ADVERSARIES IN THE ALTIPLANO: STRATEGIC COMPETITION IN SOUTH AMERICA'S LITHIUM TRIANGLE

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
Art of War Scholar

by

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

ADVERSARIES IN THE ALTIPLANO: STRATEGIC COMPETITION IN THE LITHIUM TRIANGLE, by Daniel T. Liebetreu, 135 pages.

This thesis explores the opportunities and risks facing the United States given the PRC's involvement in South America's lithium supply chains. By conducting a series of SWOT analyses, the work analyzes the lithium resources and economic and political institutions in Argentina, Bolivia, and Chile, followed by the potential opportunities and threats posed by each of the two superpowers. The study is focused on the lithium triangle due to the unique composition of the region's vast lithium deposits and untapped potential. The results demonstrate that all three countries are viable options for investment, but the US government must set the conditions for American investors due to the uncertainty associated with each country's political and economic situation. The study posits that the US government must develop and employ a comprehensive strategy for the Western Hemisphere that includes planned engagement with the lithium triangle to increase lithium extraction, decrease supply chain bottle necks, and contribute to local development. In addition, the author advocates for an industrial policy that fortifies America's global supply chains through targeted, low interest-rate financing and the employment of loan guarantees.

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ACRONYMS

APEC	Asia-Pacific Economic Cooperation
BRI	The Belt and Road Initiative
CCHEN	*Comisión Chilena de Energía Nuclear* (Chilean Nuclear Energy Commission)
CCP	Chinese Communist Party
CEO	Chief Executive Officer
Codelco	*Corporación Nacional del Cobre de Chile* (National Copper Corporation of Chile)
Corfo	*Corporación de Fomento de la Producción* (Chilean Production Development Corporation)
COVID-19	Coronavirus Disease 2019
CRS	Congressional Research Service
DOD	Department of Defense
DOS	Department of State
DFC	US International Development Finance Corporation
DLE	Direct Lithium Extraction
ECLAC	UN Economic Commission for Latin America and the Caribbean (CEPAL in Spanish)
EV	Electric Vehicle
EXIM Bank	Export–Import Bank of the United States
FDI	Foreign Direct Investment
FSO	Foreign Service Officer (US Department of State)
GDP	Gross Domestic Product
G20	Group of Twenty
ICS	Integrated Country Strategy

IDB	Interamerican Development Bank
INSSG	Interim National Security Strategic Guidance (US)
IMF	International Monetary Fund
JEMSE	*Jujuy Energía y Minería Sociedad del Estado* (Energy and Mining Company of Jujuy Province, Argentina)
JRS	Joint Regional Strategy
LCE	Lithium Carbonate Equivalent
OECD	Organisation for Economic Co-operation and Development
PMESII	Political, Military, Economic, Social, Information, Infrastructure
PRC	People's Republic of China
SOE	State-Owned Enterprise
SQM	*Sociedad Química y Minera de Chile* (Chilean Chemical and Mining Company)
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UN	United Nations
US	United States
USGS	United States Geological Survey
WHSSA	Western Hemisphere Security Strategy Act (Proposed legislation)
WOLA	Washington Office on Latin America (Non-governmental organization)
WTO	World Trade Organization
YLB	*Yacimiento de Litio de Bolivia* (Bolivian State Lithium Company)

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CHAPTER 1

INTRODUCTION

Background

A superpower has emerged from the far east and the entire world is on notice. After four consecutive decades of explosive economic growth, the People's Republic of China (PRC) is beginning to wield its newfound economic and political power in lands both near and far. The international system is facing a bipolar standoff, a new strategic competition that pits liberal democracies against authoritarian states. The result is increasingly tense relations in the diplomatic, information, and military realms, and outright competition in the economic sphere.

The PRC's economic explosion began to shape global commerce in the late 1990s and early 2000s when China released its "Go Out" strategy for outward foreign direct investment (FDI) in 1999 and then entered the World Trade Organization (WTO) in 2001. These two events, coupled with expansive economic policy, led to huge demand in China for commodities and a subsequent commodities boom from 2003 to 2013. The price of some mineral and petroleum commodities tripled, and the so-called "China Boom" drove development and poverty reduction in commodity exporting countries across the global south (Jenkins 2019, 268). As a result, China has risen as a new economic hegemon in parts of Africa and southeast and central Asia while greatly expanding its economic influence around the world. Now, the PRC could eclipse the US as the world's largest economy as soon as 2040, and the geopolitical impact is enormous.

Meanwhile, the United States continues its relative economic decline since it represented more than half of global gross domestic product (GDP) at the end of World

War II. Now, the US represents less than a fifth of global GDP and has a worthy adversary with the economic power to compete across the globe. In addition, the reputation of the US is in question as the country faces an ungraceful end to two costly wars in the Middle East, mounting debt, crippling political polarization, and the lingering effects of the coronavirus disease (COVID-19) pandemic. In this context, the rest of the world faces two vastly different superpowers on two very different trajectories.

In South America, many countries began to hedge their bets and more closely align with the Chinese economy during the commodities boom. During that time, the PRC became the number one trade partner of Argentina, Brazil, Chile, Peru, and several other smaller countries. Chinese FDI in South America exploded, particularly in extractive industries and agriculture, while Western investment tapered off following the global financial crisis of 2008-2009. The years of the so-called "China Boom" were so fruitful that millions of people escaped poverty and many economies in the region continued growing despite the disruption from the financial crisis. China was touted across the region as a new market for South American goods and a much-needed additional source of finance and investment. A natural partnership was forming.

Now as the world settles into its new normal following the COVID-19 pandemic and the US shifts its focus to resolving internal problems and national security issues in eastern Europe, the natural partnership between China and South America may provide the Chinese with a huge advantage as the strategic competition of the 21st century runs its course. One industry where the Chinese hold a significant advantage is in lithium-ion batteries, from mineral extraction and processing to battery manufacturing. This study will explore how the shifting order in South America presents both opportunities for and

threats to US national security interests as the world moves to electrify and the importance of lithium-ion batteries grows.

Problem Statement

Since China joined the World Trade Organization in 2001, its explosive economic growth has allowed it to pass the United States as South America's primary trade partner and source of foreign direct investment. During this two-decade explosion of investment and trade, Chinese companies have inserted themselves into the supply chains of many key minerals, most critical among them being lithium. Now, as the US economy transitions to renewable energy, it finds itself at a significant disadvantage in sourcing this key mineral, especially since the most economically viable lithium resources in the world are in South America's lithium triangle of Argentina, Bolivia, and Chile—where more than two-thirds of global lithium resources are located.[1]

Purpose of the Study

The purpose of this study is to explore the opportunities and risks facing the United States given the PRC's involvement in South America's lithium supply chains. This work offers new insights into the competition between the two powers by analyzing the lithium industry through the lens of the three countries in the lithium triangle. By focusing on the interests of Argentina, Bolivia, and Chile, the author highlights where the interests of the two great powers align with those of the three South American countries.

[1] The author recognizes the official names of all three countries—the Argentine Republic, the Plurinational State of Bolivia, and the Republic of Chile—but will use the shorter, more common names for brevity and overall flow.

It identifies the ways and means available to maximize local and regional development and boost global lithium supply while remaining focused on environmental sustainability. In the final chapter, the author offers unique policy recommendations that align US interests with the interests of the country or countries targeted by the policy.

Research Questions

Given the problem and purpose of the study, this work seeks to answer the following primary research question: Considering China's rise in the region, how should the US engage the countries in South America's lithium triangle (Argentina, Bolivia, and Chile) to guarantee access to the mineral for the next decade?

To answer this question, this study will investigate the following secondary research questions: What are the significant risks to US national interests presented by the PRC's involvement in lithium extraction in South America? What are the advantages and disadvantages of investment in the lithium industries of each country in the Lithium Triangle? And, how do Argentina, Bolivia, and Chile view the PRC and the US, especially with respect to the potential extraction of their lithium reserves?

Assumptions

There are several assumptions that are necessary to execute this research project. First, regarding lithium and its centrality in the study, the author is assuming that lithium will remain a critical raw material in the green energy sector for at least several decades. In addition, it is not expected that domestic US production will increase rapidly enough to fulfill the growing demand projected through 2035 and beyond (Grant and Goodenough 2021). As a result, South America's lithium will remain critical to global

supply and provide a significant portion of lithium utilized in US manufacturing. Moreover, the author assumes that the importance of other elements used in lithium battery production will continually decrease in importance, therefore increasing the value of lithium supplies in the coming decades. These elements include but are not limited to cobalt, nickel, and manganese.

Second, the author assumes that the PRC will not liberalize under Xi Jinping and the international system will continue to backslide toward bipolar rivalry as described by international relations scholars (Allison 2017; Economy 2018; Doshi 2021). Furthermore, it assumes that the PRC will continue its remarkable economic rise in some capacity and that strategic competition will continue to transpire in at least the economic sphere for several decades. Coupled with this assumption, the author views the US as a superpower in relative decline with a formidable rival in the PRC.[2] As a result, the focus in the current US administration on securing key mineral supply chains is not misplaced, as strategic competition could cause stress to existing supply chains.

Finally, many of the recommendations in this study focus on creating opportunity for the countries in South America that hold the vast reserves of lithium in their desert salt flats. This study assumes that these countries desire to develop in an equitable and sustainable way.

[2] Relative decline implies that, while the actor's overall power (economic, military, or otherwise) may continue to grow, it is not able to maintain the same growth rate as other developing economies. This concept accepts that power is not a zero-sum concept.

Definition of Terms

The following definitions developed by the author are provided to ensure uniformity and understanding of the terms throughout the study:

The China Boom: The period of record high commodity prices from 2003 to 2013 driven by exploding demand for minerals, energy, and food stuffs in mainland China following the growth of its middle class and its admittance into the WTO.

Direct Lithium Extraction: An emerging technological process that uses specialized membranes and chemicals to extract lithium ions from brines without dehydrating the brine to increase ionic concentration. DLE is not a singular technology, but a branch of technologies that must be tailored for each individual brine composition.

Foreign Direct Investment (FDI): A cross border investment where one firm establishes a significant foothold in another country through either the purchase of all or part of an existing company, or the spending of significant capital to start a new enterprise abroad.

Resources: The total amount, both discovered and undiscovered, of a mineral commodity held in a certain region. This number is often an estimate of what exists.

Reserves: The total amount of a mineral commodity that can be economically extracted and brought to market. It is the known quantity that has been discovered and resides in a place where it can be extracted for a profit.

Strategic competition: Global competition across all domains of national power (diplomatic, informational, military, economic) in which two or more nation states simultaneously compete for power and influence in multiple regions around the world.

Scope

This study is specifically focused on the supply of lithium due to the unique properties of the element. As the lightest metal (element number three on the periodic table) it is the best metal for battery production. In addition, while innovation may decrease the requirement for other metals in batteries (e.g., cobalt, nickel, and manganese), lithium will remain a critical element of batteries for at least several decades.

Furthermore, the study is focused on the countries in the lithium triangle due to the unique opportunities the region presents. The lithium triangle contains about two-thirds of the world's lithium resources in the salt flats of the *Altiplano* (or High Plains in Spanish.) The next most important lithium resources are in Australia (a US ally), mainland China, and the US, respectively. In addition, South America's lithium is the cheapest and easiest lithium to extract and process in the world—a fact that will be explored in greater depth in the following chapter.

Finally, this study does not contain information on other elements required to make batteries or other energy sources. All current trends in battery innovation seek to make lithium more critical to production, not less. Moreover, the author recognizes the possibility that disruptive technologies like hydrogen fuel cells, generation IV nuclear, and magnetic wave transfer could eventually have on the world's energy infrastructure; however, none of those challenge the lithium battery's dominance in energy storage, nor are any of them likely to be fielded at scale during this decade.

Limitations and Delimitations

There are several limitations to this study that impacted the overall scope of the work. First and foremost was the limited time afforded the author to conduct research and analysis. This project was completed in under nine months and in conjunction with a significant amount of unrelated work because it was a requirement for the Master in Military Arts and Sciences through the US Army Command and General Staff Officers Course. Furthermore, the author sought to publish the thesis in a timely manner in the hope that it will influence policy that addresses the identified issues.

A second clear limitation was derived from the nature of qualitative studies. In general, qualitative research is highly influenced by the researcher's perceptions and therefore often criticized for selection biases. As an American military officer, the author has addressed this limitation by studying documents published in each of the three South American countries, with a focus on research conducted by South American governments, businesses, think-tanks, and scholars. In addition to author bias, qualitative research is often limited by the scope of the research methodology because projects are often limited by time, page count, funding, or other limits beyond the researcher's control.

To address the previously mentioned limitations, this study narrowed its scope through the following delimitations. First, this study does not address Australia and its significant lithium reserves and already developed lithium extraction industry because the Australians are a formal US ally with increasingly tense diplomatic relations with the PRC. In addition, the Australians currently manage their lithium reserves using an open, free-market system that already has significant ties to US and Chinese firms. Second, it

does not address the potential impact of lithium battery recycling due to the significant progress the industry must make to recycle batteries and the expected gap in lithium supply even if the most optimistic research and development models come to fruition. Finally, this work does not address other elements used in lithium battery production like cobalt, nickel, and manganese due to the assumption that researchers will continue to progress toward lithium battery designs that do not require these additional metals.

Significance of the Study

The US has identified the importance of developing its own lithium battery industry and creating resilient supply chains to feed that industry. In fact, the current administration's 100-day review of supply chains bluntly states that this "is critical to U.S. national security and is essential to developing resilient defense supply chains that are not under threat from potential adversaries" (The White House 2021, 92). The review goes on to state that to "meet maritime, surface, undersea, space, air, and ground operational requirements, DOD will need reliable and secure advanced battery technologies" (The White House 2021, 92). At the present time, the US is at least a decade away from developing the mining capability to satisfy lithium demand through domestic extraction. As a result, the lithium triangle is a critical region to help the US bridge the gap.

In addition, America needs to address the lack of a definitive foreign and economic policy regarding the Lithium Triangle. A comprehensive policy toward the region could address two of the most significant foreign policy goals of the new presidential administration: countering the PRC's rising influence in third party nations, specifically those in the Western hemisphere; and attaining and maintaining global

leadership in the fight against global warming and climate change. This study is significant because it informs and prescribes economic and foreign policy that not only addresses these critical US interests, but also nests these interests with the three South American countries involved. This study hopes to identify the win-win scenarios that can drive development in Argentina, Bolivia, and Chile, while also increasing the supply of a crucial element in humanity's race to overhaul our energy system.

Chapter Summary

This chapter presented the problem facing the US as it attempts to solidify its lithium supply chain in the context of global competition with the PRC. Given China's significant head start in battery production, lithium consumption, and EV sales, the US faces an uphill battle to make headway in South America with respect to lithium procurement.

In the subsequent chapters, the author will address this gap in US policy by answering the following primary research question: Considering China's rise in the region, how should the US engage the countries in South America's lithium triangle (Argentina, Bolivia, and Chile) to guarantee access to the mineral in the coming decade? In answering that question, this work will recommend a direction for strategic engagement and investment to the right places in South America and address the gap in current US strategy with respect to ensuring a reliable supply of lithium for batteries and other strategic industries.

In the next chapter the author will present the state of the research question through a detailed literature review. This literature review will provide the reader the background information necessary to understand Chinese and US policy in Latin

America generally, and the reason for both superpowers' interest in South America's lithium resources more specifically. In addition, it will offer a foundation for the methodology described in chapter three.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this thesis is to determine what policies the US should adopt vis-à-vis the countries in the lithium triangle to solidify US access to lithium given the growing strategic competition with the PRC. Furthermore, this work explores policy options that align US interests with those of the South American countries while also increasing global lithium supply to facilitate the transition to renewable energy and electric vehicles (EVs). Thus, the primary research question addressed in this work remains: Considering China's rise in the region, how should the US engage the countries in South America's lithium triangle (Argentina, Bolivia, and Chile) to guarantee U.S. access to the mineral in the coming decade? To properly address this question, the author will explore the interests of the three nations that compose the Lithium Triangle by answering the following secondary research question: What are the advantages and disadvantages of investment in the lithium industries of each country in the lithium triangle? How do Argentina, Bolivia, and Chile view the PRC and the US, especially with respect to the potential extraction of their lithium reserves? In addition, the author will explore the implications that PRC involvement in South America has on US foreign policy by answering the following question: What are the significant risks to US national interests presented by the PRC's involvement in lithium extraction in South America?

To provide the reader with the appropriate background information required to understand how this geo-economic competition will play out in the lithium triangle, this literature review is divided into four key elements, plus a brief background of the

research methodology: first, why lithium is so important and where and how it is extracted; next, an exploration of China's interests and policy in Latin America; third, an overview of US interests and policy in the region; and finally, how each of the three countries in the Lithium Triangle approach foreign and economic policy, with specifics for each superpower covered in the analyses.

Lithium

There is a significant amount of information published on the importance of lithium to the world's transition to renewable energy. To set the stage for the analysis in chapter four, this section will describe several of the most comprehensive and erudite views on lithium supply chains and the future of the lithium-ion battery industry. Then, it will establish why lithium is so important, where it is located across the globe, and how it is extracted and processed. Answering these three questions is crucial to understanding the strategic importance of the lithium reserves and resources in South America and provides important context for the analyses in chapter four.

One of the best monograms on lithium and its role in the green energy revolution is by Polish battery materials analyst Lukasz Bednarski (2021). In his book *Lithium: The Global Race for Battery Dominance and the New Energy Revolution*, Bednarski explains how lithium and other critical minerals will replace oil to become the primary commodity of the twenty-first century. In addition, he illuminates the foresight demonstrated by the Chinese to secure their global supply chains and build an internationalized battery industry centered around their manufacturing hubs and the emerging Chinese market. Through clearly articulated industrial policy, the PRC subsidized EVs to create a market well before it was economically viable (28). Bednarski posits that these policies have

provided the Chinese with a significant first-mover advantage in lithium processing, battery production, and EV manufacturing. Now, instead of the free-market-driven supply chains that characterized oil in the twentieth century, the battery and lithium industries will follow an "Asian version of capitalism" characterized by "collective effort" with "priorities dictated from the top" (4).

Meanwhile, Alex Grant, the founder and Chief Executive Officer (CEO) of lithium consulting firm Jade Cove Partners, is more positive about the future of Western firms, technology, and innovation in solving the world's lithium supply problem. Grant is a chemical engineer with expertise in Direct Lithium Extraction (DLE) focused on making more lithium resources economically viable for exploitation while reducing the amount of water required in the extraction process.[3] Grant's research has demonstrated that projected lithium demand cannot be met by current lithium extraction technology without significant environmental degradation (Grant 2021; Grant and Goodenough 2021). He advocates for more investment in in DLE technology and an overhaul of how we approach lithium mining to create a more equitable supply and consumption of minerals like lithium (Grant and Barros 2020; Grant 2022; Grant and Keuhnert 2022).

Finally, for readers of Spanish, the reports published by the UN Economic Commission for Latin America and the Caribbean (ECLAC, or CEPAL in Spanish), provide excellent analysis of the lithium industry and the role the lithium triangle will play in battery supply chains during the green energy revolution (Obaya and Céspedes

[3] DLE will be further explained in a later subsection.

2021). In addition, their case studies on lithium governance provided significant data for the analyses conducted in chapter four (Obaya 2019; León, Muñoz, and Sánchez 2020).

Why Lithium?

