# Critical Minerals and Weaponized Interdependence: Structural Power and Institutional Conditions for Preferential Access in North America



## *Minerais críticos e interdependência armada: poder estrutural e condições institucionais de acesso preferencial na América do Norte*

## *Minerales críticos e interdependencia armada: poder estructural y condiciones institucionales de acceso preferencial en Norteamérica*

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ABSTRACT

The reshaping of the global economic order and the energy transition have placed critical minerals at the heart of geoeconomic rivalry, exposing North America to vulnerabilities stemming from concentrated processing capacity, technological control, and weaponized interdependence across value chains. This article examines the systemic and institutional conditions for establishing a North American regional critical minerals club, considering asymmetric dependencies and industrial policy compatibility while assessing the associated distributive and socioenvironmental externalities. The findings indicate that preferential access to processed minerals yields institutional benefits for club members without changing the minerals' status as rivalrous private goods, while cross-border cooperative arrangements support credible commitments and long-term investment. Yet implementation faces regulatory barriers, fiscal asymmetries, limited technological substitutes, adjustment costs, and risks of weakened regional integration. The article concludes that legitimate and sustainable regional economic security requires a mission-oriented institutional framework that combines effective fiscal coordination, strategic reserves, and territorial justice safeguards to manage production and technological asymmetries.

**Keywords:** Energy transition, Power asymmetries, Regional economic integration, Strategic autonomy, Technological dependence.

RESUMO

A reconfiguração da ordem econômica global e a transição energética colocaram os minerais críticos no centro da disputa geoeconômica, expondo a América do Norte a vulnerabilidades decorrentes da concentração do processamento, do controle tecnológico e da interdependência armada nas cadeias de valor. O artigo examina as condições sistêmicas e institucionais para a

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criação de um clube norte-americano de minerais críticos, considerando as dependências assimétricas e a compatibilidade entre políticas industriais e avaliando suas externalidades distributivas e socioambientais. Os resultados mostram que o acesso preferencial a minerais processados proporciona benefícios institucionais aos integrantes do clube sem modificar a natureza desses minerais como bens privados rivais, mediante mecanismos de cooperação que favorecem compromissos críveis e investimentos de longo prazo. Contudo, a implementação enfrenta entraves regulatórios, assimetrias fiscais, limitações à substituição tecnológica, custos de ajuste e riscos de enfraquecimento da integração. Conclui-se que uma segurança econômica regional legítima e sustentável requer um arranjo institucional orientado por missões, capaz de articular coordenação fiscal, reservas estratégicas e salvaguardas de justiça territorial para lidar com assimetrias produtivas e tecnológicas.

**Palavras-chave:** Assimetrias de poder, Autonomia estratégica, Dependência tecnológica, Integração econômica regional, Transição energética.

**RESUMEN**

La reconfiguración del orden económico global y la transición energética han situado los minerales críticos en el centro de la rivalidad geoeconómica, exponiendo a América del Norte a vulnerabilidades derivadas de la concentración del procesamiento, del control tecnológico y de la interdependencia armada en las cadenas de valor. El artículo analiza las condiciones sistémicas e institucionales para formar un club regional norteamericano de minerales críticos, considerando las dependencias asimétricas y la compatibilidad industrial, y evaluando sus externalidades distributivas y socioambientales. Los resultados indican que el acceso preferencial a minerales procesados genera beneficios institucionales de club sin alterar su naturaleza de bienes privados rivales, mediante una arquitectura de cooperación que favorece compromisos creíbles e inversiones de largo plazo. No obstante, la viabilidad operativa enfrenta fricciones regulatorias, asimetrías fiscales, restricciones de sustitución tecnológica, costos de ajuste y riesgos de degradación de la integración. Se concluye que un diseño orientado por misiones, con coordinación fiscal, reservas estratégicas y salvaguardias de justicia territorial, capaz de gestionar asimetrías productivas y tecnológicas, constituye una condición necesaria para una seguridad económica regional legítima y sostenible.

**Palabras clave:** Asimetrías de poder, Autonomía estratégica, Dependencia tecnológica, Integración económica regional, Transición energética.

## 1 INTRODUCTION

The reconfiguration of the international geoeconomic order has placed critical minerals at the center of strategic competition, revealing that the most significant vulnerabilities in global value chains stem not from geological scarcity but from the geographic concentration of processing and refining capacity and control over specialized technologies (Kalantzakos, 2020; Vivoda et al., 2024). Rather than signaling a breakdown of complex interdependence, these conditions illustrate how asymmetric dependencies within transnational production networks create substantial bargaining advantages and opportunities for economic coercion (Farrell; Newman, 2019; Keohane; Nye, 1977). Against this backdrop, the accelerating energy transition and expansion of advanced manufacturing are intensifying competition for strategic

inputs, making control over intermediate stages of production a key determinant of national economic security (Deberdt et al., 2026).

Understanding these dynamics requires integrating club goods theory with approaches to global value chain governance and structural power. Club goods theory helps explain how, although minerals themselves remain rivalrous private goods, the institutional benefits associated with coordinated preferential access can take on the characteristics of exclusive club goods available to participating members (Buchanan, 1965; Sandler, 2004). This institutional logic intersects with hierarchies of production coordination (Strange, 1988; Gereffi et al., 2005), in which the capacity to organize information flows, reduce transaction costs, and provide greater certainty for fixed-capital investment shapes the credibility of collective commitments and the forms of regional cooperation that can emerge (Keohane, 1984; Ponte; Sturgeon, 2014).

