85 FORUM

Prices behind electro-mobility – Contestation around and beyond price determination and setting in the lithium global production network and extraction in Chile

Luisa Leisenheimer

Master's Thesis

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Preface

Minerals have gained much attention in the context of policies around 'sustainability transformations'. A majority of countries in the Global North and South has pledged large-scale decarbonization efforts to reach the 1.5°Celsius goal of the Paris Agreement and place high hopes on 'green' technologies. A key element of such technologies are battery systems for electric vehicles and stationary forms of energy storage, which heavily rely on lithium – making the latter a critical commodity. While the problematic social and environmental impacts at places of minerals' extraction have been debated, the issue of prices has been largely side-lined. However, the processes to determine world prices and their use in commodity transactions have important distributional implications for different actors and locations and impact on whether electro-mobility is socially and environmentally feasible and effective.

Luisa Leisenheimer's master thesis is about determining and setting prices in the lithium global production network, with a focus on the lithium sector in the key producer country Chile. The thesis combines in-depth theoretical engagement with detailed empirical investigation and shows that current price determination mechanisms lack transparency. The price setting is further linked to the lithium extraction in Chile and its embeddedness in historical and current political economy processes as well as the role of dominant lithium producers. The results show that it is difficult to take into account long-term risks and costs such as ecological degradation and social injustices within the current price determination and setting mechanisms.

The thesis provides new insights for academic and policy debates on the resource-intensive shift towards electro-mobility and the high demand for critical resources such as lithium created by green transition policies in the European Union and other regions. The results of this study are thus a critical reminder to take into account the financial dimension of commodity sectors and the political economy in producer countries to better understand distributional, social and ecological effects of increasing minerals extraction. This is also relevant for the creation of development cooperation projects that seek to promote responsible resource extraction.

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Abstract

Against the background of political and academic debates around strategies to slow down global warming, the shift to electro-mobility is broadly perceived as a key strategy, particular in the Global North but also countries such as China. There are high expectations in electric vehicles (EVs) and the prevailing technology of lithium-ion batteries which demand a rapid increase of its main component lithium. A growing body of literature thereby focuses on the problematic socio-ecological impacts of lithium extraction. However, despite the current peak in lithium prices, limited attention has been put on the role of prices and pricing in research and policy circles around green extractivism. In contrast to the premise of prices simply being an output of supply and demand in abstract markets – an assumption propagated by neoclassical thinking – prices and price determination must be seen as politically, socially, and culturally embedded. Price determination procedures are contested processes taking place in an environment of competition and are (re-)producing status, power and trust that have distributional impacts. Based on 22 interviews with lithium sector stakeholders and experts in Europe and Chile, one of the main lithium producing countries worldwide, this thesis assesses the contestation around and beyond price determination and setting processes in lithium extraction in Chile and the lithium global production network. Currently, price determination in the lithium market is rather opaque and there is not one world price to be used throughout the industry. These opaque contracts and prices stabilise the power of producers in the production network of lithium. At the same time powerful price determination institutions like the London Metal Exchange (LME) and Price Reporting Agencies (PRAs) follow practices that lack transparency, and often pursue rather short-term strategies instead of considering long-term risks and costs like ecological degradation. How and by whom (lithium) prices are determined has important distributional outcomes as this process includes social and environmental concerns and questions of representation and inclusion in decision-making processes. The complex political economy in Chile, social injustices and fights over territories furthermore structure the socio-cultural realities of lithium extraction and influences global trade patterns. The control of lithium extraction by only two companies, strengthens their position in price determination processes on a global level and together with a political system in Chile where almost all power originates from the centre weakens the opportunities of alternative production systems and critical voices towards the model of green exractivism. Generally, the high demand for lithium induced by a certain narrative about a socio-ecological transformation can foster the unsustainable use of lithium.

Kurzfassung

Vor dem Hintergrund politischer und akademischer Debatten um Strategien im Kampf gegen die Klimakrise, betrachten insbesondere Länder im Globalen Norden aber auch Länder wie China den Übergang zur Elektromobilität als essenziell. Besonders hohe Erwartungen gilt dabei den Elektroautos und der vorherrschenden Technologie von Lithium-Ionen-Batterien, die einen raschen Anstieg ihres Hauptbestandteils Lithium erfordert. Autor*innen und Forscher*innen befassen sich momentan vor allem mit den problematischen sozio-ökologischen Auswirkungen des Lithium-Abbaus. Trotz der enorm hohen Lithiumpreise, wurde jedoch der Rolle von Preisen und der Preisgestaltung bis heute nur wenig Aufmerksamkeit geschenkt – weniger noch im Zusammenhang mit dem Konzept des grünen Extraktivismus. Entgegen der von der Neoklassik propagierten Prämisse, dass Preise lediglich Ergebnis von Angebot und Nachfrage seien, müssen Preise und die Preissetzung als politisch, sozial und kulturell verankert betrachtet werden. Preisfindungsprozesse sind also umkämpfte Prozesse, welche Status und Macht (re-)produzieren und damit direkt mit der Verteilung von Wohlstand verbunden sind. Auf der Grundlage von 22 Interviews mit Interessensvertretungen und Expert*innen des Lithiumsektors in Europa und in Chile, einem der wichtigsten lithiumproduzierenden Länder, setzt sich diese Arbeit mit umkämpften Prozessen um Preissetzung in globalen Produktionsnetzwerken von Lithium mit Fokus auf Chile auseinander. Derzeit ist die Preisbildung im Lithiumsektor enorm intransparent und es gibt keinen einheitlichen Weltmarktpreis. Die Arbeit zeigt, dass intransparente Verträge und Preise die Macht von Lithiumproduzent*innen stärken. Gleichzeitig verfolgen mächtige Preisfestsetzungsinstitutionen wie die Londoner Metallbörse (LME) und Preisberichtsagenturen (PRAs) bestimmte Interessen und intransparente Praktiken, welche die langfristigen Risiken und Kosten von Ressourcenextraktion wie die ökologische Zerstörung ignorieren. Wie und von wem (Lithium-)Preise festgelegt werden, hat wichtige Auswirkungen auf die Verteilung, da dieser Prozess soziale und ökologische Belange sowie Fragen der Inklusion in Entscheidungsprozesse enthält. Die komplexe politische Ökonomie in Chile, soziale Ungerechtigkeiten und Kämpfe um Territorien strukturieren darüber hinaus die soziokulturellen Realitäten der Lithiumgewinnung und beeinflussen globale Handelsmuster. Die Kontrolle der Lithiumförderung durch nur zwei Unternehmen stärkt deren Position bei der Preisbildung auf globaler Ebene und schwächt zusammen mit einem politischen System in Chile, in dem fast alle Macht vom Zentrum ausgeht, die Möglichkeiten alternativer Produktionssysteme und kritischer Stimmen gegenüber dem Modell des grünen Exraktivismus. Generell kann die hohe Nachfrage nach Lithium, die durch ein bestimmtes Narrativ über eine sozio-ökologische Transformation ausgelöst wird, die nicht nachhaltige Nutzung von Lithium fördern.

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List of Abbreviations

BEVs	Battery electric vehicles
BMI	Benchmark Mineral Intelligence
CC	Commodity Chain
CCHEN	Comisión Chilena de Energía Nuclear (Chilean Nuclear Energy Commission)
CEOL	Contratos especiales de operación de litio (special contracts of lithium operations)
CIF	Cost, Insurance, Freight
CIT	Corporate Income Tax
CONADI	Corporación Nacional de Desarrollo Indígena (National Indigenous Corporation)
CPA	Consejo de Pueblos Atacameños (Committee of Atacama Peoples)
CS	Convergencia Social (Social Convergence)
DLE	Direct Lithium Extraction
DRC	Democratic Republic of Congo
EU	European Union
EVs	Electric vehicles
FMC	Food Machinery Cooperation
FOB	Free on Board
GCC	Global Commodity Chain
GPN	Global Production Network
GHG	Greenhouse gas emissions
GVC	Global Value Chain
HEV	Hybrid electric vehicles
ICE	Internal Combustion Engine
LCE	Lithium carbonate equivalent
LFP	Lithium-iron-phosphate
Li-ion	Lithium-ion
LME	London Metal Exchange
NCA	Nickel-cobalt-aluminium
NGO	Non-governmental organisations

NMC	Nickel-manganese-cobalt
OECD	Organization for Economic Co-operation and Development
PHEV	Plug-in hybrid electric vehicle
PRA	Price Reporting Agency
PS	Partido Socialista de Chile (Socialist Party of Chile)
SCL	Sociedad Minera del Litio (Chilean Lithium Society)
SQM	Sociedad Química y Minera (Society for Chemistry and Mining)
SVS	Agencia de Control del Mercado de Valores de Chile (Chilean Securities Market Supervisory Agency)
TTC	Trade and Technology Council
UN	United Nations
USGS	U.S. Geological Survey

1 Introduction

The climate crisis is one of the toughest challenges in the 21st century. Parts of the globe have become too warm to be inhabited or will be underwater in the next few years (IPCC, 2022). Political and academic debates around strategies to slow down global warming are heightened and many governments, especially in China and in countries in the Global North, consider the shift to electro-mobility as crucial on the path towards lowering greenhouse gas (GHG) emissions, as demonstrated with China subsidising electric cars (Azevedo et al., 2018, p. 3) or by the European Green Deal. There are high expectations in the continuing development of battery-electric vehicles (BEVs). Around 30 million vehicles using electric battery-powered motors are planned to be on *European Union* (EU) roads by 2030 (European Parliament, 2022). However, they have a critical socio-ecologically damaging downside: their resource-intensive production (Prior et al., 2013, p. 785). Lithium-ion (Li-ion) batteries, the most prevalent battery technology for electric vehicles (EVs) at the moment (LaRocca, 2020, p. 2), demand a rapidly increasing amount of lithium. Global demand in this minor metal is expected to increase by more than 300% by 2025 compared to 2017 (Martin et al., 2017, p. 17).

The growing body of literature around *'green' (electro-)mobility* focuses on the social and environmental impacts of increased extraction and metal and mineral production that are in particularly perceptible in countries of the Global South, where these resources are concentrated (Berasaluce et al., 2021; Dorn, 2021; Fornillo, 2018; Mares, 2022). Despite the current peak in lithium prices, limited attention has been put on the role of prices and pricing in research and policy circles around *green extractivism.* Pricing of natural resources, however, can be seen as a major factor in the distribution of value and as an important driver of the world economy (Bargawi & Newman, 2017, p. 164). Lithium prices have jumped up to 50.500 US Dollars/ton by August 2022 compared to 12.250 US dollars/ton in August 2021 (Benchmark Mineral Intelligence, 2022). Thereby price-determination and setting processes in the lithium market are characterised by a great deal of opaqueness.

Against this background, the premise of prices simply being an outcome of supply and demand in abstract markets – an assumption propagated by neoclassical thinking – needs to be challenged (Wojewska, 2022). Instead prices should be understood as being "made by the market" (see Çalişkan, 2010, p. 22) and thus by different policies and institutions. Institutional regulations like state interventions through quality standards, property rights, incentives like

CO_2-emissions and the implementation of taxes are different mechanisms that can influence prices (ibid., pp. 11-13). Consequently, how and by whom (lithium) prices are determined has important distributional outcomes and determine whether for example social and ecological costs are sufficiently reflected in prices (Heinrich-Böll-Stiftung, 2014).

Hence, and following Bourdieu (2005), Polanyi (1944) and Granovetter (1985), prices and price determination must be seen as politically, culturally and socially embedded (Bourdieu, 2005; Granovetter, 1985; Polanyi, 1944). This is of great importance in metal markets since prices drive extraction and trade. The expected growing demand in lithium due to the current narrative around a socio-ecological transformation and electro-mobility together with a supply squeeze, lead to dramatically increasing prices. High prices can contribute to efficiency and growing recycling capacities, but can also motivate firms, elites and state companies controlling the lithium production to further invest in production (Ciccantell & Smith, 2009, p. 370). Accordingly, prices behind electro-mobility are not only high numbers that determine whether individual car drivers can afford to buy an electric car or not. Prices are major drivers for the (un)sustainable use of natural resources and therewith structure trade patterns. This thesis argues for the importance of assessing critically lithium prices and price determination mechanisms. Price determination procedures are contested processes and part of power asymmetries and governance structures in a *global production network* (GPN). They (re-) produce key factors of production such as status, power and trust and can be directly connected to the distribution of wealth (Beckert, 2011, pp. 1–2).

On a global level, the London Metal Exchange (LME) is of great relevance in price determination practices for metals and minerals trade. There, usually price determination, which provides 'world prices' to be used for trade transactions by all market participants as well as risk management, takes place (Löf & Ericsson, 2019, p. 15). Despite the new hype around lithium, currently there is not one world price or global benchmark to be used throughout the industry. Missing price regulations and a lack of consistency in prices along the lithium global value chain can create uncertainty for market participants. With the LME not being the established price determining institution in the lithium market, there are power struggles around who gets to decide how lithium prices are determined and which costs they contain. Additionally, considering the high degree of volatility in mineral markets, to use a dominant benchmark can ease negotiation processes for physical actors (Kusigerski, 2018, p. 4). In this context, especially in the lithium sector, Price Reporting Agencies (PRAs) gain in relevance in discussions on price determining institutions.