Lithium is important because it is the lightest of all the alkali metals. This means that it is the lightest element—number three on the periodic table—in a family of highly reactive metals containing a single valence electron. This single electron in the metals' outer shell makes it so reactive that lithium does not occur in nature in its pure form, only as an element in a compound. In addition, this means it is an excellent conductor of heat and electricity and therefore the ideal metal for use in lightweight batteries (Bauer 2020).

Since the first rechargeable hand-held video camera employed a lithium-ion battery in 1991, lithium-ion technology has been the gold standard for small, lightweight, and high-powered batteries. The commercialization of lithium-ion technology was one of the catalysts for the mobile phone revolution. These batteries provide the electricity required to power nearly all the wireless electronics that enable our day-to-day activities, including smart phones, tablets, laptop computers, smart watches, and more. Moreover, these batteries are so critical to the nation's economic and military interests that The White House (2021, 92) recently stated that "establishing and protecting a high-capacity [lithium-ion] battery manufacturing capability in the United States […] is critical to U.S. national security and is essential to developing resilient defense supply chains that are not under threat from potential adversaries."

From a purely economic standpoint, the primary industry employing lithium-ion batteries is the auto industry through the employment of EVs. The auto industry has been dominated by the internal combustion engine for more than a century, but now falling

battery costs have industry experts predicting EVs to price similarly to their gas-burning competitors within five years (Foldy and Gold 2021). This has caused the market share of EV maker Tesla to eclipse more than $975 billion—more than ten times the value of competitors Ford and General Motors. In China where government policy is pressuring out new gas-powered autos, EV sales accounted for more than 20% of new vehicle sales in August 2021 (Flannery 2021). Nearly every major auto maker has announced plans to make their fleets all-electric in the coming decades, and the lithium-ion battery is the key to the transition.

However, lithium's future is more broad than just electric vehicles. There is huge potential demand coming from battery makers geared toward bulk electricity storage. As more renewables join electrical grids around the world, the necessity for large, cheap batteries to store wind and solar energy will further drive demand. For example, Tesla has been installing batteries and solar panels in new homes in Australia and the US for several years (*The Economist* 2016). On a larger scale, utilities companies are looking at investing in large battery packs to store electricity during periods of low demand and provide electricity as surge capacity during periods of increased demand. Some energy experts predict that a critical "tipping point" in the green energy revolution is the point where power companies build battery farms in lieu of a gas or coal plant to deal with high-demand times.

Location of Global Lithium Reserves

Due to its share of global reserves and resources, South America's lithium is strategically significant. Argentina and Chile contain about half of the world's current lithium reserves—that is, half of the total lithium that can be economically extracted

today. Another quarter of global reserves reside in Australia, with about 7% in China, and 3.5% in the US. Meanwhile, global resources are even more highly concentrated in the Lithium Triangle with 58% of total resources contained in the salty brines under the salt flats' crusty surfaces (USGS 2022, 98-99). More significant, these resources contained in underground brines are the cheapest to extract and process into lithium carbonate, especially given the extremely dry climate in the altiplano desert (The White House 2021, 102). Table 1 shows the global array of lithium resources and reserves listed by country.[4] In addition, the map at Figure 1 shows the locations of the South America's most significant lithium-rich salt flats, all of which will be referenced in chapter four's case studies.

[4] There are various sources for the status of global lithium reserves and resources. One of the best is the annual report published by the USGS (2022). However, for strategic reasons the USGS withholds much of the data pertaining to the reserves and resources in the United States. For an accurate assessment of where the US stands, the author relied on data published by the companies with the mineral rights (which tend to be optimistic) and the research of Alex Grant (2021).

Table 1. Lithium Resources and Reserves by Country

Country	Resources		Reserves		2021 Production
	Quantity	Percentage	Quantity	Percentage	
Bolivia	21,000,000	24%	ND	ND	ND
Argentina	19,000,000	21%	2,200,000	10%	5,900
Chile	9,800,000	11%	9,200,000	42%	21,500
United States	9,100,000	10%	750,000	3%	ND
Australia	7,300,000	8%	5,700,000	26%	39,700
China	5,100,000	6%	1,500,000	7%	13,300
Canada	2,900,000	3%	530,000	2%	0
Zimbabwe	500,000	1%	220,000	1%	417
Brazil	470,000	1%	95,000	0%	1,420
Portugal	270,000	0%	60,000	0%	348
Others	13,560,000	15%	2,700,000	12%	0

Source: Created by author using quantities gathered from USGS 2022.
NOTE: Quantities denoted in tons of LCE.

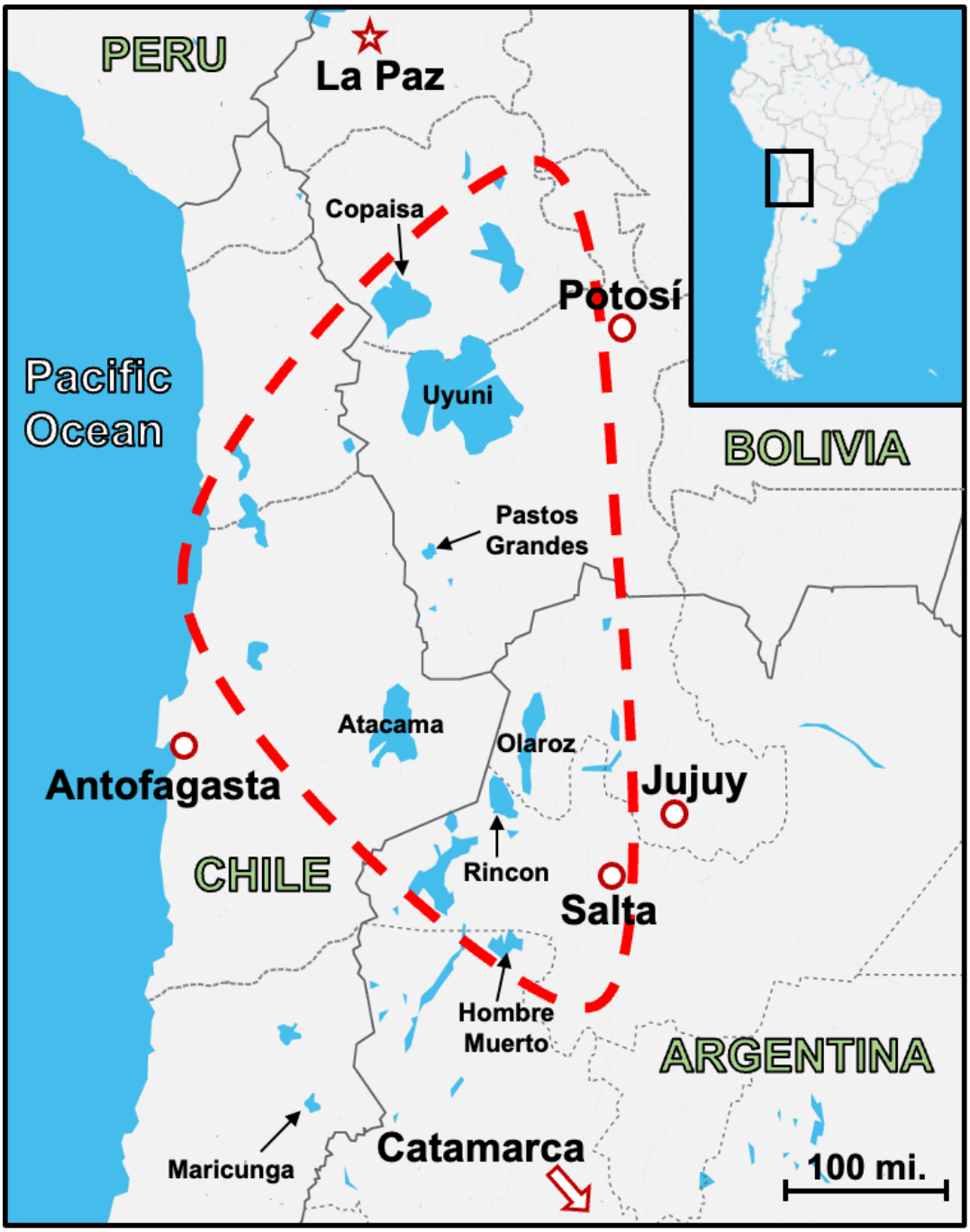

Figure 1. South America's Lithium Triangle

Source: Created by author using Snazzy Maps; data from Munk, Hynek, Bradley, Boutt, Labay and Jochens 2016, 342–343.

How Lithium is Extracted and Processed

There are currently two primary ways to exploit lithium reserves and each extraction operations' method is determined by the way the mineral is geologically arrayed. The more economical extraction via salt brine is used in South America's *altiplano*, as well as in locations in central China and portions of the Nevada desert. The process involves drilling approximately ten meters into the crust of these desert lakes to reach a mineral rich brine, then pumping the salty mixture to the surface into a series of evaporation pools. Once much of the water from the brine evaporates and the mixture is highly concentrated—a process that usually take twelve to eighteen months—the salt's prize, lithium carbonate ($LiCO_3$), can be removed and shipped to facilities for processing (*The Economist* 2016; Bauer 2020).

The second extraction method comes from spodumene rock, which is common in Australia, China, and North Carolina, and involves pit mines where the rock is pulverized and then shipped to east Asia for processing (*The Economist* 2017). These spodumene rock formations contain lithium hydroxide (LiOH), a more highly sought after compound for lithium-ion battery manufacturing because it is chemically easier to convert to cathode materials such as lithium cobalt oxide ($LiCoO_2$), lithium manganese oxide ($LiMn_2O_4$), lithium nickel oxide ($LiNiO_2$), and lithium iron phosphate ($LiFePO_4$) (Obaya and Céspedes 2021, 59). The characteristics and ideal uses for each type of battery are described in the chart in Appendix A.

Converting lithium carbonate from a salt brine into lithium hydroxide requires an additional chemical process utilizing either soda ash (sodium carbonate/Na_2CO_3) or slaked lime (calcium hydroxide/$Ca(OH)_2$). This adds an additional cost to processing and,

if done on sight at a salt brine operation, can add significant infrastructure requirements due to the road or rail network required to bring in the soda ash or slaked lime.

An additional factor in salt brine lithium extraction is the concentration of lithium in the brines. Since lithium is extremely common—in fact it is even present in ocean water at very low concentrations—the concentration of lithium determines whether extraction is economically viable. In general, brines with a lithium concentration over 100 parts per million (ppm or mg/L) is considered potentially viable (Munk et al. 2016, 339). The highest known concentrations of lithium in salt brines occur in the lithium triangle's *altiplano* region, in some locations reaching more than 1,500 ppm. The chart at Table 2 shows the concentration of lithium in known salt brines across the lithium triangle.

Table 2. Salt Brine Compositions in the Lithium Triangle

Basin	Country	Basin Floor Area (km2)	Avg Li (mg/L)	Total Lithium Resources (Mt)	Precip (mm/yr)	Evap (mm/yr)	Aridity Class	Significant Impurities	Process Technology
Salar de Atacama	Chile	2,115	1,800	6.3	39	1,440	Arid	None	Pure Evaporation
Salar de Maricunga	Chile	136	920	0.2	52	950	Arid	Calcium	Chemical-Evaporative
Salar de Surire	Chile	106	340	0.0	247	1100	Semiarid	TBD	TBD
Salar del Hombre Muerto	Argentina	581	521	0.8	91	1106	Arid	None	DLE
Salar del Rincon	Argentina	421	400	0.2	61	1233	Arid	Sulfates	DLE (T)
Salar de Olaroz	Argentina	480	650	1.0	90	1246	Arid	Sulfates	Chemical-Evaporative
Salar de Cauchari	Argentina	480	510	1.0	90	1246	Arid	Sulfates	Chemical-Evaporative
Salar de Llullaillaco	Argentina	128	450	0.0	30	1148	Hyperarid	TBD	TBD
Salar de Uyuni	Bolivia	13768	321	10.2	62	1318	Arid	Magnesium & Sulfates	Chemical-Evaporative & DLE (T)
Salar de Copaisa	Bolivia	3055	243	0.0	320	1316	Semiarid	Magnesium & Sulfates	Chemical-Evaporative & DLE (T)
Salar de Pastos Grandes	Bolivia	142	1062	0.0	57	1094	Arid	Magnesium & Sulfates	TBD

Source: Created by author using data from Grant 2021; Munk, Hynek, Bradley, Boutt, Labay, and Jochens 2016, 342–343.

The People's Republic of China: Interests and Policy

There is nearly an endless amount of academic literature focused on the geo-political implications of China's economic rise since Deng Xiaoping articulated the strategy of "Reform and Opening Up" at the Chinese Communist Party's (CCP) third-party plenum in December of 1978. Much of the best and most recent literature has astutely analyzed how this economic growth has reshaped the global landscape in unprecedented ways (Kissinger 2011; Economy 2018; Mahbubani 2020; Doshi 2021). China is now a massive consumer of raw materials, a manufacturing hub for much of the world's manufactured goods, and a growing presence in digital technology and innovation. It has become an economic superpower with broad interests that span the globe. In this section, the author will present a summary of the literature covering the

PRC's global interests, as well as explore its ends, ways, and means employed in the Latin American region.

China's Primary Interests and Resultant Policies

It is well established that the CCP's primary interest is the retention of political legitimacy, and since the end of the Cultural Revolution that legitimacy has come through widespread economic growth (Kissinger 2011; Economy 2018; Larus 2020, 90). During the 1990s and 2000s, the Chinese accomplished much of this growth by luring in FDI—especially in the "special economic zones" along the coast—and establishing joint ventures with Western firms looking to take advantage of China's cheap labor and huge market (Larus 2020, 174-175). The resultant industrialization required energy and raw materials as well as a steady supply of food for 1.4 billion people. Therefore, the CCP's primary foreign policy goal has been to support this continued economic growth through what one international political economy expert calls China's "internationalized development strategy" (Wise 2020, 132). This strategy has manifested in the importing of raw materials in their most basic form, the execution of the value-added production on Chinese soil with Chinese labor, and the exporting of these goods around the world (Liebetreu 2021a, 91). This has helped the PRC to develop at an unprecedented pace but tempered the development in countries that have supported the PRC's economic model.

To support this economic strategy, the PRC is taking bold new moves to reshape the international system and achieve Xi Jinping's "Chinese Dream" (Economy 2018; Rosales 2020, 26). One of these bold moves is the Belt and Road Initiative (BRI)—a vast collection of development and investment initiatives that will connect East Asia to Europe, the Horn of Africa, the Middle East, and even Latin America. The most erudite

and balanced analysis of the initiative comes from BRI expert Jonathan Hillman (2020), who debunked the myth of debt-trap diplomacy and describes the BRI as a tool to create an international economic system centered around Beijing. Taking it a step further, Rush Doshi (2021), current Director for China on the Biden administration's National Security Council, suggested that the BRI is not singularly a means to make a profit, but rather a piece in China's grand strategy to redesign the international system with more power held in mainland China (244). For example, Doshi identified the Asian Infrastructure and Investment Bank (AIIB) as a tool to decrease global dependence on the US led Bretton Woods system by providing countries with an additional source of financing and another option for global currency, the Chinese renminbi (240). This revisionist mindset is an important tendency to remember as the analysis moves to the Latin American region.

In addition to its internationalized development strategy, the CCP has played an ever-evolving role in the domestic Chinese economy, most recently through the employment of an industrial policy known as "Made in China 2025." The late international political economy scholar Robert Gilpin defined industrial policy as "deliberate efforts by a government to determine the structure of the economy through such devices as financial subsidies, trade protection, or government procurement." He explained how governments employ industrial policy when they deem "some industrial sectors [to be] more important than others for the overall economy" (Gilpin 2001, 154). "Made in China 2025" was launched in 2015 to upgrade Chinese industry through innovation, education and training programs, and targeted investment. It describes Xi Jinping's vision for achieving global dominance in ten critical industries, to include information technology and artificial intelligence, robotics, and green technology

(Siripurapu 2021). Given the lithium-ion battery's key role in many of these technologies, lithium has a close linkage to "Made in China 2025."

Some would argue that the PRC has employed industrial policy for decades and that the government's role in Chinese innovation has been critical to its success, however, the PRC did not employ industrial policy during its first three decades of free-market reforms. Much of what has been incorrectly categorized as industrial policy was simply expansive government spending and investment in infrastructure. Recently scholarship by Barry Naughton (2021) has demonstrated that China did not develop industrial policy until the global financial crisis of 2008-2009, but has since employed it "on a massive and unprecedented scale" (20). Given only the recent employment of industrial policy by the PRC, the data supporting its impact on the PRC's growth over the previous decade is inconclusive at best.

Finally, China has a new global interest that applies directly to this study: the race against climate change. As a global power with 20% of the world's population but just 8% of the world's arable land and 6% of its fresh water, China is extremely vulnerable to the environmental changes caused by a warming planet (Méndez Morán 2018, 262). As a result, Xi Jinping made a surprise pledge in late-September 2020 when he announced to the United Nations (UN) that China was striving for "carbon neutrality" by the year 2060 (*The Economist* 2020). This has huge implications for the global economy since the PRC is the largest net importer of both coal and crude oil and seeks to become the world's innovation hub for emerging green technologies. However, the PRC's campaign against carbon emissions is already conflicting with economic growth as factories trying to meet growing demand in the West have experienced rolling backouts due to government

mandated caps on regional energy consumption (Rosen 2021). *The Economist* (2021a) has described Chinese climate policy as a "mess of contradictions" and how the PRC manages these contradictions in the future will have far reaching economic and political impacts.

China's Ends, Ways, and Means in Latin America

On the surface, Latin America and the PRC appear to have a "natural partnership" (Liebetreu 2021b, 46-50). Latin America is a commodity exporter and has been a key source to fulfill much of the PRC's demand for food stuffs, energy, and minerals since China entered the WTO in 2001. To capitalize on the shared interests, the PRC has released several strategies for continued engagement with the region, to include one published in December of 2021. That document has an added emphasis on "green development" and the promotion of cooperation "for the transition towards cleaner and more inclusive energetic systems" (MFA PRC 2021). It alludes to the importance of the lithium triangle by calling for "[deepening] cooperation" in the extraction of "geological and energy mining resources" (MFA PRC 2021). Considering the scope and scale of Chinese investment in South America's lithium sector prior to the 2021 joint action plan, it is reasonable to expect continued Chinese engagement with lithium actors in all three South American countries for the foreseeable future.

Given the relatively short time since the 2021 China-CELAC joint action plan was published, the most important and effective strategy for Latin America remains the China-CELAC Cooperation Plan for 2015-2019, more commonly referred to as the 1+3+6 cooperation plan. During a July 2014 speech in Brasilia, Xi described how the "one plan" would serve as a driver of three engines—"trade, investment, and financial

cooperation"—with six key fields of cooperation—"energy and resources, infrastructure construction, agriculture, manufacturing, scientific and technological innovation, and information technologies"—to promote cooperation and sustainable development in the twenty-first century (MFA PRC 2021). Due to its widely regarded success, the plan remained in place past the originally planned five-year period and was only recently succeeded by a new plan in December of 2021.

This 1+3+6 plan has been analyzed by both Latin American and American scholars, with most opinions highlighting the opportunity of Chinese engagement, but with a cautionary sidenote that China remains focused and its own interests and will only help Latin American states when interests are aligned (Myers 2015; Méndez Morán 2018; Wise 2020). This has led some observers, including the author, to caution of a new dependency relationship (Jenkins 2019; Stallings 2020; Liebetreu 2021a), while others believe the trade and financing are largely beneficial to the region (Gallagher 2016; Wise 2020).