Despite growing scholarly interest in raw material security, a persistent analytical misconception equates abundant mineral deposits with effective control over value chains, overlooking the distinct role of processing and refining (Andrieu et al., 2025). A related theoretical gap concerns how technological bottlenecks shape relative power within deeply integrated regional production systems (Cuevas Verdin et al., 2026). The central research challenge, therefore, is to determine whether efforts to diversify supply chains can reduce asymmetric dependencies or instead redistribute vulnerabilities among regional partners within North America's integrated production system (Pavlínek, 2024).

The systemic consequences of these dynamics extend beyond trade to affect macroeconomic stability and regional productive autonomy. Increasing returns and path-dependent processes create persistent structural constraints that raise the cost of developing alternative refining and manufacturing capacity (Pierson, 2000; Firmanto et al., 2025). At the same time, uncertainty surrounding expected returns and differences in risk premiums affect the cost of capital for capital-intensive projects (Vivoda, 2026). Together, these conditions not only threaten the continuity of industrial production and supply flows in the face of external shocks but also exacerbate inequalities in the geographic distribution of value added and the disproportionate concentration of socioenvironmental burdens in mineral extraction regions (Davis et al., 2018; Malone et al., 2024).

Against this background, this article examines how the concentration of technological control and critical mineral processing capacity shapes the governance of North American supply chains. Its theoretical contribution lies in moving beyond conventional geological determinism by developing analytical distinctions that help identify the institutional conditions under which trilateral cooperation can establish credible commitments to preferential access to strategic inputs (Ufimtseva et al., 2024). The analysis also provides a basis for assessing the political sustainability of such arrangements in relation to institutional legitimacy and distributive equity.

The article begins by examining the economic and institutional conditions governing preferential access to processed critical minerals,

with particular attention to supply uncertainty and investment incentives. It then analyzes the asymmetric interdependencies and bargaining power arising from concentrated processing capacity and technological control, alongside differences in industrial policy and institutional development across the three North American countries. Finally, the analysis considers the operational feasibility of trilateral governance and the territorial consequences of how value added and socioenvironmental costs are distributed, including their implications for the political legitimacy of regional cooperation.

## 2 CREDIBILITY OF PREFERENTIAL ACCESS COMMITMENTS FOR CRITICAL MINERALS

The analytical viability of a North American critical minerals club depends, first and foremost, on clearly identifying the benefits that regional cooperation could provide, rather than on the economic characteristics of the minerals themselves. Conventional approaches to minerals in international trade theory have generally treated them either as private goods allocated through markets or as strategic commodities whose supply may be subject to government intervention. Neither perspective adequately captures the institutional conditions under which preferential access to processed minerals could generate collective benefits for a defined group of countries. A more useful theoretical starting point is the classification of goods developed in Buchanan's seminal theory of clubs (Buchanan, 1965), which establishes that nonmembers can be excluded from collectively provided benefits while members share in their consumption, subject to congestion and capacity constraints. The central proposition, therefore, is that a regional arrangement can provide club benefits without turning the minerals traded within it into club goods.

From this perspective, critical minerals, whether extracted, refined, or incorporated into industrial components, remain rivalrous private goods: a quantity consumed by one producer cannot simultaneously be consumed by another. Instead, the collective institutional benefits associated with preferential access may exhibit the characteristics of club goods, provided that participation can be restricted and members can derive identifiable shared advantages from cooperation (Buchanan, 1965; Sandler, 2004). Such advantages may include access to shared information about supply conditions, greater predictability in commercial relationships, and agreed procedures for determining eligibility for preferential treatment. A regional arrangement must therefore distinguish between the conditions of membership and the allocation of physical supplies, which remains constrained by production capacity and competing demand. Preferential access may improve the terms under which members obtain minerals, but membership alone cannot guarantee adequate supplies.

The significance of this distinction extends beyond the classification of goods. It bears directly on investment under uncertainty, one of the most significant obstacles to diversifying supply chains. Investment

in mineral processing requires substantial fixed capital, specialized infrastructure, technical expertise, and expectations of sustained demand. Its attractiveness depends on several factors, including feedstock availability, commodity prices, regulatory predictability, and financing conditions (Firmanto et al., 2025; Vivoda, 2026). Supply uncertainty becomes particularly consequential when prospective investors cannot reliably anticipate access to feedstocks or downstream markets. Regional cooperation may help reduce such uncertainty, although its effectiveness depends on whether the commitments undertaken are credible enough to shape investment expectations.

In this context, a regional club could strengthen institutional credibility by establishing transparent membership criteria, predictable access conditions, and commitments that participating governments have incentives to uphold. International institutions can facilitate information sharing, reduce transaction costs, and support cooperation under uncertainty, but they cannot eliminate investment risks simply by virtue of their existence (Keohane, 1984). Credible commitments require more than formal declarations. Their reliability depends on clearly defined obligations, alignment among participating governments' interests, and expectations of future compliance. Existing economic ties among the United States, Canada, and Mexico may provide a foundation for such commitments, but their credibility in the critical minerals sector cannot be inferred from broader trade agreements alone.