Besides analysing price determining institutions, considering the specificity of extractive sector and how producer countries are embedded in the world-economy, needs special attention. Global lithium reserves are highly geographically concentrated, and its global extraction is controlled by only a few companies. The largest quantity of lithium resources can be found in the South American lithium-triangle between Chile, Bolivia, and Argentina. Wide ranging debates about how to best manage the "white gold" (see Barandiarán, 2019, p. 381) are currently taking place. While some are pledging for high-scale commercialisation and see lithium as a great driver for development, others are pushing for more state or regional control and are concerned about the ecological damages and negative impacts on communities, considering lithium as a new source of a potential resource curse (ibid.). It is vital to consider Chile when thinking about lithium prices and price determination, due to it being a target for green extractivism and its resource exporting strategies. Pricing of lithium is very opaque in Chile and two of the largest lithium producing firms worldwide control its entire production (Azevedo et al., 2018, p. 9).

The overarching theme guiding this thesis is the contestation around and beyond price determination and setting processes in the lithium GPN and extraction in Chile. Therefore, two main research questions are broken down into several smaller ones:

1. ***How are prices determined and set in the lithium GPN across scales from 'world prices' to production in Chile?***
   1.1 Which prices are used by firms in the lithium GPN from Chile to Europe?
   1.2 What is the role of the London Metal Exchange and Price Reporting Agencies?
   1.3 What is the role of the regulatory and institutional context in Chile?

2. ***What are the struggles in the Political Economy in Chile around and beyond price determination?***
   2.1 What power struggles and different interests determine price levels at the local level in Chile?
   2.2 What are further contestations around social and environmental struggles in Chile?

In Chile, lithium extraction takes place in the Atacama Desert, one of the world's driest places. Hence, extraction there has major impacts on the water supply and ecosystems, causing conflicts over territories and property rights between indigenous communities and multinational companies (Dorn & Gundermann, 2022, p. 345). To this day, only two companies, *Albemarle* and the *Society for Chemistry and Mining* (SQM)[1] have permission from the Chilean state to extract, produce and export lithium from the brines in the *Salar de Atacama*. These permissions

[1] The names of Chilean companies and organisations are translated in English, but their Spanish acronyms, which they are known for, are maintained throughout this thesis.

date back to the era of the dictatorship in Chile (Poveda Bonilla, 2020, p. 20). Since the beginning of the 21st century, lithium demand has steadily increased due to the continuous rhetoric of green capitalism, especially by countries of the Global North but also by South American governments. The lack of market and price regulations has additionally put pressure on both the supply and demand of lithium (Jerez et al., 2021, p. 1). This "lithium fever" (see Jerez et al., 2021, p. 1) can be seen as part of a *green extractivism*, the responses to the climate crisis to mitigate climate change by stakeholders, governments and societies.

Extractivism describes the project of political and economic strategies to promote extractive activities and an ideology influenced by neoliberal thinking aimed at predominately exporting unprocessed raw materials from mostly countries of the Global South to countries of the Global North (Romero Toledo et al., 2017, p. 232). Green extractivism has similar characteristics but describes specifically the rise in extractive activities aiming at reducing GHG emissions, thereby enhancing capitalist (re-)production, consumption and accumulation (Bruna, 2022, p. 842). Chile and other Latin American countries became suppliers of raw materials in the world system with the Iberian conquest (Jerez et al., 2021, p. 2). The Pinochet regime and the neoliberal agenda in the 1980s then privatised Chile's water, which illustrates the extent to which nature has been continuously commodified through history (ibid., p.3). Moreover, today the example of SQM, Chile's largest lithium producing company - that is still partly controlled by Pinochet's former son in law Julio Ponce Lerou - shows the enormous intersection between Chile's economy and its politics (Balcazar, 2022).

The lack of research on lithium price determination on a global level and price setting mechanisms on a local level, as well as its entrenchment in Chile's Political Economy, is central to this thesis and the analysis of prices behind minerals for electro mobility. This thesis wants to contribute to current research and aims at discussing policies for more just outcomes in the lithium GPN related to price determination. Most recently the war in the Ukraine and the exploding energy prices in Europe illustrate the intersection of resource dependency, commodity prices and governance. While some energy companies and coal plants currently make gigantic profits from the rising gas and energy prices in Europe, private households and public organisations and companies are faced with sky-high energy bills (Schäfer, 2022, pp. 3–4). This shows the current importance of transparent pricing and prices.

Theoretically this thesis builds on the literature of chain and network approaches, specifically drawing on the Global Production Network (GPN) approach. Its concepts of power, value and embeddedness contribute to the better analysis of the economic (surplus) value of lithium

extraction. The latter is embedded in power asymmetries between firms, the state, and communities, as well as broader network-specific governance patterns of the strategic mineral lithium. From this perspective, the specificity of extractive sectors and lithium's materiality and territoriality, support the argumentation of tightly intertwined social and natural processes. These conceptual frameworks are then combined with literature regarding the way in which prices are political. This includes also the broader financialisation literature which see the emergence of financial activities on commodity markets as a possible driver of opaqueness, competitiveness and ecological degradation. Green extractivism as a specific regime of green-capitalist accumulation like electro-mobility and increasing financialisation processes goes hand in hand with ecological destruction (Wissen, 2013a, p. 8). By further applying the theoretical lens of Critical Political Economy, it becomes possible to critically assess lithium extraction and the contested processes around and beyond it in terms of hegemonic ideas and the political logic to transform natural resources into a mode of capitalist accumulation.

Due to the lack in research around price determination, methodologically, fourteen semi-structured interviews with actors in the lithium production network directly in Chile were conducted. These interviews include lithium producers, relevant state agencies, related businesses in the lithium sector as well as NGOs and academics in Chile. This seven-week research stay in Chile was supported by a short-term grant abroad (KWA) by the University of Vienna. Additionally, eight interviews from prior research with further experts, predominately in Europe were conducted. All interviews were systematically analysed with assistance of the *content structuring qualitative content analysis*. Together with trade and price data and an actor and sector mapping, they form the methodological framework of this thesis.

This thesis concludes with a complex illustration of the contested pricing practices on a global and local level, as well as (distributional) struggles around and beyond pricing in the lithium GPN and the lithium extraction in Chile. The lithium market does not yet have one dominant global benchmark but there are ongoing struggles between powerful actors like lithium producers – that have increased power due to the current lithium boom – as well as the LME and PRAs, on which price becomes dominant. Having no global benchmark can be seen as problematic, as opaqueness in lithium pricing leads to an unequal distribution of costs and risks and excludes certain actors from the production network as investing in a commodity without dominant benchmark is riskier for actors without access to a lot of know-how and financial resources. On the other hand, a global benchmark generally ignores geographically specific production structures, social realities, and ecosystems. Moreover, practices of dominant global

price determination institutions like the LME and PRAs lack transparency, are importantly influenced by transnational physical actors like lithium producing firms and financial investors and are often based on short-term strategies, thereby ignoring long-term risks like ecological degradation. Even though currently producers in Chile seem to be powerful actors, this may shift to China where the most value-adding activities takes place after the extraction.

The contestation around lithium pricing on a global level consequently impact the local level in Chile. The high demand for lithium induced by a certain narrative around a socio-ecological transformation targeted towards mitigating climate change with 'green' mobility, gives power to lithium producing firms in Chile. Highly volatile lithium prices stabilise their power since currently battery and EV producers need to secure supply at any cost. Social realities of the people directly influenced by lithium extraction and ecological costs are not included in lithium prices, even if these factors should be of paramount importance in a socio-ecological transformation. The embeddedness of lithium extraction and production in a complex political economy impacted by the Pinochet regime, social injustice, and fights over territories, further contributes to the unsustainable use of the resource lithium. The control of lithium extraction by only two companies, strengthens their position in price determination processes on a global level. Together with a political system in Chile where almost all power originates from the centre, this weakens the opportunities of alternative production systems and critical voices towards the model of green exractivism, supporting to include ecological and social costs in lithium prices.

The thesis is structured in seven chapters. The first chapter contextualizes the contents of the theoretical approaches based on relevant literature. The next chapter contains a discussion of the methodological approach before illustrating the sector background of lithium based on literature, trade and price data in chapter 4. Chapter 5 describes the sector background of lithium production in Chile and chapter 6 follows, discussing the findings of the field work analytically. The thesis concludes with major findings as well as an outlook and possible policy implications.

2 Theoretical framework

Through the lens of Critical Political Economy, the interplay of global value chain and network literature and the broader financialisation and price-setting literature forms, the basis of this thesis' theoretical framework. Hence, the evolution of the chain and network research as well as the specificities of extractive sectors is assessed in the following, before drawing attention to the wider financialisation and price-setting literature and the conceptual framework of the Critical Political Economy. This section ends with a synopsis and the direct implications the theoretical framework has on the next chapters.

2.1. Chain and network approaches

Theoretically, this thesis predominantly draws upon major conceptual elements of GPN approach when analysing the sector background of lithium as well as the historical background of Chile. This approach delivers insights on power relations, strategies of different actors in globalised production as well as their positioning in the network (Henderson et al., 2002, pp. 438–439). What follows is a reflective summary on the GPN's most relevant precursors being particularly decisive for the emergence of the GPN framework.

The term *commodity chain* (CC) dates back to the late 1970s and was first mentioned by Terrence Hopkins and Immanuel Wallerstein in an article that analysed the modern world-system. In it, they criticised the prevailing developmentalist perspective of the time, which assumed that autonomous markets and societies move up paths of development independently from each other (Hopkins & Wallerstein, 1977, p. 111). Instead of seeing the development of the capitalist world economy as a sequential process in which different state-centred national entities move towards an international market at different paces, they argue according to the world system approach (see Hopkins & Wallerstein, 1977, p. 112). Thereby they see the different social spheres coexisting with the division of labour and its regional constituents thus continually reproducing the world as an integrated whole with cores and peripheries. Capital accumulation thereby must be considered as part of a dialectic process, intertwined with unequal exchange: if one country moves upward, another will automatically move downward (Hopkins & Wallerstein, 1977, p. 112). According to Hopkins and Wallerstein (1986), CCs are an essential part of this world-economy. In a follow-up article they define them as a "network of labour and production processes, whose end result is a finished commodity" (see Hopkins & Wallerstein, 1986, p. 159), thereby tracing back each step from the finished commodity to its components extraction. Researchers of commodity chains and world-system theorists

predominantly convey a historical perspective, focusing on the linkage between commodity chains and the rise of capitalism in the long sixteenth century, that continuously reproduce a hierarchal world-structure (Bair, 2005, p. 156).

In the 1990s Gary Gereffi et al. (1994) developed an operational research paradigm they called *Global Commodity Chains* (GCCs). Aimed at capturing the contemporary development issues and changes in the world economy, their research had a greater focus on the macro-micro links between processes in commodity chains than the previous paradigm (Gereffi & Korzeniewicz, 1994, p. 2). They define GCCs as "sets of interorganizational networks clustered around one commodity or product, linking households, enterprises, and states to one another within the world-economy" (see Gereffi et al., 1994, p. 3). Hence, this approach views commodity chains more as an "emergent organizational form" (see Bair, 2005, p. 157) with lead firms as key actors, controlling the either producer-driven or buyer-driven commodity chains (ibid.). Lead firms in producer-driven commodity chains derive their power from knowledge in production and technology. This type of governance is particularly present in capital-intensive sectors like the automotive industry; key production processes are carried out by lead firms and only labour-intensive activities are outsourced to suppliers. Lead firms in buyer-driven commodity chains in contrast control spatially widely spread networks of suppliers and are also called "manufacturers without factories" (see Fischer et al., 2021, p. 35). Those commodity chain structures can typically be found in the apparel or toy sector, where lead firms preliminary focus on the design and marketing and outsource production to several suppliers (Humphrey & Schmitz*, 2001, p. 22).

The GCC framework considers globalisation as a contemporary process facilitated by more integrated production processes and value that is created by different actors along the GCC (Bair, 2005, p. 157). According to Gereffi et al. (1994, p. 97), GCCs have four dimensions, namely the input-output structure, meaning that in every process stage value is being created and services are linked together in a value-added sequence (1). The territoriality illustrates the spatial dimension, including dispersion and concentration of production (2). The governance structure illustrates the function of lead firms and how production determines financial, material and human resources within a chain, reflecting the power relations (3). The institutional framework with local and (inter-)national institutions and regulations is considered the fourth dimension (4) (Fischer et al., 2021, p. 34). Furthermore, the term *upgrading* is of great relevance in the GCC-framework. Economic upgrading is mostly understood as a process through which firms improve their position within the chain. This process is greatly intertwined with firm-

competitiveness (Bair, 2005, p. 165). However, economic upgrading does not automatically lead to social upgrading, namely higher wages, and better work conditions. Hence, social upgrading has become its own subject of investigation (Fischer et al., 2021, p. 43).