In addition to analyzing Chinese policy, there is extensive research on Chinese trade, FDI, and aid in the region. Data from the World Bank shows that the PRC has recently become the number one trade partner for nearly every country in South America and is not the Latin American region's top partner collectively only because of the bilateral trade between the US and Mexico. Similarly, the Latin America and the Caribbean Network on China (*RED-ALC China*) at the *Universidad Nacional Autónoma de México* closely monitors FDI and has shown that China is now the region's largest investor. The network's program director Enrique-Dussel Peters (2014) has cautioned that this investment should be closely regulated and tightly monitored due to "the vast

and omnipresent participation of the Chinese public sector" in commercial negotiations (290). Therefore, many American scholars advocate for a balance between FDI from Chinese state-owned enterprises (SOEs) and private western companies (Gallagher 2016; Myers and Ray 2021).

Experts largely agree that Latin America must move away from its historical tendency toward protectionism to seize the benefits of China's economic rise. However, there is much discussion over how far to go. Economic data supports a neoliberal approach involving free trade, much like the approach of Chile and Peru (Wise 2020, 130-152; Liebetreu 2021a, 47, 66-105). However, it is not possible to fully tease out the value of a free market approach since many of the more protectionist countries struggle with corruption and poor institutions, as is the case with Argentina, Ecuador, and Venezuela.

Institutional strength is an especially important consideration when dealing with FDI coming from Chinese state-owned enterprises (SOEs). In fact, according to Rhys Jenkins (2019), when ranked by annual outward FDI, nineteen of China's twenty largest companies in 2015 were state-owned (75).[5] In Latin America, SOEs account for 87% of Chinese FDI, while 99% of that investment is concentrated in the energy and raw materials sectors (Gallagher 2016, 52). This reinforces the claim that China is involved with the region mostly to support its need for raw materials and is especially important to consider when analyzing the future of Latin America's lithium reserves.

[5] The one private company in the top twenty was the telecommunications giant Huawei.

The United States: Interests and Policy

Like the extent of literature written about the rise of China, there is a significant amount of literature written about the "relative decline" of American power and the resultant impact on US interests. This decline does not imply that the US has not continued to expand its economic and military power since 1945, but rather that it has not grown at the same rate as the recovering powers in Europe and East Asia, nor the developing world across the global south. Among the most erudite analyses of this decline are the thoughts of the two international relations giants Immanuel Wallerstein and Robert Keohane. Wallerstein (2003; 2017) believed that a combination of poor foreign policy decisions, internal divisions, and outright nationalism led to the decline of American power since the Vietnam War era. While he was a bit extreme regarding the implications—he was a Marxist that believed this decline would lead to the end of capitalism—his argument has proven to be prescient. Similarly, Keohane (1984) made the case that America was in a relative decline as its share of global GDP dropped from around half at the end of World War II to less than a quarter by the start of the 1980s. However, his outlook was much different. Keohane is a neoliberal institutionalist who proposed that the US should solidify the international system because a hegemon is not necessary for global stability.

More contemporary international relations literature agrees with these early assessments regarding the US decline but is uncertain of the implications. Some scholars wonder if the US and China will fall into "Thucydides' Trap" (Allison 2017) and eventually fight a war, while others question whether China may have already won (Mahbubani 2020). Regardless, this study accepts the economic numbers and views the

US as a superpower in relative decline with a formidable rival in the PRC. This notion is important for the country analyses in chapter four.

The United States' Primary Interests and Resultant Policies

Unlike the PRC, the United States of America has been a leader in the international system since the end of World War II and has a vested interest in maintaining the current global order. The best outline of America's strategic objectives vis-à-vis the PRC is contained in the final chapter of Rush Doshi's book *The Long Game: China's Grand Strategy to Displace American Order* (2021). Doshi believes that the current international system is well suited to support American interests and values since many international institutions are headquartered in the West and are foundationally based on Western, democratic values. Therefore, he describes American global objectives as the reinforcement of "the foundational elements of American order—particularly its alliances, financial power, military power, technology leadership, role in global institutions, and influence over information flows, among others" (315). According to Doshi, the current international system set the conditions for more than seventy-five years of relative peace and prosperity and must be preserved to promote further economic growth and prevent widespread military conflict in the Indo-Pacific.

However, following the global financial crisis in 2008 and the slow recovery experienced in parts of the country, there has been debate across America's political spectrum of the merits of globalization and what elements of the current global order must be preserved. While free trade and American FDI contributed to the decline of global inequality and the rapid decrease of extreme poverty abroad, it also factored into the deindustrialization of parts of the US and rising inequality within the country

(Bourguignon 2016). These trends provide important economic and political context for understanding the US foreign and domestic policies that impact this study.

The first key policy is the current administration's "build back better" plan to recover from the pandemic, address the off shoring of American industry, and confront the growing economic rivalry with the Chinese. In the *Interim National Security Strategic Guidance* (INSSG) published in March of 2021, the President addressed the off shoring of American jobs and in broad terms laid out a plan for the rejuvenation of American industry. Furthermore, he emphasized the importance of investment in the nation's transportation infrastructure, with added importance on green technology, to "[build] an equitable, clean, and resilient energy future" (U.S. President 2021, 17).

In addition to the INSSG, the government published two important reports in June of 2021: the White House's 100-day review on the state of supply chains and domestic manufacturing; and a National Blueprint for Lithium Batteries published by a consortium of government agencies headed by the Department of Energy. The former describes why "secure and resilient supply chains" are critical to national and economic security and maintenance of technological leadership (The White House 2021, 5). Furthermore, it claims that China has "created a distorted supply chain landscape" and articulated a strategy for addressing several aspects of that economic competition, including a relevant one to this study: lithium batteries (The White House 2021, 92). In the National Blueprint for Lithium Batteries, the study identifies the gap in the nation's "access to a reliable supply of raw, refined and processed material inputs" (FCAB 2021, 6). Most important of those materials is the lithium itself. While the National Blueprint for Lithium Batteries identifies the importance of securing lithium supply chains, it does not address where the

US will get the lithium prior to development of a domestic supply sometime between 2030 and 2035. This study will offer recommendations on how to fill that gap.

Finally, it is important to highlight America's ends, ways, and means regarding climate policy. In contrast to Beijing's authoritarian decision making, the direction of American climate policy depends on the political party represented in the White House (*The Economist* 2021d). Since neither the Republicans nor Democrats have been able to pass significant climate legislation or energy policy in recent decades, the president often sets the course for US climate policy via a series of executive orders and the resultant level of compliance with international climate goals (*The Economist* 2021c). In its first year in office, the Biden administration has prioritized rejoining international climate agreements like The Paris Agreement from the 2015 United Nations Climate Change Conference. In addition, the administration is advocating for a second phase of the build back better legislation that incorporates billions of dollars in green infrastructure spending to include building a national EV recharging network, improving the energy grid to accommodate clean energy sources, and subsidizing a national energy storage network that will power the nation throughout the night and during the winter when solar is not available (*The Economist* 2021d). The level of demand for lithium will depend heavily on the success of these green energy initiatives, and by extension, will depend on the political direction of the country during the rest of the decade.

The United States' Ends, Ways, and Means in Latin America

There is limited open-source documentation related to the Biden administration's foreign policy toward Latin American since the most recent Joint Regional Strategy (JRS) was published under the previous administration in January of 2019. However, the

four ends identified in that 2019 strategy likely remain unchanged: a secure hemisphere, a prosperous hemisphere, a democratic hemisphere, and a hemisphere receptive to U.S. leadership and values (DOS 2019, 5-6). Of these four objectives, the administration's policies have focused on security and the promotion of democracy; the former through executive orders on immigration and increases in COVID-19 related aid, and the latter through bi- and multi-lateral engagement related to Venezuela and Nicaragua and the December 2021 Summit for Democracy. The Congressional Research Service (CRS) (2022b; 2022c; 2022d) has informative, non-partisan, and frequently updated summaries of the administration's priorities for and actions in the region.

In addition to the JRS, each US Embassy mission publishes an Integrated Country Strategy (ICS) that outlines the chief of mission's priorities and aligns the mission's efforts with national policy. At the time of publishing, the ICS in the Bolivia and Chile missions were published in 2018, while the Argentina ICS was published in April of 2022. Despite the currency of the Argentina ICS, only the Chile ICS mentioned the PRC or plans to collaborate on innovation or local economic development.

Furthermore, the Department of State (DOS) Western Hemisphere objectives are embedded in senior official's speeches. For example, during Secretary Antony Blinken's October 2021 trip to the region, he gave an important speech in Ecuador on the future of democracy and Latin America's critical role in protecting it. Secretary Blinken stressed the need to resist authoritarianism, especially during a crisis like the ongoing pandemic, and claimed that democracies have the responsibility to "deliver on the issues that matter most to people" (Ryan 2021). These comments echoed the need to solidify democracy in the region and, while Secretary Blinken did not directly address the PRC, made it clear

that the recent rise in authoritarianism throughout the region is of deep concern to US interests.

In contrast to the DOS messaging, official statements from the DOD and USSOUTHCOM are focused on the PRC's involvement in the hemisphere. In General Laura Richardson's posture statement given before the Armed Services Committee in March of 2022, the PRC is mentioned in the USSOUTHCOM commander's opening lines and holds a central role throughout her remarks. General Richardson described PRC involvement in the Western hemisphere as a "relentless march to expand its economic, diplomatic, technological, informational, and military influence" with a goal of "expanding long-term access and influence in this hemisphere" (U.S. Congress, Senate 2022a, 2-3). It is likely that this is the view across all of government, but the DOS hides the message better in its diplomatic language.

Now more than a year into the Biden administration's time in office, experts have weighed in on the effectiveness of its policies and actions toward the region and the consensus is that the administration must do more. For example, in a cutting review, CSIS analyst and Western Hemisphere expert Ryan C. Berg (2022) wrote that, "effective U.S. action in the Western Hemisphere has been in short supply." Moreover, the liberal-leaning Washington Office on Latin America (WOLA) criticized the administration for inaction and a failure to deliver on campaign promises surrounding immigration, human rights, and the situation in Venezuela (WOLA Staff 2022). All of this has provided opportunity for extra-hemispheric actors to increase their influence in Latin America.

One possible reason for the lack of action is that the United States has not published a national strategy for Latin America that combines all departments of the US

government and outlines clear priorities and lines of effort for engagement with the region. While the Western Hemisphere may not be the primary theater for strategic competition, the US has the capacity to engage with allies, partners, and other nations in multiple theaters simultaneously. In addition, as Naval War College professor Sarah C. Paine (2012) writes, "governments have national policy objectives, and the more comprehensive their strategies, the more likely they are to attain their objectives" (xii). Without a comprehensive strategy in place, official policy has focused on migration, drug-trafficking, and the ideological struggle between authoritarianism and democracy, but failed to address the economic hardship brought on by more than two years of pandemic related recessions and slow growth (CRS 2022b, 19-26).

Fortunately, two members of the Senate Foreign Relations Committee have proposed bipartisan legislation that would require the development of a national strategy for the region. On February seventh of this year, Senators Bob Menendez (a Democrat from New Jersey) and Marco Rubio (a Republican from Florida) proposed the Western Hemisphere Security Strategy Act (WHSSA) requiring the development of "a multi-year strategy […] for purposes of enhancing diplomatic engagement and security assistance and cooperation, promoting regional security and stability, and advancing United States strategic interests in the Western Hemisphere" (U.S. Congress, Senate 2022b.). In addition, both houses of Congress have approved bills geared toward strategic competition with the PRC that include provisions mandating the creation of a U.S. strategy for Latin America. According to the Congressional Research Service (2022c), the House and Senate each passed resolutions in February and March of 2022 respectively, that would "require a strategy to strengthen U.S. economic competitiveness

and promote good governance, human rights, and the rule of law in LAC" (2). At the time of publishing, it is unclear when and if the Congress will be able to pass this legislation, but the framing of competition with the PRC is generating bi-partisan support.

The View from South America

Each of the three countries covered in this analysis have utilized a broad range of economic development models with a varying range of success and failure. To provide context for the analyses in chapter four, this section of the literature review will briefly describe each country's political, economic, and foreign policy history; the history of their mineral exploitation; and a brief history of relations each country shares with China and the United States.

Argentina

The first of three country studies in chapter four will focus on the Argentine Republic, a member of the Group of Twenty (G20) with tremendous economic potential but a more than century long history of financial mismanagement and institutional weakness (Spruk 2019). Key to understanding the lithium industry in South America's second largest country is its history of default. Argentina has defaulted on its debt a record nine times—including three times this century—highlighted by the massive default in December 2001 that completely alienated the Argentinians from global financial markets, and the most recent default in May 2020 that has caused a huge spike in inflation and significant financial hardship during the pandemic (Binetti 2020). These financial troubles are largely the result of two issues: political polarization and an over-reliance on high commodities prices for access to foreign reserves (Bartenstein, Maki and

Gertz 2020). The result is that the Argentinians cannot obtain loans from most western-led financial institutions like the World Bank and IMF. Instead, they have been accepting loans from Chinese state-owned banks at 3% to 5% higher interest rates (Gallagher 2021). Furthermore, the Chinese loans have not come with conditions guaranteeing institutional reforms, so many economists maintain a bleak outlook for the future of Argentinian finance (Méndez Morán 2018, 295-300; Binetti 2019).

Despite the economic turmoil, Argentina still draws significant FDI into its mining sector. Much of the country's mining policy is based on a decentralized approach that stems from Argentina's federal system and its mid-1990s neoliberal reforms (León, Muñoz and Sánchez 2020, 60-71). With much of the power and decision making held at the provincial level, two distinctly different provincial development models have evolved: one in which the provincial governments focus on augmenting output as a means of increasing tax revenue (employed in Catamarca and Salta provinces); and another in which the provincial government establishes a provincial-run enterprise focused on industrializing the entire process from exploration and extraction to processing and battery manufacturing (employed in Jujuy province.) In general, the former has been more effective at encouraging FDI and boosting output, however the prospect of creating all levels of production in a single province are too promising to give up the centralized approach in Jujuy province. The best studies of the Argentinian lithium sector are available in Spanish from the UN Economic Commission for Latin America and the Caribbean (ECLAC in English, CEPAL in Spanish) and the Interamerican Development Bank (IDB) (López et al. 2019; León, Muñoz and Sánchez 2020, 60-71).

Argentinian relations with the Chinese have been defined largely by two trends: Argentina's quest for international finance and China's search for food and natural resources to feed its population and growing economy. The importance of Chinese financing dates to December of 2001, as China was joining the WTO and pushing its "Go Out" economic policy, Argentina defaulted on its debt for the eighth time. As a result, very few countries have been willing to take a risk on the Argentinians other than the Chinese (Méndez Morán 2018, 295-300). Argentina is one of the four countries in South America that has taken on most of the Chinese financing. Since 2007, the Argentines have accepted thirteen loans from Chinese state banks totaling 17 billion dollars (Gallagher and Myers 2021). More than three-quarters of the financing has gone to rail construction and public transportation; however, the most notorious project is a 2.5-billion-dollar dam in former president Néstor Kirchner's home province that was agreed upon when his wife Cristina Fernández de Kirchner was president. In addition to financing, the two countries' interests align in that the Argentines are a net exporter of soy and China is the world's largest importer of the protein-rich commodity crop. In a previous work, the author (Liebetreu 2021a) outlined how the case of soy represents two common trends in the PRC's engagement with Latin America:

> First, as global population increases and food scarcities become more prevalent, the Chinese view [Latin America] as an important part of their foreign policy due to the region's role in guaranteeing China's food security. China's "emerging model of international state capitalism" is focused on building an "international food supply chain" that can feed 1.4 billion Chinese and therefore provide a critical element of political security (Turzi 2016, 122-123). Second, China seeks to obtain materials in their raw form and execute the value-added portion once the raw materials arrive in China. In the case of soy for example, China imports less than 20 percent of Argentine soy oil and none of its soy meal, meanwhile it accounts for more than 80 percent of Argentina's raw soybean export. While Argentina has invested heavily in the processing of soy in the

> *Pampas* region, the Chinese have been building soy processing plants in their coastal cities and thus forcing the Argentines to find customers for their oil and soy meal in other markets. (Liebetreu 2021a, 57)

The current administration of Peronist President Alberto Fernández is continuing the tendency by other leftist administrations of turning to the PRC for financing. Fernández flew to Beijing for the 2022 Winter Olympics and signed on to the BRI in hopes of enticing more Chinese investment and finance as the country continues its recovery from the COVID-19 pandemic (Ellis 2022).

The best accounts of Sino-Argentine relations can be found in the writings of Carol Wise (2020, 153-177), who is generally positive about Argentina's increased ties with the PRC, but cautions that increased ties during the China Boom led to "the slowing of vital reforms and the neglect of domestic economic institutions" (155); R. Evan Ellis (2021; 2022), who is decidedly more cautious and believes most of the PRC's dealings with Argentina are solely to increase its power and influence in the region; and, in Spanish, Daniel Méndez Morán (2018, 251-277), who demonstrates how the relationship can be mutually beneficial, but cautions that Argentina may become dependent on Chinese banks for financing, thus leaving themselves exposed to coercion.

Meanwhile, Argentine relations with the US have been largely defined by the ideological stance of the administrations in Buenos Aires and Washington (Roy 2022). For example, during the first decade of this century, the two governments disagreed on the appropriate role for Hugo Chavez's Venezuela in region governance. Furthermore, many leftist governments resisted the Washington-backed economic reforms that have come with renegotiations and bailouts from the IMF (Binetti 2019). In contrast, free-market oriented politicians from the center-right like former president Mauricio Macri

have been more open to engagement with the US. In fact, Macri was the first Argentine president to visit the US in more than a decade when he met with former President Trump at the White House to discuss trade and the situation in Venezuela (Roy 2022). Key to the relationship moving forward, the two countries share common ground on climate change and understand the critical role of Argentinian lithium in the green energy revolution. For further information on Argentina's economic and political situation, the author recommends the work of Bruno Binetti (2019; 2020) and the Council of Foreign Relations backgrounder by Diana Roy (2022).

Bolivia

The second country study will examine the Plurinational State of Bolivia, one of South America's most mineral rich and yet poorest countries due to centuries of exploitation by foreigners and decades of political instability and dysfunctional institutions. The story for Bolivian lithium begins with the rise of Evo Morales and his political party *El Movimiento al Socialismo* (Movement Toward Socialism or MAS) in the early 2000s. Morales rose to prominence during the 2003 gas conflict in which violent protests broke out over the exploitation of Bolivia's natural gas reserves by foreign enterprises. He was elected president in 2006, becoming the country's first indigenous president, and led a nationalization effort that included oil and gas, lithium, and other mineral resources (Zissis 2006). The MAS social policies, coupled with an unprecedented surge in commodities prices during the China Boom, pulled many Bolivians out of extreme poverty.

However, after more than a decade of rule and amid falling commodities prices, Morales ignored a public referendum and ran for an unprecedented fourth presidential

term in 2019 (*The Economist* 2021b). When the public took to the streets to protest the questionable election results, the government violently responded. Three weeks of demonstrations finally subsided when Morales fled the country, leaving in place a conservative interim government that led through much of the first year of the coronavirus pandemic. Fortunately, the political environment has steadied since Morales' former Minister of the Economy Luis Arce won a fair election in late-2020. He has returned to the MAS's popular economic policies that *The Economist* (2021b) describes as "public investment, import substitution, and wealth redistribution," without the authoritarianism and polarizing rhetoric common during Evo's time in power. Now, the key to sustainable growth is likely how Arce's government manages the socialist agenda while still luring in FDI in important sectors.

