

Article [EN]

## Can Lithium OPEC be Realized? Feasibility Analysis of South America's Lithium Cartel

*¿Se puede hacer realidad la OPEP del litio? Análisis de viabilidad del cártel del litio en Sudamérica*

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**[EN] Abstract:** Global warming has driven the historical shift towards clean energy, with lithium playing a crucial role in this green transition and becoming a focal point of global competition. Due to its high performance and widespread application in manufacturing lightweight energy storage batteries, lithium is at the forefront of electrification, which is essential for achieving zero emissions. Latin America, home to over half of the world's lithium resources, sees an extraordinary opportunity in this monumental transition. Lithium-producing countries in Latin America are currently proposing a lithium OPEC to influence pricing and enhance profitability. This study evaluates the feasibility of such a cartel and examines the challenges using the framework of commodity cartels, analyzing factors such as demand, supply, production, market structure, and synergies. The paper concludes that resource-rich countries in Latin America are correct in their assessment of the prospects for developing their lithium industry amidst the global energy transition. However, the proposal of a lithium OPEC might be too radical given the current production capacity and market influence of the involved countries. Latin America should seek more practical approaches to develop lithium resources through various regional collaborations and the adoption of new technologies.

**Keywords:** feasibility, lithium cartel, Latin America, global energy transition

**[ES] Resumen:** El calentamiento global ha impulsado una transición hacia las energías limpias, con el litio desempeñando un papel clave y convirtiéndose en un punto focal de la competencia global. Gracias a su alto rendimiento y su uso en la fabricación de baterías ligeras, el litio está a la vanguardia de la electrificación, esencial para alcanzar emisiones cero. América Latina, que posee más de la mitad de los recursos mundiales de litio, percibe una oportunidad única en esta transición. Actualmente, los países productores de litio en la región proponen una "OPEP del litio" para influir en los precios y aumentar la rentabilidad. Este estudio evalúa la viabilidad de dicho cartel y los desafíos involucrados, utilizando un marco de carteles de materias primas y analizando factores como demanda, oferta, producción y estructura de mercado. El documento concluye que, aunque los países latinoamericanos están bien orientados en su intento de desarrollar su industria del litio, la creación de una "OPEP del litio" podría ser demasiado radical dada su capacidad de producción actual y su influencia en el mercado. Se sugiere adoptar enfoques más prácticos mediante colaboraciones regionales y la adopción de nuevas tecnologías.

**Palabras claves:** factibilidad, cártel del litio, América Latina, transición energética global

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**Cita:** Ling, S. (2024). Can Lithium OPEC Be Realized? Feasibility Analysis of South America's Lithium Cartel. *Ibero-América Studies*, 8(2), 65-75.

**DOI:** <https://doi.org/10.55704/ias.v8i2.06>

**Editores académicos:** Ordóñez Huerta, M. Z.

**Recibido:** mayo 2024. **Aceptado:** julio 2024

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## 1. Introducción

Climate change is closely related to disastrous natural hazards and has inflicted broad economic losses. The need for a structural green transition has been further fueled by energy insecurity stemming from geopolitical tensions, as demonstrated by the overwhelming reliance on traditional energies during the Russia-Ukraine conflict. (Bordoff & O'Sullivan, 2023, p.104) In fact, numerous countries have recognized the urgency of clean energy shift. The European Union (EU) approved the European Green Deal in 2020. More than 30 national governments have pledged to phase out the sale of new gasoline and diesel-powered vehicles globally by 2040 (Plumer & Tabuchi, 2021). President Biden signed the Inflation Reduction Act of 2022 into law to bolster investment in clean energy (the White House, 2022). Evidently, the landscape of future great power competition is poised to shift ultimately to climate. Nations with advanced clean energy technologies are expected to dominate the global economy in the 21st century (Granados, 2021). In this historical process, critical minerals, fundamental to clean energy technologies, are of paramount importance. Former U.K. Prime Minister's Envoy, Lord Mark Sedwill, even emphasized that "critical minerals, semiconductors, and data are the oil, steel, and electricity of the 21st century" (UNECE, 2022).