With the turn of the millennium, a new trail established itself in the chain literature, when Gereffi et al. (2005) introduced the term *Global Value Chain* (GVC) (Gereffi et al., 2005, p. 79). According to the authors, "the global commodity chains framework did not adequately specify the variety of network forms that more recent field research has uncovered" (see ibid., p. 82). Research on value chains in the beginning of the 2000s has moved away from seeing the process of globalisation and international trade in goods and services solely as market-based transactions. This approach sets a more precise focus on the whole range of activities along the GVC, thereby problematising the question of governance structures and upgrading processes (Gereffi et al., 2001, p. 1). It does not only focus on governance and upgrading in terms of firm-level competitiveness in a particular industry, but instead sheds light on the critical question of winners and losers in the globalisation process (Bair, 2005, p. 154). The way global value chains are structured has important implications on who can access them and which potential firms have – especially in the Global South – to upgrade within the chain (Gereffi et al., 2001, p. 2). Within this approach, five new typologies around governance have been developed: market, modular, relational, captive and hierarchical (Gereffi et al., 2005, p. 89). The analytical type of *market governance* is solely based on market linkages. The cost for both customers and suppliers to switch to new partners is low; the *hierarchical governance* structure forms the polar opposite to market governance, since it is not based on mere market structures but on vertical integration within the chain (ibid.). Vertically integrated global value chains are thus characterised by hierarchical structures, with lead firms owning several tiers of the supply chain (Bair, 2005, p. 159). The other three governance categories modular, relational and captive lie in between these two poles of market governance and hierarchical governance (Gereffi et al., 2005, pp. 83–84).

Ultimately, with the advancement of the government definition, the concept of *governance as driving* was replaced by *governance as coordination*. The latter had a more precise focus on different types of suppliers within a GVC and their relations to lead firms (Gibbon et al., 2008, pp. 319–322). Furthermore, they point out that external actors like NGOs, certification bodies or experts besides lead firms can also play a pivotal role in governing global value chains. This understanding of governance in GVCs can be referred to as *governance as normalisation.* In this way, capitalism is not said to only strive toward commodifying new products, but also

commodifying information in respect of normative ideas that influences management, production, and consumption. This is also how ecologically friendly and ethical products and services evolve during a process of capitalist accumulation. In contrast to the other two governance types, governance as normalisation identifies governance through dominant paradigms and normative sense instead of pure market concentration (ibid., p. 325).

The Global Production Network (GPN) approach can be considered the fourth paradigm within the chain and network research. This framework evolved in the context of criticizing the chain approach (Fischer et al., 2021, p. 38). In particular, Henderson et al. (2002, p. 439), criticised the insufficient focus on corporate power in the institutional context of firm-based activities and on territorial arrangements that include social and economic asymmetries. As a key weakness of the chain approaches, they name the conceptualisation of production as being vertically linear. Instead, they propose the metaphor of a *network* since "[…] such processes are better conceptualised as being highly complex network structures in which there are intricate links – horizontal, diagonal, as well as vertical – forrming multi-dimensional, multi-layered lattices of economic activity" (see Henderson et al., 2002, p. 442). Moreover, the term *production* better captures social processes that are involved in production and reproduction of knowledge, capital, and labour.

Henderson et al. (2002, p. 448-449) base their argumentation on three "conceptual categories" (see ibid.: p. 448), namely value, power and embeddedness. With *value* they refer to Marx' term of surplus value, the circumstances under which value is created and how it can be captured. With *power* they touch on corporate power of lead firms, institutional power of the state, inter-state agencies, power of institutions like the World Bank or World Trade Organisation (WTO) and collective power of non-governmental organisations (NGOs), trade unions and employer associations within the network. Lastly, with *embeddedness*, they refer to the socio-political context in which actors are embedded in, including their strategies and expectations that are profoundly influenced by particular forms of capitalism (ibid., p. 451). Furthermore, Henderson et al. (2002, pp. 453-455) name four conceptual dimensions that build the framework for the creation of value, the practice of power and the institutional embeddedness: firms, sectors, networks and institutions. The GPN approach therefore takes into account firm-specific differences, sector-specific structures and technologies, network-specific governance and the different consequences institutions and their regulations have for GPNs. By mapping the main elements, actors and linkages of a specific production process, GPNs can be visualised and analysed (ibid., p. 455).

Using the GPN approach as "heuristic framework" (see Bos & Forget, 2021, p. 168) to understand the lithium market and lithium extraction in Chile, will help to analyse the interconnections of not only inter-firm relations but also the role of the state in value creation. It furthermore supports mobilizing a critical perspective on different power relations in lithium production and local development outcomes that impact the global level and visa versa over space and time.

2.2. Specificity of extractive sectors

Extractive sectors – like mineral extraction's possibility to contribute to regional development – have been the centre of much debate in policy cycles and academia for much of the post-war era (Bridge, 2008, p. 390). Underpinned by the theory of comparative advantage in international trade, resource extraction is considered a driver of development. According to modernization theory the extraction of natural resources can give a *big push* to the local economy, thereby providing the opportunity to *plug into* the global economy. According to neoclassical theory, natural resources are capital assets that can be realised only by their extraction (ibid., p. 391).

However, alternative views see pivotal limitations in natural resource extraction as a driver of development. The scepticism towards the assumption that resource extraction drives regional development has come to be known as the *resource curse* thesis, a term coined by Richard Auty in 1993 (Badeeb et al., 2017, p. 123). The cases of for example Bolivia, Zambia, or Angola show that resource-rich countries do not always succeed in development issues (Bridge, 2008, pp. 392–393). In the case of lithium, Barandiarán (2019) states that the unknown future of lithium is by some actors considered the "source of a new resource curse" (see Barandiarán, 2019, p. 381) in Chile. The occurrence of the resource curse depends on numerous factors, such as a country's export structure, its horizontal and vertical policies, its trade policy and exchange rate as well as overall price volatility and a country's degree of resource-dependency (Gelb, 2010, pp. 7–13).

Today, especially highly instable mineral prices, environmental degradation, human rights violations and corruption have reopened discussions scrutinising the correlation between extractive industries and regional development (Bridge, 2008, p. 392). More frequently resource-based development challenges are considered as an issue of governmental management and framed as a question of *good governance* (Bridge, 2008, p. 393). However, Bridge (2008) stresses that these discussions insufficiently include the extension of production and interfirm networks of extractive sectors to outside of state boundaries. He therefore suggests applying the GPN's analytical framework to resource extraction and socio-economic

development. He generally argues that extractive industries have until today not been a major part of the GCC, GVC or GPN projects (ibid., p. 390).

Ciccantell et and Smith (2009, p. 362) also criticise the inadequate focus on the extractive system of a production network found in some of the chain literature. They therefore, propose to analytically "lengthen the chains" (see ibid., p. 362) against the background of ecological degradation. To be able to examine *ecologically unequal exchange* within the current world-system, chain analysis with primary products forces the examination of so-called *extractive regimes* (ibid., p. 362). According to Ciccantell and Smith (2009), GVCs of raw materials are today greatly linked to location-specific processes that shape the strategies of lead firms and states and are object to conflicts over the access to resources. Hence, they propose to apply the *new historical materialism* approach to the chain framework. This approach, contrary to the GCC framework "focuses attention on the upstream end of the commodity chain, highlighting the critical role of raw materials extraction, processing and transport in shaping the evolution of the capitalist world-economy" (see Ciccantell & Smith, 2009, p. 368). It builds on the argument that a central feature of the contemporary world-economy is the ongoing exploitation of nature with labour, more specifically the division of labour that has been globalised in the last decades (Bunker & Ciccantell, 1999, p. 107). Following Ciccantell and Smith (2009, pp. 368-369), the main challenge to using raw materials appears in the tension between the increasing economies of scale for raw material's extraction and the increasing transport costs that are correlated with a rising pace of extraction and technological innovation. Solving that problem at the very upstream part of a natural resources' production network requires coordination between the physical and the social sphere, namely between firms, the state, new technologies and labour.

Following this argumentation, tightly intertwined social and natural processes need special consideration in an expanding capitalist world-economy that steadily incorporates more of the earth's surface (ibid., p. 363). Furthermore, the fact that mineral deposits are mostly tied to a specific territory and thus often globally integrated but locally disconnected, represents a potential conflict between local populations and multinational firms operating the respective extractive sectors (ibid., pp. 362-363). In this debate, Bridge (2008) highlights the need to apply the terms *materiality* and *territoriality* to the GPN framework when analysing extractive industries (Bridge, 2008, p. 411). Materiality thereby refers to the high degree natural resources rely on the transformation of nature which cannot be found in service or manufacturing sectors. Hence, a large part of the production chain depends on "biophysical processes" (see Bridge,

2008, p. 412), namely production, transportation and processing or refining. The materiality of a product describes its "variation in quality and ease of recovery" (see Bridge, 2008, p. 394) and influences local and global production and development opportunities. With territoriality Bridge (2008) refers to how natural resources, specifically minerals, are embedded not only in ownership structures but also institutional, cultural, and political structures of the state (ibid., p. 413). Most of the time at the upstream end, mineral reserves are property of the respective states they are located in. Therefore, the assets are often not owned by the responsible extractive firm; they however mostly control them via lease of licenses granted by state or governmental institutions. Hence, the state plays a big role within extractive industries and access to the underlying core assets does not only rely on different interests within the production network but is also greatly linked to taxation regulations and impact price rates of natural resources (ibid.). Ownership over resources or (mineral) reserves and its embeddedness in certain territories and cultural and political contexts has major implications on power within the production network (ibid.)

Baglioni and Campling (2017) similarly highlight the strengths of the GVC literature in their ability to map an entire industry through its various relations between labour, state, capital and further institutions. However, due to the missing ecological dimension in the GVC literature, they argue for a more precise focus on the scarcity of resources and its historical relation to the global political economy, (Baglioni & Campling, 2017, p. 2439). They state: "To take nature seriously, we need to recognise the complementarity between the spheres of circulation and production because the ability of lead firms to govern GVCs cannot be disjointed from the appropriation of nature, strategies to control the labour processes and firms' associated ability to capture surplus value" (see Baglioni & Campling, 2017, p. 2440). The sphere of production can – following Baglioni and Campling's argumentation – only be explained by seeing the appropriation of nature in a dialectic process with the relations among firm strategies and governance and the circulation of capital (ibid.). Rules for instance in the form of contracts are set within the exchange of different firms and affect production and nature, as well as determine where value in the extractive sector is captured and how risks and costs are transmitted along the value chain (ibid., p. 2441). Hence, thinking through the circuit(s) of capital is of high relevance when examining natural resource industries, since value is directly realised through the extraction of raw materials. Natural resources therefore need to be considered both a socio-ecological and a socio-political construct (ibid., p. 2445).

2.3. Price-setting and financialisation

The goal of this thesis is to analyse the price determination and setting processes around the lithium extractive sector in Chile. Therefore, the importance of prices for understanding economic issues, as well as the broader price determination and financialisation literature are outlined in the following. Until today, detailed examinations of price determination and price setting mechanisms in chain and network studies have been scant. Issues of prices have instead generally been considered as crucial conditions that influence the organization of trade and production (Bargawi & Newman, 2017, p. 164). Only some authors have linked network and chain approaches to financialisation literature so far (Coe et al., 2014; Milberg, 2008).

According to mainstream economic price theory, prices are simply the result of demand and supply (Beckert, 2011, p. 1). However, when looking into prices from a sociological point of view, it becomes clearer that prices do not just emerge from the market (ibid., p. 3). According to Bourdieu (2005) "the notion of field breaks with the abstract logic of automatic, mechanical, and instantaneous determination of prices in markets in which unfettered competition prevails: it is the structure of the field, that is to say, the structure of relations of force (or power relations) among firms that determines the conditions in which agents come to decode (or negotiate) purchase prices (of materials, labour, etc.) and selling prices" (see Bourdieu, 2005, p. 77). Today, mainly research within economic sociology investigates prices as an outcome of struggles between market actors, thereby rejecting the basic premise of economic price theory.

The function of prices goes beyond coordination; it rather needs to be directly connected to the distribution of wealth, since prices are anchored in specific regulations, policies and the institutional structure of markets (Beckert, 2011, pp. 1–2). Network approaches, focus on social embeddedness of economic strategies and relationships in the production network (Bargawi & Newman, 2017, p. 167). However, prices have not been a major part of research within this field (ibid., p. 164). Prices within global production networks, though, can be seen as an important part of governance: they are the outcome of relationships among actors in the market (ibid). Prices therefore produce and reproduce key factors in supply chains like power, trust, and status. They create or don't create space for certain actors to negotiate prices and strengthen their position within the production network. Hence, price determination and price setting need to be seen as not only a natural outcome of demand and supply but as a political and contested process (ibid., pp. 167 – 168.). Throughout this thesis the two terms price determination and price setting will be used; price determination refers to the processes and institutions that determine prices before these prices are being used in bilateral contracts between buyers and sellers, a process that will be labelled price setting (Wojewska et al., unpublished draft).