The Bolivian experience with natural resource extraction dates to the Spanish Empire and the massive silver mines of Potosí. For two centuries, the Spanish funded wars with the riches mined from their possessions in the Americas, a fact that continues to shape the politics of resource extraction to this day (Burkholder, Rankin and Johnson 2017, 102-104). In the modern era, Bolivia's golden goose has been natural gas, an industry that was privatized during the free-market reforms of the Washington Consensus and then put back under state control during Evo Morales' first year as president. This decade of privatization was key to the current success of Bolivia's state-led natural gas industry since billions of dollars of private investment were put into the sector in the 1990s (Zissis 2006). Thus, the Bolivian government simply took over a well-established and profitable industry and did not have to build a capable oil and gas sector from the ground up (Bonifaz and Lefebvre 2014). In contrast, Bolivia has struggled to build a

profitable lithium industry at scale. As the case study in chapter four will explore, Bolivia has suffered from institutional weakness in a state-led lithium industry as well as had problems overcoming magnesium impurities in the country's lithium brines. Commodities expert Lukasz Bednarski still believes that lithium could be the new oil, and Bolivia is the next Saudi Arabia (2021, 125-144). However, others are more skeptical that Bolivia can make the political and economic reforms necessary to succeed (Johnson and Palmer 2019). In addition to the previously cited works offered in English, there is a vast wealth of information on the Bolivian lithium industry available in Spanish from ECLAC (Obaya 2019; Obaya and Céspedes 2021).

The history of Bolivian relations with the PRC is limited since the Chinese focused their initial efforts in Latin America on larger markets and more stable governments. The Bolivians' right-wing military government that ruled from 1964 to 1985 did not even recognize the PRC or establish diplomatic relations until its final weeks in power (Ellis 2009, 138). Following the return of democracy in La Paz, several Bolivian presidents visited China in an attempt to improve relations and entice investment, but Chinese firms were unable to overcome the country's challenging legal framework and political instability. However, the rise of Evo Morales presented a unique opportunity for the Chinese, especially as Morales' government began to stabilize the economy. Evo grew up admiring Mao Zedong and the PRC's socialist revolution, often listening to Chinese radio being broadcast in Quechua across the Andean highlands (Ellis 2009, 138). Even before his inauguration in January of 2006, Morales visited Beijing and described the PRC as a "political, ideological, and programmatic ally of the Bolivian

people" while expressing interest in working with Chinese SOEs to exploit the country's oil and gas reserves (MacDonald 2006).

This connection with the PRC continues even after Evo's departure from power and will likely shape the future of Bolivia's lithium industry. Due to their limited interaction relative to the rest of the region, there is a relative lack of academic writing on Sino-Bolivian relations. The three best pieces were all written during the Morales era and highlight the growing ideological and economic ties that took place during the China Boom, but caution that the relationship was largely dictated by Chinese priorities and has done little to help Bolivia on its path to development (Ellis 2009, 137-46; 2016, 3-19; Poveda 2012, 153-66).

The US has a much longer history of interaction with Bolivia, albeit of limited scope relative to Bolivia's neighbors. In general, the Americans have only become interested in Bolivia when there are direct US interests involved. In his book on US-Bolivian relations, American author Kenneth Lehman (1999) described how partnerships between the two countries have often devolved into relationships defined by power and interests. For example, the US nurtured close ties to Bolivia during the Second World War only because Bolivia offered the single reliable source of tin in the Western Hemisphere (Lehman 1999, xiv). Similarly, the US provided the Bolivians with aid only during periods when leftist movements threatened US hegemony in the hemisphere (Lehman 1999, 91-102). This unfortunate context has tainted the narrative around

potential US investment in Bolivia, especially since the rise of Evo Morales and his expulsion of the American Ambassador amid political unrest in 2008 (Romero 2008).[6] Now, as described in the case study in chapter four, two US startups are attempting to compete with giant Chinese SOEs while overcoming this significant bias in the Bolivian government (Obaya and Céspedes 2021). Since American DLE technology may be the key to unlocking Bolivia's lithium resources and Bolivia's lithium is plentiful enough to meet global demand on its own, the US-Bolivia relationship has global implications.

Chile

Situated between South America's southern Pacific coast and the Andes mountains, Chile is a geographically diverse country that has risen from the instability of the Cold War to transform into South America's most developed and dynamic economy.[7] However, economic inequality remains high and political polarization has returned, threatening economic growth much as it did during the tumultuous decade of the 1970s when the world's first democratically elected Socialist Salvador Allende (1970-1973) was killed in a military coup and replaced by the authoritarian military government of General Agosto Pinochet (1973-1990) (Fermandois 2005, 352-362; Vásquez 2021a). In fact, nearly fifty years later that ideological conflict remains at the heart of Chilean politics.

[6] The US ambassadorial position in La Paz has remained vacant since Philip S. Goldberg was expelled by Evo Morales in September of 2008 (Romero 2008).

[7] According to statistics from the World Bank (https://data.worldbank.org/), Chile has the highest GDP per capita in Latin America and is higher than many countries in Eastern Europe, including Poland, Hungary, and Romania.

Following a series of violent protests in late-2019 against rising inequality known as the *Estallido Social* (literally translated social outburst), Chileans voted to rewrite their Pinochet-era constitution and democratically elected a left-leaning constitutional convention with the mandate to address rising healthcare costs, a broken pension system that only pays retirees $125 per month, and the over-privatization of land and water rights (Bonnefoy 2020). Now, under the supervision of President Gabriel Boric, a 36-year-old socialist that rose to fame during the 2019 protests, progressives have an opportunity to shape Chile's political framework for a generation or more (Bonnefoy and Londoño 2021). However, Chilean conservatives have a reason to be concerned with the rapid changes in Santiago's politics, for even though the "temporary" military government transitioned into a seventeen-year military dictatorship marred by human rights violations and poor relations with its neighbors, the neoliberal economic reforms led by Pinochet's "Chicago Boys" set the conditions for explosive economic growth following the return of democracy in 1990 (Yergin and Stanislaw 1998, 238-243).

Despite the country's economic success during the past three decades, Chile has less than 2% of the population and GDP of the PRC and remains a small actor on the international stage. As a result, the country is highly dependent on stability in the international system for continued economic growth. In fact, Chilean scholar Manfred Wilhelmy (2017) writes that the country's primary foreign policy interest is the maintenance of a "high degree of fluidity of international trade" (170). Since its economy is powered by commodities and produce exports that require access to global markets, the Chileans have signed numerous free-trade agreements (FTAs), including with both the US and PRC. Wilhelmy continues by describing how these interests are preserved

through “international stability and preservation of peace, a commitment to non-intervention, the observance of validly concluded treaties, and the peaceful settlement of disputes” (170). This includes the maintenance of its FTAs and the observance of WTO rules. In simplified terms, the Chileans have never wielded the hard power required to ensure compliance of international norms by other nations, so they have chosen to become a prominent advocate for international institutions and the interdependent global economy. Unfortunately, dependence on globalization left it vulnerable to the recent shocks caused by the COVID-19 pandemic, which contributed to a more than 10% drop in GDP from 2019 to 2020.

In addition to fully embracing globalization and the rules-based international order, the Chileans have been champions of mining and commodities exports to drive economic growth. The Chileans began exporting copper in the early twentieth century, generating significant FDI from the United States and providing much needed tax revenue (Fermandois 2005, 56). To this day, copper accounts for nearly half of all exports and, until recently, funded much of the country’s military budget.[8] Despite the neoliberal reforms under Pinochet, Chile’s copper is state owed. The nationalization process was started under the center-left administration of Eduardo Frei Montalva (1964-1970), finalized early in the Allende administration, and continued under the military government as a vital source of public funding. Full ownership of all Chilean copper

[8] President and former general Carlos Ibáñez del Campo enacted a law in 1958 that directed ten percent of profits from copper exports to the Chilean military. Remarkably, even though Chile has not fought a war since the 1880s, Chileans only began phasing out these direct payments to the military in July of 2019.

operations remains under the Chilean National Copper Corporation (Codelco–*Corporación Nacional del Cobre de Chile*).

Chile has maintained sensible and effective diplomatic relations with both the PRC and the US and hopes that the growing strategic competition between the two superpowers does not complicate economic relations with either. For more than fifty years, Chile-China relations have been extremely pragmatic and constructive, what journalist Daniel Méndez-Morán (2018) describes as "Realpolitik in its purest form" (327). While it was Allende who recognized the PRC in 1970 for ideological reasons, neither Pinochet nor the Chinese chose to end diplomatic relations following the military coup. Since that time, the two sides have preferred to avoid political discussions that could hinder commerce. In addition to being the first country in South America to recognize the PRC in 1970, the Chileans hold the distinction of several other "firsts" that are frequently mentioned in bilateral engagements between heads-of-state, diplomats, and trade representatives. For example, Chile was the first country in Latin America to formally support China's entry into the WTO in 1999, the first to formally recognize China as a market economy in 2004, and the first nation to sign a bilateral FTA with the PRC in 2005 (Méndez Morán 2018, 334-338). Most recently, Chile is the only country in Latin America to send their president to both BRI forums: President Michelle Bachelet in 2017 and President Sebastian Piñera in 2019 (Reyes Matta 2020). Both countries hope to maintain this momentum by expanding their bilateral trade while avoiding ideological discussions.

However, there are some elements of Chilean civil society that have grown weary of the PRC in recent years due to illiberal tendencies under the Xi Jinping administration

and a growing dependency on the Chinese market for exports (Heine 2020). Particularly startling for the Chileans was the PRC's actions in 2020 toward Australia during the coronavirus pandemic when the latter called for an investigation into the origin of the virus and the Chinese responded with tariffs on several Australian imports (Russell 2021). This has even led to suspicion that the incident involving suspected contamination of the 2021 Chilean cherry harvest was fabricated by the CCP to retaliate for Chile's decision to run its trans-pacific fiber optic cable through New Zealand and Australia in lieu of directly to Shanghai (Tan 2021). While these claims have not been substantiated, they reveal the rapidly changing sentiment toward the Chinese that occurred during the COVID-19 pandemic.

In the case of the United States, the Chileans have maintained good relations with the US, albeit with more history and complexity than the bilateral relationships that the Chileans share with the PRC. As previously mentioned, American commercial interests in Chile started in the early twentieth century as mining firms began investing in Chilean copper. The political struggle that followed World War II complicated the relationship, especially during the nationalization of Chilean copper reserves in the 1960s and early 1970s, but since the end of the military dictatorship and the Cold War, the countries' shared economic interests have brought them together.

However, there have been several events in the previous two decades where the Chileans have felt that the US has bullied them and not appreciated their agency within the international system. The first occurred just after Chile and the United States finalized their FTA in December of 2002 when members of the Bush administration threaten to delay ratification of the FTA if the Chileans did not support the US invasion of Iraq on

the UN Security Council (Fermandois 2005, 526). The Chileans held firm and did not support the invasion and Congress still ratified the FTA; however, the Chilean foreign policy establishment took away a valuable lesson from the experience: power politics still exists in the post-Cold War era.

Theoretical Framework

Finally, regarding the theoretical framework that follows in the next chapter. the author will describe a framework used to understand the interests of the Lithium Triangle's three South American countries. The primary framework is an analysis of the countries' strengths and weaknesses, followed by the perceived opportunities and threats posed by each of the two superpowers. This type of analysis is commonly referred to as a SWOT analysis (for strengths, weaknesses, opportunities, and threats) and is often employed by businesses to describe potential investment opportunities. For the purposes of this study, the author utilizes the definition from David W. Pickton and Sheila Wright (1998) and accepts that the analysis of strengths and weaknesses is executed "in comparison to the competition" (i.e. the other two countries in the lithium triangle), and opportunities and threats are "relative and not absolute" with the goal to find "competitive advantage" for its lithium resources.

Chapter Summary

This chapter set the stage for the analysis in chapter four by providing background on the interests of the PRC and the US. In addition, it explained the importance of lithium for the future of the global economy and where and how the metal is extracted. It then provided a brief history of the economic and political situation in each country in the

lithium triangle, followed by a summary of each country's relations with the PRC and the US. Finally, it explored some of the previous literature that describes and utilizes elements of this works research methodology. Now, the following chapter will explore how the author will employ that methodology in the analysis in chapter four.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

This chapter covers the research methodology used to conduct the qualitative analysis that answers the primary research question of: Considering China's rise in the region, how should the US engage the countries in South America's lithium triangle (Argentina, Bolivia, and Chile) to guarantee access to the mineral over the course of the next decade? Based on this question, chapter four consists of a series of analytical case studies focused on each of the three lithium rich countries. The author conducted the analysis from the standpoint of the South American country, attempting to better understand how the actions of the US and PRC are interpreted within these nations. When developing conclusions and recommendations, this analysis will help align potential US policy with the interests of these South American countries, thereby providing legitimacy to the policy in the target country and maximizing the benefits for both parties.

Method

Due to the nature of the question, this thesis consists of qualitative research to interpret the interests of each country in the lithium triangle and consider how each one views potential investment and engagement by the US and China. To execute this analysis, the author conducts a study of the strengths, weaknesses, opportunities, and threats (SWOT) associated with each country and their country's lithium reserves. To further narrow the scope of the analysis, the author focused on the current state of lithium

extraction in the country and three specific systems of the country's operating environment as described by the acronym PMESII in Joint Publication 2-01.3 Joint Intelligence Preparation of the Operational Environment: the political, economic, and infrastructure systems (CJCS 2014, III-38).

In the first phase of the SWOT analysis the author analyzes the strengths and weaknesses of the country's lithium industry, to include the characteristics of its reserves and resources, its accessibility, the current state of its exploitation, and potential controversies associated with the extraction of lithium. Each case study then describes the internal factors of the South American country by broadly analyzing the strengths and weaknesses of the country's political, economic, and infrastructure systems. This systems perspective assists the author in understanding how and why each country would react to potential US or PRC policy actions.

Following an analysis of the internal factors, the case studies include an examination of the external factors by investigating the opportunities and threats presented by each of the two superpowers. This will focus on the actors and policies employed by each country to create a comparative advantage for their firms, as well as the overall trends associated with their country's mining firms and FDI. The resultant methodology can be understood utilizing the graphic at Figure 2, where each of the three country studies in chapter four consists of one iteration of the SWOT analysis depicted in the following graphic.

STRENGTHS	WEAKNESSES
Strengths related to the extraction of the country's lithium Overall political, economic, and infrastructure strengths of the country	Weaknesses related to the extraction of the country's lithium Overall political, economic, and infrastructure weaknesses of the country
INTERNAL FACTORS	
OPPORTUNITIES	THREATS
Opportunities presented by engagement with the People's Republic of China Opportunities presented by engagement with the United States of America	Threats presented by engagement with the People's Republic of China Threats presented by engagement with the United States of America
EXTERNAL FACTORS	

Figure 2. SWOT Methodology Employed in Chapter Four

Source: Created by author.

Chapter Summary

In summary, this project seeks to employ a series of SWOT analyses from the perspective of each country within the lithium triangle. Each analysis will consist of two phases: first, analysis of the internal factors—strengths and weaknesses—focused on the political, economic, and infrastructure systems, as well as the lithium industry specifically; and second, analysis of the external factors—opportunities and threats—with a focus on the two global superpowers competing for influence in global lithium supply chains. These analyses will then inform policy recommendations presented in chapter five focused on addressing the project's primary research question.

CHAPTER 4

COUNTRY STUDIES

Introduction

This purpose of this work is to explore the policy options for the U.S. government that create a competitive advantage for its companies operating in the lithium triangle. Since the Chinese have significantly expanded operations in South America in the previous two decades, this is critical to securing lithium supply chains, both for the green energy transition and in the event of a conflict between the Chinese and the United States. Through a series of SWOT analyses, this chapter analyzes the lithium resources and economic and political institutions in Argentina, Bolivia, and Chile, followed by the potential opportunities and threats posed by each of the two superpowers. Each of the three countries finds itself at a crossroads regarding its lithium resources and the model it will follow to extract them. Which path it chooses and to what degree it accepts influence from foreign actors may determine the level of success they have in extracting their lithium resources and furthering their path of economic development.

The first case study shows how Argentina has taken a decentralized approach and left much of the power and decision making at the provincial level. This has led to two distinctly different provincial development models. 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. The provincial governments are focused on augmenting output as a means of increasing tax revenue. In contrast, in the province of Jujuy, the provincial government has established a provincial-level state owned enterprise (SOE) focused on industrializing the entire process from exploration

and extraction to processing and manufacturing. Both models offer enticing advantages but contain potential drawbacks.

The second case explores how Bolivia has approached technological challenges due to the chemical composition of its lithium brine. Currently, there is an ongoing competition for the right to serve as the Bolivian State lithium company's partner in a potentially lucrative joint venture. Eight companies—four Chinese billion-dollar firms, two American startups, the Russian state uranium company, and a private Argentine lithium firm—are vying to prove that their Direct Lithium Extraction (DLE) technology is capable of making Bolivia's lithium competitive. Thus, the country with the largest lithium resources in the world hopes to drastically expand extraction and processing during this decade but cannot make the leap on its own.

In Chile, the final case study, the most economically open and prosperous nation in Latin America is facing a potential economic policy course reversal. Following the massive protest movement of late 2019 known as the *Estallido social* (literally translated as "social outburst"), the Chilean people voted to rewrite their neoliberal constitution and forge a new social contract that is more inclusive and environmentally friendly. Then in December of 2021 they elected a thirty-six-year-old Socialist named Gabriel Boric who has suggested that Chile should nationalize the nation's lithium industry utilizing a model similar to the current Chilean state copper company. Boric hopes to use the additional funds generated by a nationalized lithium industry to pay for broad reforms to the pension, healthcare, and public education systems. The uncertainty created by these statements will impact foreign investment in the lithium sector for years to come.

Each of these case studies highlights the advantages and disadvantages of the three countries lithium industries, and economic policies more broadly. To ensure a secure lithium supply for the next decade, the US government must balance relations with all three countries and develop the proper policies to give American private equity and innovation the opportunities to thrive.

Argentina

The first of three case studies is focused on the lithium industry in one of South America's largest, but most troubled economies: Argentina. Despite its size and economic potential, the Argentinians have a long history of fiscal mismanagement dating back to the late-nineteenth century. The country has defaulted on its debt nine times—most recently at the beginning of the COVID-19 pandemic in May 2020—and has exhausted its credibility with Western financial institutions (Bartenstein, Maki and Gertz 2020). For example, in March of 2022 the country's congress agreed to an IMF Extended Fund Facility (EFF) program designed to weather the medium-term balance of payment problems the country faces from its 29-billion-dollar debt (IMF 2022).[9] As a result, the country is plagued by double-digit inflation, a poverty rate above 40%, and debilitating political polarization. Like several of his left-leaning Peronist Party predecessors, the current President Alberto Fernández has turned to China for assistance, joining the BRI in February of 2022 and encouraging investment from Chinese firms (Ellis 2022). As this study will demonstrate, this is the context that Argentina must manage as it expands its

[9] A brief explanation of the IMF's Extended Fund Facility program is offered in the glossary. In addition, the author recommends the IMF website for a description of the EEF program and the economic conditions that warrant it.

lithium industry and seeks to remain competitive in a rapidly expanding global market. Ultimately, whether Argentina's lithium industry thrives or stagnates will hinge on the amount of international investment it acquires, and key to that is its ability to entice investment from both China and the West.