As a key solution to reducing carbon emission and enhancing energy security, direct electrification is revolutionizing the transport sector. Without a structural transformation, the transport sector, the largest emitter within the energy industry, could see carbon emissions rise by 16%-50% by 2050. (SLOCAT, 2023) According to data from the Department of Energy of the United States (DOE, 2022), electric vehicles (EVs) emit 60% less carbon pollution than gasoline-powered cars. In an effort to reduce emission, EU has announced to prohibit the sales of new petrol and diesel cars from 2035. (European Parliament, 2022) Since 2015, the EV industry has experienced remarkable growth, driving an increased demand for critical minerals. Over the past two decades, the annual trade in critical minerals has increased significantly, from USD 53 billion to USD 378 billion. (Snoussi-Mimouni & Avérous, 2024) As the energy transition progresses, global demand for critical minerals is expected to increase by 400% to 600% in the coming decades. (IRENA, 2021)

Currently, lithium-ion batteries are the primary energy storage system for transportation. Given current technical conditions, lithium is indispensable in manufacturing light-weight, portable energy storage battery units. The past few years witnessed the exponential increase of lithium price. From 2016 to 2018, the price of lithium doubled. After a brief period of stabilization, the price of lithium carbonate surged from 40.000 CNY/T in November 2020 to 600.000 CNY/T in November 2022. (Trading Economics, 2022) To meet the requirements for EVs and battery storage in climate-driven scenarios, global demand for lithium is projected to increase more than 40-fold by 2040. (IEA, 2021a).

Latin America, which holds an estimated 60% of the world's identified lithium reserves, is unlikely to remain unaffected by the growing demand for this critical mineral. It is projected that Latin America could generate over US\$530 billion annually from lithium exploitation by 2040 (Duran, 2023). In the decade after the global financial crisis, the regional GDP growth rate plummeted from 6% to 0,2%. Between 2014 and 2019, growth averaged just 0,4%, the lowest level since the 1950s (CELAC, 2020, p.8). The COVID-19 pandemic further exacerbated Latin America's economic challenges during a period of economic slowdown. The ongoing energy transition now presents Latin America with an unprecedented opportunity to address its economic difficulties. Latin America "has much to gain if it integrates as a bloc and much to lose if it moves toward a 'lithium balkanization' and every country acts separately" (Páez, et al., 2022). As a matter of fact, the idea of a lithium version of OPEC has sparked heated discussions.

Hence, this paper aims to conduct a feasibility analysis of the lithium OPEC that Latin American countries are currently attempting to establish. The paper is structured as follows: the introduction section covers the background and methodology of the research. Primarily, this paper employs the conventional and standardized method utilized by social scientists to conduct qualitative research, such as critical analysis of existing literature and case study. Section 2 reviews the relevant literature and construct an analytical framework to be applied in the next section. The concept of commodity cartels and their sustenance will be elucidated in this part. Accordingly, a theoretical framework will be developed to systematically assess the feasibility of the lithium OPEC in Latin America. Subsequently, Section 3 presents a case study on the potential lithium OPEC in South America. In the concluding section, the key findings will be discussed.

## 2. Literature review and theoretical framework

Research on cartels falls far behind people's attention onto them. Back in the 18th century, Adam Smith (1776) has already noted that meetings among "people of the same trade" tend to induce "conspiracy against the public or contrivance to raise prices." The desire of maximum profit is the inherent instinct of all participants in commercial

activities and catalyzes the formation of various cartels. However, systematic study of cartel did not appear until the 20th century when general consensus was reached upon the basic reference of cartel.

### 2.1 The concept of cartel

The term “cartel” originated in the 19th century from the German word *kartell*, French *cartel*, and Latin *carta*, which means paper or written notice. Around 1880, Germans began to use cartels to refer to alliances among firms. Subsequently, the concept of cartel was broadened to encompass associations, unions or groups of companies. Since the beginning of the 20th century, cartels have been understood as trade agreements, whether formal or informal. History has clearly demonstrated that cartels may appear in any market where production is confined to a limited number of suppliers, such as the cartels of aluminum, rubber, sugar, tin and petroleum, among others. Following World War II, cartelization experienced a significant surge, and the concept of cartels began to assume the center stage in international business circles, particularly since the 1960s. Various researchers offer diverse definitions of cartels based on distinct approaches and research objectives. In its simplest form, Liefmann (1932, p.7) defined a cartel as an association of producers with monopolistic purposes. George Stigler (1964) noted in his paper entitled “A Theory of Oligopoly” that rational and profit-maximizing sellers naturally tend to avoid competition that diminishes their profit. In a clear and concise way, a cartel is defined as an agreement between businesses not to compete with each other (Government of UK, 2014). In a broader sense, cartel is synonymous with “explicit” forms of collusion. Subsequent refinements were made to facilitate academic researches. John Sanghyun Lee (2016, p.9) further elaborates on cartels, defining them as agreements or collective actions aimed at restraining reciprocal business activities among plural independent entrepreneurs competing in the same level of a business or industry to prevent competition thereby securing extra profit. Generally speaking, cartels refer to attempts to emulate that of monopoly by restricting industry output, raising or fixing prices in order to make higher profits.