According to Çalişkan (2010, p. 16), markets do not only produce commodities but also prices. Thereby prices are realised through constant interventions in the market, by exchange, different indexes, standardization, and different forms of perception (ibid., p. 17). Despite this focus on the institutional embeddedness of prices, Beckert (2011, pp. 11–13), argues for five mechanisms through which institutional regulation influences prices and price determination. He first states that institutional rules can influence competition by either regulating production costs or directly adjusting supply by introducing restrictions, quality standards, minimum wages or property rights. Secondly, institutions can influence the market price by reducing the opportunities of producers to externalise ecological or labour costs with, for example, the implementation of a market for emission permits. In this example producers would get incentives to avoid CO_2 – emissions. This again influences production costs and thus the product's market price. As a third mechanism Beckert names warranties and further forms of consumer protection regulations that can reduce market uncertainty in terms of unevenly distributed information between different actors. A fourth mechanism is the implementation of taxes. Product prices are institutionally influenced by either tax on corporate profits, value-added taxes or consumer taxes. This mechanism is used by political actors to either provide or deny the access to certain goods. Lastly, the monetary policy can influence product prices by the implementation of, for example, interest rates. These institutional mechanisms provide valuable theoretical insight into the study of prices and markets. However, institutions should not be seen as fixed, because they are political themselves and are (re-)produced by social entities and network relations as well (Bargawi & Newman, 2017, p. 169). This analysis shows that prices therefore greatly influence economic activities, namely trade and production patterns, structure the distribution of wealth and prices themselves need to be viewed as outcomes of forces that influence the market exchange (Bargawi & Newman, 2017, p. 164)

Price-setting mechanisms should therefore be crucial elements within GPN and GVC research, but studies which take them into account are rather rare and focus predominantly on agricultural products (Bargawi & Newman, 2017; Newman, 2009; Purcell, 2018; Quarmine et al., 2014; Staritz et al., 2018, 2022). This is especially problematic when analysing extractive (mineral) sectors that are not only heavily influenced by volatile price levels (Badeeb et al., 2017, p. 124), but also by their materiality and territoriality (Bridge, 2008, pp. 412–413). It is useful to not only link the GPN and GVC approach to the general price formation literature but also to the wider financialisation literature, despite the fact that commodity markets have been experiencing increasing financialisation in the last decades (Adams & Glück, 2015, p. 93; K. Tang & Xiong, 2012, p. 54).

The most popular definition of financialisation was given by Gerald Epstein in 2005: "[...] for us, financialisation means the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies" (see Epstein, 2005, p. 3). Financialisation thus describes processes in which an increasing quantity of capital is not invested as productive capital anymore but rather occurs as fictitious capital bearing interests of generating surplus value (Brand & Wissen, 2014, p. 16). Researchers from various disciplines have been using the concept of financialisation to investigate how global finance has transformed the logics of industrial capitalism since the early 2000s (Van der Zwan, 2014, pp. 99–100). Studies of financialisation contribute to the investigation of contemporary capitalism (ibid., p. 114). Financialisation processes in general emerged from the strategy to overcome the crisis of Fordist accumulation strategies in the 1970s when profit rates decreased, and class conflicts increased. Despite new technologies and a globalisation of the capitalist mode of production, profit rates in the Global North started to increase leading to over-accumulated capital (Brand & Wissen, 2014, p. 23). According to Brand and Wissen (2014) "financialization was and is an effect of strategies to restore profits and to deal with over-accumulation through privatisation, deregulation, a reorganisation of the relationship between industrial and financial capital, the invention of new financial products, and the opening of new spheres of accumulation" (see ibid. pp. 23-24). Politicians, media and other neoliberal institutions and actors justified these processes and argued for the advantages of the state's limited influence on the economic sphere and promised to facilitate the participation of households in the new finance-led accumulation regime (ibid., p. 24).

Against this background, scholars have identified three different approaches within financialisation literature. First, financialisation is used as a phenomenon to describe a new regime of accumulation, mainly by regulationists (ibid., p. 101). This approach explores the correlation between the "declining profitability of manufacturing and the growing financial activities of non-financial firms" (see ibid., p. 101). To understand the emergence of this new capitalist accumulation regime largely led by finance, the integration of the political and economic spheres needs to be recognised (Boyer, 2000, p. 279). The second approach within financialisation literature revolves around a shift of power relations from industrial to financial capital (Brand & Wissen, 2014, p. 24). With the crisis of the Fordist accumulation regime, corporations have been restructured and moved away from the aim of "retain and reinvest" (see Lazonick & O'Sullivan, 2000, p. 14) to the goal of maximising shareholder-value. The term shareholder value describes the idea that the core principle of a company is to make profit for the shareholder (Van der Zwan, 2014, p. 102). In contrast to the retain and reinvest principle,

the financial gains were now distributed through, for example, dividend outputs (Van der Zwan, 2014, p. 108). Thereby, industrial firms often transformed into financial actors themselves with their profits from financial activities becoming higher than the ones from their industrial or productive activities (Brand & Wissen, 2014, p. 24). The third approach centres around the financialisation of everyday life which was made possible with the "democratization of finance " (see Van der Zwan, 2014, p. 111). Researchers within this approach argue for various ways in which finance is anchored in practices of everyday life. They thereby refer to the increasing participation of individuals in pension plans or the rise of individuals and middle-class households in owning financial assets (ibid., p. 102). According to Van der Zwan (2014, pp. 111–114), governments have directly pushed towards this kind of financialisation, thereby politicizing the practice of finance itself and making it a fundamental class issue. This results in a growth of financial flows and an increasing individualism within the everyday financial regime which leads to an increasing individual exposure to risk. All three approaches question the neutrality of finance and shed light on the role of the state in the establishment of financial markets, by making apparent the structural inequalities and power asymmetries within financial market and equity-based economies (ibid., pp.119-120).

Financialisation within the global world economy also comes with the impact financial markets have in the commodity sector (Basak & Pavlova, 2016, p. 1511). Here it is argued that the coupling of finance capital and the production of nature has become more intense since the beginning of the neoliberal era (Ouma et al., 2018, p. 500). Firstly, financiers have become more engaged in the natural world through new financial arrangements in, for example, mining and mineral extraction and secondly, new financial instruments that are concerned with the human-nature relationship have been introduced, such as commodity index funds or weather derivatives (ibid., p. 501). Ouma et al. (2018) named these processes with a wide interest in the natural world by financiers as the "financialisation of nature" (see ibid.). Resource-based production has started to serve as a means to solve capitalism's multiple crises (ibid.) The latter describes the several crises and their interaction, such as the financial, economic and environmental crisis. The financialisation of nature thereby needs to be seen as a hegemonic project that promises to cope with the multiple crises by exploiting new fields of capital accumulation, continuously supporting the logic of capitalism (Brand & Wissen, 2014, pp. 16–17). In regards to commodity markets, Basak and Pavlova (2016) have described the financialisation of commodities as a "sharp increase in the popularity of commodity investing over the past decade [that] has triggered an unprecedented inflow of institutional funds into commodity future markets" (see Basak & Pavlova, 2016, p. 1511). Since the turn of the 21st

century, scholars have witnessed an increasing financialisation of commodity markets (Adams & Glück, 2015, p. 93; K. Tang & Xiong, 2012, p. 54). Before, commodity markets had not been linked to financial markets to the extent they are today (K. Tang & Xiong, 2012, p. 54). Many commodity and capital markets changed from being non-profit physical utilities aiming at facilitating trade to for-profit businesses managed by outside financial actors (Seddon, 2020, p. 526). Several scholars explored a correlation between the rise of commodity prices and price volatilities and the growing influence of financial investors on commodity markets (Basak & Pavlova, 2016, p. 1511; Singleton, 2014, p. 301). The anatomy of price determination can thus be considered as having undergone crucial transformations (Seddon, 2020, p. 526) that lead to distributionally asymmetric outcomes (Mayer, 2012, p. 765). These theories reject the neoclassical understanding of a market structure, formed solely by supply and demand. Macro-structural outcomes of financialisation have to be sufficiently analysed (Mayer, 2012, p. 765) when investigating price determination mechanisms in a global world economy. This is important when paving the way for a climate-neutral future with an ecologically, socially and economic fair transition.

This outline shows that the theoretical framework of chain and network literature – that often fails to consider processes of financialisation – need to be complemented with the theoretical implications of the specificities of the extractive sector as well as the wider price setting and financialisation literature.

2.4. Critical Political Economy

Economic interrelationships can be characterised by different economic theories with rather conflicting arguments. The analysis of this thesis will be theorised through the lens of Critical Political Economy. Jäger and Springler (2012, pp. 7–9) identified three main paradigms of economic thinking: neoclassical economics, Keynesian economics and (Critical) Political Economy. The latter specifically rejects the ideas of neoclassical economics and follows Karl Marx's ideas on perceiving economics as a societal relationship (ibid., p. 69). Thereby the integrative analysis of economics and politics is central. Following Karl Marx's theories of class conflicts and the capitalist system, Political Economy considers the interaction of human-nature relations and labour that transforms raw materials into valuable economic goods as a basis. To maximise profits, those controlling the means of production, namely business owners, aim to accumulate as much capital as possible, by paying the lowest possible wages to their workers. How actors within the so-called *superstructure* (the structure that supports the means of production) behave, further depends on ideological ideas and beliefs. The latter needs to be viewed as institutionally embedded and socially contested (ibid., pp. 72-73).

The chapter on the specificity of extractive sectors illustrated the way in which the political economy of natural resources follows a political logic. The materiality and territoriality of natural resources, as well as the scrutiny of these resources, requires a sufficient critical approach against the background of the globalisation of trade and labour. While the demand for certain natural resources and technology changes, "capitalism's general dependence on them remains" (see Baglioni & Campling, 2017, p. 2451). In the context of chain and network literature, scholars criticise the insufficient analysis of a production network's macro level (Fischer et al., 2021, p. 41). However, it is crucial to study how chains are articulated within a certain political environment and to what extent certain actors benefit from that (Bair, 2005, pp. 167–168). Analysing contemporary capitalism and how this system is affected by class structures, market institutions and the regulatory mechanisms should be an important part of chain and network literature (ibid., p. 171).

In the context of the climate crisis for example, all three paradigms see the causes differently. While the neoclassical perspective perceives the causes of climate change in market failure, the Keynesian view sees a necessity to stabilize the market through regulative political instruments of the state. From a political-economy perspective however, those stabilisation measures would not go far enough. Contrarily to the Keynesian perspective, Critical Political Economy sees the capitalist state not only as an actor that can control the society rationally; the capitalist state needs to be seen within asymmetric power structures (Wissen, 2015, pp. 230–233). On a conceptual level, neo-Gramscian theories and the term of hegemony will help to analyse the power of the state and different classes in the world system. Hegemony in this context refers to a globally enforced supremacy of the state, shaped by concerns and ideology (Jäger & Springler, 2015, pp. 358–359). How different interests in global production networks are enforced thus needs to be seen in context of hegemony, ideology, and asymmetrically distributed power.

Furthermore, the practice of finance and prices must not be seen as an unpolitical, neutral process but rather as a class project and a branch of capitalist accumulation which supports the structural power of capital markets and the neoliberalisation (Ouma et al., 2018, p. 507; Seddon, 2020, p. 529). Financialisation literature often cannot sufficiently explain in which way financial markets and interests impact political economies and lack a well-founded historical contingency in financialisation literature (Van der Zwan, 2014, pp. 106–115). Therefore, "financialisation has become a current major issue in critical political economy" (see Brand & Wissen, 2014, p. 16). On a conceptual level the regulation theory can help to explain the current crises and why the system of capitalism is that adaptable and survivable, despite the multiple

crises it is experiencing. According to regulation theory, the accumulative imperative of capitalistic societies is supported by institutional regulation. As soon as the dominant accumulation regime becomes unstable, for instance through the exhaustion of natural resources, new accumulation strategies like new technologies or exploiting new natural resources can support the stabilization of capitalism (Jäger & Springler, 2015, pp. 200–201). According to Wissen (2013b, p. 8), the stabilization of crises by means of a green-capitalist accumulation regime – like electro-mobility – goes hand in hand with the advancing ecological destruction around which a new (global) speculative (financial) market segment is developing.

2.5. Synopsis

This thesis will outline the lithium market and its value distribution, its power relations, and embeddedness in the current capitalist world-economy with the theoretical approach of the GPN framework, extending it to extractive sector's specificities in Chile. The advantages of the GPN approach will help to shed light on the categories of value, power and embeddedness to acknowledge that global networks are also local in terms of institutional and social contexts (Bair, 2008, p. 4). Moreover, the GPN framework helps to highlight the network- and sector specific governance of lithium extraction in the South American country Chile. The GPN's underlying conceptual elements of governance and regulations imposed by different institutions on both the global and the local level of lithium production, fit best to analyse the practice of power and the distribution of value between the state, different – private and public – stakeholders and institutions as well as and civil society. Furthermore, considering lithium's input-output structure and certain ideologies as well as normative sense that impact its global trade, support a critical perspective on lithium's production network.

In this context the related materiality and territoriality of lithium and lithium extraction need particular attention as they influence lithium's embeddedness in national policies as well as socio-cultural realities and the wider imaginary of lithium extraction. Since this thesis has a strong focus on prices, the analysis also goes beyond the traditional chain and network literature that is often criticised for lacking in considering price-setting and financialisation processes. However, against the background of increasing financialisation processes which impact the organisational structure of markets, and in order to realise a socio-ecological transformation, prices are of great importance (Seddon, 2020, p. 526). For that reason, the GPN approach is linked to price-setting literature, including underlying considerations of the broader financialisation literature.

Furthermore, the theoretical lens that has been used throughout this thesis strongly rejects the framework of neoclassical economics, where economical outcomes are considered a result of optimal agent's decisions. It rather draws upon the assumptions of the Critical Political Economy, a paradigm that criticises as well as extends the Classical Political Economy of Adam Smith and David Ricardo (Jäger & Springler, 2012, p. 69). Building upon these literatures, I argue that lithium extraction in Chile is embedded in networks of political institutions and infrastructures while at the same time lithium price making is contested and needs to be seen as a highly political process.