The effects on investment incentives operate through distinct but interconnected channels. Predictable access conditions may reduce uncertainty about feedstock availability and future demand for processed minerals. Credible commitments may also strengthen expectations that institutional arrangements will remain in place throughout the investment horizon. Taken together, these conditions could make projects involving complementary processing activities more attractive to investors. Whether greater predictability translates into actual investment, however, depends on project profitability, technological feasibility, market conditions, and access to financing (Vivoda, 2026). Institutional cooperation should therefore be understood as one potential factor shaping investment decisions, not as a sufficient condition for expanding regional processing capacity.

Risk premiums and the cost of capital also play an important role in this relationship. Investors may demand higher expected returns when projects face considerable regulatory, supply, demand, or contractual uncertainty. To the extent that credible institutional commitments reduce specific sources of perceived risk, they may help create more favorable financing conditions. However, the magnitude and direction of their effects cannot be determined without considering other factors, including interest rates, project-specific risks, capital structure, and expected revenues. Lower uncertainty does not necessarily translate into an automatic or proportional reduction in the cost of capital. The analytical challenge, therefore, is to identify the institutional conditions that may influence risk assessments while accounting for the independent effects of financial and commercial factors (Keohane, 1984; Vivoda, 2026).

Beyond investment considerations, club goods theory helps clarify the collective-action problem involved in organizing preferential access among countries with different supply needs and expectations of cooperation. Although cooperation can generate shared benefits, individual participants may have incentives to minimize their contributions while continuing to benefit from collective arrangements (Olson, 1965). Membership requirements and reciprocal commitments are therefore important because they can make access conditional on agreed obligations and reduce uncertainty about other participants' behavior. At the same time, differences in demand, existing processing capacity, and investment priorities may complicate how the costs of cooperation are distributed. The economic case for a regional club must consequently be grounded in identifiable net benefits for each participating country, rather than an assumption that their interests necessarily align (Buchanan, 1965; Sandler, 2004).

Within this theoretical framework, excludability also provides a basis for defining membership. Club goods theory holds that the appropriate size and composition of a club depend on the balance between the additional benefits of participation and the costs of accommodating new members (Buchanan, 1965; Sandler, 2004). For the United States, Canada, and Mexico, a preferential arrangement could build on established trade relationships and opportunities to develop complementary processing activities. However, neither geographic proximity nor participation in a shared trade framework is sufficient to establish that trilateral membership is economically optimal. Determining whether such an arrangement is warranted requires assessing whether the anticipated gains from more predictable access and coordinated investment outweigh the costs of sustaining credible commitments and managing preferential participation. Club goods theory thus provides a framework for identifying the economic and institutional conditions under which preferential regional cooperation may be viable, while the assessment of specific coordination mechanisms belongs to the subsequent analysis of regional governance.

## 3 ASYMMETRIC INTERDEPENDENCE DRIVEN BY CONCENTRATED MINERAL PROCESSING

The reconfiguration of critical mineral supply chains cannot be explained solely by the internal dynamics of regional economic integration. Incentives to diversify supply relationships also stem from the concentration of processing capacity and technological control within established international production networks. Such concentration matters because economic interdependence does not imply that participating economies depend on one another to the same degree (Keohane; Nye, 1977). The concept of weaponized interdependence further identifies the conditions under which states that occupy strategically important positions in global economic networks can use those positions to exert coercive pressure (Farrell; Newman, 2019). The two approaches are complementary: asymmetric interdependence accounts for differences

in vulnerability and bargaining positions, while weaponized interdependence explains how particular network advantages can be used for coercive purposes.

Critical mineral supply chains are characterized by a high concentration of processing, refining, and specialized technological capabilities, creating dependencies that cannot be understood from the geographic distribution of mineral deposits alone (Kalantzakos, 2020; Deberdt et al., 2026). The strategic importance of these dependencies hinges on whether alternative processing facilities, technologies, and suppliers can be accessed quickly enough to maintain industrial production. Concentrated processing capacity can create bottlenecks when particular facilities or capabilities are difficult to replace, but concentration alone does not make an activity a potential instrument of coercion. Control over access must also be distinguished from the physical location of production, since ownership arrangements, technological specialization, and commercial relationships can place effective control in different jurisdictions (Andrieu et al., 2025; Deberdt et al., 2026). Structural power offers a broader framework for understanding these production and technological asymmetries without assuming that they necessarily result in coercive action (Strange, 1988; Rolf et al., 2026).

The relationship between economic dependence and bargaining power is therefore central to understanding the reconfiguration of regional supply chains. Dependence arises when an actor relies on inputs, technologies, or production capabilities controlled or supplied by others, whereas vulnerability refers to the costs of adjusting when access to those resources is disrupted or restricted (Keohane; Nye, 1977). Bargaining advantages can arise when adjustment costs are unevenly distributed and some participants have more credible alternatives than others (Hirschman, 1945). However, the ability to impose economic costs is distinct from actually imposing them. Coercive capacity requires effective control over a strategically significant point of access, while exercising coercion entails using that control to influence another actor's behavior (Farrell; Newman, 2019). Processing concentration is thus a potential source of bargaining power, but its effects depend on the availability of alternatives, the feasibility of technological substitution, and the distribution of adjustment costs.