The current groundwork for Argentina's lithium policies were laid in the 1990s, a period of rapid economic and ideological change centered around deregulation, privatization, and decentralization. There are two legacy results of this: mining in Argentina is a relatively new industry (as opposed to the industries in Bolivia and Chile which are written into those countries' constitutions) and therefore does not have an outdated, cumbersome regulatory framework; and the regulatory frameworks that do exist are held at the provincial level (León, Muñoz and Sánchez 2020, 39-40). This decentralized approach has led to two distinctly different provincial development models.

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 provincial governments are focused on augmenting the investing firm's output as a means of increasing tax revenue. A 2019 Interamerican Development Bank study terms this the "extractivist" model focused on maximizing the quantity extracted by promoting investment, innovation, and research and then utilizing taxes to support other government initiatives (León, Muñoz and Sánchez 2020, 61).

In contrast, in the province of Jujuy, the provincial government has established a provincial-level state owned enterprise focused on industrializing the entire process from exploration and extraction to processing and manufacturing. This "industrialization" model collects a percentage of all lithium carbonate produced in the region and uses it to

attract companies that conduct value added production (León, Muñoz and Sánchez 2020, 61). The strengths and weaknesses of both models are summarized in Figure 3 and will be discussed in detail below.

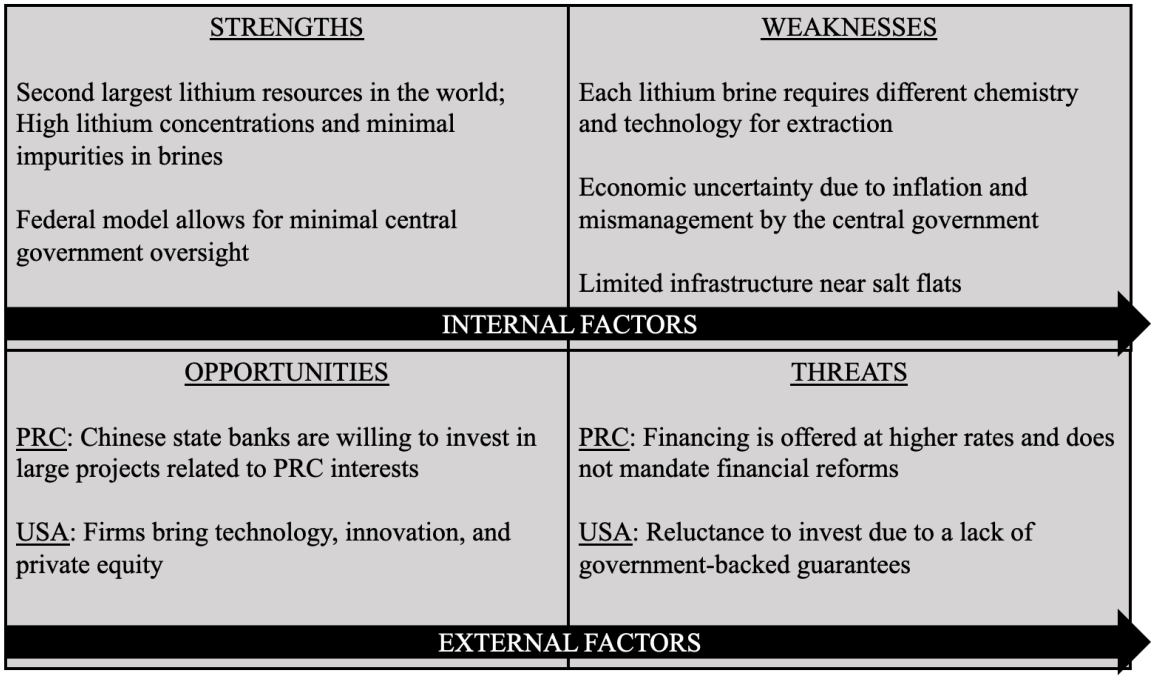

Figure 3. SWOT Analysis–Argentina

Source: Created by author.

Strengths and Weaknesses of Resources and Reserves

At an altitude of thirteen thousand feet in northwest Argentina's *altiplano* (or high plains) sits one of the country's most spectacular landscapes. Thousands of years of erosion has created beautiful white expanses hiding the second largest collection of lithium resources in the world. Based solely on the numbers, Argentina's lithium industry has a tremendous amount of potential—the country's 19.3 million tons of known lithium resources are second in the world behind only Bolivia. While the country has just two

fully functioning extraction projects, the output of these two combines to make up the fourth largest production by any country in the world (behind Australia, Chile, and China respectively.) Moreover, those two projects alone sit on giant *salares* that make up the world's third largest lithium reserve. In addition, Argentina has more than sixty other projects in either the exploration, construction, or pilot phase looking to turn the *altiplano*'s vast resources into economically viable reserves (Geist 2021).

For mining firms, Argentina's lithium is compelling for more than just its quantity. The quality is excellent as well. All of Argentina's known lithium resources contain between 400 and 650 parts per million (ppm or mg/L) of lithium in the brine, and anything over 100 ppm is considered over the threshold to be economically viable (Munk et al. 2016, 339). For comparison, this is about three times more concentrated than the salt flat chemistries in the United States. But these remarkable *salares* sit in one of the driest and most remote places on earth, and the lack of water presents both advantages and unique challenges for the lithium extraction process. Naturally, the dry climate is good for the evaporation process used across the lithium triangle, however the brine extraction process requires huge amounts of water to pump the brines out of the ground and into the evaporation pools. Unfortunately, based on distances and the lack of infrastructure, water cannot be brought in from the outside without a massive investment in roads and/or pipelines. Moreover, provincial governments and mining companies have struggled to reach agreements with the indigenous tribes that have occupied this land for millennia and rely on the scarce water for drinking and farming. To overcome these challenges, Argentina's lithium industry requires investment and technology. Where they

obtain this investment and know-how might help determine who controls lithium supply chains for the next several decades.

Due to the quantity and quality of Argentina's lithium, it is no surprise that there are companies and investors from around the world participating in exploration, pilot projects, and extraction operations. However, there are currently only two major operations extracting and exporting lithium on a large scale: *Salar de Olaroz* owned by Orocobre Ltd. of Australia (66.5% stake), Toyota Tsusho Corp. (25% stake), and the provincial company *Jujuy Energía y Minería SE* (JEMSE—8.5% stake); and *Salar de Hombre Muerto* in Catamarca province, which is owned and operated by the American firm Livent. Both projects are major contributors to global lithium supply with *Salar de Olaroz* contributing 17,500 tons of LCE annually, and *Salar de Hombre Muerto* supplying 22,500 tons of LCE annually. A third major project should begin operations in mid-2022: the Cauchari-Olaroz project in Jujuy operated by Chinese firm Genfeng Lithium Ltd. (46.7% stake), Canadian firm Lithium Americas (44.8% stake), and JEMSE (8.5%). Despite the limited number of large-scale operations, there are more than sixty additional operations in various stages of development. Appendix B shows several of the most significant emerging projects in Argentina's lithium sector.

Analysis of the Political, Economic, and Infrastructure Realms

In comparison with its two neighbors, Argentina offers some distinct advantages in the political realm. First, there are unique benefits to Argentina's federal system. The provincial governments, many of which predate the founding of the Argentine nation, have, "a high level of autonomy and responsibility in providing public service, undertaking public investment, and supporting regional and local development more

generally" (OECD 2020, 33-34). This federal model has created a decentralization of the governing of lithium extraction resulting in multiple dynamic opportunities for engagement with the three provinces containing vast lithium resources. It allows companies to pick the regulatory framework most conducive to their needs. Also, in the provinces of Catamarca and Salta there is no requirement to sell processed LCE locally, and in Jujuy the requirement is only 5% (compared to 25% required by Chile.) In addition, the central government has passed legislation to encourage investment and limit the impacts of the country's macroeconomic problems. In 2020, the national mining export tax was dropped from 12% to 8% (Geist 2021). Then in April of 2021, the central government eased capital controls on investments over $100 million dollars that were imposed to fight inflation, essentially removing the requirement to immediately convert foreign denominated FDI into Argentinian pesos at a rate determined by the federal government (Vásquez 2021b). These changes contribute to an increasingly friendly investment environment in the lithium sector.

Unfortunately, there are still several drawbacks to the Argentinian model of decentralization that creates hurdles for investors. First, the regulatory uniqueness from one province to the next limits inter-provincial investment, and several of the country's largest salt flats straddle provincial borders. In addition, investing in multiple provinces involves relationship building across multiple provincial governments, each with its own systems, interests, indigenous advocacy groups, and political polarization. As *The Economist* (2017) describes, mining firms must "find their way through a confusion of provincial rules and regulations." Furthermore, the provincial model does not completely shield investment and businesses from the political instability at the central government

level (*The Economist* 2017). For example, the debt renegotiations in May of 2020 created widespread uncertainty that stalled investment and was further stymied by the country's five-month long national lockdown from the coronavirus.

In the economic realm, Argentina offers one clear advantage: its mining industry is the most open of the three countries in the triangle. This holdover characteristic from the 1990s reforms means the federal government meddles in the industry very little. In the provinces of Catamarca and Salta, the provincial governments employ the "extractionist" model and are hyper-focused on increasing investment in exploration, extraction, and processing. These policies are geared toward increasing output and therefore create a great environment for foreign investment. Both provinces have lowered tax rates and recently rewritten regulations to further improve the business environment. Even in Jujuy, where the provincial government has taken a more hands-on approach through quotas and a provincial run operation, there are unique opportunities to enter the lithium extraction sector for smaller companies willing to accept the limited scale of operations and the terms of the provincial joint venture. With the federal government easing tax burdens on mining exports and encouraging FDI, the provinces have a real opportunity to increase their global competitiveness.

The primary economic weaknesses in the Argentine model stem from the macroeconomic instability and political polarization that has plagued the country for decades. For example, even under the guidance of the former center-right president Mauricio Macri, the government "re-imposed capital controls on business and consumers" in late 2019, "limiting their access to foreign exchange" (DOS 2021). Unsurprisingly those controls remained in place when President Fernández took over in

December 2019, thus maintaining the aura of uncertainty in the business climate just prior to the disruption caused by the pandemic. As the DOS's investment climate survey states, "market regulations such as capital controls, trade restrictions, and price controls enhance economic distortion that hinders the investment climate in the country" (DOS 2021). And there are no projected changes to this stance in the near future.

In addition to problems at the federal level, there are drawbacks to the provincial model, especially when considered from the Argentinian point of view. There is not a national lithium strategy, nor a national lithium tax. In fact, there are not federal regulations specific to lithium, only those that apply to mineral rights more broadly (León, Muñoz and Sánchez 2020, 39). Some of the issues that are specific to lithium (like water rights, for example) are not clearly defined. While this may promote the flow of FDI, it does not deliberately promote local development, equity, or sustainability and has led to tension with local indigenous groups. Meanwhile, for the foreign investors, there is no protection for foreign capital from the macroeconomic instability that has plagued Argentina. Their capital is taxed at a high rate upon initial entry into the country, and they are often reliant on loan guarantees from their home country to mitigate the risk of investment given the volatile macroeconomy.

In the realm of infrastructure, the existing network in all three provinces is underdeveloped but improving. The best network is in Jujuy, where the two operational mines have access to major paved highways, a rail system that links the mines to the port of Antofagasta in Chile, a high-voltage power grid, and a gas pipeline. While not as developed, the provinces of Catamarca and Salta are spending provincial level funds to

build logistics nodes that support mining operations and investing in access roads to help increase efficiency and throughput, however much work remains to be done (Geist 2021).

Understanding the federal system is key to analyzing the strengths and weaknesses surrounding the lithium industry, and ways to address the weaknesses. While the federal government is solely responsible for natural gas distribution and airports, and aids in the planning, construction, and maintenance of highways and rail lines, it has no role in the maintenance of the electrical grid and local road networks, or the development of logistical areas and industrial parks (OECD 2020, 36-37). As a result, the provincial governments are primarily responsible for subnational spending and investment, with a secondary role held at the municipal level.

The largest obstacle to improving Argentine infrastructure stems from problems of governance. There is no long-term strategic vision for infrastructure that establishes priorities focused on development and competitiveness (OECD 2020, 42). As a result, Argentina has underinvested in its infrastructure, especially in these arid, remote regions in the northwest. The three provinces trace along the Chilean border and its Atacama Desert, where the geography produces problems—a lack of water, bad roads and difficult driving conditions, poor energy and gas infrastructure, and an aging freight rail network—that can only be overcome through large infrastructure projects. While economists encourage infrastructure investment in emerging economies on the order of 5% of GDP per year, Argentina has not surpassed 3% since the 1980s (Jenkins 2019, 258). This infrastructure investment is critical for the industry to move from just extraction to processing and manufacturing since the process requires chemicals, energy, and water that are not currently available in the region.

Opportunities and Threats Posed by Chinese Investment

Given the similar political ideologies, Argentina's need for infrastructure, and China's projected demand for lithium, the relationship between the Argentinians and the Chinese appears to be a natural one. In this light, there are numerous opportunities the Chinese present the Argentinian lithium industry. First among those is financing. The importance of Chinese financing dates to December of 2001, as China was joining the WTO and pushing its "Go Out" economic policy, Argentina experienced the worst of its nine debt defaults and was thrown into the worst recession in its history. During the two decades since, as the Chinese engaged with the developing world in search of raw materials, destinations for their financing, and markets for their construction firms, Argentina chose to rely on China in lieu of the West to the tune of $17.1 billion in loans, much of it provided during the second half of the China boom from 2009 to 2014 (Gallagher and Myers 2021; Liebetreu 2021a, 56).

The significance of Chinese financing for Argentina during the previous two decades cannot be understated. Chinese financing has backed huge infrastructure projects like the modernization of the freight railway system, a project that brought in nearly $12 billion in CDB loans. In addition, there is a $10 billion peso-renminbi currency swap fund to facilitate further investment. Very few countries are willing to take a risk on the Argentinians due to their recent fiscal troubles, but, as Daniel Méndez Morán (2018) describes, China has financing, Argentina needs it, and that has left room for the Chinese to make a profit (295-300). Many scholars consider the Chinese led commodities boom and the Chinese willingness to invest to be the key factors that rescued the Argentinian economy during the first decade of this century.

In addition to financing, China presents the Argentinians with additional opportunities. Chinese firms have a vast array of experience in the lithium sector, to include expertise in lithium extraction from brines. In fact, some of these companies have already made big investments in Argentine lithium. In 2019, Genfeng Lithium paid $160 million for a majority stake in the Cauchari-Olaroz mine, and now hopes to increase production to forty-thousand tons of LCE annually by the end of this year (Geist 2021) (Ellis 2021). Genfeng is the world's largest lithium company by market capitalization and produces batteries for Tesla, owns lithium-spodumene mines in China and Australia, and is China's most experienced brine extraction firm with operations in China, Mexico, and Argentina. The firm is part of the massive Chinese EV and battery manufacturing industry that provides a clear market for lithium and potential partners for projects that will streamline the supply chain through investment in infrastructure, energy production, and processing efficiency (Bednarski 2021, 40-44). For example, Genfeng plans to invest 600 million dollars in its Mariana project in Salta, to include a major investment in solar energy for its processing plant (InfoNegocios 2021).

Finally, the Chinese have earned a reputation for moving quickly when opportunities arise. When Chinese SOEs move to invest abroad in strategic sectors, they can rely on the full support of their government (Méndez Morán 2018, 17; Bednarski 2021, 28). In a fast-moving sector like lithium, this can be the difference between pilot projects or manufacturing operations receiving capital investments or being left behind.

However, there is much debate in academic and foreign policy circles surrounding the utility of Chinese financing for developing economies. While the West's warnings of "debt-trap diplomacy" are largely overblown, there are reasons to be cautious with

Chinese loans (Albright, Ray and Wang 2021). Critically, Chinese loans are not offered at the same low rates as those of the International Monetary Fund (IMF) and World Bank (2-3%) and instead are usually around 6-8% annually (Gallagher 2021). In the case of Argentina, where loans from the IMF and World Bank were no longer an option, the Chinese became what Carol Wise (2020) described as the "de facto lender of last resort" (163). In fact, Wise continued writing that, "Argentina's financial and diplomatic isolation from 2002 to 2015 had left it disproportionately dependent on China" thus leading to the takeover of an eighty percent stake in the Standard Bank of Argentina by China's state-owned Industrial and Commercial Bank of China (ICBC) in 2011 (Wise 2020, 165; Liebetreu 2021a, 57). Moreover, the lack of financial reforms (a usual concession when receiving financing from the IMF or World Bank) left the Argentinians vulnerable and contributed to their default in 2020 (Koop 2019). While it is true that the Argentinians need the financing and the Chinese may be part of the few who are willing and able to provide it, Argentina would be wise to approach Chinese loans with caution.

In addition to the threat of over-extending through Chinese financing, the Argentinians should continue to be cautious of the other trends observed when dealing with Chinese loans and financing in the developing world. For example, Chinese firms often want export to China the most basic form of the commodity and then use Chinese labor to do the value added on Chinese soil (Jenkins 2019, 240; Wise 2020, 20). This has been true of Argentinian soy, which the Chinese only import as raw soybeans even though the Argentinians have built a robust soy processing industry in recent decades (Jenkins 2019, 240-241). If the Chinese only extract the LCE from the salt flats and then

export it to China for processing, Chinese involvement in the lithium industry will not help the Argentinians on their development path.

Opportunities and Threats Posed by American Investment

The United States presents a different set of opportunities and threats to the Argentine lithium industry due to the United States' economic philosophy. Since the US does not have large state-owned corporations to direct investment priorities, the US relies on its dynamic private sector and its remarkable capacity to innovate combined with the private equity that is often drawn to emerging technologies. So, US firms offer the Argentinians access to technology, especially emerging direct lithium extraction (DLE) methods, and the financing required to start pilot projects and eventually scale up production.

For example, there are several companies actively engaged in lithium extraction projects in Argentina attempting to overcome the inefficiencies and water sustainability issues involved in lithium extraction through evaporation. One company, Lilac Solutions, has developed a DLE method using ion exchange that the company claims can recover up to 90% of the lithium from most brines, up from 45-55% from evaporation (Lilac Solutions 2021; Promnitz 2022). While increasing the amount of lithium extracted from brine is important, the technology could be a game changer for salt brine extraction for another reason: it does not require large amounts of water. Normally salt brine extraction requires that the amount of brine pumped out of the ground needs to be replaced by an equal amount of fresh water. Lilac and several American lithium startups are pumping brines into processing plants, removing the lithium from the liquid, and immediately returning the brine to the ground (Promnitz 2022). This minimizes the impact on the local

water table and lowers the infrastructure burden since water does not need to be brought in via pipeline, train, or truck. Both are contentious issues for the indigenous communities in Argentina's northwest deserts.

While DLE could ease some of the infrastructure burden in Catamarca, Jujuy, and Salta, there are still huge requirements for other materials to process lithium carbonate and lithium hydroxide. Here, American companies could be part of the solution. Much of the soda ash required for processing originates in the United States and is transported by American supply chain companies. As operations continue to expand, Argentine business leaders hope to work with America's supply chain and logistics experts to overcome the infrastructure gaps in the three provinces (Calo 2022).