3 Methodology

For an assessment of the controversies and contestation around and beyond price determination and setting in the lithium GPN and extraction in Chile, a mixed methods approach is being used. According to Buch-Hansen and Nielsen (2020, p. 23), using mixed methods in social sciences can help to overcome quantitative-qualitative dualism. Quantitative data, not least descriptive statistics, helps to broadly analyse phenomena in numbers, while qualitative research like interviews can then help to investigate these phenomena in depth. Hence, this thesis uses (1) a descriptive analysis of trade and price data to get an overview of trade flows and the development of lithium prices and (2) a broad sector and actor mapping considering secondary literature and primary sources (such as contracts and reports) that is completed by (3) semi-structured interviews. Out of the twenty-two interviews included in my analysis, fourteen interviews were conducted during a seven-week research stay in Chile from end of April to beginning of June 2022.

3.1. Descriptive Trade and Price Data

To identify the trade flows of the main export countries of lithium carbonate and hydroxide, this thesis considers the descriptive analysis of export data retrieved from UN Comtrade. This United Nations (UN) database allows free access to global trade statistics broken down by commodity and trading partner (UN Comtrade, 2022). When analysing international trade, it is quite a common tool to use mirror data statistics. Using mirror data means using the data reported by the respective trading partner instead of using the export flows declared by a country. This is done due to poor quality of export data and missing values like taxation issues in export flows (Bacchetta et al., 2012, p. 37; Carrère & Grigoriou, 2014, p. 1).

Besides identifying main trade flows in the lithium global production network, this thesis will draw on the descriptive analysis of lithium price data in order to capture the market trends and changes within the last years. Therefore, price data from three different sources will be used to illustrate general trends of lithium prices. Firstly, Benchmark Mineral Intelligence (BMI) provided price data on lithium carbonate (CIF Asia) for the years 2017 to 2022. Secondly, price data for lithium hydroxide was retrieved from the data bank of the London Metal Exchange (LME) (London Metal Exchange, 2022b) (see Appendix I). Thirdly, publicly accessible export data from the Chilean Customs Service *Chile Adunas* is analysed. This data on export prices includes monthly data of the value of lithium exports from Chile in US Dollars as well as the weights of exported lithium in kilograms between 2017 and 2022 (see Appendix II). The export

prices per unit (ton) were then calculated. While these export prices do not consider differences between specific lithium products and export prices are often criticised for being inaccurate, as stated above, they can still help create a picture of a general price trend together with the other two prices.

3.2. Actor and sector mapping

Identifying the firms, activities, stakeholders and locations involved in the process from production to final consumption is a common tool within the theoretical framework of network approaches (Ponte et al., 2019, p. 30). According to Ponte et al. (2019) an important part of mapping a value chain and its sector and actor background is analysing the input-output structure as well as the "supporting environment" (see ibid., p. 32), namely the institutional actors at the global and local level as well as the legal and social parameters. This includes mapping governmental organisations, regulations, industry associations and infrastructure (ibid., p. 32). This is crucial in order to then analyse how value is being created under which governance structures and what this means for distributional outcomes in the GPN (ibid., p. 30).

The sector background therefore contains not only the input-output structure, but also a section on the main actors in the lithium GPN on a global level identified through secondary literature. The latter also takes newspaper articles and online blog posts into account due to the current lack of academic research and the topic's contemporaneity. In the chapter on the case study background and lithium extraction in Chile, actors in the lithium GPN – with specific focus on Chile – are identified through both literature research and qualitative interviews. Further legal and social parameters relevant in the lithium GPN originate from the analysis of primary documents. These include the contracts between lithium producers and the Chilean state, the text from the (planned) new constitution in Chile as well as the report of the National Lithium Committee (Comisión Nacional del Litio, 2013; Corfo, 2018; La Convención Constitucional, 2022).

3.3. Semi-structured interviews

Solely considering trade and price data as well as literature can, however, not adequately answer the research question. Firstly, because there is not yet enough research about how prices are determined and set in the lithium GPN and secondly because it cannot adequately picture the degree of power and distributional struggles beyond prices. Given the current rapid moving events in the political economy in Chile today, this thesis uses qualitative interviews with actors identified in the sector and actor mapping as well as throughout the research in Chile.

Qualitative methods include specific case studies, action research, discourse analysis and interviews (Buch-Hansen & Nielsen, 2020, p. 74). Thereby, interviews can be considered as one of the most common methods in qualitative research and can generate a multitude of different perspectives by various actors related to the research topic (Dannecker & Vossemer, 2014, p. 154). In the lithium GPN there are many different actors who are embedded in various regulatory and institutional contexts on global and local levels. With regards to price setting mechanisms in particular, qualitative interviews can help to connect and analyse different motives, self-interpretations and everyday theories of companies and other groups or organisations (ibid.).

Especially when considering prices as an outcome of power struggles and thus a crucial element within GPN research as mentioned in the theoretical framework of this thesis, qualitative interviews will support the critical analysis of the research questions.

There are different types of qualitative interviews such as biographical, open or group-focused interviews. This thesis uses semi-structured interviews that are recommended by Dannecker and Vossemer (2014), when conducting research in a rather short time span (ibid., p. 158). Even if this method of interviewing relevant actors of the specific sector has more rigid structure than open interviews for example, semi-structured interviews can help to explore, describe and analyse the different living environments of the interviewees. In comparison to a questionnaire, the type of guideline[2] used within semi-structured interviews is more flexible and the questions can be adapted to different conversation dynamics and different levels of knowledge of the interviewees (ibid., p. 159). Specifically with regards to analysing the research questions through the lens of Critical Political Economy, rejecting the ideas of neoclassical economics and following Karl Marx' idea of perceiving economics as a societal relationship (Jäger & Springler, 2012, p. 69), semi-structured interviews will help to sufficiently consider the ideological angle and class affiliation from which the interview partner is answering the questions. Besides the strength of semi-structured interviews to analyse different living environments, they support creating a general picture of the topic and sector that is to analyse. Hence, in this thesis the interviews help to explore the lithium production network on a global and local level; areas that I usually don't have access to as I am not involved in, nor affected by it.

[2] The term guideline and questionnaire are used synonymously throughout this thesis.

3.3.1. Preparation

Before writing this thesis, I was already familiar with the broader research topic having assisted a research project at the University of Vienna on the role of commodity prices in a socio-ecological transformation. As part of this project, I travelled to London with a colleague of mine to conduct interviews with specifically different Price Reporting Agencies (PRAs) and other sector experts. Hence, I also included data from these interviews in my thesis since they helped me explore the environment of price determination process in the lithium market on a global level. Moreover, I had written an essay in a one-year mandatory research seminar within my master's program on socio-ecological conflicts in the value chains of cobalt and lithium. However, I only scratched the surface of the Chilean lithium sector during this project.

There are different opinions regarding the ideal grade of content preparation prior to the field research. While some authors argue for detailed knowledge on the research topic prior to selecting the interview partners, thereby narrowing down the perspective on the research area, others highlight the importance of having worked with relevant literature in order to get a sufficient overview of the current state of the art (Englert & Dannecker, 2014, pp. 238–239). In my case, it certainly helped to have prior knowledge not only on the theoretical framework but also the topic of price-setting in order to sufficiently prepare my research goal. Furthermore, it was particularly useful for me to practice conducting semi-structured interviews during the research trip to London prior to my actual field work in Chile.

The seven-week research stay in Chile was supported by a short-term grant abroad (KWA) by the University of Vienna. Prior to the research conducted in Europe – mainly London – and Chile, I identified four actor groups of potential interview partners in order to adequately address the research question(s). These included (1) LME and PRAs such as Fastmarkets, Benchmark Mineral Intelligence and CRU, (2) lithium producers and mining and refining companies, (3) policy actors and associations, and (4) civil society, NGOs, social movements, local communities, and academia. Actor group 1 was largely covered in the interviews within the research trip to London, but I also conducted one follow-up interview with a PRA after the field work in London.

In this context, the interview guideline contained thematic blocks as recommended by Dannecker and Vossemer (2014) (Dannecker & Vossemer, 2014, p. 160), with several more open questions in the beginning of each block and more concrete ones in the end. The questions were thereby the result of an operationalisation process of the research question(s) (ibid., p.

159). Finally, three questionnaires tailored to three broader actor groups ((2), (3), (4)) were designed (see Appendix IV).

The final questionnaires or interview guidelines contained several thematic blocks, which included:

For actor group (2) lithium producers and mining and refining companies:

1) An introduction of the interviewee and organisation profile
A) lithium GVC
B) contracts and pricing
C) price volatility and risk management
D) Chilean mineral policies
E) different interests in the lithium GVC
F) future outlook

For actor group (3) policy actors and associations:

1) an introduction of the interviewee and organisation profile
A) Chilean lithium sector and national policies
B) different interests in the lithium sector in Chile
C) industry trends and lithium prices
D) future outlook

For actor group (4) Civil society: NGOs, social movements, local communities and academia

1) an introduction of the interviewee and the lithium sector in Chile
(A) Chilean lithium sector and broader development implications
(B) national policies
(C) lithium prices
(D) trends, drivers, challenges

The interview guidelines were structured differently for each actor group, in order to recognise the different socio-cultural backgrounds as well as the different kinds of knowledge of the interviewees. This was done based on Dannecker and Vossemers (2014) point to structure the interview guidelines according to the research question(s) by considering the interests, goals, behaviour and knowledge of the interview partners (Dannecker & Vossemer, 2014, p. 159). Already prior to the fieldwork, the literature review demonstrated that these points would differ between different actor groups in the Chilean sector of lithium extraction and production. Even though most questions in the three guidelines were similar, some were tailored specifically to the respective actor group. Finally, the guidelines were also modified during the research stay based on new developments and knowledge with questions being asked openly and being modified according to the respective interview dynamic (ibid.). All questionnaires were also translated into Spanish.

During the research stay, fourteen interviews in Chile were conducted in total. These included one representative of a lithium producing company and one prior lithium producer, three representatives of different NGOs, four University professors, three representatives of different Chilean state companies and one lithium economics analysist. Thereby, one of the interviewed University professors is currently also working for the Chilean government, another was a former politician and worked for a Chilean state agency and another one was a member of the National Lithium Commission in Chile. Additionally, one interview (Interview 15) was an online follow-up interview with a Price Reporting Agency (actor group 1). Ten of the interviews were conducted in English, four in Spanish. The following Table shows an excerpt of the Interviewee list, that can be found in Appendix V.

Table 1 Excerpt of the interview list

Interviews		
Number	**Interview partner**	**Location**
1	Founding partner of a business consulting firm specialised in the lithium market, based in Chile	Online
2	Employee of a European Price Reporting Agency (1)	London, UK
3	Employee of a European Price Reporting Agency (2)	London, UK
4	Employee of a spot trading platform	Online
5	Employee of a former lithium producing company	Santiago, Chile
6	Former politician and head of a state-agency; University professor	Santiago, Chile
7	Lithium Economics Analysist	Santiago, Chile
8	Economist working for a non-Governmental Organisation with a focus on sustainability,	Santiago, Chile
9	Chemical engineer and employee of a Chilean governmental organisation	Santiago, Chile
10	University Professor Chile (anthropology)	San Pedro de Atacama, Chile
11	…	…

In total, I spent about three weeks in the Chilean capital Santiago and about three weeks in a small village in the North of Chile, in San Pedro de Atacama. This village is located in the Atacama Desert, the place where lithium extraction takes place in Chile. Hence, I also had the chance to visit one of the production sites, where I could not only talk to employees but also take pictures of the lithium extraction processes (see Chapter 5.4). Furthermore, I had the opportunity to work at a research department[3] of the *Universidad Católica del Norte* in San Pedro de Atacama. This gave me access to the academic debates taking place there and helped me to observe the social realities of people living close to the lithium extraction sites.

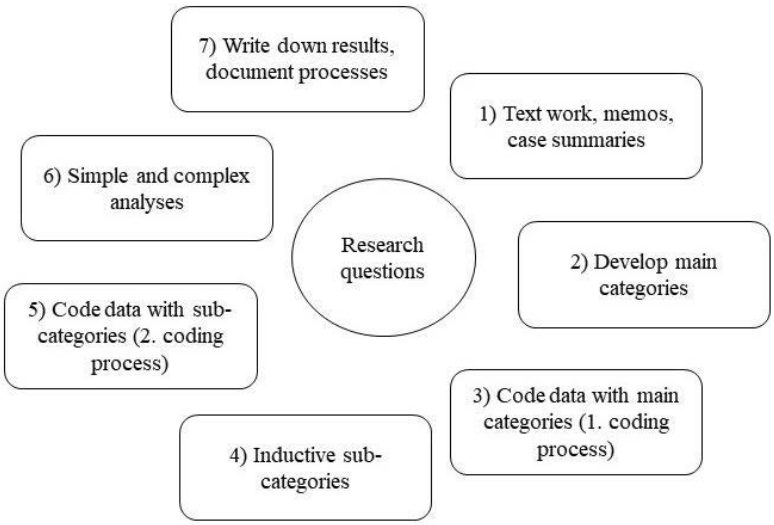
[3] Instituto de investigaciones arqueológicas y museo

3.3.2. Analysis

Out of the fourteen interviews, eleven were recorded with the consent of the interview partners. Written notes were taken in three interviews, because the interview partner did not want to be recorded. All interviews were taken anonymously and nothing the interviewees said is directly attributed to them or their company or organisation in this thesis. In the course of the field work in Chile as well as afterwards, the interviews were transcribed and then systematically analysed with assistance of the "content structuring qualitative content analysis" (inhaltlich strukturierende qualitative Inhaltsanalyse) (Kuckartz & Rädiker, 2022, pp. 129–130).