The time and technology required to develop mineral processing capacity reinforce the importance of these distinctions. Establishing alternative refining, separation, or component manufacturing facilities may require specialized equipment, accumulated technical expertise, reliable input supplies, and substantial capital investment (Firmanto et al., 2025; Vivoda, 2026). Such requirements can prolong dependence on existing processing centers and raise the costs of responding to supply disruptions. However, these constraints differ across minerals and technologies and do not necessarily imply irreversible dependence. Increasing returns and path dependence help explain the persistence of established production relationships, as accumulated capabilities can make alternative production systems costly to develop (Pierson, 2000). The resulting asymmetries therefore depend in part on how

long it takes to develop viable substitutes and diversify technological capabilities.

Efforts to reduce external vulnerabilities may consequently change the nature of dependence without eliminating its asymmetries. Diversification can reduce exposure to specific external suppliers while increasing reliance on alternative processing facilities, proprietary technologies, or specialized inputs within emerging regional production networks. The strategic significance of such changes lies in how the redistribution of production and technological capabilities affects the alternatives available to each participant (Pavlínek, 2024; Deberdt et al., 2026). Greater regional integration does not necessarily lead to a more balanced distribution of bargaining power, particularly when essential processing activities remain concentrated in a small number of firms or locations. Whether diversification reduces vulnerability must therefore be assessed by examining which dependencies are displaced, reproduced, or created as supply chains are reorganized.

Within North America, the United States, Canada, and Mexico occupy different positions in critical mineral supply chains, reflecting an uneven distribution of extraction activities, processing capacity, industrial demand, and technological expertise (Holley et al., 2025; Téllez-Ramírez; Sánchez-Salazar, 2024). Participation in an integrated regional production system does not mean that these capabilities are evenly distributed or that the three economies face similar costs when adjusting to changes in access. Expanding regional processing capacity could reduce reliance on external suppliers while creating new dependencies among the three countries, depending on where essential production activities are located and who controls them. The key question is therefore how readily each country can find alternative suppliers, gain access to processing technologies, and sustain production when established supply relationships change. Such conditions influence bargaining positions independently of the effectiveness of specific national policy instruments.

Beyond the potential complementarities within North America, the broader restructuring of critical mineral supply chains reflects efforts to reduce exposure to concentrated sources of supply amid geopolitical competition. International initiatives to diversify mineral supply relationships demonstrate the growing emphasis on reducing dependence on established processing centers (Vivoda, 2023; Vivoda et al., 2024). However, developing alternative commercial relationships does not necessarily eliminate existing vulnerabilities. The effectiveness of diversification depends on whether new production networks offer technologically viable substitutes and lower the costs of supply disruptions or restricted access. Likewise, export restrictions illustrate how access to specific materials can become a source of strategic contention, but the use of such measures must be distinguished from the underlying concentration that makes them potentially effective (Farrell; Newman, 2023; Zhou et al., 2025). Maintaining this distinction prevents asymmetric supply relationships from being automatically interpreted as instances of weaponized interdependence.

The material requirements of energy technologies and advanced manufacturing further underscore the strategic importance of processing capacity and technological specialization in international supply chains (Kalantzakos, 2020). Rising demand may increase competition for available processing capacity, although the consequences for dependence and bargaining power vary with the minerals involved, the availability of substitutes, and changes in production capabilities (Moon et al., 2025; Deberdt et al., 2026). For North America, the central implication is that efforts to reduce external supply vulnerabilities may redistribute asymmetric interdependence rather than eliminate it. The resulting bargaining relationships depend on which actors control essential processing capabilities and technologies, how quickly alternative suppliers can be developed, and how adjustment costs are distributed among the United States, Canada, and Mexico. The analysis therefore identifies the conditions under which concentrated capabilities can strengthen bargaining power while preserving the distinction between structural dependence, coercive capacity, and the actual exercise of coercion.

## 4 INDUSTRIAL POLICY DIVERGENCE IN NORTH AMERICA

The development of regional critical mineral supply chains depends in part on how well the industrial strategies of the United States, Canada, and Mexico align. Although all three economies participate in an established framework of regional economic integration, their approaches to critical minerals differ in fiscal capacity, regulatory institutions, industrial specialization, and historical patterns of state intervention. These differences shape the extent to which national strategies can foster complementary production activities or create barriers to trilateral cooperation (Anzolin; Pietrobelli, 2025; Ufimtseva et al., 2024). Domestic political and institutional considerations are especially important because international agreements must be compatible with the interests and constraints of participating governments (Putnam, 1988). The analysis therefore examines national policy frameworks as factors shaping industrial compatibility rather than assuming that shared economic interests automatically lead to regional cooperation.

Mexico's approach to critical minerals is rooted in a constitutional tradition that gives the state a central role in mineral resource ownership and regulation. A key distinction is that public ownership of subsoil resources does not necessarily entail uniform restrictions on exploration, extraction, processing, or commercialization. Recent policy changes concerning lithium have strengthened the state's role in that particular mineral sector, while other mining activities remain governed by different legal and administrative arrangements. The historical concentration of mining activities and the structure of mining and metallurgical industries also shape the production base on which new industrial initiatives would build (Téllez-Ramírez; Sánchez-Salazar, 2024). The compatibility of Mexico's industrial strategy with regional processing development therefore depends on whether its regulatory

framework can accommodate investment, technological capabilities, and participation in higher-value stages of production.