Despite the variety of definitions, some commonalities can be traced. Three components can be identified from the various definition: an agreement, competing parties, and competition aversion. First, cartels invariably involve secret conspiracies, so an agreement is essential, be it formal or informal. Second, an agreement should be reached between competitors or companies of the same industry at the same level of the value chain (manufacturers, distributors, or retailers). Third, competition aversion is inherent to cartels, which explains why the study of cartels usually include the discussion of monopoly or oligopoly. In this paper, cartels are defined as agreements or joint practices between two or more independent actors, firms, or countries operating on the same market aiming at fixing prices, restricting output or sales quotas, and allocating markets to generate higher profits, restrict competition and achieve autonomy of decision making.

### 2.2 Literature review

As illustrated above, cartel theory is originally an economic theory aiming to study the competition-averse commercial activities such as oligopoly. Studies estimated that during the 1930s, 30 to 40% of global trade in manufactured goods were cartelized. (Machlup, 1945) With the groundbreaking foundation laid by Stigler’s work, modern cartel theory has developed. Since the 1970s, a substantial body of theory has emerged, wherein the stability of a cartel became the focus of many studies. For instance, Osborne (1978) identified the internal and external problems that a cartel faces and holds that the commonly recognized flaw of a cartel can be fixed via discreet detection of cheating behavior. In terms of this, game theory is utilized in numerous researches to study why some cartels can endure. (Levenstein & Salant, 2007)

The application of modern cartel theory can be categorized into three. The first is the case study of various commodity cartels in history, such as OPEC (Alhajji & Huettnner, 2000) or the International Aluminium Cartel (Litvak & Maule, 1975). Some scholars examined the impacts of cartels on the national economy and competitiveness through case studies, such as that of Lithuania (Bruneckienė et al., 2015). In this case, the cartel theory is still applied within the subject of economics. The second is the study of cartels from the perspective of governance. In some countries, the force of free market and the force of competition-averse cartels contest fiercely with each other, contributing to the issue of regulations and enforcement, as is shown in the cartel cases in EU (Hellwig and Hüscherlath, 2017), the practices of cartel in India (Basu, 2017). Some discussed the legal issue caused by cartels. Davidow (1982) investigated the influence of cartel regulation on international trade. Harding and Joshua (2010) probed into the challenges faced by the European countries regulating cartels. The third application is the political scientists’ borrowing of the concept of cartel to study parties, sovereign nations, etc. In the political sphere, cartels denote a union of political parties or interests, or an agreement on common objectives or actions. Blyth and Katz (2005) applied cartel party theory to the study of adaptations to

endogenous coordination problems. Acharya and Lee (2022) argue that the modern territorial state system resembles an economic cartel, wherein states have local, bounded monopolies in governing their citizens, while refraining from violating each other's monopolies. The authors examine what makes this system stable, when and how it emerged, how it spread, how it has been challenged, and what made it so resilient over time.

Modern cartel theory offers a perfect theoretical framework to the study of commodity cartels in history. Somehow, the lithium cartel that Latin American countries try to establish hasn't been studied from the perspective of cartel theory. That's the problem that this paper will try to solve—to conduct the feasibility analysis of the lithium cartel using the theoretical framework of cartel.

### *2.3 Prerequisites to sustain a cartel*

Cartels can occur across diverse industries and encompass goods or services at various stages of the supply chain, including manufacturing, distribution, or retail. However, certain circumstances increase the likelihood of cartel formation, such as a limited number of competitors in the market, restricted competition regarding quality or service, established communications channels between competitors, excess capacity in the industry, economic downturns, and inelastic demand. Despite this, pinpointing the exact conditions for cartel formation remains challenging. Economists and political economists have yet to agree on a theoretical model explaining the longevity of cartels. Nevertheless, specific conditions conducive to cartel sustainability can be outlined.

Aiming at revenue maximization (Radetzki & Wårell, 2020) or value maximization (Adelman, 1994), cartels are always easier to build than to sustain. Although scholars debate vigorously on specific explanations, some well-acknowledged conditions can still be summarized. David R. Mares (2022, pp.4-5) asserts that understanding a cartel should begin with comprehending the market characteristics, which form the preconditions for cartel formation. Specifically, there are three major factors impacting the construction of cartels: demand, supply, production, and market structure. First, the demand curve should be inelastic, meaning substantial profits would be made if a cartel occurs. Second, reserves of the commodity should be concentrated among a few countries, with substitutes not readily available to consumers. Third, production and market structure entail that the range between high-cost and low-cost producers should be narrow enough not to incite cheats on the cartel. These are the starting points for forming a cartel, but the ultimate feasibility depends on synergy, as it represents an agreement among competitors in essence. However, in the case of the lithium cartel, Latin American countries have attached their social agendas and ambitions, not purely economic considerations. Therefore, the final factor should also be considered when studying the feasibility analysis, which is synergy. It requires a similar pace of production, a similar level of production and similar regulations and policies so that few impediments might occur. Indeed, the circumstances sustaining a cartel are quite a lot and complicated, but this paper will utilize a framework encompassing the above-mentioned factors to assess the feasibility of the lithium cartel that Latin American countries are endeavoring to build.