While there are huge benefits to American private equity, innovation, and emerging technologies, there are potential drawbacks from relying too heavily on American firms. The largest threat to the Argentines is that US firms will not feel comfortable expanding investment due to a lack of confidence in Argentina's economic situation. Since the US does not currently offer loan guarantees to protect US companies from risk when investing in Argentina, fiscal uncertainty at the federal level could scare away long-term investment (Calo 2022). In contrast to the Chinese—who view the Argentinian lithium as highly strategic and, therefore, offer financial support for risky investments—the US has not articulated a specific policy or written legislation to encourage investment in South American lithium. Until this occurs, the Argentinians will not receive the benefit of the combination of American innovation and private equity.

Case Study Summary

Argentina presents an excellent investment opportunity for American lithium mining and lithium-ion battery firms. The provincial system provides two unique investment environments, one focused on maximizing the quantity of extracted lithium and the other on developing a lithium battery industry, from extraction to processing and manufacturing. Both have advantages and disadvantages that could appeal to US companies. While the fiscal uncertainty involved in investment in Argentina is unlikely to subside, the potential upside is too great to ignore.

In terms of strategic competition, the Chinese have an advantage on American firms because of the size of recent investments and the geopolitical trends given Argentina's recent admission to the BRI. However, there are still plenty of opportunities to get involved that could be beneficial to long-term US strategic interests. The sheer quantity and diversity of lithium extraction projects warrants investigation by US policy makers into programs that provide American companies a comparative advantage. One policy possibility is an EXIM Bank program that provides loan guarantees to American companies investing in lithium extraction in Argentina. While American capital has been reluctant to invest in Argentina in recent decades, the next two cases will demonstrate why Argentina may be the best investment option in South America's lithium triangle.

Bolivia

The second country study is focused on the Plurinational State of Bolivia, a landlocked country with the largest known lithium resources on the planet. For more than a decade, lithium has been a central theme in Bolivian politics as the country grapples with how to best exploit its mineral resources and fend off deep-seeded anxiety stemming

from the country's history of exploitation by foreign powers dating back to the Spanish Empire's silver mines in the 16th century (Burkholder, Rankin and Johnson 2017, 102-104). This complicated history has shaped the discussion around mineral extraction and led to a highly centralized, state-driven extraction model based on a popular and widely successful model it uses for natural gas. However, gas was put under state control after the investment of billions of dollars of foreign, private equity in the 1990s (Zissis 2006). Unlike with lithium, the Bolivian government did not have to build a capable oil and gas sector from the ground up; it only continues to profitably manage an already established industry that accounted for more than half the country's annual exports.

Unfortunately, as this case will demonstrate, the state-controlled lithium industry is inefficient and way behind its competitors in Argentina and Chile. The establishment of joint ventures has rarely made it past the pilot phase, and the largest and most recent joint venture—a deal between the state-owned lithium enterprise *Yacimientos de Litio Boliviano* (YLB) and the German green-technology manufacturer ACI Systems—was canceled by Evo Morales just days before he escaped into political exile in November 2019. Fortunately, after the political turmoil that ended the Morales administration and a difficult bout with the coronavirus under an interim government in 2020, Bolivia is beginning to settle into the post-Morales era under Morales' former Minister of Economy Luis Arce. This has restored hope to the Bolivian lithium industry. In early 2021, YLB held another round of competitions in search for a Direct Lithium Extraction (DLE) technology that makes the extraction of lithium from Bolivian salt brines economically viable. Despite the political turmoil and unfriendly business environment, the chemical composition of the Bolivian salt brines is likely the single biggest factor that explains

why the nation with the largest lithium resources in the world has long struggled to capitalize on this mineral wealth. Now, eight companies have passed the initial stage of the DLE competition and are in the pilot stage. If the Bolivians can ally with a company capable of overcoming this technical hurdle, the trajectory of global lithium markets could be determined by operations in Bolivia's *altiplano* for decades to come.

Strengths and Weaknesses of Resources and Reserves

Without a doubt, the greatest strength of Bolivian lithium is its potential (see Figure 4). The collection of the three Bolivian *salares*—Uyuni and Pastos Grandes in the department of Potosí, and Coipasa in the department of Oruro—combine to create the world's largest lithium resources held by any single country.[10] According to the USGS, the Bolivian *salares* hold approximately 21 million tons of LCE (USGS 2022). However, the Bolivian government believes that the *Salar de Uyuni* alone could contain 140 million tons (Alper 2017). The thirteen thousand square kilometers of glimmering white salt flat may hold enough lithium to fuel the world's EV revolution by itself.

[10] Bolivian states are known as departments, of which there are nine total.

STRENGTHS	WEAKNESSES
Largest lithium resources in the world; high concentrations of lithium in brines The central government has a strategy; the central bank offers financing; and there is increasing stability under President Arce	High magnesium concentration in brines means none of the brine is economically viable yet Required joint venture with state lithium company YLB; enduring risks of political instability Lithium exists in least developed areas
INTERNAL FACTORS	
OPPORTUNITIES	THREATS
PRC: Large SOEs have access to financing, know-how, and China's huge market USA: Livent and EnergyX bring technology, innovation, and access to private equity	PRC: Traditionally imports commodities in raw form, does not assist in value-added production USA: Minimal assistance from the US government due to political considerations
EXTERNAL FACTORS	

Figure 4. SWOT Analysis–Bolivia

Source: Created by author.

Due to its size and the quantity of lithium resources it holds, the advantages of the *Salar de Uyuni* warrant further investigation. Uyuni has excellent economic potential due to high lithium concentrations (320 ppm) and an arid climate in the southern portion of the *altiplano* where average annual rainfall is only sixty-two millimeters. Coupled with the relatively high evaporation rate (1,150 mm/year) the viability of lithium extraction through evaporation ponds is clear (and comparable to the arid index of its competitor in the Chilean Atacama Desert—see table two on page twenty) (Munk et al. 2016, 342-232). Unfortunately, the *Salar de Uyuni* still poses some technical problems that must be overcome before the Bolivian's YLB can expand its operations even further.

While the political turmoil in Bolivia has played a role in the slow development of the country's lithium industry, the primary reason for the delay is based on chemistry.

The salt brines contained in the *Salar de Uyuni* have high ratios of dissolved magnesium—at least four times greater than ratios found in other brines—leading to high concentrations of magnesium in the evaporated salts or additional processes to extract the magnesium from the brines prior to evaporation (Alper 2017; Bradley et al. 2017, K12). Currently, the processes used to separate lithium and magnesium either require large quantities of chemicals and generate waste in the form of magnesium chloride or are extremely energy intensive (Zheng et al. 2019). This additional step has prevented large scale operations in Bolivia from becoming profitable.

This chemistry hurdle has been further compounded by a bureaucratic hurdle imposed by the Bolivians: processing of the virgin brine must be done by YLB and only later in the operation can the residual brine be further refined by the joint venture. This two-step process is not only less efficient and therefore more expensive, but it is also dependent on YLB having the technology to process the virgin brine (Obaya 2019, 55). Unfortunately, to date, either this technology does not exist, or it is not in the hands of YLB.

Fortunately, the administration of Luis Arce recognizes the challenges involved in Bolivian lithium exploitation and understands the need to partner with foreign companies to attract the financing and technology required to overcome the chemistry. As a result, the Bolivians are hosting a competition to develop a DLE technology capable of extracting lithium from Bolivian brine. The competition criteria not only include effectiveness in extracting lithium from the brine, but also environmental factors like impact to local water resources and plans to include the local community. Currently eight companies—four Chinese billion-dollar firms, two American startups, the Russian state

uranium company, and an Argentine lithium firm—are attempting to develop the right technology in exchange for up to a 49% stake in a joint venture with YLB.

Analysis of the Political, Economic, and Infrastructure Realms

While chemistry plays a huge role in the Bolivians struggle to industrialize its lithium resources, it is certainly not the only reason. For a deeper understanding, one must analyze the political and economic trends in Bolivia. Politically, Bolivia has two key strengths; one relative to its competitors, and a second relative to the Bolivian status quo prior to 2020. First, Bolivia has a comparative advantage relative to neighbors in the lithium triangle in that it has declared the development of lithium extraction, processing, and integration into local manufacturing as a national priority and developed a corresponding national strategy that aligns with this goal. Much of the political rhetoric in national debates centers around lithium's economic potential. In fact, one lithium expert claims that Bolivia's economic strategy is "defined by the idea of lithium as the new oil" and even describes the country as the "Saudi Arabia of Lithium" (Bednarski 2021, 127). This focus at the national level means that companies investing in the lithium sector will get priority support from the central government and receive funding from the Bolivian Central Bank (Obaya 2019, 37). Second, the political situation in the country has improved since Luis Arce was inaugurated in November of 2020. Arce is an economist with many published works on Bolivian economics. His administration has pushed for conditions that encourage FDI, especially in the lithium sector. The ongoing competition for a stake in the state-owned joint venture could be a first step in the right direction for the Bolivia's state-centric industrial model, and President Arce could be the right politician to lead that transition.

However, there are clear drawbacks to the centralized structure of the Bolivian political and economic systems, and YLB is an excellent example of this. Centralization is a holdover from Evo Morales, who sought to remake the country by utilizing centrally controlled, state-owned industries that could redistribute the profits derived from the nation's mineral wealth. In the case of YLB, the Bolivian government has mandated that any joint venture must maintain YLB as the majority stake holder, likely divided up as 51% and 49%. In an excellent case study on Bolivian lithium governance, ECLAC consultant Martín Obaya (2019) describes how, "the industry's most capable companies have not shown interest in entering into a strategic partnership with YLB as a minority stakeholder in a country with little experience in the sector" (55). So, Bolivia's biggest hurdle is technological, but the political system is preventing companies with technology and innovative experience from participating. As a result, many of the world's largest companies involved in lithium brine extraction are not participating in the ongoing competition. Instead, the major players are Chinese firms looking to diversify into brine extraction and American startups looking for access to major salt flats.

In addition, there is tension between the central government and the citizens in Bolivia's *altiplano*, many of whom are indigenous and fear that the state will either seize their land or move forward with development projects that do not consider their interests. These departments in Bolivia are the least developed and historically most exploited (Obaya 2019, 8). As the country with the highest indigenous population in Latin America—more than 60%—Bolivia is appropriately focused on balancing economic opportunity with the local populace's rights and interests (Bednarski 2021, 125). As a result, any project that does not clearly benefit the local populace will face protests and

strikes—a common occurrence across Bolivia, and most especially in the regions with high indigenous populations like the *altiplano*'s departments in Bolivia's southwest.

An additional element that hinders investment in Bolivia's lithium stems from its lack of infrastructure. Since Evo Morales' repeated attempts to boost infrastructure spending were hindered by government deficits that arose in 2014 as oil prices dropped, there are very few relative strengths when compared to its Argentinian and Chilean neighbors. The Bolivian *salares'* remote desert locations require a robust network of roads to transport the soda ash and lime required to extract magnesium and convert the lithium chloride into lithium carbonate or lithium hydroxide. In addition, the process requires access to a significant amount of water and a skilled and educated workforce. Bolivia's departments of Potosí and Oruro are the poorest regions in the country and lack in both civilian and physical infrastructure. What little infrastructure that is in place in Uyuni—to include medium voltage electrical lines and a pumping system—was built by the state during the expansion of the national pilot project in 2018 (Obaya 2019, 43). However, any large-scale operation will require a significant increase in road capacity, improvements to the water system and electrical grids, and more.

Opportunities and Threats Posed by Chinese Investment

As explained in chapter two, Bolivian relations with the PRC were limited prior to the rise of Evo Morales in 2006, however, he quickly established the PRC as a political and economic ally across multiple fronts. Morales' connection with the PRC led to agreements involving infrastructure construction, financing for projects in the petroleum and mining sectors, academic exchanges, and trade—although Bolivian imports from

China are more than four times its exports, and much of those exports are raw materials with little to no domestic value added production (Ellis 2016, 6).

This budding engagement has led to cooperation in the lithium sector. Several Chinese companies have executed pilot projects in conjunction with YLB, and multiple other projects are under construction at this time. In August of 2011, the private Chinese mining firm CITIC Gouan Group signed two agreements to study Bolivia's salt flats. In the *Salar de Uyuni*, CITIC Gouan conducted research and development with the Bolivian government that could not overcome the high magnesium content in the brine. In the *Salar de Coipasa*, the company teamed up with the Bolivian Ministry of Development and Planning to carry out prospecting and valuation of the salt flats resources (Obaya 2019, 36). Then in February of 2014, YLB opened a lithium-ion battery pilot plant in La Palca, Department of Potosí, that was constructed in conjunction with the Chinese battery manufacturer LinYi Dake Co. Ltda. (Obaya 2019, 38) Finally, on February 6, 2019, President Evo Morales announced that YLB had selected the Chinese manufacturer Xinjiang Tbea Group LTD to "establish the preliminary conditions" for the exploitation of the Coipasa and Pastos Grandes resources (YLB 2019). Even after Morales canceled the deal with German ACI-Systems and fled the country, the Chinese have continued construction of these plants. While these projects are small and remain in the pilot or research and development stages, Chinese firms have a head start on the rest of the world when it comes to access to the Bolivian lithium market and partnerships with YLB.

From the Bolivian government's perspective, there are many strengths associated with Chinese companies, and the PRC more broadly. In many ways, it is a natural partnership. Evo Morales has keenly stated that the nature of the PRC's centralized

approach aligns with the Bolivian model. While the new administration is more open to outside investment, it still holds many of Morales' views on the value of YLB and the need to use SOEs to drive development (Krauss 2021). (President Luis Arce was in fact Evo Morales' economic minister.) In addition, the lack of deep historical ties to China makes deals with the PRC more politically viable than associations with Western firms. While China's reputation in Bolivia is not perfect, Chinese projects are not associated with imperialism in the way leftist Bolivian politicians have characterized American involvement in Bolivia for decades (Ellis 2016).

Finally, and maybe most importantly, China and its companies have access to financing backed by the Chinese central banks. A recent report on lithium extraction featured in the New York Times described how "Chinese banks give low-interest loans to Chinese mining and construction companies operating abroad to advance President Xi Jinping's plans to dominate industries of the future" (Krauss 2021). China has the financial power to fund large lithium projects in Bolivia, and a track record in South America that suggests they are willing to use it.

Analysis at the community level shows that there is an additional opportunity presented by Chinese firms that is extremely appealing. The four Chinese finalists are all billion-dollar companies capable of mega projects like the mining projects China has executed in other countries in South America. In Peru for example, Chinese SOE China Minmetals relocated an entire town near *Las Bambas* copper mine and provided the villagers with excellent new housing, schools, and transportation and water infrastructure (Méndez Morán 2018, 87-105). With the backing of China's central banks as described above, these companies could contribute a huge amount to Bolivia's infrastructure

deficiency. Potosí and Oruro departments have a huge need for roads, sustainable power generation, and access to clean water. Partnership with Chinese firms could be part of the answer.

However, there are certainly drawbacks to working with Chinese firms. Chinese companies have demonstrated a trend in Latin America in which they favor contracts in which they can access materials in their most raw forms. The PRC prefers to import raw materials in their most basic form and then execute the value-added production on Chinese soil and with Chinese labor (Jenkins 2019, 240; Wise 2012; 2020, 20). Moreover, Chinese companies often include contract clauses that ensure Chinese workers are used in construction jobs executed in the developing world. This in part contributed to the quality issues in Ecuador's Coca Codo Sinclair dam project (Ellis and Lazarus 2021; Loaiza 2021). And it certainly will not fare well with the local interest groups looking for jobs from the construction. In addition, Chinese firms are comfortable operating within weak institutions and will therefore not push the Bolivians away from corruption or influence operations (Ellis and Lazarus 2021). Despite the potential drawbacks, the Bolivian central government views Chinese firms as a great option for the Bolivian lithium industry. This conclusion is supported by the presence of several companies already involved in the sector and the fact that four of the eight finalists for the current Uyuni competition are Chinese.

Opportunities and Threats Posed by American Investment

From the Bolivian perspective, the exit of Evo Morales has reopened the possibility for American companies to participate in the downstream investment process, and the two American startups currently vying for a stake in the YLB joint venture offer

unique opportunities and potential drawbacks. The US has a longer history with Bolivian lithium than the Chinese, in fact, US-based FMC-LITHCO was the first company to explore *Salar de Uyuni* in the late-1980s (Obaya 2019, 29). Unfortunately, since the political left in Latin America has long associated American investment with exploitation and unequal exchange, particularly in the mining and natural resource realm, there is always a potential for political blowback when associating with a US firm (Burkholder, Rankin and Johnson 2017, 269-270, 314-316). In fact, Evo Morales' has used the term "imperialist" to drum up political support among his constituents. Furthermore, Evo canceled the deal with German green-technology manufacturer ACI Systems during the social unrest in November of 2019 in hopes that disassociation with the Western company would ease the political tensions (Temla Jemio 2020). As discussed above, Chinese firms do not face similar historical hurdles.

However, US companies offer the Bolivians a powerful combination that they crucially need to succeed in the increasingly competitive lithium-ion battery market: technology, innovation, and private equity (Calo 2022). Given the nature of the Bolivian *salares* chemistry, YLB should be focused on partnering with the firm whose DLE technology performs the best in the ongoing trials. If that company is one of the American startups, lithium experts believe the flow of American private equity into the Bolivian lithium industry could be enormous (Krauss 2021).

Another advantage of these US firms is their size. Since they are small operations without established mining projects, they should be more willing to work with the local populace and employ Bolivian labor. These small companies would bring their technology and skilled engineers without insisting on importing all the low skilled labor

for construction or the mid-level managers for daily operations. Partnering with one of the US companies may lead to more job growth for YLB.

However, there is a clear drawback to the US firms when compared to the potential of the Chinese SOEs. Since there are so many needs in the departments of Potosí and Oruro—for better roads, modern infrastructure, and schools—the Bolivians may look for partners that are willing to invest to improve local infrastructure. Large Chinese SOEs have a history of partnering with Chinese central banks to combine mining investments with large-scale infrastructure projects, but there is little chance that a US startup could make a similar offer. In fact, recent media coverage points out that Livent and EnergyX have not even received significant help from the US embassy in La Paz (Krauss 2021). In short, the US firms bring potentially revolutionary technology, but little else.

Case Study Summary

Bolivia may be the perfect case where the advantages of engagement with both the Americans and Chinese could coincide. If the Bolivians have the flexibility built into their competition to select multiple winners, they could capitalize on the strengths of both the innovative American companies and the massive Chinese firms. An American startup could provide the DLE technology that finally makes the Bolivian brines economically viable while a billion-dollar Chinese SOE could help bring the operation to scale. Much will still hinge on the capabilities of YLB and the institutions within the Bolivian government, but after more than a decade of slow progress, the Bolivians could be on the precipice of a breakthrough.

Chile

The final case study in this thesis covers the Republic of Chile, a long and geographically diverse country that stretches more than 2,600 miles from the edge of Antarctica in the south to the dry high mountain deserts in the north. Its importance to lithium supply chains is clear since it holds the largest lithium reserves in the world and is the largest global producer of LCE from salt brine. Furthermore, Chile's political and economic reforms are an example for its neighbors in the Southern Hemisphere since it has overcome the political turmoil of the Allende and Pinochet eras to become South America's most dynamic economy—the first to join the Organisation for Economic Co-operation and Development (OECD) in 2010 (OECD 2022). However, as Chilean historian Joaquín Fermandois (2005) wrote in his acclaimed work *Mundo y fin de mundo* (The World and the End of the World), Chile's political and economic trends have been linked to global trends "since its origin" (21). In this sense, the growing political polarization that has encapsulated the West has also touched the Chileans, and this has had wide ranging economic impacts that relate directly to its lithium reserves and the global competition to secure supply chains for lithium-ion batteries.