Canada's critical minerals strategy, by contrast, operates within a federal system that divides responsibility for resource development, environmental assessment, and industrial promotion between federal and provincial governments. Provincial authority over mineral resources creates differences in regulatory procedures, investment conditions, and project development requirements, while federal initiatives pursue broader goals of supply chain development and industrial diversification. Recent revisions to Canada's critical minerals strategy reflect evolving policy priorities and the need to coordinate activities across different stages of mineral value chains (Zhang et al., 2026). The resulting institutional framework creates opportunities for specialization but also requires coordination that varies by province and industrial activity. Canada's contribution to trilateral industrial complementarity thus depends on how well national priorities, provincial responsibilities, and available processing and downstream manufacturing capabilities align.

The United States, meanwhile, makes comparatively extensive use of federal industrial policy tools to support domestic manufacturing and strategically important supply chains. Tax incentives, public financing, procurement measures, and investment support are part of a broader strategy that links critical minerals to energy technologies, advanced manufacturing, and economic security (Ufimtseva et al., 2024; Arsenault et al., 2025). However, the effectiveness of these measures in expanding domestic processing capacity depends on more than public funding. Technological feasibility, project costs, input availability, and existing industrial infrastructure also play important roles (Holley et al., 2025). The relationship between U.S. industrial priorities and regional integration is therefore conditional. Policies that expand domestic production capacity may complement activities in Canada and Mexico, but national eligibility requirements and investment priorities may also constrain opportunities for cross-border industrial development.

Fiscal capacity is another important source of variation in the industrial development options available to the three countries. Governments with greater fiscal resources may be able to maintain larger or more diversified support programs, while tighter fiscal constraints can limit the scale, duration, and scope of industrial initiatives. Yet higher public spending does not necessarily translate into more effective industrial policy. Investment outcomes also depend on implementation capacity, prevailing industrial conditions, and how well support measures match production needs (Anzolin; Pietrobelli, 2025; Arsenault et al., 2025). From a comparative perspective, differences in fiscal capacity may encourage complementary specialization when national policies support different stages of production. They may also create competing incentives for industrial activities that could otherwise be distributed across several jurisdictions. The key question, therefore, is how the design and objectives of national support policies influence industrial compatibility, not whether larger fiscal commitments necessarily produce better results.

Institutional trajectories also shape these differences by influencing the policy options available to each government. Path dependence describes processes through which earlier institutional choices generate increasing returns or adjustment costs that make established arrangements difficult to change (Pierson, 2000). In the critical minerals sector, legal traditions, administrative responsibilities, existing industrial activities, and past investment decisions may influence how governments pursue new policy objectives. However, the historical origins of an institutional arrangement are not sufficient evidence of path dependence. Such an explanation requires identifying the mechanisms through which earlier decisions continue to constrain or shape current choices. A comparative assessment must therefore distinguish inherited institutional features from identifiable barriers to policy adaptation while recognizing that regulatory reforms and changing economic conditions can also alter established trajectories.

Mexico's institutional trajectory highlights the need to distinguish mineral resource governance from industrial development policy. State ownership and regulatory authority determine the conditions under which mineral activities take place, but expanding domestic processing capacity also requires productive capabilities, infrastructure, investment, and opportunities for technological development. Experience in mineral extraction does not necessarily translate into the specialized expertise needed for refining or advanced manufacturing, nor does participation in extractive industries guarantee movement into higher-value activities (Pietrobelli; Rabellotti, 2011; Cuevas Verdin et al., 2026). The central question for comparative analysis is therefore whether the institutional framework governing mineral development is compatible with the requirements of processing investment and technological upgrading. Resource ownership arrangements alone cannot establish such compatibility.

Canada's institutional trajectory combines established regulatory responsibilities with evolving industrial development goals. Dividing authority between federal and provincial governments can help policies respond to regional conditions, but it can also complicate coordination between project development procedures and industrial priorities. Environmental assessments and Indigenous consultation requirements are part of the legal and institutional framework governing mineral development. Their implications vary by jurisdiction, project characteristics, and applicable procedures. Such requirements should not automatically be viewed as barriers to industrial development, since clear regulations and predictable procedures can also help create favorable conditions for investment and project implementation. The central issue is whether established regulatory responsibilities and changing industrial priorities can be coordinated effectively across different stages of production (Zhang et al., 2026).

The United States also faces institutional constraints despite its comparatively extensive industrial policy resources. Federal support programs depend on legislative authorization, administrative procedures, eligibility criteria, and implementation decisions that can differ

across policy instruments and change over time. Both the persistence of established industrial structures and the development of new processing activities therefore depend on existing production capabilities and continued policy support (Arsenault et al., 2025; Deberdt, 2026). Taken together, the three national cases show that industrial complementarity cannot be inferred solely from differences in mineral resources or fiscal capacity. Rather, it depends on compatible regulatory conditions, access to productive and technological capabilities, and the ability of national policies to support interconnected activities without requiring identical institutional arrangements. Differences among the United States, Canada, and Mexico may thus foster cooperation through industrial specialization or hinder it when national requirements and development priorities prove difficult to reconcile.