## **3. Feasibility analysis of the lithium cartel in Latin America**

Latin America is home to an estimated 60 percent of identified lithium in the world, with approximately 58 percent concentratedly found in a region in the Andean southwest corner of South America, spanning the borders of Argentina, Bolivia, and Chile and forming a geographic triangle (usually referred and known as the Lithium Triangle). As the demand and price of lithium skyrocketed with the burgeoning production of EVs in the past decade, Latin America has become a new nexus for global competition as the producer of the essential mineral for electrification transformation. In order to expand South America's processing capacity, turn more of their mined lithium into batteries, and tap into the EV manufacturing sector, the call for creating a lithium cartel arises.

### *3.1 Lithium cartel in Latin America: background and status quo*

The proposal of building a lithium cartel dates back to 2011 when Bolivia and Chile suggested creating a "lithium OPEC" at the regional level. However, diplomatic tensions stemming from historical factors (bilateral diplomatic relations between Bolivia and Chile was severed in 1978 due to failed negotiations on territorial disputes) and ideological divergence between the two countries have long impeded the progress of the proposal. Later in 2019, the then-president of Bolivia Evo Morales accused the United States of coveting the rich lithium resources after his resignation amid a domestic political crisis in Bolivia. Subsequently, in the general election held a year later in Bolivia, Luis Arce, leader of the leftwing party Movement for Socialism, won the presidency. Shortly after President Boric's inauguration, Chile initiated discussions on potentially reestablishing diplomatic relations with Bolivia (teleSUR, 2022). It was not until Chile

turned leftist by electing Gabriel Boric that the proposal of building a lithium cartel was back on the agenda. Representatives from Argentina, Chile and Bolivia have been discussing the concept since July 2022, when ministers met at the Community of Latin American and Caribbean States (CELAC) conference in Buenos Aires.

Other Latin American countries, such as Brazil, Mexico, and Peru, have also been paying close attention to the discussion of a lithium cartel despite their comparatively low production, and expressed interest in participation when conditions are favorable. In April 2022, Mexico discussed with Lithium Triangle countries the extraction and development of lithium. In May 2022, Mexico and Argentina reached a consensus on promoting cooperation to move up in the value chain of lithium. After President Luis Ignacio Lula da Silva's inauguration in January 2023, Brazil joined the talks of cooperation with Lithium Triangle countries. In a mining convention held in Canada, an Argentinian delegation raised the idea of creating a lithium cartel, akin to what OPEC did with oil. Later, in March 2023, Bolivian president Luis Arce accused the US government of interfering with the lithium mining policies in Latin American countries and repeatedly called upon the completion of a lithium-producing organization dominated by Latin America. The ideological alignment among these countries establishes a robust basis for inter-governmental negotiations aiming at safeguarding resource sovereignty, countering external interference, and fostering cooperation. Moreover, resource nationalism appears to be a viable option in the current wave of "pink tide", which is characterized by the dominance of leftist parties in Latin America. Essentially, the objective of manipulating commodity prices became more apparent due to OPEC's significant economic influence in the 1970s, and the lithium cartel follows a similar pattern. The abundant reserves of lithium resources form the foundation for this ambitious proposal. Regarding lithium, governments in Latin America have sought to include visions of economic development by moving up the value chain and social programs to achieve a higher level of development (Barandiarán, 2019, pp.381-391). Latin America, cornered onto the periphery of the world economic system, has long served as a supplier of raw materials, including gold, silver, sugar, and guano, among many others. History has demonstrated repeatedly that solely providing raw materials only leads to diminished profits and an imbalanced economic structure. Therefore, for Latin America, integrating lithium resources within the continent and enhancing the value of lithium-related products represents the sole viable strategy to alleviate the resource curse and assert greater influence in the international market. Amidst the global shift toward renewable energy and worldwide commitment to decarbonization, lithium and Latin America emerge as pivotal players in ensuing great power rivalry, owing to their significance and indispensability in this transformative era. Establishing a collective entity through a lithium cartel would provide Latin America with flexibility and autonomy amidst the anticipated great power competition. In conclusion, economic factors alone cannot sufficiently explain the motivations behind a lithium "OPEC", as it confronts a multifaced and complexed domestic, regional and global environment.

So the establishment of lithium cartel in Latin America centers on the triangle countries like Chile, Bolivia and Argentina, while other Latin American countries like Brazil, Mexico, Peru sits on the periphery, likely to participate whenever time favors.