The analysis of the transcript data was based on the seven phases (see Figure 1) of content structuring qualitative content analysis identified by Kuckart and Rädiker (2022).

Figure 1 Seven phases of the content structuring qualitative content analysis



Source: Adapted by author based on Kuckartz and Rädiker (2022), p.132

Phase 1 includes the intense reading of the transcript and the highlighting of specifically important text parts. In step two several main categories were developed (ibid., pp. 132-134). Kuckartz and Rädiker (2022) thereby differentiate between various categories – in this case "content-based categories" (ibid., p. 56) were developed, which function as a "road sign, which points out a thematic area or topic in a text" (see Kuckartz & Rädiker, 2019, p. 66). For the categorization or coding – two terms that are being used synonymously throughout this thesis – I worked with the computer software program MAXQDA. A central feature of this software

is the option to work with large text volume and to code different segments creating a “hyper-structure across [different] documents” (see Kuckartz & Rädiker, 2019, p. 5).

The main categories generated in phase 2 were based on the research questions and deducted thematic blocs illustrated above. Phase 3 then contained the first coding process, in which the main categories were assigned to the respective text parts of all transcripts in MAXQDA. After the first coding process the relatively general main categories were differentiated in phase 4. Therefore, new sub-categories according to the process of inductive category-building were generated for some main categories. The term *inductive category-building* thereby (Kuckartz & Rädiker, 2022, p. 138) refers to the process of building new categories directly on the material, in this case the text transcripts (ibid., pp. 82-83). Within this phase Kuckart and Rädiker (2022) recommend listing all categories and codes text passages before creating new sub-categories and systemizing them according to their main categories. The second coding process (phase 5) then consists of assigning the sub-categories to the text passages that have been coded with the main categories. This process requires going through the transcripts again. It is quite common in a research project to not build sub-categories for all main categories and modify sub-categories while reading the transcripts again (ibid., p. 142). The following table (Table 2) shows the main categories - including their sub-categories used for the analysis of the qualitative interviews conducted in Chile.

Table 2 Main categories & sub-categories built in the course of interview analysis

Main categories	**Sub-categories**
Contracts and pricing	• Price formula
Lithium prices	• Environmental and social costs • Price volatility • Transfer prices
Lithium GPN	• Downstream processes • China • Bolivia and Argentina • Brine vs. hard rock • Carbonate and hydroxide • Supply and demand
Chilean politics and broader regulations	• Illegal financing of politics • Privatisation process • New constitution
Salars in Chile	
National policies in the lithium sector in Chile	• Royalties and taxes • Lithium as strategic mineral • Contracts with Corfo • CEOLs • National Lithium Company
Different interests in the lithium sector	• Water • Contracts between producers and indigenous communities • extractivism
Trends, drivers and challenges	• new technologies • Chile: trends, driver and challenges • Battery types • financialisation
LME and PRAs	
Other remarks	

Source: Author

According to Kuckartz and Rädiker (2022, p. 150), one possibility for analysing the data in phase 6 is to use the assistance of a tabular case summary. In particular I analysed the data according to a "cases x categories matrix" (see ibid., p. 145). The cases thereby represent the interviews, and the categories represent the main- and subcategories. This table helped not only to easily analyse the different categories, but also to draw comparisons between the different interviews. MAXQDA thereby contributes to an easy and digitalised illustration of this matrix. Within this software one can choose which categories and which cases he or she* wants to look at. Figure 2 shows an example of a "case x categories" matrix, with the sub-category "supply and demand" and two different interviews. The interviewee names are anonymised with "Interview X". Phase 7 then involves writing down the most important findings.

Figure 2 Excerpt of a "case x categories" matrix

	26.04.2022 Interview X	06.05.2022 Interview X
supply and demand	It is a boom right now. And we are we are we have the luck to be in this market And that kind of market is pushing by time. Yes, that is the current situation. We know that you are pushing for producing more, EVs, but unfortunately, China is pushing a lot and they're very fast. only one or two years ago battery makers and EV firms started to approach SQM because they wanted to buy the raw material directly from them. They needed the raw material to ensure lithium supply.	I think the case of lithium is a lot of supply and demand. In terms of demand, there has been of course in the last six or five years a huge increase in electromobility and all the batteries and all the different things that need lithium to work. I don't have the numbers of how this demand has increased in the last years, but maybe you have it and if you see it...you know in the last six or five years, the demand has increased a lot. But the supply hasn't increased on the same level. because where are the places you can produce lithium? You have Australia, Chile, Argentina, Bolivia, which is not producing nothing but could, and China

Source: retrieved from MAXQDA

3.4. Limitations and reflections

There are several limitations to the research design I used for this thesis. The main limitations concern my research stay in Chile but there are also limitations regarding the use of trade and price data as well as the actor and sector mapping. In terms of data quality, it needs to be highlighted that the trade data used for this thesis only focuses on the export of four countries and the data of lithium hydroxide exports also takes oxide into account, a product that will not play a key role during this thesis. In terms of price data, the lack of transparency needs to be considered. All three price data sources lack transparency since there is no information on the exact origin and composition of different data points. Moreover, the data retrieved from the LME and the company BMI in particular needs to be considered as socially embedded and representing certain interests. Regarding the actor and sector mapping, one important limitation is the lacking literature and rapidly moving developments in both the world economy of lithium production and the political economy of Chile. Often, newspaper articles and blog posts therefore supported the actor and sector mapping, because no scientific literature was yet available.

My research stay in Chile took place in April and May 2022 and thus still during the Covid 19 pandemic. Even though the number of people infected with Covid 19 was not that high anymore, the regulations had only been lifted one week before I arrived, and many people still worked from home. Therefore, I also had to conduct some online interviews, which could have possibly influenced the insights and findings. Another major challenge during my research stay was the limited access to the lithium producer firms in Chile – I only got access to one of the two lithium producing companies. Furthermore, I was in Chile during a special time, namely the rewriting of the new constitution. This also greatly influenced the atmosphere and the

conversations I had. Moreover, organising interviews in Santiago, the capital, was rather easy. Most of the governmental organisations and private companies as well as large NGOs have their headquarters there and contacting them via e-mail and meeting them in their office spaces was uncomplicated. It was more complicated to contact smaller NGOs and communities affected by the lithium extraction in the Atacama Desert in the North of Chile, and this is also where I specifically have to reflect on my own position (Dannecker & Vossemer, 2014, p. 155).

In her text "Under Western Eyes: Feminist Scholarship and Colonial Discourses" (1984), Chandra Mohanty illustrates that science and research are always political. She criticises several western feminist texts and among other factors, their illustration of the "Third World Women" (Mohanty, 1984, p. 333) as one homogenous group regardless of class, religion and race (ibid., pp.336-337). This is part of a western cultural imperialism which enforces a hegemony of western ideas and the system of knowledge production (ibid., pp. 352-353). Reflecting this is an important part of field work. With me being a student at the University of Vienna I am also part of a western knowledge production system. Before my field work for example, I have mainly read literature about Chile and the lithium sector in English written by researchers from the Global North. It is therefore important to realize the "ideological doctrine of scientific method(s)" (see Haraway, 2020, p. 577) and that the perspective of the researchers can never be considered neutral but is always embedded in power relations and social localization (ibid.).

This also includes the reflection of me not being directly affected by lithium extraction in a country that is embedded in post-colonial and extractive structures, with a dictatorship that only ended about thirty years ago. Only through my interview partners did I get access to the local but also the global level of the lithium production network and for instance the debates at the LME or between PRAs. I have never experienced the direct consequences of the lithium extraction in Chile and the socio-ecological problems that come with it, neither have I been part of the contestation around price determination in London. Therefore, a constant reflection on my position as a white European woman having a research scholarship conducting research in a country of the Global South, has been part of the preparation, realization, and analysis of the field work.

Furthermore, before field work, I didn't speak any Spanish, which is why I intensively practised the language prior to the trip and reached a good level of the language during my field work. Speaking the relevant language is not only important for the direct research interest but also for the social competency, the access to interview partners and their perception of you as a researcher (Englert & Dannecker, 2014, p. 237).

Another major factor that required reflection during the entire interview analysis process was the fact that all interviewees were male. Gender needs to be considered as a structural category in field work and influences the realization and results of the research as it comes with certain power structures (Englert & Dannecker, 2014, p. 246). Ultimately, the short timespan I had for research, has possibly limited the depth of my outcomes.

4 Sector background: the strategic mineral lithium

This chapter discusses the sector background by providing an analysis of the lithium GPN and the process with which it determines prices. Firstly, lithium's definition as a strategic mineral will be explored before mapping its main export and import countries with the help of trade data and its input-output structure which forms part of the underlying instruments of chain and network approaches. What follows is an illustration of the main actors in the lithium GPN. With these insights, lithium extraction in South America as well as lithium market trends by means of price data will be discussed. The section on lithium price determination identifies the general price determination in metal and mineral markets before taking a closer look at the London Metal Exchange (LME) and Price Reporting Agencies (PRAs). This section ends with the illustration of a lithium price chain.

4.1. The lithium global production network

4.1.1. Lithium as strategic mineral

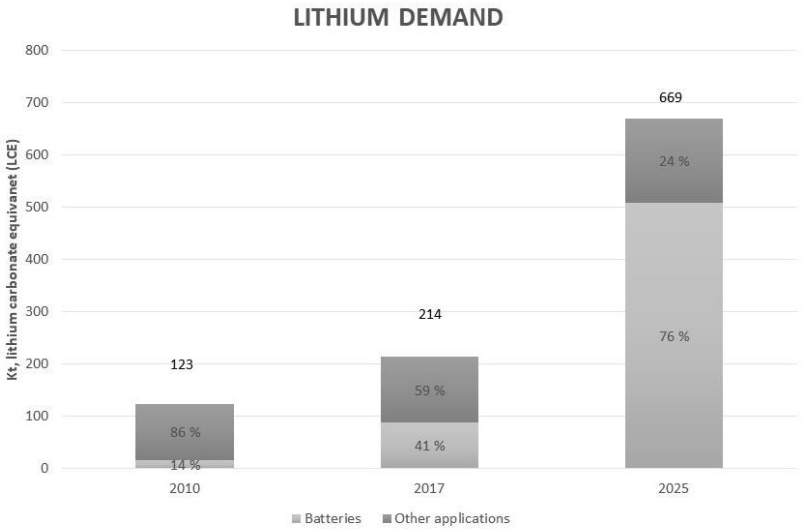
Transport-related greenhouse gas (GHG) emissions have been increasing dramatically in the last decades. Since 1970 these CO_2 emissions have risen by 250% globally and in 2010, the transport sector accounted for 23% of all energy-related GHG emissions (Mattioli et al., 2020, p. 1). Due to the implications of global warming and the issue of decreasing air quality linked to vehicles powered by dwindling fossil fuels, growing popularity can be seen in the use of electric vehicles (EVs) (Egbue & Long, 2012, p. 52). EVs were invented in 1834 and in the 1930s the electric car was the most popular car in the United States of America (USA). However, EVs have always been subject to different boom-and-bust cycles and have only experienced a revival in the last decades (Narins, 2017, p. 323). This revival and the broadening of the global EV industry was influenced not only by environmental factors, but also underlying social, economic, and technological elements. Today, car manufacturers and consumers consider the electric car not only as an ecologically friendly, but also as an "aesthetically appealing alternative mode of transport" (see ibid.) to petroleum dependent cars. The rising oil prices and concerns about the decreasing availability of fossil fuels as well as technological advances further contributed to a growing EV sector (Egbue & Long, 2012, p. 52).

EVs thereby include hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs), with BEVs being considered the most popular kind of EVs (IEA, 2021, p. 17). Several battery types have great potential for its use in EVs, but forecasts assume lithium-ion (Li-ion) batteries to be the most prevalent battery technology in

the future (LaRocca, 2020, p. 2). As the name indicates, the main component in lithium-ion-batteries besides cobalt is lithium (ibid., p. 4).

Lithium is a silver-white metal that mainly occurs as a mineral compounded in hard rocks, salt brines or in seawater (Sterba et al., 2019, p. 416). Due to the growing EV sector and increasing demand for Li-ion batteries, a sharp rise in the lithium demand can be seen (see Figure 3).