## 5 OPERATIONAL FEASIBILITY OF TRILATERAL CRITICAL MINERALS GOVERNANCE

Moving from theoretical justification to institutional design requires examining how the United States, Canada, and Mexico could coordinate decisions and implement commitments related to critical mineral supply chains. The operational feasibility of a trilateral regime depends not only on shared objectives but also on clearly defined responsibilities, decision-making rules, coordination procedures, and compliance monitoring mechanisms (Keohane, 1984). Differences in national interests and institutional capacity are constraints that any regional arrangement must accommodate, rather than obstacles that cooperation can be expected to overcome on its own. The central institutional question, therefore, is whether the proposed arrangements can support collective decision-making while allowing sufficient flexibility for national participation and establishing credible expectations that commitments will be implemented. Assessing operational feasibility also requires distinguishing between the formal adoption of cooperative mechanisms and their implementation in practice.

The first potential coordination mechanism involves establishing shared strategic reserves of selected processed critical minerals. A trilateral arrangement could improve preparedness for supply disruptions by defining common inventory targets, contribution requirements, information-sharing obligations, and conditions for accessing reserves. However, the effectiveness of coordinated stockpiling would depend on which minerals are selected, where inventories are held, who owns them, storage requirements, and whether usable materials can be released quickly enough to meet industrial needs (Holley et al., 2025; Moon et al., 2025). Possible approaches include nationally maintained reserves governed by coordinated release procedures or jointly managed inventories, each with different responsibilities and implementation requirements. An operationally feasible arrangement would therefore need predetermined rules for contributions, reporting, verification, and emergency access, rather than assuming that shared reserves necessarily offer greater protection than national stockpiles.

Managing strategic reserves also requires explicit rules for collective decision-making. A trilateral body could oversee inventory reporting, monitor indicators of supply disruptions, and authorize coordinated releases under previously agreed procedures. The choice of voting rules is particularly important because equal voting rights, consensus requirements, and weighted voting allocate decision-making authority differently. Consensus may safeguard national interests but delay responses, while majority or weighted voting may expedite decisions but raise concerns about unequal influence. No single approach can be considered operationally superior without assessing each participant's obligations and the implications of collective decisions for its supply needs. The institutional framework must therefore specify how disagreements will be resolved, how emergency exceptions will be handled, and which decisions will remain under national authority (Keohane, 1984; Olson, 1965).

A second potential coordination mechanism involves joint public investment in selected regional processing projects, complementing the supply security benefits of strategic reserves. Such cooperation would aim to coordinate project selection, allocate responsibilities, and establish shared oversight procedures for investments involving more than one government. Joint investment does not require equal financial contributions or identical domestic support programs. Instead, it requires agreement on eligible projects, the distribution of commitments, and implementation procedures. A trilateral framework could establish a joint project committee to evaluate proposals against agreed criteria, including their contribution to regional processing capacity, technical feasibility, and consistency with participating governments' commitments (Anzolin; Pietrobelli, 2025; Arsenault et al., 2025).

Allocating responsibilities within such a framework would require careful consideration of differences in national interests and institutional authority. Joint projects may be located in one country while supporting production networks across all three, potentially creating disagreements over project selection, administrative responsibilities, access to resulting processing capacity, and the distribution of implementation obligations. Clear rules for participation, oversight, information disclosure, and changes to commitments could reduce ambiguity without eliminating differences in national priorities. Allowing different levels of participation would also enable governments to collaborate on selected projects without requiring equal involvement in every initiative. Such arrangements would need to specify whether commitments are legally binding, how amendments are approved, and what consequences follow from failure to fulfill agreed obligations (Keohane, 1984; Putnam, 1988).

A third institutional component involves common procedures for information sharing, technical coordination, and recognition of relevant regulatory requirements. Differences in national standards and administrative procedures do not necessarily require comprehensive regulatory harmonization. Instead, practical coordination could involve standardized reporting formats, comparable technical information,

and procedures for determining when specific requirements may be treated as equivalent under applicable law. Such measures could facilitate the implementation of regional commitments while preserving separate national regulatory systems. However, mutual recognition cannot be assumed to extend to all environmental, labor, or technical requirements, since equivalence must be established for specific purposes and legal obligations (Sasmal, 2026; Srivastava, 2023). Assessing the feasibility of these procedures therefore requires examining their legal foundations, administrative requirements, and intended scope.

To balance effective coordination with national decision-making authority, the proposed arrangement could establish a ministerial forum supported by a technical secretariat and specialized working groups. The ministerial forum would set priorities and approve major commitments, while the secretariat would coordinate reporting, maintain institutional records, and monitor implementation. Specialized working groups could address strategic reserves, joint investment projects, and technical requirements within their respective areas of responsibility. However, assigning these functions would not, by itself, guarantee effective governance. The arrangement's performance would depend on clearly delegated authority, adequate administrative resources, and requirements for communicating decisions and implementation outcomes. The institutional structure should therefore be assessed by its ability to facilitate coordination and accountability without unnecessarily duplicating existing institutions (Keohane, 1984; Sasmal, 2026).

A fourth component involves compliance monitoring and dispute settlement, both closely connected to the proposed decision-making arrangements. Monitoring procedures would need to identify which commitments are subject to review, establish reporting obligations, and determine how potential implementation failures will be assessed. Disputes could arise over contributions to shared reserves, participation in joint projects, eligibility for preferential treatment, or compliance with agreed administrative procedures. A graduated process involving technical consultations, ministerial review, and an agreed dispute settlement mechanism could create opportunities to resolve disagreements before they undermine cooperation. However, the effectiveness of such procedures would depend on participants' acceptance of the applicable rules and the ability to implement decisions within their respective legal systems (Keohane, 1984; Sasmal, 2026). Clear procedures may encourage compliance, but they cannot guarantee adherence when national interests diverge.