### 3.2 Feasibility analysis

Case studies conducted by economists usually cover factors like supply and demand, production and market structure. So various tools and models are applied to detect cheating in case it might impact the production and supply structure. Since the importance of lithium in the energy transition has garnered sufficient attention from great powers fiercely competing for the critical minerals, the lithium cartel cannot avoid the influence of political factors. Therefore, the feasibility analysis of lithium cartel in Latin America will be conducted from the perspective of demand and supply, production and market structure, and the synergies among Latin American countries, mainly the Lithium Triangle countries.

#### 3.2.1 Supply and Demand

Sustainability of a cartel relies on a highly inelastic demand curve, indicating significant monopoly profits if a cartel forms. However, the demand curve of lithium differs significantly from that of petroleum. Despite being termed as the "oil of the 21st century" (MarketWatch, 2018) or the "new oil" (Bruno, 2019), lithium is merely a non-essential commodity required by several industrial countries with a restricted range of uses. In contrast, petroleum, often referred to as the "blood of industry", is an irreplaceable and large-scale product with an inelastic demand for its applications in almost every sector of economy and social development. Moreover, oil shortages may lead to national security concerns in numerous instances. On the international market, lithium is traded as a specialist product rather than a primary commodity, and the demand for lithium can never match that of oil. In 2021, global oil consumption reached 4,25 billion tons, starkly contrasting with global lithium consumption of 93,000 tons (lithium carbonate equivalent), equivalent to

only one-fifth of annual oil consumption. (Xu, 2023) According to the estimation of the World Bank, the global demand for lithium is expected to range from 4 to 10 million tons by the year 2050. (Hund et al., 2020) In this context, lithium is more like guano or rubber rather than oil either in terms of strategic importance or market volume, suggesting that exporting countries may not adapt to declining demand for their resource. In summary, lithium is never equivalent to oil.

With the aim of manipulating market prices, the lithium cartel might face resistance from the market. It is important to note that the lithium cartel was proposed to regulate prices in the international market, particularly to maintain high prices for profit maximization. Paradoxically, the combined efforts to raise prices and maximize profits will accelerate the market's search for alternatives, thereby further eroding the competitive advantage of exporting countries. Technical innovations to supplement resources and enhance recycling are already accelerating. Due to the significant increase in lithium carbonate prices in recent years and its flammable and unstable chemical properties, rechargeable battery manufacturers have been seeking new alternatives, such as vanadium redox flow, zinc-air, sodium, sulfur, nickel, and others. (McKinsey, 2022) Toyota collaborated with researchers from the University of Kyoto on a new fluoride ion battery, expected to provide approximately seven times the energy per unit weight of conventional lithium-ion batteries and potentially allowing electric vehicles to travel 1.000 kilometers on a single charge. (Randall, 2020) In addition, battery recycling is expected to increase in the current decade, even though not to game-changing levels. The World Economic Forum (2019) estimated that around 54% of end-of-life batteries are expected to be recycled in 2030, accounting for 7% of the total demand for raw materials for battery production that year. Over time, advancements in lithium-free battery and recycling technologies will redirect the current excessive focus on lithium toward other economically viable resources.

### 3.2.2 Production and Market Structure

Latin America contains 58% of the world's current lithium reserves. The highly concentrated lithium resources lie within the salt brines beneath the crusty surfaces of salt flats. The Lithium resources found in Latin American underground brines are the cheapest to extract and process into lithium carbonate, especially due to the arid climate in the altiplano desert. There are at least 53 lithium brines with a total covering area of over 25.000 square kilometers, including renowned salt lakes like Atacama, Maricunga, Hombre Muerto, Rincon, and Uyuni, to name a few. The reserves in Atacama alone are sufficient to meet the global lithium demand for approximately 50 years. (Munk et al., 2016)

Nevertheless, abundant reserves of lithium do not always translate into high production yields. Collectively, the Lithium Triangle countries contribute only 35% of the global lithium output. For instance, Chile, the largest lithium-producing country in the Lithium Triangle, exemplifies this situation. Although over half of the world's lithium reserves are located in Chile, the country's share of global production in 2023 was only 30%. In contrast, Bolivia, despite having larger lithium reserves than the other countries in the world, has minimal production output. Conversely, Australia and China collectively dominate more than 60% of the current global lithium production market. (Filipenco, 2023) These disparities highlight the significant gap and disproportionate gulf between the actual and potential production capacity of the Lithium Triangle. Moreover, the overwhelming production capacity of external actors diminishes the bargaining power of lithium-producing countries in Latin America. It is nearly impossible for them to surpass competitors in a short time span given its dissatisfying technological conditions and poor infrastructure which are essential to the production and industrialization of the lithium industry.