As this study will demonstrate, Chile has a long history of lithium exploitation and therefore has a well-regulated industry that does not hold the same potential as the other two countries in the lithium triangle. However, US policy makers should not take their eye off the country "at the end of the world" due to the involvement of the world's largest lithium producer: the private American mining company Albemarle. Since Albemarle is one of just two lithium producers in Chile, it is vital to US interests that the Chileans maintain a market-based model for its lithium industry. Similarly, the PRC

views the Chileans as a critical partner in its globalized development model. The Chinese are the Chileans largest trade partner and biggest importer of Chilean copper and fresh produce. In addition, Chinese lithium giant Tianqi Lithium Corporation made a massive $4.1 billion investment in 2018 to purchase a non-majority stake in *Sociedad Química y Minera* (SQM), the Chilean owned mining firm that constitutes the other half of Chilean lithium production (MINING.com Editor 2021).

However, as described in chapter two and explored further in this case study, recent political upheaval in Chile has left the future of the lithium industry in doubt. A constitutional convention is currently rewriting the Chilean constitution and has contemplated the nationalization of Chilean lithium under the model of its currently nationalized copper reserves. Furthermore, the recently elected Socialist president Gabriel Boric often mentioned lithium during his campaign as a potential source for state revenue to pay for his social reforms. Boric would even like to create a national lithium-ion battery industry that conducts value-added production on Chilean soil. So far, this has proven an impossible task since, while Chile has an abundance of copper and lithium carbonate for batteries, the supply chains for other important elements like nickel, cobalt, and cadmium run through East Asia. Moreover, the Chileans do not have the manufacturing infrastructure or technical expertise to compete with East Asian firms. When analyzing the entire lithium-ion battery supply chain, Chile's comparative advantage lies in the location and composition of its brines. There is just not a strong case for greenfield investment in battery production facilities in northern Chile. Given this context, Chile is a fascinating case that must be closely monitored as the strategic competition in the lithium triangle unfolds.

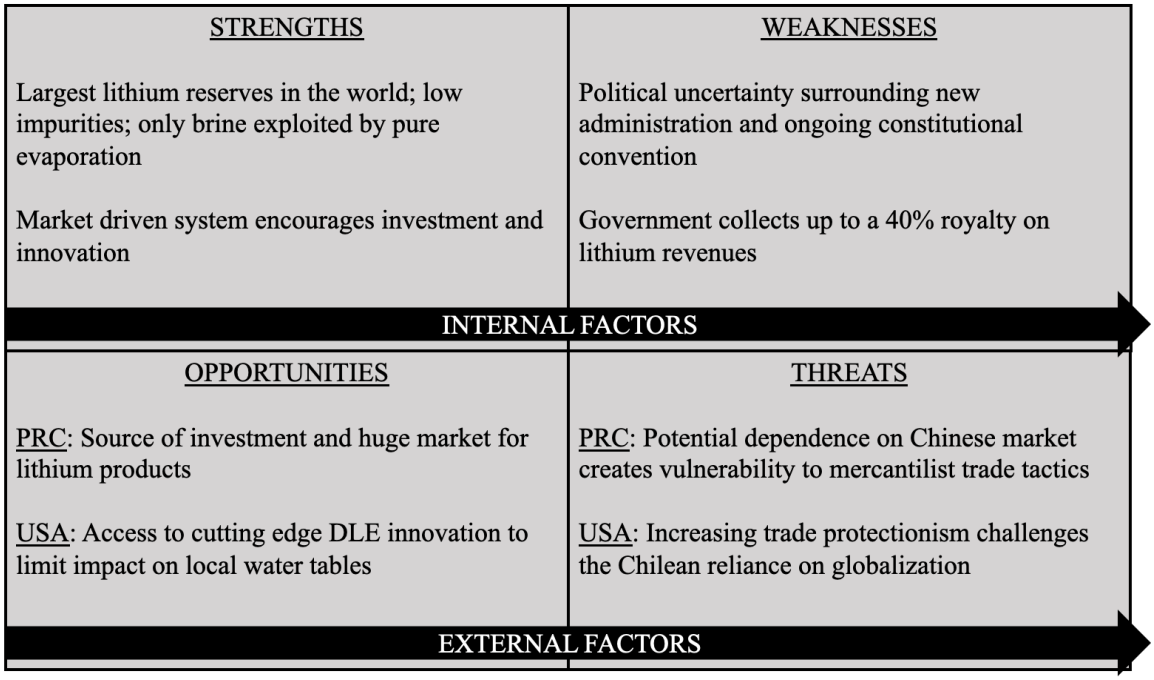

Figure 5. SWOT Analysis–Chile

Source: Created by author.

Strengths and Weaknesses of Resources and Reserves

The characteristics of Chile's lithium reserves are the gold standard for lithium brine extraction. In fact, the lithium in the brines of Chile's *Salar de Atacama* are the least expensive lithium reserves to extract and process in the world. This is due to the composition of the salt brine and the unique environmental factors in this portion of the *altiplano*. As a result, the average price to produce one ton of LCE in the Atacama is around $2,500—a remarkably low cost considering that the global price per ton of LCE has not been below $4,000 since before the 2008 financial crisis and has approached $30,000 in early 2022 (Bednarski 2021, 97; USGS 2022). For this reason, the two evaporation operations in the Atacama Desert are the world's longest continually running lithium extraction operations, both operating since 1980, as well as two of the world's

largest and most profitable. SQM's operation currently produces 70,000 tons of LCE annually, while Albemarle's operation produces 44,000 tons of LCE annually.

The Atacama Desert's lithium brine is the most concentrated lithium brine in the world, containing on average between 1,400 and 1,800 ppm of lithium. Furthermore, it contains relatively few impurities (Munk et al. 2016, 342; Grant 2021). Combined with the high altitude and low rainfall that make for ideal evaporation conditions, the brine composition makes the Atacama the only place in the world where lithium can be extracted through pure evaporation (as opposed to the combination of evaporation and chemical processes or DLE used in other salt brine extraction in Cauchari-Olaroz, Argentina or Silver Peak, Utah, USA, for example.) While the total resources in Chile are not as large as Argentina or Bolivia, the unique characteristics of the brine and the desert environment make almost all the known lithium in Chile economically viable reserves with today's infrastructure and technology. Thus, Chile has the largest quantity of lithium reserves in the world (9.2 million tons), claims the highest percentage of reserves to resources of any country (almost 94 percent reserves of 9.8-million-tons in total resources), and will remain a critical supplier for the at least the next decade as other less economically viable resources experiment with new DLE technology.

While the conditions in Chile's northern desert are ideal for evaporation extraction operations, there is a chance that one of the region's greatest strengths could halt operations in the future—a lack of rainfall. Since the *Salar de Atacama* only receives an average of 39 millimeters of rainfall annually, there is a significant risk that brine levels could drop too much for Albemarle and SQM to continue pumping brine out from

underneath the salt flat's salty crust (Munk et al. 2016, 342).[11] Environmentalists and Chilean government officials closely monitor the brine levels due to the unique flora and fauna in the Atacama that are reliant on the *salares* for water and nutrients. There is a chance that extraction in the Atacama will have to transition from pure evaporation to a combination of evaporation and DLE technology to sustain the water level in the underground brine solution (Grant and Barros 2020). This could increase production cost and negate many of the Atacama's advantages.

Analysis of the Political, Economic, and Infrastructure Realms

Beginning with the return of democracy in 1990, Chile has built itself into a stable democracy with strong institutions and little corruption. For two decades and four presidential administrations, the center-left Coalition of Parties for Democracy (known in Spanish as *La Concertación*) held the presidency and managed a peaceful political transition through negotiation and consensus. It is one of the few countries in Latin America with institutional strengths on par with the OECD averages (see Appendix D.) In terms of lithium policy, the country developed a national strategy and the National Lithium Commission in 2014 under President Michelle Bachelet (Bednarski 2021, 107). This commission, which consists of public and private experts including economists, academics, and environmentalists, plays an important role in managing the interests of various groups impacted by lithium extraction, most importantly the indigenous residents of the northern Chile's Atacama Desert and the two lithium companies currently

[11] For comparison, this is less than 40% of the average rainfall in the Sahara Desert.

operating in Chile. Since its creation, it has balanced extraction with environmental sustainability by helping establish lithium quotas and manage water levels in the *salares*. This ability to balance sustainability and profitability is critical to maintaining the long-term value of Chile's lithium reserves.

Unfortunately, much of the certainty that had characterized the Chilean political model for three decades has deteriorated in the wake of the *Estallido Social* and the COVID-19 pandemic. The protests in October and November of 2019 were so violent and widespread that the 2019 UN climate change convention COP25 was moved from Santiago to Madrid and the 2019 Asia-Pacific Economic Cooperation (APEC) executive meetings scheduled for December were canceled. Chile entered the pandemic unable to lure in FDI due to the uncertainty surrounding the political unrest and a potential rewrite of their constitution. Now, with the constitutional convention ongoing and the recent inauguration of Socialist president Gabriel Boric, Chile's near-term economic outlook remains mixed (Banco Central de Chile 2022).

There is an additional political hurdle for lithium producers in Chile that dates to the military dictatorship. The central government still owns all the country's lithium reserves based on laws written in the 1970s when the mineral was identified as strategic due to its role in nuclear arms production. As a result, the government leases mineral rights in the Atacama's *salar* to private producers—currently just Albemarle and SQM—in exchange for a significant royalty. Similarly, with the help of the National Lithium Commission, the Chilean Nuclear Energy Commission (CCHEN) sets annual quotas for each producer that align with environmental sustainability and needs of the government, essentially giving it veto power over expanded production. The CCHEN most recently

exercised this “veto” in March of 2018 to prevent Albemarle’s proposed expansion of their operation in the Atacama (León, Muñoz and Sánchez 2020, 32, 47-48). These clauses make Chilean lithium policy more restrictive than the extractionist models in Argentina’s Catamarca and Salta provinces and have impacted Chile’s role in global lithium production. Despite explosive global demand, the Chilean’s share of global lithium production has fallen from 40% to 20% over the previous decade (USGS 2022).

Despite the political uncertainty, the Chileans have many economic strengths and remain one of the most open economies in the world for FDI and trade. This is in part because the Chileans have a robust and well-respected Economics Ministry that has negotiated thirty trade agreements encompassing countries that represent more than 80% of global GDP. Furthermore, seventeen of those agreements are free trade agreements (FTAs), including with the likes of the United States, the PRC, South Korea, Canada, Mexico, and several other emerging economies in East Asia (International Trade Administration 2022). In fact, the Chilean trade commission is held in such high regard that the PRC chose to negotiate their first bilateral FTA with Chile in 2006 to build experience in bilateral negotiations prior to negotiating with larger markets (Heine 2006, 143-144).

While Chile’s openness has created great opportunities for trade and investment, the state’s role in lithium has created a comparative disadvantage in the economic realm that could become decisive as investors look to open and expand operations in South America’s *altiplano*. First, to foment the creation of a domestic battery manufacturing sector, lithium producers are expected to sell one quarter of their output at preferential prices to companies in Chile (*The Economist* 2019; Vásquez 2021a). Furthermore,

Chile's national development agency *Corporación de Fomento de la Producción* (CORFO), collects a royalty between 6.8 and 40 percent of revenue depending on the market price of lithium. Since the forty percent threshold is for all sales over $10,000 per ton and the long-term outlook for lithium prices is more than double that number, SQM and Albemarle will both likely hand over a huge portion of their revenues for the foreseeable future. Lithium expert Lukasz Bednarski (2021) has demonstrated how the sliding scale for the royalty makes lithium production in Chile more disadvantageous as the price increases (110). Essentially, as the price continues to increase above the $10,000 per ton threshold, producers in Chile pay more and more, while their advantage in production cost becomes less and less significant.

Of the three countries analyzed in this report, Chile has the most developed infrastructure system to support its lithium industry. This is further aided by geography, as both Chilean evaporation sites are located on the west side of the *Salar de Atacama* and have direct access to processing facilities and ports on Chile's Pacific coast just 150 miles away. In contrast, Bolivian and Argentinian projects must cross an international border and continental divide to access the same Chilean ports or take a long journey eastward to access ports on the Atlantic coast. In addition, both companies own processing plants near the port city of Antofagasta: SQM is investing $987 million to expand its *Salar del Carmen* facility east of Antofagasta; and Albemarle opened its *La Negra II* plant southeast of the city in 2017. Both facilities are state of the art and produce high quality battery-grade lithium carbonate and lithium hydroxide (Fundacción Terram 2021; Albemarle n.d.).

However, there are gaps in local infrastructure that could be addressed to maintain the Atacama's lithium extraction advantage. First, the lithium extracted from the two evaporation operations in the Atacama utilize trucks to transport evaporated lithium salts to processing facilities on the coast. Utilizing trucks instead of rail is more costly and more carbon intensive, however, unlikely to change due to the investment required to build a rail line. Second, the cost of electricity remains relatively high due to the cost of energy in Chile (a country without petroleum reserves) versus Bolivia and Argentina (two countries with vast reserves.) However, there is enormous potential for photovoltaic electricity given the region's abundant sunshine. The construction of solar farms and long-term battery storage facilities near the evaporation operations could further drive down cost and decrease the overall environmental impact of the lithium extraction process (Obaya and Céspedes 2021, 29).

Opportunities and Threats Posed by Chinese Investment

As previously described in chapter two, Chile and the PRC have a more than fifty-year history of pragmatic foreign relations and growing economic engagement. Both countries have traditionally been champions of free-trade and aligned their development model with globalization—Chile by exporting metal commodities, high-quality food products, and wood; and the PRC by importing food for its massive population and raw materials for construction and manufacturing while exporting value-added products. These two models are closely aligned, and, for that reason, the PRC is now Chile's largest trade partner (Heine 2020; Wise 2020, 143).

In addition to trade, the Chinese offer the Chileans a massive source of investment. In fact, between 2018 and 2020, there were three multi-billion-dollar

investments by China's two largest utility providers Southern Power Grid Company and State Grid Corporation of China (De la Jara 2018; Nogales Toledo 2019).[12] The hope is that these capital commitments by well financed Chinese SOEs will lead to improved services and updated power distribution infrastructure. In addition, and most relevant to this study, Chinese lithium giant Tianqi Lithium Corporation purchased 24% of SQM for 4.07 billion dollars in 2018. While the massive investment did not give Tianqi a majority stake in SQM, it gave the Chinese preferential access to SQM's lithium carbonate exports and provided SQM with access to Tianqi's massive and well-established supply chain.

However, upon further investigation, the current trends in increased trade and Chinese FDI are not without potential problems. When it comes to trade in lithium, the Chinese appear to be a big partner for the Chileans—they purchase 21.7% of Chilean lithium exports accounting for 46% of China's imported lithium hydroxide and 70% of China's imported lithium carbonate. However, the numbers are skewed because most Chinese lithium imports come from spodumene rock imported from Australia. In lieu of purchasing lithium hydroxide or lithium carbonate from Chile and its neighbors, the Chinese prefer to import spodumene and then conduct the value-added processing on Chinese soil with Chinese labor (Obaya and Céspedes 2021, 46). This highlights one of the primary problems that much of the developing world has with the PRC: the Chinese want to import materials in their most raw form and rarely support projects to improve

[12] Southern Grid purchased of 27.8% of Chile's high-tension electricity system provider *Transelec* for 1.3 billion dollars (De la Jara 2018); and State Grid purchased the electricity generation companies that cover 57% of Chile's population *Chilquinta Energía* and *Compañía General de Electricidad* for US$ 2.23 billion-dollars and about three billion-dollars respectively (Nogales Toledo 2019).

value-added production abroad (Jenkins 2019, 240; Wise 2020, 20; Liebetreu 2021b, 87). Even though the PRC has announced plans to be carbon neutral by 2060 and Chinese demand for lithium should continue to grow, it is unlikely that the PRC will import huge quantities of battery grade LCE while they have access to Australian spodumene.

The slew of Chinese investment from 2018 to 2021 demonstrated another negative trend for emerging and developing economies that are dealing with the PRC: most Chinese FDI involves purchasing existing operations. None of these four multi-billion-dollar investments were green field investment projects that create jobs or expand the industry. Chile needs green field investment to drive growth as the pandemic subsides. Thus far, Chinese FDI in Chile has been highlighted by big purchases but has not been a major driver of growth (Liebetreu 2021a, 83-88, 134-135).

A final threat associated with the PRC is the uncertainty surrounding the illiberal tendencies exhibited by party leadership, especially since the rise of Xi Jinping. As a small geopolitical actor, Chile is reliant on the current, rules-based international order. Some elements of Chilean civil society have grown weary of the PRC since the start of the coronavirus pandemic due to increasing Chinese FDI in strategic sectors and the PRC's use of trade as a tool in the international system (Heine 2020). One example of the latter occurred when the PRC applied tariffs to Australian barley, copper, and coal in 2020 when the country formally called for investigations into the origin of the virus (Russell 2021). As mentioned in chapter two, this incident led to serious debate in Chile—to include in the Senate—about the risks of over reliance on the PRC for trade and investment (Heine 2020; Sánchez 2021). China's massive market certainly offers the Chileans a great opportunity to grow its exports, but the PRC's increasingly authoritarian

government is reason for Chile to diversify their export markets and avoid an export dependency with the PRC.

Opportunities and Threats Posed by American Investment

Like the Argentinian and Bolivian cases, the continued involvement of the US offers a variety of opportunities to the Chilean lithium industry. The primary opportunity is access to American technology. As previously mentioned, the salt brines in the Atacama may be at risk of drying out to the point where pumping the brines out of the ground and into evaporation ponds becomes impossible. The key to sustainability is likely the emerging DLE technologies in development, of which American companies have taken a leading role. This could allow the Chileans to extract lithium from the Atacama's brines and immediately pump the brine back into the *salar*, thus sustaining the hydrography of the surrounding environment (Grant and Barros 2020; Grant 2022). The involvement of Albemarle in Chile's Atacama is excellent proof of this concept. Shortly after entering Chile via the purchase of Rockwood Holdings in 2016, Albemarle invested $600 million into the expansion of their *Salar de Atacama* evaporation facility and their La Negra II processing facility. CCHEN approved the expansion on grounds that the technological upgrades allowed for increased production without harming the environment (León, Muñoz and Sánchez 2020, 32; Obaya and Céspedes 2021, 114-116). Given the edge US based companies have in DLE and other membrane extraction technologies, the Chileans should keep the Americans engaged in the Atacama.

The most significant threat to Chilean interests posed by the US is the rise in nationalism and trade protectionism seen throughout the last decade. Chile was a huge benefactor of the US-led globalization of the 1990s and early 2000s, but rising

protectionism in America has Santiago concerned. The most consequential event to Chile occurred when an executive order by former President Trump removed the US from the Trans-Pacific Partnership (TPP), a twelve-country trade deal meant to counter China's economic rise negotiated by the Obama administration (Brown 2021).13 While the rhetoric in America has cooled off under the Biden administration, there remains a lack of political will in Washington to renegotiate the TPP (Brown 2021; Cutler 2021). In fact, there is a growing movement in Washington to build self-sufficient supply chains for minerals like lithium that could leave the Chileans out. Furthermore, there remains a high probability that Donald Trump or a similarly minded candidate will win the Republican party nomination in 2024 and contribute to an additional surge in US protectionism (Lester 2021). While the Chileans are actively hedging for this possibility, the uncertainty is bad for investment and harms long term economic growth.