The relationship between the proposed regime and the United States-Mexico-Canada Agreement (USMCA) also requires careful legal and operational assessment. The existing regional trade framework could provide a basis for consultation and coordination, but it does not automatically authorize new obligations concerning shared mineral reserves, joint public investment, or preferential access to processed materials. The appropriate legal form of additional commitments would depend on their substantive provisions, the authority of participating governments, and their consistency with applicable regional and

multilateral trade rules (Srivastava, 2023; Sasmal, 2026). Operational feasibility therefore cannot be assumed simply because new initiatives could be incorporated into existing institutional structures. Rather, it must be evaluated in terms of compatible decision-making rules, enforceable commitments, workable implementation procedures, and the ability to resolve disagreements arising from differences in national interests and responsibilities.

## 6 DISTRIBUTIVE LEGITIMACY OF REGIONAL PRODUCTION INTEGRATION

The institutional framework outlined in the preceding section addresses the technical and organizational requirements of trilateral cooperation. Its territorial implications, however, raise a separate question: how economic benefits and socioenvironmental costs are distributed across the regions and communities involved in critical mineral supply chains. The location of extraction, processing, and manufacturing activities shapes where income, employment opportunities, environmental pressures, and infrastructure-related impacts occur. Yet the location of production does not necessarily determine who captures the resulting economic benefits, as ownership structures, contractual arrangements, and the organization of production also influence the distribution of value (Baglioni; Campling, 2017; Cuevas Verdin et al., 2026). The analysis therefore shifts from the institutional organization of regional cooperation to its potentially unequal territorial outcomes, without assuming that participation in the same supply chain yields comparable local benefits.

The distribution of benefits is particularly important in North American critical mineral supply chains because the geographic allocation of production activities may create unequal opportunities to capture value. Mineral extraction can generate local jobs and public revenue while concentrating environmental pressures near production sites. Processing and manufacturing, in turn, may create different employment opportunities and sources of value added. However, the benefits generated at each stage depend on production capabilities, ownership arrangements, and how economic returns are distributed, rather than on the type of industrial activity alone (Davis et al., 2018; Cuevas Verdin et al., 2026). For Mexico, Canada, and the United States, the central question is whether the geographic distribution of production activities aligns with the distribution of income, employment, and locally retained value. Any disparities must be established empirically rather than inferred from an assumed hierarchy between extraction and processing regions.

The geographic distribution of socioenvironmental costs adds another dimension to the analysis. Mining and mineral processing can generate environmental and social pressures that vary with production technologies, ecological conditions, regulatory enforcement, and the characteristics of affected communities (Heffron, 2020; Sovacool, 2021). Such pressures may include land-use changes, water consumption, pollution risks, and disruptions to local livelihoods, while some of

the resulting economic benefits may flow to actors and regions beyond those bearing the impacts. Questions of environmental and distributive justice arise when affected communities bear disproportionate burdens relative to the benefits they receive. Although such disparities should not be presumed to occur in every project, they are important considerations when assessing the territorial consequences of regional supply chain integration (Riofrancos, 2023; Malone et al., 2024).

Programs designed to support disadvantaged communities illustrate why equitable territorial outcomes cannot be assessed through aggregate indicators alone. Policies that direct a specified share of investment benefits toward designated populations may fail to distinguish between where funds are spent, who receives the benefits, and where environmental burdens fall (Malone et al., 2024). In the critical minerals sector, these distinctions matter because investment in a particular area does not necessarily mean that nearby communities receive benefits commensurate with the costs of extraction or processing. A place-based assessment must therefore distinguish economic activity from locally retained value, direct employment from broader development outcomes, and formal eligibility for benefits from their actual distribution. Such an approach makes it possible to evaluate distributive outcomes without assuming that particular development initiatives have succeeded or failed.

Procedural and epistemic justice provide an additional basis for understanding why territorial impacts cannot be assessed solely through income and environmental indicators. Affected communities may hold knowledge of local ecosystems, historical land use, and social conditions that technical assessments do not adequately capture. When such knowledge receives insufficient recognition, communities may have less influence over how impacts are identified, interpreted, and evaluated (Zhou; Brown, 2024). Epistemic injustice arises when certain forms of knowledge are systematically assigned less credibility or when established assessment frameworks fail to account for experiences that affected populations consider significant. Although these conditions do not mean that every consultation process is ineffective, they underscore the need to distinguish formal opportunities for participation from the meaningful consideration of community perspectives.

Territorial conflicts may arise when affected groups challenge how economic benefits are allocated, environmental burdens are distributed, or development decisions are made and justified. Such disputes may involve compensation, employment opportunities, environmental protection, land use, or recognition of community interests. Their existence does not necessarily signal opposition to regional economic integration, as grievances may instead concern specific projects or the conditions under which production activities take place (Heffron, 2020; Riofrancos, 2023). Distinguishing project-level disputes from broader challenges to regional cooperation is therefore essential. Territorial grievances become relevant to the legitimacy of the trilateral regime when institutional or political processes link them to decisions, commitments, or responsibilities arising from regional cooperation.