An analysis of major mines that came online between 2010 and 2019 reveals that it took 16,5 years on average to develop projects from discovery to first production, although the exact duration varies by mineral, location and mine type. Exploration and feasibility studies typically span over 12 years, with the construction phase lasting 4-5 years on average. (IEA, 2021b) The long lead time raises questions about the ability of supply to ramp up output if demand were to pick up rapidly. According to Deloitte (2022), the gap between lithium supply and demand is projected to emerge and gradually widen after 2025. The impending emergence of this gap, coupled with the accelerating momentum of the global energy transition, signifies the rapid closure of the window of opportunity for Latin America. Due to the inadequate infrastructure of the mining industries in the Lithium Triangle countries, none of them will be capable of rapidly scaling up production to alleviate supply shortages. The ambitious lithium cartel might encounter obstacles before advances.

Not only does the current situation in the upstream segment of the supply chain pose risks and challenges for Latin America, but also the midstream bides not well. Since minerals like lithium cannot be put into end-applications like EVs, smart phones and computers fresh from the mine. They need to be chemically processed into compounds with the right purity. Although lithium extracted from salt brines is significantly cheaper than that from hard rocks, it is more suitable for less energy-dense cathodes due to its low-grade quality. Conversely, hard rock lithium possesses a higher lithium grade and is more used in higher energy-density cathodes. Australia leads in the production of hard rock lithium, particularly in mineral spodumene, which is the highest grade among hard rock deposits. China holds approximately 65%

of the world's lithium processing capacity, solidifying its dominant role. (IEA, 2023) The entry of new spodumene suppliers into the market will address the demand gap and is anticipated to lower spodumene prices to a more reasonable and sustainable level (S&P Global, 2023). Thus, the advantage in cost of lithium produced in Latin America would be further eroded. In the next decade, China is projected to triple its current capacity and further maintain a commanding position. (Brunelli et al., 2023) As existing players increase their investments, more participants will enter the market. The rise in production in Australia and Brazil (Duraó & Freitas Jr., 2023), along with discoveries in the United States (Cowen, 2023), will intensify the competition for securing new investments in a rapidly growing market. Given the ongoing development of alternative battery technologies, Argentina, Bolivia and Chile face a narrow opportunity to capitalize on the influx of foreign capital benefit from the influx of foreign capital directed towards the Andean salt flats before investment trends change. (Quinn, 2023)

In addition, technology is poised to be a transformative force. As noted previously, lithium extraction from the salars of the Lithium Triangle countries is the most cost-effective. Through straightforward and low-tech evaporation, the average cost of lithium carbonate extraction in the Lithium Triangle is \$4.500/t, markedly lower than that of hard rock lithium ore (\$7.000/t), owing to the arid conditions in the high Andes. However, every coin has two sides, and lithium extraction in the Lithium Triangle is no different. The process consumes a substantial amount of water, approximately 500,000 gallons per ton of lithium extracted (Berg & Sady-Kennedy, 2021), despite the Lithium Triangle being one of the driest regions on earth. In Chile's Salar de Atacama, lithium extraction conducted by multiple companies has depleted 65 percent of the region's water supply. (Ahmad, 2020) Several proven Direct Lithium Extraction (DLE) technologies are being tested extensively to mitigate environmental damage and enhance output. The implementation of DLE has the potential to substantially boost lithium supply from brines, akin to shale's impact on oil, nearly doubling lithium production. Goldman Sachs (2023a) indicates that the adoption of Direct Lithium Extraction (DLE) is projected to boost the yield to 80%-90% from 40% to 60% of the conventional evaporation process, significantly reducing the processing time from 9-18 months to just days or even hours, allaying concerns about drought in arid regions like the altiplano. With the ongoing efforts, DLE could be implemented between 2025-2030 in both Chile and Argentina. (Goldman Sachs, 2023b) Consequently, it holds a more pessimistic outlook for lithium, forecasting that supply will exceed demand from 2023 onward. By increasing yield, shortening the processing time, and widening the cost curve, DLE will prolong the size and duration of lithium market surpluses while mitigating deficits. Accordingly, the evolving market dynamics due to technological advancements may further undermine Latin America's competitive advantage in the global lithium arena.

### 3.2.3 Synergy and Collaboration

Synergy is a crucial aspect to contemplate while conducting the feasibility analysis of the lithium cartel, encompassing various factors such as developmental level, policy framework, governance structure, and others.