Figure 3 Evolution of lithium demand spit by battery sector and other applications



Source: Author, based on Azevedo et al. (2018: p. 8)

Global demand in lithium is expected to increase to 669 kilotons (kt) of lithium carbonate equivalent (LCE)[4] in 2025 compared to 214 kt of LCE in 2017. Even though lithium is also used in a much wider array of industries (e.g. the glass industry, pharmaceutical products, ceramic sector) than only as a component in batteries, the increasing production of EVs is considered to be the major driver of the increasing lithium demand (Martin et al., 2017, p. 171). The value of lithium can be derived from the metal's electrochemical potential (Egbue & Long, 2012, p. 52), because it allows Li-ion batteries to be "lighter and more energy dense than alternative battery metals" (see LaRocca, 2020, p. 4). Hence, lithium can be viewed as being strategically important in the transformation of the transport sector and the growing popularity of EVs (LaRocca, 2020, p. 1). Currently there are no materials with comparable characteristics

[4] LCE is the standard terminology used in the lithium industry and is equivalent to lithium carbonate (Li_2CO_3). LCE is 5,323 x Lithium (Li) (European Metals Holdings Limited, 2015; Perotti & Coviello, 2015, p. 21).

that could substitute lithium, which leads to supply concerns and price volatility (LaRocca, 2020, p. 5; Martin et al., 2017, p. 171).

There are further influences that impact the rapid growth of the EV sector and the demand for lithium, including battery costs, available EV infrastructure, the choices of car manufacturers and consumer preferences (Azevedo et al., 2018, p. 3). Furthermore, governments have been playing a major role in paving the way to EVs by applying incentives and regulatory targets. China for instance, have introduced subsidies for electric cars that have a range of 300 km and 400 km (ibid., p. 4) while the European Union (EU) and its Green Deal plan to raise the number of electric vehicles from 975.000 in 2019 to 13 million in 2025 (European Commission, 2019). To achieve this goal the EU will need 18-times more lithium by 2030 and 60-times more lithium until 2050. In addition, the EU has classified lithium as a critical raw material in 2020. Critical raw materials are metals, minerals and other natural materials that are of economic importance and thus essential for the integrity of industrial ecosystems. At the same time, they have a high supply risk. This aspect of lithium concerns the governance of supplier countries as well as environmental aspects, possibility of substitution, and trade restrictions (European Commission, 2020, pp. 1–5). This means that lithium is not only strategically important for the change to EVs, but its supply and consumption also contain a certain level of criticality (ibid., p. 2).

Furthermore, the fact that no country has a monopoly over lithium resources and the geopolitical competition between nation-states to create a mass-market for electric cars has caused a "battery war" (see Narins, 2017, p. 322). Even though lithium trade is not a "big business" (see The Economist, 2016, p. 69) per se, as its sales only amount to around $1 billion a year[5] (state: 2016), it is a vital component for the EV sector. This makes lithium an extremely lucrative commodity, that is used "as a weapon in global politics" (see Barandiarán, 2019, p. 386). The Economist (2016) therefore claimed lithium to be the "world's hottest commodity" (see The Economist, 2016, p. 69) and lithium's unknown future has led to optimism among stakeholders and investors who have been calling lithium "the new oil or white gold" (see Barandiarán, 2019, p. 381).

In contrast to other natural resources, the risks and uncertain future in lithium supply cannot be derived from the resource's scarcity. Current lithium production could still be tripled and we

[5] In comparison: the world trade of copper had a value of $ 14.4 billion in 2020 (OEC, 2020).

would have 135 years supply available by only using the reserves[6] known today (Narins, 2017, p. 321). The criticality and uncertainty of lithium's supply can instead be viewed in terms of certain ideas and stories about a "green" transformation (Narins, 2017, p. 322). According to Narins (2017, p. 322), the central idea of lithium's materiality is built around its perceived usefulness in a socio-ecological transformation. This social and temporal utility together with many – albeit very concentrated – reserves are central to recent criticality. Lithium has been viewed as a key factor to enable the growth of the EV market and critical in addressing the climate crisis. Hence, lithium criticality and highly volatile prices origin from not only high demand and a supply squeeze but also its social value in transforming the global transport sector. Therewith, it is embedded in hegemonic ideas about how to handle the climate crisis.

The lithium market can be described as oligopolistic: currently only eight countries are producing lithium from which Chile, Australia and China were responsible for 85 percent of global supply in 2017 (Azevedo et al., 2018, p. 9). Thereby, five companies, namely, Jiangxi Gangfeng Lithium, Society for Chemistry and Mining (SQM), Albemarle, Tianqi Lithium and Mineral Resources Limited control most of the extraction (state February 2022) (Murray, 2021). The amount of market power these producers thereby have, leads to increasing barriers for smaller producers wanting to enter the market. However, the limited diversity of suppliers also means an increasing risk of supply disruption (Egbue & Long, 2012, p. 59).

One major market entrance barrier for further producers in Chile - one of the most important countries for lithium carbonate exports (LaRocca, 2020, p. 8) - is a law from the 1980s, when lithium was declared a strategic mineral for nuclear power. As a consequence, lithium could – and still can – only be exploited directly by the state or by means of exploration commissions granted by the state (Perotti & Coviello, 2015, p. 35). This example shows that there exist different meanings and definitions of the term "strategical" when analysing the lithium market, that influence the lithium global production network.

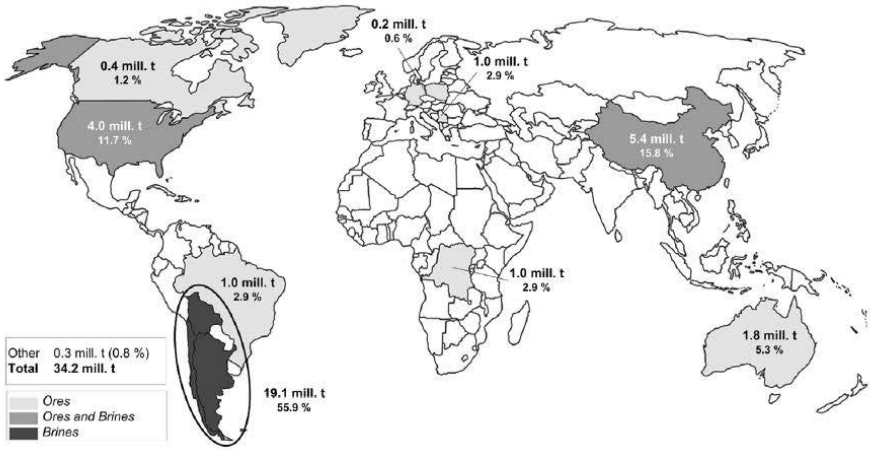
4.1.2. Main export and import countries

Lithium can either be produced from lithium-rich concentrate from brine deposits or lithium ores from hard rock mines. The most important brine deposit is located in the Atacama Desert in the North of Chile (Martin et al., 2017, p. 172). The most important lithium hard rock minerals from ore deposits appear in granitic pegmatites (Azevedo et al., 2018, p. 10). These

[6] Reserves are commodities that "[…] could be economically extracted or produced at the time of determination" (see U.S. Geological Survey, 1980, p. 1), while resources can be seen as being part of reserves that can be extracted using the current market price and existing technology (Egbue & Long, 2012, p. 52).

contain, among others, the most prevalent mineral spodumene and the largest ore deposits are situated in the Greenbushes mines in Australia (Martin et al., 2017, p. 172). The most commonly traded products from these sources are lithium carbonate sourced from brines and lithium hydroxide sourced from hard rock mines (Azevedo et al., 2018, p. 10). Which product EV manufacturers decide to use to procedure batteries depends on several variables, such as lithium availability and quantity, prices, political stability of the producer country, chemical purity and current battery technologies (Narins, 2017, p. 322). Figure 3 shows the global geographical distribution of lithium resources.

Figure 4 Global lithium resources (state 2017)



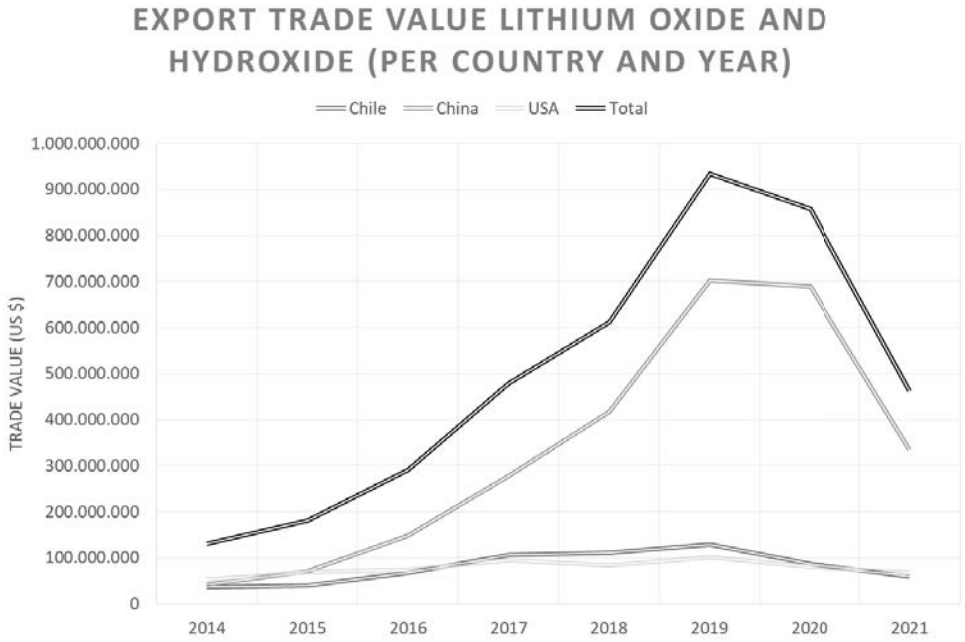
Source: Martin et al. (2017, p. 172)

The largest quantity of lithium resources can be found in South America, in Chile, Bolivia and Argentina. A crucial component within the global lithium production network involves a complex trading system that implies trading unprocessed and processed lithium minerals. Thereby the "biggest bilateral trade pattern" (see LaRocca, 2020, p. 7), involves unprocessed lithium from Australia to China, where the raw material is further refined to carbonate or hydroxide and finally used in Li-ion batteries (ibid.). Australia's exports from unprocessed lithium to China has steadily increased each year since 2014, with a value of an approximate value of between 134 million US dollars to 1 billion US dollars in 2018 (LaRocca, 2020, p. 10).

Besides unprocessed lithium, the trade of processed lithium has also been rising steadily since 2014 (LaRocca, 2020, p. 13). Since production of processed lithium products from Chile, Argentina, USA and China accounted for the majority of global worldwide production in 2020

(U.S. Geological Survey, 2021, p. 99), the export data of these four countries will be shortly described in the following. Therefore, the years 2014-2021 will be considered.

Figure 5 Exports of lithium oxide and hydroxide (2014-2021)

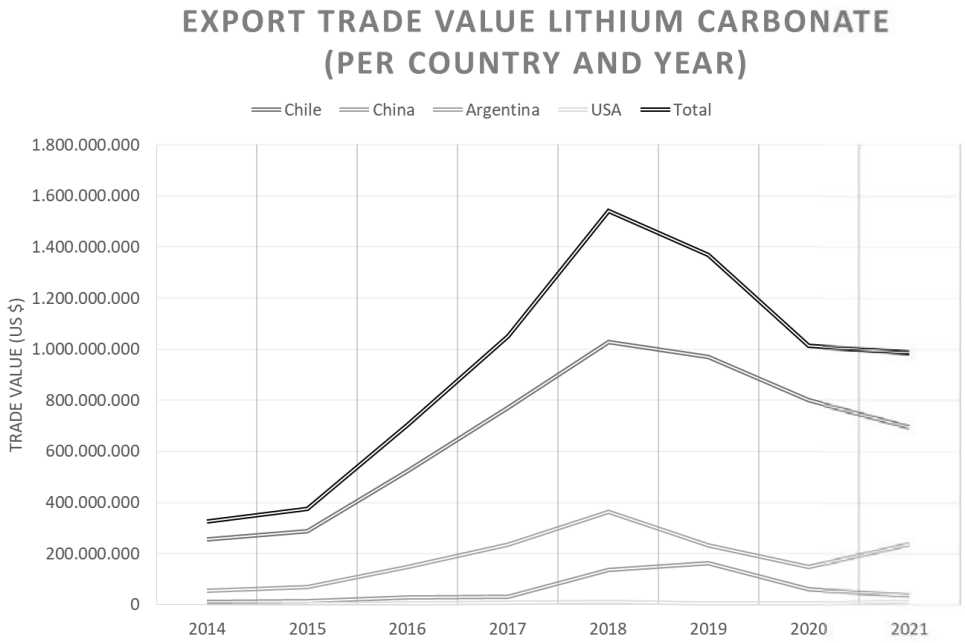


Source: Author, based on data retrieved from UN Comtrade, accessed 27.09.2022 (UN Comtrade, 2022)

For lithium hydroxide and oxide as well as lithium carbonate, a decrease in traded value can be observed from mid-2019 onwards. According to the U.S. Geological Survey (2021), his was firstly a consequence of lithium production exceeding demand in 2019, which resulted in decreasing prices, and secondly the response to the economic impact of Covid 19 and related disruptions of trade. The largest exporter during the entire period (2014-2021) for lithium oxide and hydroxide was China, with steadily increasing trade values prior to 2019. China has continuously exported primarily to Japan, and the Republic of Korea. Chile, as the second largest exporter for lithium oxide and hydroxide, has predominantly exported to the USA, Japan, India and the Republic of Korea. In contrast to Chile and China, the USA has been exporting predominantly to Japan, Argentina, Canada, Australia, and The Republic of Korea (UN Comtrade, 2022).