Territorial conflicts may influence regional institutions through several identifiable channels, including litigation, administrative appeals, public consultations, organized political opposition, and demands directed at government authorities. Depending on their scope and consequences, such processes may affect the approval, continuation, or public justification of projects and activities connected to regional supply chains. However, a dispute involving a single project does not automatically call the legitimacy of the broader cooperation framework into question. Its wider significance depends on whether it exposes shortcomings associated with regional commitments, leads governments to reconsider their participation, or generates sustained opposition to how responsibilities and benefits are distributed (Putnam, 1988; Malone et al., 2024). Assessing the effects of territorial conflicts on regional governance therefore requires tracing the institutional and political mechanisms through which local grievances influence decisions at higher levels of government.

The political legitimacy of trilateral cooperation must therefore be distinguished from both its operational effectiveness and the distributive outcomes of individual production activities. A regional arrangement may coordinate activities effectively while facing opposition from communities that regard its consequences as inequitable. Conversely, territorial inequalities do not necessarily undermine legitimacy when affected groups consider decision-making procedures responsive, transparent, and capable of addressing their concerns. Distributive justice concerns how benefits and burdens are allocated, whereas procedural justice concerns participation, recognition, and fairness in decision-making (Heffron, 2020; Zhou; Brown, 2024). Whether these dimensions affect political legitimacy depends on how communities perceive institutional responsibilities and the extent to which their demands shape public decisions.

The international reach of critical mineral supply chains also raises questions about how changes in North American sourcing and processing affect communities beyond the three participating countries. Deeper regional integration does not necessarily eliminate environmental burdens elsewhere, as imported inputs and intermediate products may still originate in external production networks. Shifting extraction or processing activities across borders may therefore change where costs are incurred without producing a more equitable distribution of benefits and burdens (Baglioni; Campling, 2017; Heffron, 2020). For this analysis, such external effects represent an important consideration that defines the scope of the assessment rather than a separate explanation for interstate cooperation. The central question remains whether the geographic distribution of value added and socioenvironmental costs within North American supply chains gives rise to conflicts that can affect the legitimacy of trilateral cooperation through identifiable institutional and political channels.

## 7 CONCLUSION

Critical mineral governance in North America involves more than managing natural resources. It is also shaped by asymmetries in technological control and refining capacity. Understanding preferential access as an institutional club benefit helps explain why reducing external vulnerabilities does not eliminate asymmetric interdependence but instead reshapes power relations and bargaining positions among regional partners. From this perspective, supply security depends less on geographic proximity or mineral abundance than on credible institutional arrangements that reduce investment uncertainty and help manage the costs of adjusting to supply disruptions.

Distinguishing the rivalrous nature of minerals as physical goods from the institutional benefits of coordinated access provides a framework for examining collective action under geoeconomic competition. Bringing together club goods theory and asymmetric interdependence helps explain how concentrated processing capacity can create structural advantages without necessarily translating into coercion. Whether such advantages confer bargaining power depends on the availability of alternatives and the costs of substitution. Differences in regulatory frameworks, fiscal capacity, and institutional histories across Mexico, Canada, and the United States also show that industrial complementarity cannot be assumed simply because the three countries share a trade framework. Rather, it depends on how their policy priorities, productive capabilities, and path-dependent institutional arrangements interact.

Making trilateral governance operational requires moving beyond the pursuit of comprehensive regulatory harmonization toward practical mechanisms for technical coordination, shared strategic reserves with clearly defined release rules, and targeted public co-investment. Such arrangements must balance the need for timely responses to supply disruptions with the preservation of national decision-making authority. Their broader legitimacy also depends on whether regional industrial development creates opportunities to capture more value beyond primary extraction while incorporating meaningful socioenvironmental safeguards and mechanisms to prevent producing communities from bearing a disproportionate share of the costs.

These findings point to a research agenda focused on measuring differences in value capture across subnational territories and stages of production, particularly the extent to which income generated by extraction is retained locally compared with the returns captured in advanced manufacturing. Further research should examine how subnational jurisdiction, Indigenous territorial rights, and trilateral commitments interact, including whether procedural and epistemic justice mechanisms meaningfully influence corporate and government decisions. Future studies should also assess how the relocation of supply chains affects third countries, particularly mineral-producing economies in the Global South. A central question is whether efforts to strengthen regional resilience reduce external vulnerabilities while reproducing unequal extractive relationships elsewhere.

The restructuring of supply chains for the energy transition and advanced manufacturing presents a fundamental challenge: efforts to strengthen productive autonomy may also reinforce longstanding territorial inequalities. The success of a North American critical minerals regime should therefore be judged not only by its ability to maintain supply security amid geopolitical disruptions but also by how fairly it distributes the benefits and burdens of industrial development. Treating mineral governance solely as a matter of defensive economic security would overlook its broader political implications. Decisions about where minerals are extracted, processed, and transformed ultimately shape who benefits from industrial development, who bears its costs, and how resource sovereignty and socioecological limits are reflected in regional cooperation.

## AI USAGE STATEMENT

The large-scale language model GPT-5 was used in preparing this article to identify and correct drafting and spelling mistakes. The prompt issued was "detect and correct all drafting and spelling errors". After receiving the system's output, a thorough review of the final text was conducted to ensure that the result preserved both the tone and the intended meaning of the original draft.

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