To start with, the variance in production among the Lithium Triangle countries could lead to disunity. The lithium resources in Lithium Triangle countries remain underdeveloped due to their insufficient production capacity. Chile not only is the only country to achieve large-scale development in the Lithium Triangle countries but also has long outpaced Argentina and Bolivia in attracting investment to lithium mining. Although possessing the world's most extensive confirmed lithium resources, Bolivia has so far been incapable of extracting them and yet to produce lithium at a commercial scale. Known for possessing the most technically intricate deposits, lithium projects in Bolivia encounter spiraling costs. The low concentrations of lithium, high levels of impurities in the Bolivia's salt flats and a rainy season that lasts several months of the year together contribute to the complexity of the extraction process. For instance, the magnesium ratio in Uyuni's brine is 21 to 1, while in significant contrast, the ratio is only 5 to 1 in Chilean salt flats. A high magnesium ratio makes the extraction process more difficult because it entailed extra procedures of purification. Bolivia's national lithium company Yacimientos de Litio Bolivianos (YLB) once attempted to cooperate with German company ACI systems to implement DLE technology but its endeavor ultimately faltered due to staunch opposition from local communities. However, it is noteworthy that there are only five operations using DLE technologies at a commercial scale: one in Argentina and four in China, wherein none of these operations relies solely on DLE but rather combines it with solar evaporation. In another word, even though Bolivia is willing to apply the new technology and the national conditions in Bolivian salt brines are suitable to do so, large-scale commercial production of lithium in Bolivia still faces numerous setbacks. This challenge is exacerbated by insufficient infrastructure, a deficit in local skilled labor, and other factors. Thus, it remains a daunting task for Bolivia to achieve as large-scale production as Argentina or Chile.

On top of that, political factors such as divergent stances or policy inconsistency can further contribute to instability. Amidst the current "pink tide" of leftist governments sweeping Central and South America, nationalization has become the most direct tool with which Chile, Mexico, and others are constructing plans for mining industries that go beyond raw

commodity supply. In April 2022, Mexican President Andrés Manuel López Obrador legally declared his country's lithium deposits as national property. The governments of the Lithium Triangle countries now share an ideological affinity, which is typically deemed essential to regional cooperation. (Nolte, 2021) But there has been heated discussion concerning the lithium industry, and three salient (though partially overlapping) positions could be identified: (1) lithium as a banal market commodity; (2) lithium as a strategic resource; and (3) lithium as the subject of a sociotechnical imaginary that reimagines how mining can serve development goals. (Barandiarán, 2019, p.382) Different stances lead to varied approaches, as evident in the Lithium Triangle countries: Bolivia's state-controlled project on one end of the spectrum, Argentina's liberal stance on the other, and Chile somewhere in between.

Bolivia boasts the world's largest volume of confirmed lithium resources and ranks among the most underdeveloped nations in Latin America. It underscores the strategic importance of lithium, with former vice President Álvaro García Linera once asserting that the lithium industry would be a boon to the 40% of Bolivians living in extreme poverty. (Draper, 2019) The Morales administration previously devised a plan called "¡100 percent Estatal!", advocating for full state control of lithium extraction. In 2009, Bolivia nationalized its lithium industry and demands full state control through the state-owned company YLB founded in 2017. Full state control of the lithium industry has contributed to its diminished output. Recently, the Bolivian government has tried to collaborate with private companies, such as the German company ACI Systems, to enhance lithium extraction effectively. But following Morales' resignation on 3 November 2019, the interim government rescinded legislation that established the extraction partnership with ACI Systems, leaving the country's lithium industry in a state of uncertainty. Tellingly, policy consistency is pivotal when forming a lithium cartel.

In stark contrast to Bolivia, Argentina has adopted a more liberal approach to developing its lithium industry, characterized by limited state involvement, low taxes, and permissive regulation and thus providing a relaxed regulatory environment. This light regulation has sparked a surge of investment from international companies since lithium prices started to rise in mid-2020. Besides, there has been a widespread political consensus supporting mining in Argentina due to its macroeconomic challenges. To address the government's need for foreign currency to replenish international reserves and meet debt obligations, special regulations are being formulated for export sectors, such as facilitating access to foreign currency. Hence, the export-driven lithium sector is advancing rapidly. However, what is idiosyncratic about Argentina is that the lithium resources belong to the provinces, in contrast to the centralized strategies of Chile and Bolivia. They—not the federal government—collect a 3% royalty tax for lithium mining (compared to a 40% ceiling in Chile and 45% in Bolivia), and the corporate environment is relatively free of state oversight for foreign mining companies, attracting a diverse array of investors to Jujuy, Salta and Catamarca provinces. This decentralized approach leads to two distinctively different models of development. In the provinces of Catamarca and Salta, foreign and private domestic companies are awarded mineral rights based on proposals to explore, invest, and extract resources. These two intend to augment the output to increase tax revenue. While in the province of Jujuy, the provincial government has established a provincial-level state-owned enterprise focusing on industrializing the entire process from extraction to processing and manufacturing. This "industrialization" model aims at achieving value-added production. (Liebetreu, 2022)

