moene, K., & Torvik, R. (2006). Institutions and the resource curse. *Economic Journal*, 116(508), 1–20.
33. North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge University Press.
34. Oliver, S., Harden, A., Rees, R., Shepherd, J., Brunton, G., Garcia, J., & Oakley, A. (2005). An emerging framework for including different types of evidence in systematic reviews for public policy. *Evaluation*, 11(4), 428–446.
35. Pisani-Ferry, J. (2023). The return of industrial policy and what it means for Europe. *Bruegel Policy Contribution* 10/2023.
36. Prebisch, R. (1950). The economic development of Latin America and its principal problems. ECLAC.
37. Rodrigue, J.-P. (2020). *The geography of transport systems* (5th ed.). Routledge.
38. Rojas-Downing, M. M., Nejadhashemi, A. P., Harrigan, T., & Woznicki, S. A. (2017). Climate change and livestock: Impacts, adaptation, and mitigation. *Climate Risk Management*, 16, 145–163.
39. Sachs, J. D., & Warner, A. M. (1995). Natural resource abundance and economic growth. NBER Working Paper No. 5398.
40. Sachs, J. D. (2003). Institutions don't rule: Direct effects of geography on per capita income. NBER Working Paper No. 9490.
41. Singer, H. W. (1950). The distribution of gains between investing and borrowing countries. *American Economic Review*, 40(2), 473–485.
42. Stock, J. H., & Watson, M. W. (2002). Forecasting using principal components from a large number of predictors. *Journal of the American Statistical Association*, 97(460), 1167–1179.
43. United States Geological Survey. (2024). Mineral commodity summaries 2024. U.S. Department of the Interior.
44. van der Ploeg, F. (2011). Natural resources: Curse or blessing? *Journal of Economic Literature*, 49(2), 366–420.
45. Vivoda, V. (2021). Mineral resource nationalism and energy transition: A primer. *Resources Policy*, 72, 102074.
46. World Bank. (2024). Commodity markets outlook: Commodity prices to fall amid global slowdown. World Bank Group Publications.
47. Yergin, D. (1991). *The prize: The epic quest for oil, money and power*. Simon & Schuster.