Case Study Summary

This final case study on the lithium industry in Chile is an example of a good balance between government oversight and the free market to manage economic interests and the interests of local populations and environmental groups. The central government has managed this delicate balance through strong institutions—the National Lithium Council and CCHEN—and the quotas they set based on environmental factors. Both

[13] The other eleven countries pressed on and created the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP-11). The trade deal was signed in Santiago de Chile in March of 2018, however, there is now doubt surrounding Chile's membership. Chile's lower house ratified the CPTPP-11 in 2019 before the *Estallido Social*, but deliberations have ceased in the Senate with no plan to debate it during the constitutional convention process.

well-established operations have increased their annual lithium output as demand has increased and technology has made further exploitation ecologically sustainable. In this regard, Chile should serve as an industry standard.

In terms of strategic competition, Chile is an example of where the US and China can coexist while benefiting both the host nation and the lithium industry more broadly. Both Albemarle and Tianqi Lithium have made huge investments in Chilean lithium to meet growing global demand. These types of investments create jobs, contribute taxes to the local and national governments, and increase the royalties Chile will make from its lithium reserves. As Chile debates the merits of nationalization, it is important to consider that both superpowers (who happen to account for more than half of Chilean trade) have a vested interest in maintaining the status quo.

Chapter Summary

The preceding three cases have demonstrated the importance of the lithium resources in South America's lithium triangle, in addition to the advantages and disadvantages of investment in each of the three countries covered. Furthermore, the chapter explored how each country in the lithium triangle views the involvement of the PRC and the US in their economies, with a particular focus on their role in each country's lithium sector. The detailed SWOT analyses have revealed areas within each lithium industry where the US government or American companies with government support could have an important, positive impact. In the following chapter, the author will draw on these SWOT analyses to present conclusions and offer policy recommendations that can address the rising strategic competition with the PRC and increase access to lithium during the coming decade.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

Summary

The United States has fallen behind the PRC in securing a reliable supply of lithium for its EVs, smartphones, and defense technologies that require light, high-energy density batteries. However, there are still many opportunities available to US policy makers, both at home and abroad. While building a domestic supply of lithium is critical and should remain the government's primary focus related to lithium-ion battery supply chains, the US must enact a global approach to ensure consistent and competitive lithium access. This will not only keep lithium prices down and drive a faster transition to EVs, but it will also counter China's rising influence in the developing world and challenge its dominance of the lithium-ion battery industry. For this reason, the lithium triangle is of critical importance to US interests and warrants significant attention from policy makers.

The initial goal of this project was to identify ways in which the United States can engage the countries in the lithium triangle to help guarantee access to lithium over the coming decade. Based on the case studies in chapter four, the author recommends continued diplomatic and economic engagement with all three countries covered. Argentina will be a critical actor in the green energy revolution because it offers the best opportunity for investment due to the openness in Catamarca and Salta provinces. However, the US government should create programs to protect US investors from the fiscal uncertainty caused by the central government's economic mismanagement. Meanwhile in Bolivia, the ongoing Direct Lithium Extraction (DLE) competition presents a potential opportunity to turn the page on poor US-Bolivian relations since the

creation of a DLE process in Uyuni is in the interest of both countries. The Bolivian DLE competition is the perfect place to showcase American innovation as two US startups compete against large state-owned Chinese firms. Finally, as the most established lithium provider in the region, Chile remains a critical player to the near-term supply of lithium, especially given the involvement of US-based Albemarle. Given the current discussions surrounding the potential nationalization of Chilean lithium, the DOS must continue to foster relationships in Santiago to ensure fair treatment of US firms and help maintain Chile's reputation as a friendly destination for American FDI.

In addition to the recommendations for each country above, the author has identified three ways in which the United States can engage the region while better supporting US interests. First, the government must publish a national strategy for the Western Hemisphere that promotes economic development, enhances American companies' opportunities to sustainably invest in the region's mineral wealth, and counters the growing influence of authoritarian extra-hemispheric actors. Second, the government must create an industrial policy that provides upstream investment in lithium related technologies like DLE to help US companies gain and maintain a technological advantage over Chinese and other foreign firms. Finally, the US must enact a "whole-of-government" approach to provide financing and incentives for American companies investing abroad in strategic supply chains. By adopting these policies, the US can ensure access to South America's lithium reserves while also regaining credibility with South American governments and populations that have begun turning to the PRC for financing, investment, and overall leadership in the international system.

Recommendation One: Publish a National Strategy for the Western Hemisphere

Unlike the PRC, the United States has not published a national strategy for Latin America outlining clear priorities and lines of effort for engagement with the region. Given China's growing influence described in chapter two, this is problematic. China continues to emphasize "trade, investment, and financial cooperation" as described in their 1+3+6 plan released in 2014, and their latest strategy for the region has added a focus on the extraction of "geological and energy mining resources" (MFA PRC 2014; 2021). While the Western Hemisphere may not be the primary theater for strategic competition, the US has the capacity to engage with allies, partners, and other nations in multiple theaters simultaneously. To maintain stability in the Americas and secure a reliable supply of lithium, the US must develop and enact a comprehensive strategy.

The Western Hemisphere Security Strategy Act (WHSSA) proposed by Senate Foreign Relations Committee members Bob Menendez and Marco Rubio in February of 2022 could serve as the catalyst for this strategy development. The legislation would require the development of "a multi-year strategy […] for purposes of enhancing diplomatic engagement and security assistance and cooperation, promoting regional security and stability, and advancing United States strategic interests in the Western Hemisphere" (U.S. Congress, Senate 2022b). This is an encouraging first step, but the proposed legislation falls short by not incorporating regional development initiatives or a plan to counter the huge PRC investments in energy, infrastructure, and natural resource exploitation.

To be most effective, the WHSSA should require a strategy that incorporates three national priorities: security and stability in the Western Hemisphere in the face of

extra hemispheric actors, democracy promotion and institutional reform, and access to vital minerals required for the green energy transformation. The proposed legislation includes the first two elements, but as this study has identified, the third is equally critical and interrelated. Since a key element of the administration's energy transition strategy is ensuring cheap, reliable access to lithium for America's innovative green technology companies, it should also be incorporated into the strategy that covers the region with the largest lithium resources in the world. In addition, the new strategy must incorporate all elements of national power and leverage the capabilities of organizations like the United States International Development Finance Corporation (DFC), which will be discussed in further detail in recommendation three. In summary, without a strategy that clearly aligns all available ways and means to deliberate lines of effort, the US will struggle to accomplish its strategic objectives in the Western Hemisphere and lead the global green energy revolution.

Recommendation Two: Develop Industrial Policy to Maintain the Advantage

Over the course of the next decade, technology and access to resources will determine which lithium and battery companies succeed and which ones fail. The US government must do everything in its power to help American companies achieve success. To give its companies a comparative advantage in the strategic competition with the PRC, the US government must develop an industrial policy that ensures the US leads the green energy revolution. Through limited, yet effective policies, the government can guide the free market through the green energy transition by procuring charging stations and other EV infrastructure, subsidizing EV purchases and bulk battery storage, and slowly removing the current subsidies that support the oil and gas industry. While

America's economic dynamism stems from its adherence to limited government, the ensuing climate crisis warrants a fundamental shift in economic policy directed at limiting fossil fuel consumption and expanding green energy's role in the electrical grid and transportation sector.

For comparison, the PRC is effectively employing an industrial policy known as "Made in China 2025" focused on upgrading Chinese industry through targeted investment, trade policy, and innovation enhancing education and training programs. The policy describes Xi Jinping's vision of achieving global dominance in ten critical industries, to include information technology and artificial intelligence, robotics, and green technology (Siripurapu 2021). Policy makers in Washington finally understand the threat China poses to US economic interests. It is time to create an industrial policy to counter that threat.

Effective US industrial policy should focus on specific industries that support the green energy transformation and relate to industries where US companies are competing with Chinese firms. One example related to this project's scope is DLE. The government should provide research grants to companies and research institutions involved in upstream DLE research. While traditional lithium extraction through evaporative ponds is slow and only recovers 45-55% of the lithium in the brines, ongoing research in DLE has demonstrated the potential to extract 80-90% of dissolved lithium while utilizing much less time and water. Since every lithium brine deposit has a unique chemistry, the government should focus on upstream investment in research that could impact a variety of lithium operations (for example, research involving membrane materials) and then leave private businesses to tailor their processes to the individual chemistries of their

respective brines. Government funded research could have given American companies a huge advantage in the DLE competition in Bolivia, but Livent and EnergyX were left to fend for themselves in a competition with several billion-dollar Chinese SOEs. Well formulated and executed industrial policy could provide US lithium producers greater access to resources at home and abroad; much needed financing for research and development in green technologies like DLE; and an advantage over foreign battery and EV manufacturers.

Recommendation Three: Provide Financing and Loan Guarantees to US Companies\

For the countries in the lithium triangle, America's greatest strength is its ability to combine innovative technologies with private equity. Unfortunately, when there is too much risk due to geopolitical or economic instability, the equity holders are unwilling to invest. However, if the US government can mitigate some of the risk, the private financing will diligently seek promising investment opportunities and rapidly flow to wherever there is potential. While the US government does not want to "pick winners" per se, it can play a role by minimizing investment risk due to the strategic nature of the lithium extraction projects in these three countries.

One policy option that could appeal to American private equity is a loan guarantee program for companies investing in the lithium triangle. This would be a leap from current Export-Import Bank (EXIM Bank) policies toward Argentina and Bolivia, two countries whose currency issues have scared away public investment support. However, the strategic significance of lithium and the rapidly rising price per ton of LCE is changing the risk tolerance for both public and private actors. Stephen Promnitz, Chief Executive Officer (CEO) of lithium firm Lake Resources, has recommended that the US

government explore export credit agency support in which the US government partners with downstream participants like EV manufacturers and battery makers. These conglomerates then provide financing for mining and processing companies in exchange for preferred access to lithium exports. Export credit agencies like the EXIM Bank and the recently formed US International Development Finance Corporation (DFC) offer what Promnitz describes as the "key financing factor" that could provide the US with a decisive advantage (Promnitz 2022).

Support and financing from the DFC could be a game-changer for American lithium companies and EV and battery manufacturers. The agency is a development financier that, according to the Congressional Research Service (CRS), was designed in part to respond to China's BRI (CRS 2022d). It was formed in December 2019 to combine several government funds and agencies including the Overseas Private Investment Corporation and the Development Credit Authority (formally part of the United States Agency for International Development, or USAID). The agency provides direct loans, loan guarantees, political risk insurance, equity investment, and feasibility studies. In addition, potential projects in South American lithium extraction align with the agency's stated priorities of innovation, investment in the Western Hemisphere, and addressing climate change (CRS 2022d). Given Argentina's currency problems and the uncertainty generated by Bolivia and Chile's recent political transitions, when the US

government publishes its national strategy for the Western Hemisphere mentioned in recommendation number one, the DFC should be featured in a prominent role.[14]

Conclusion

Given the role of lithium in modern battery technology, the world's lightest metal will continue to power the ongoing green energy revolution for decades to come. In addition, lithium-ion batteries will continue to shape defense technologies related to communications, drones, robotics, mobile computing, and more. Due to these critical roles for lithium in economics and defense, it is concerning how far the United States has fallen behind China in ensuring reliable access to the metal. With demand projected to outpace supply by up to thirty percent by 2030, the lithium triangle has become a vital region for US interests.

With the objective of securing its lithium supply chains and gaining a competitive advantage over the PRC in the economic, diplomatic, and military realms, the US government must develop and implement a comprehensive strategy for increased engagement in the Western Hemisphere. This strategy must be tied into a broader industrial policy related to American competitiveness during the green energy revolution. These two objectives align in Argentina, Bolivia, and Chile, where access to their lithium reserves has become a critical component in the twenty-first century's strategic competition.

[14] For more information on the U.S. International Development Finance Corporation, see the Congressional Research Service report by Shayerah I. Akhtar and Nick M. Brown, updated on February 22, 2022.

Fortunately, the US has several means to accompany these ends and ways. For example, by increasing American financing in the region through aid and loan guarantees the US can provide protection for American investors considering projects in these three South American markets. In addition, the US government can increase funding for research and development in battery and DLE technologies to maintain America's technological advantage. Through expanded diplomatic initiatives and more funding DFC, the US government can better support American companies competing abroad in strategic areas against Chinese firms. Furthermore, this diplomacy and regional engagement should strive to align US strategic objectives with those of the countries in the lithium triangle, thus enhancing local development and strengthening America's partnerships in South America. Since strategic competition effects all aspects of American foreign and economic policy, the most comprehensive and integrated strategies will have the greatest impact.

APPENDIX A

CHARACTERISTICS OF LITHIUM-ION CATHODES

Type of Cathode	Cathode Chemistry	Anode	Debut	Battery Characteristics		Industrial Applications
				Advantages	Disadvantages	
Lithium Cobalt Oxide (LCO)	$LiCoO_2$	Graphite	1991	Very high specific energy and storage	Expensive, relatively short life span, low thermal stability	Mobile phones, laptops, digital cameras
Lithium Magnesium Oxide (LMO)	$LiMn_2O_4$	Graphite	1996	Fast charging and high-current discharging, safer than Li-Cobalt	One third less capacity relative to Li-Cobalt	Power tools, medical devices
Lithium Nickel Magnesium Cobalt Oxide (NMC)	$LiNiMnCoO_2$	Graphite	2008	Provides high capacity and high power	Slightly lower voltage and less stable than LCO and LMO	EV powertrains, E-bikes, medical devices
Lithium Iron Phosphate (LFP)	$LiFePO_4$	Graphite	1996	Very flat voltage discharge curve, one of safest Li-ions	Lower nominal voltage, no tolerance for moisture	EV powertrains, industrial energy storage
Lithium Nickel Cobalt Aluminum Oxide (NCA)	$LiNiCoAlO_2$	Graphite	1999	High specific energy, good specific power, and a long life span	Least stable cathode, expensive due to cost of cobalt	Medical devices, industrial, electric powertrain (Tesla)
Lithium Titanate (LTO)	LMO or NMC	Li_2TiO_3 (titanate)	2008	Long life, fast charge, wide temperature range, extremely safe	Low specific energy and expensive	EV powertrains **Emerging technology**

Source: Created by author using various sources, primarily Obaya and Céspedes 2021, 59.

APPENDIX B

PROJECTS UNDER DEVELOPMENT IN THE LITHIUM TRIANGLE

Country	Project	Company	Home country of the investing company	Anticipated Production	State of the Project
Argentina	Expansion of the Salar del Hombre Muerto	Livent	United States	Increase of 6,000 tons LCE	Under construction
	Expansion of Salar de Olaroz	Orocobre	Australia	Increase of 25,000 tons LCE	Under construction
		Toyota	Japan		
		JEMSE	Argentina		
	Olaroz-Cauchari	Ganfeng Lithium	China	40,000 tons LCE	Under construction
		Lithium Americas Corp	Canada		
	Centenario-Ratones	Eramet	France	24,000 tons LCE	Construction suspended
	Sal de los Ángeles	NextView New Energy Lion HK Ltd	China	25,000 ton LCE	Pilot Project and Feasibility Study
		Hanaq	Hong Kong		
	Sal de Vida	Galaxy Resources Ltd.	Australia	25,000 ton LCE	Pilot Project
	Salar del Rincón	Rincon Ltd.	Australia	25,000 ton LCE	Feasability Study
				50,000 ton LCE	Pilot Project
	Pastos Grandes	Millennial Lithium	Canada	24,000 ton LCE	Pilot Project and Feasibility Study
	Tres Quebradas	Neo Lithium Ltd.	Canada	20,000 ton LCE	Pilot Project and Feasibility Study

Country	Project	Company	Home country of the investing company	Anticipated Production	State of the Project
Argentina	Sal de Oro	Posco	South Korea	25,000 ton LCE	Exploration and Pilot Project
	Rincon Lithium Project	Argosy Minerals Ltd.	Australia	10,000 ton LCE	Pilot Project
Bolivia	Salar de Uyuni	YLB	Bolivia	15,000 tons LCE (lithium hydroxide)	Pilot Project
		ACISA	Germany	30,000 ton LCE	Canceled
Chile	Expansion of La Negra processing plant	Albemarle	United States	Increase of 42,500 ton LCE	Under construction
	Expansion of Salar del Carmen	SQM	Chile	Increase of 40,000 ton LCE	Recently received environmental approval
	Expansion of lithium carbonate processing plant	SQM	Chile	Increase of 110,000 ton LCE	Under construction

Source: Adapted from Obaya and Céspedes 2021, 53. Translated by author.

APPENDIX C

ACTIVE LITHIUM EXTRACTION OPERATIONS

IN AUSTRALIA, CHILE, CHINA, AND ARGENTINA

Country	Project	Propriatary Companies	Location	Production Capacity
Australia	Greenbushes	Tianqi Lithium (51%) Albemarle (49%)	Western Australia	120,000 ton LCE
	Mt. Marion	Mineral Resources Ltd. (50%) Ganfeng Lithium Co. Ltd. (50%)		50,500 ton LCE
	Wodgina	Albemarle (60%) Mineral Resources Ltd. (40%)		56,750 ton LCE
	Pilgangoora-Pilbara	Pilbara Minerals Ltd		41,600 ton LCE
	Mt. Cattlin	Galaxy Resources Ltd.		24,000 ton LCE
	Pilangoora-Altura	Altura Mining Ltd.		27,750 ton LCE
	Bald Hill	Alita Resources		10,000 ton LCE
Chile	Atacama-SQM	SQM (76.23%) Tianqi Lithium Corp (23.77%)	Antofagasta	70,000 ton LCE
	Atacama-Albemarle	Albemarle Corp.		44,000 ton LCE
China	Yichun	Yichun Tantalum Co Ltd	Jiangxi	Not Disclosed
	Chaerhan Lake	Qinghai Salt Lake Industry Co.	Qinghai	15,000 ton LCE
	East Taijinair	Western Mining Group		Not Disclosed
	Zhabuye	Tibet Mining Development Co.	Tibet	5,000 ton LCE
Argentina	Salar de Hombre Muerto	Livent Corp.	Catamarca	22,500 ton LCE
	Salar de Olaroz	Orocobre Ltd. (66.5%) Toyota Tsusho Corp. (25%) Jujuy Energía y Minería SE (8.5%)	Jujuy	17,500 ton LCE

Source: Adapted from Obaya and Céspedes 2021, 40. Translated by author.

GLOSSARY

Extended Fund Facility (EFF). An IMF program designed to help countries facing medium-term balance of payment problems due to structural weaknesses and macroeconomic events outside the country's control. For more information, see the IMF's Extended Fund Facility factsheet at imf.org (International Monetary Fund 2021).

Foreign Direct Investment (FDI). A cross border investment where one firm establishes a significant foothold in another country through either the purchase of all or part of an existing company, or the spending of significant capital to start a new enterprise abroad.

Greenfield Investment. A type of FDI that involves the creation of a brand-new subsidiary in a foreign country, establishing a new entity in the destination country.

Lithium Carbonate Equivalent (LCE). Standard term used in the lithium industry to denote the first commonly traded lithium intermediate within lithium supply chains. Note: To convert tons to the LCE, multiply by 5.23.

Outward Foreign Direct Investment (OFDI). The FDI funds leaving the referenced source nation of the investment and destined for use abroad.

Resources. The total amount, both discovered and undiscovered, of a mineral commodity held in a certain region. This number is often a "best guess" of what exists.

Reserves. The total amount of a mineral commodity that can be economically extracted and brought to market. It is the known quantity that has been discovered and resides in a place where it can be extracted for a profit.

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