Chile is commonly regarded as the most neoliberal economy in South America. However, this light-touch regulation does not extend to lithium, which the government considers a strategic resource. Consequently, owners of mining properties in Chile do not possess any lithium discovered and must apply for a special license to extract it—an authorization no private company has yet received. In practice, companies have to lease from the state, as only two lithium mining companies—SQM and Albemarle—have done. No new mines have been opened in the past 30 years. The Chilean government collects royalties of up to 40 percent, and the expansion is complicated due to resistance from local communities. Presently, the Boric administration is considering to establish a new state lithium company to extract lithium in alliance with private companies, thereby bolstering the state's involvement in the sector.

Other than the differences in policy and strategic position held by different countries, the ESG issue might be an impediment to forming a cartel. Displacement and conflicts will surely follow the expansion of the lithium plants in the absence of adequate governance. The shift to EVs and clean energy will significantly lessen the greenhouse gas emission, but perceived from a whole industrial cycle it is evidently not as environmentally friendly as many imagine. According to the estimation of Helms, et al. (2016), the particulate emissions of EVs over the entire lifecycle are approximately 60 percent higher than those of petrol cars. The extraction in the Lithium Triangle consumes a large amount of water and lowers water tables, potentially causing the drying up of lakes, wetlands, springs and rivers. Water levels in some wells on the southern part of the salt flat in Chile declined by about one meter over the last decade in total. (Millan, 2019) Meanwhile, the Indigenous people of the high Andes increasingly fear that the scarce water on which they rely for domestic use is being jeopardized in a global drive for green vehicles to combat climate change. For example, in the Tercer Malón de la Paz, demonstrators in Buenos Aires marched a protest (Lavaca, 2023) which garnered attention, demanding



enhanced community consultation and a broader commitment to water rights for Indigenous communities in Jujuy province. In Bolivia, protesters in the lithium-rich region of Potosí blockaded a key processing plant, demanding legislation that guarantees better benefits for local communities and larger royalties from extraction of lithium. (Ramos & Machicao, 2023) In the unprecedented global transition to clean energy, Latin Americans might once more be cursed by its bountiful lithium resources. The ESG issues owing to the expansion of lithium extraction without improper control and regulation might ignite strong civil resistance and further constrain the ambition of a cartel.

Furthermore, in contrast to other metals and commodities known for their stable chemical properties, lithium exhibits high reactivity and typically requires storage in an inert substance, incurring additional expenses. Therefore, direct trading of lithium is unfeasible. In addition, the lithium market exhibits high volatility. Following an exceedingly exponential price increase from 2021 to 2023, lithium carbonate prices plummeted dramatically to below 110,000 CNY/ton from a peak of 598,000 CNY/ton. Such high volatility may induce speculative expansion and abrupt market downturns. Politically, Latin America is known for its oscillations between right-wing and left-wing ideologies. Changes in governments and policies could further exacerbate uncertainty and instability. Javier Milei's inauguration this year in Argentina is expected to lead to the implementation of a more liberal policy and reduced regulation regarding the development of domestic lithium resources. These factors could present further challenges to the formation of a lithium cartel.

#### 4. Conclusions

The global transition to clean energy has significantly boosted the EVs market, driving a surge in demand for lithium resources. Consequently, the price of lithium carbonate has soared in the past few years. Latin America, home to 58% of the world's confirmed lithium reserves, perceives an unparalleled opportunity to increase profits, enhance development, and move up the lithium value chain. Latin America is well-positioned to benefit from the global energy transition. The region, with its abundant natural resources and expanding renewable energy sector, stands poised to benefit from the shift towards sustainable energy sources. Latin America's vast reserves of lithium position it as a critical player in the global energy landscape. Moreover, by adopting renewable energy technologies, Latin American countries can not only reduce their carbon footprint but also stimulate economic growth and enhance energy security. The current wave of "pink tide" of leftist governments in Latin America provides political propellant for regional cooperation. They have reached a consensus on leveraging the global energy transition to ensure resource sovereignty and pursue sustainable development through a lithium cartel. However, the feasibility analysis in this paper indicates that Latin America may be overly optimistic about the current momentum. In the long term, expanded conventional production and new technologies will alter the supply-demand balance and market structure. External actors' strong production capabilities will counter efforts to form a cartel through greater investment in exploration, development, and manufacturing. Differences in production capacity, development levels, and policies among Latin American lithium producers will also impede regional collaboration. In conclusion, forming a lithium cartel may be too ambitious for Latin America given its current production capacity and market influence. A more practical approach would be to first establish a regional resource association to consolidate lithium resources and improve its value chain position through producing higher value-added products using advanced technologies.

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