Figure 6[7] shows the export data for lithium carbonate from the year 2014 to 2021. Chile has been the largest exporting country since 2014, exporting continuously to the Republic of Korea, Japan and China.

Figure 6 Exports of lithium carbonate (2014-2021)



Source: Author, based on data retrieved from UN Comtrade, accessed 27.09.2022 (UN Comtrade, 2022)

The second largest exporting country of lithium carbonate has been Argentina since 2014 with exports to China, USA, Japan and the Republic of Korea throughout the years. China's exports of lithium carbonate are much smaller than those of lithium hydroxide and oxide, and their main export countries for carbonate are the Republic of Korea, Japan and the USA.

Currently, the trade volume for lithium products in general is increasing again and the U.S. Geological Survey (USGS) observes a growing demand for lithium carbonate as well as hydroxide that will result in rising trade value as well as higher lithium prices (U.S. Geological Survey, 2022, pp. 100–101). With the majority of downstream activities taking place in China today (processing of Li-ion components), the most significant amount of value is captured there

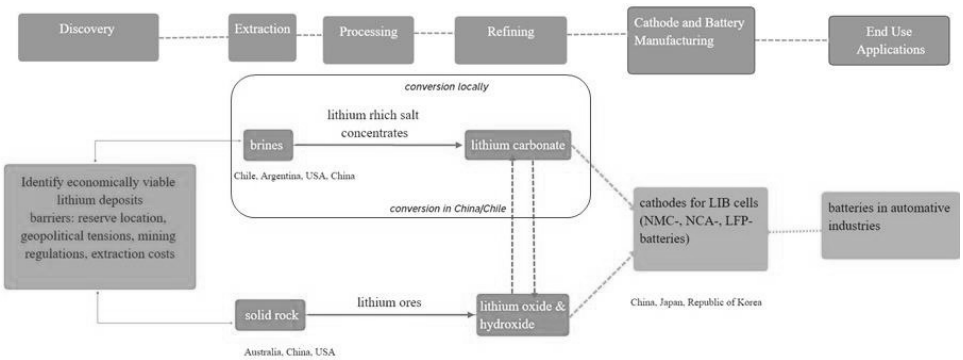
[7] The value of lithium carbonate exports by the USA (2014-2021) are much lower than of the other countries, which can be observed in Figure 5. Detailed information and an illustration of a zoomed graph can be found in Appendix III.

(LaRocca, 2020, p. 23). The dependencies and limited diversity this market and trade structure (re-)produces, combined with the materiality of lithium, poses a risk to the stability of lithium supply (Egbue & Long, 2012, p. 59). Since production costs vary greatly depending on the lithium concentration and other external factors such as infrastructure, the main challenge for producers is to achieve and in particular to maintain profitable lithium extraction. The choice to extract lithium thereby highly depends on the commodity prices and future price development (LaRocca, 2020, p. 6).

4.1.3. Input-output-structure

Against the background of possible undersupply scenarios, price volatility and criticality within the lithium global production network, modelling the global supply chain allows us to assess the different steps from lithium extraction to its consumption (Calisaya-Azpilcueta et al., 2020, p. 2). Furthermore, it helps to explain the different interests of actors within the network (Narins, 2017, p. 325). Analysing the input-output structure, which describes the process from extracting the raw material to transforming it into a final product, is one of three dimensions identified by Gereffi (1994) – discussed in the chapter on theoretical approaches – that helps to assess a GVC (Bair, 2005, p. 9). Figure 7 represents the general input-output structure of the lithium GPN from extraction to consumption and includes main export and import countries identified in the previous section.

Figure 7 Input-Output structure of the lithium production network



Source: Author. Based on Arvidsson (2022, p. 1107); Azevedo et al. (2018); Calisaya-Azpilcueta et al. (2020); Egbue & Long (2012); LaRocca (2020) and trade data from Chapter 4.1.2

There are several main stages in the input-output structure of the lithium GVC. The most upstream part includes the discovery of the mineral. Issues like economic viability, deposit location, geopolitical tensions, national mining regulations, environmental costs and extraction

costs as part of the bigger institutional framework have a significant impact on the choice of extraction. These factors create a potential risk for current producers as they contribute to variations in supply curves (Egbue & Long, 2012, p. 58).

As mentioned before, there are two main sources from which lithium can be extracted: brine deposits and solid rock deposits (Calisaya-Azpilcueta et al., 2020, p. 2). After extracting the mineral from the brine by means of solar evaporation, the lithium salts are further processed and occur in the form of lithium rich concentrates, before they are refined to lithium carbonate (Li_2CO_3), containing 19% lithium. Until this point, these processes mostly take place in the producer country (LaRocca, 2020, p. 8). From there, it can be further processed into lithium hydroxide (Calisaya-Azpilcueta et al., 2020, p. 9). In contrast, the first lithium compound of solid rock deposits, mostly extracted from open-pit mines, are lithium ores. These unprocessed lithium compounds are then processed and refined in China into lithium hydroxide (LiOH) (ibid., p. 9). Which processes concentrates or ores undergo, depend on the composition and lithium content of the starting material (ibid., p. 12). Furthermore, lithium hydroxide can be converted into lithium carbonate and vice versa, even though it is not very common to convert hydroxide to carbonate (Interview 15). These processing steps also take place mainly in China, but there is also one production site to produce lithium hydroxide from carbonate in Chile (LaRocca, 2020, pp. 15–23). Lithium hydroxide is cheaper to produce from lithium ores and lithium carbonate is cheaper to produce from brine concentrate (LaRocca, 2020, p. 13). Which material battery manufacturers choose – to produce cathodes and batteries – depends on current market trends and product prices.

Currently most used nickel-manganese-cobalt (NMC) battery technology, Nickel-cobalt-aluminium (NCA) and lithium-iron-phosphate (LFP) battery technologies are dominating the market. Their key differences lie in their composition and lithium's share in the actual battery cell material. The last step of the input-output structure of the lithium GPN is then using the cathodes and lithium-ion battery cells in the automotive industry. The largest percentage of lithium within this last step is consumed internally by China for end use applications; other large markets are the USA, Germany, South Korea, India and Vietnam (LaRocca, 2020, p. 23).

LaRocca (2020) claims that due to the differences in extracting from brines or from ores, the processing steps that follow contribute to the development of "two different GVCs" (see LaRocca, 2020, p. 23). In both GVCs, the amount of lithium produced, strongly depends on the mineral's price, which also greatly impacts entrance barriers for different actors and shapes

their market power (ibid., p. 7). Therefore, in the following, the actors within the lithium GPN are mapped broadly.

4.1.4. Main actors in the lithium global production network

As Barandiarán (2019, p. 381) states, the company Tesla can be considered as one of the key business actors driving the boom in the lithium demand. Tesla has been experiencing a great growth in its battery and EV sales in the last few years. According to Narins (2017), Tesla has "excelled at creating excitement for electric vehicles as well as setting expectations for its leading the way for the rapid expansion of the electric car market" (see Narins, 2017, p. 325). This is best shown by the company's success in its one-week launch of the Model 3. Even though no prototype was available before the launch, within just one week, 325.000 people pre-ordered the car model that was priced at US $35,000 (Barandiarán, 2019, p. 381). The Chinese company BYD is also becoming one of the biggest firms globally, due to their growth in sales of electric vehicles and batteries (Narins, 2017, p. 325). While these companies can be considered as major forces behind the increase in EV demand, "international chemical companies" (see Barandiarán, 2019, p. 385) predominantly control much of the market operations in the lithium sector both from brines and from solid rock.

In 2015 only three companies, namely Albemarle Corporation, FMC Corporation[8] and SQM controlled around 53% of global lithium production (Sterba et al., 2019, p. 417). In 2016, these three companies, together with Tianqi Lithium, covered 83% of the global lithium output (Maxwell & Mora, 2020, p. 57). The lithium market is currently controlled by five companies, namely Jiangxi Gangfeng Lithium, headquartered in China, the North American Albemarle, Chinese Tianqi Lithium, Chilean SQM and the Australian mining company Mineral Sources Limited (Murray, 2021). In the following, the activities of these five companies in the lithium GPN and their relationship with other actors will be illustrated.

Jiangxi Gangfeng Lithium is a Chinese lithium processing firm (Maxwell & Mora, 2020, p. 62) and a shareholder of several lithium producers, namely Yiliping, a Chinese brine producer, Pilbara, an Australian spodumene producer and Mount Marion another Australian mineral producer (Interview 1). They also bought a share from the Cauchari Olaroz brine in Argentina by SQM in 2018 (Maxwell & Mora, 2020, p. 62).

Albemarle is a North American chemical company active in lithium extraction, processing and refining throughout the world (LaRocca, 2020, p. 15). They have a brine production site in

[8] FMC Corporation separated their lithium business in 2018 (FMC Corporation, 2022); rebranded to Liven Corporation (Cornell, 2019).

Chile and a second in Nevada, USA. They furthermore hold a 60 percent share in Wodgina, an Australian spodumene mine (Albemarle Corporation, 2019) and own several processing plants as well as one refining plant in Chile (LaRocca, 2020, p. 15). In 2019 they combined their corporation with Mineral Resources Limited (MRL) (Albemarle Corporation, 2019).

Tianqi Lithium is a Chinese refiner and shareholder of SQM (23.77%) (Bos & Forget, 2021, p. 176) and Talison Lithium (51% together with IGO Limited) (Talison Lithium, 2021).

SQM is a Chilean publicly listed company, mainly operating in the Salar de Atacama in Chile, and also partly in Australia (LaRocca, 2020, p. 15). They concluded a joint venture with the gas concern Western Australia and together they have a mineral project in Australia that is called Mount Holland (Interview 1). They own several processing plants in Chile to convert the brine's raw material to lithium carbonate and also started to produce lithium hydroxide at the Salar de Carmen in Chile (LaRocca, 2020, p. 15). SQM is currently planning an extraction project in Argentina together with the company Lithium Americas (BNN Bloomberg, 2018).

Mineral Resources Limited holds a 40% share in Wodgina (the other 60% are held by Albemarle). They hold a share of Mount Marion, where the other shareholder is Jiangxi Gangfeng Lithium (Mineral Resources, 2022).

All of these companies are privately owned and publicly listed. The origin of ownership and structure of a firm's entity has important implications for their strategies and behaviours. Factors that influence a company's strategy are, for example, the origin and place of ownership as it shapes the way companies are embedded in the local economy, and the extent to which firms are affected by shareholder value interests. A company's position within the GPN is determined by their ability to add value through their technical capabilities to operate extraction, and tasks that exceed the pure process of extraction (such as refining). These capabilities require technological know-how, infrastructure and logistics, and influence whether or not mineral producers can operate mining, refining and processing steps at the same time and thus add local value (Morris et al., 2012, p. 411).

Besides these privately owned multinational companies, state-owned mining companies and policies by the state play a key role in mineral sectors. Usually, mineral policies are initiated to accelerate economic and social development. Revenues from mineral extraction are ideally used to support education, infrastructure, housing and other services in the producer country (Maxwell & Mora, 2020, p. 65). According to Maxwell et al. (2020) "practising good mineral policy involves appropriate combination of fiscal policy (spending and taxation), exchange rate

management, wages policy, occupational health and safety regulations and environmental protection" (see Maxwell & Mora, 2020, p. 65). The way in which governments conduct their mineral policies is influenced by the market power of main producing companies (like SQM or Albemarle), and the extent to which these firms can, for example, avoid paying taxes (Maxwell & Mora, 2020, p. 65). Another group of actors in mineral GPNs are traders and trading companies (OECD, 2016, p. 32). Due to the few processing steps and few intermediate products compared to the GPN of copper for example, merchant traders and trading companies don't play a significant role in the lithium market. Specifically the GVC from brines to lithium carbonate, where processing steps are often conducted locally directly by the extracting company, traders don't have an active role in the up- to midstream stage (Bos & Forget, 2021, p. 175; Maxwell & Mora, 2020, p. 61).

This short illustration of the main actors involved in the lithium GPN not only shows the oligopolistic character of the lithium market, but also the complexity of these companies' interrelations as they partly hold shares in the same lithium project. Even though the number of large companies involved in the lithium sector has increased from three to five within a few years, the world's lithium industry is still highly concentrated. In the lithium market, as well as most mineral sectors generally, major producers control a large share of the market and several production processes. Maxwell (2020) notes that major companies have increased their production level by extending to further activities within the lithium GPN and by operating more internationally, as shown in the description of the actors' activities above (Maxwell & Mora, 2020, pp. 60–61). Through their growing influence in the lithium market, these companies can possess high levels of market power and prices in monopolies or oligopolies are usually higher than in a competitive market (Barkley, 2019, pp. 153–154).

Barandiarán (2019) additionally states, that national policies in lithium producing countries are attracting "a new generation of lithium mining companies[…] oriented at the car market and differ from incumbent lithium producers [like], SQM, FMC and Albemarle" (see Barandiarán, 2019, p. 385). These are usually joint ventures between mining companies, electronics companies and car companies, such as Toyota and Mitsubishi (ibid.). Due to the growing lithium market in the last couple of years, new companies like Youngy, Orocobre, Sichuan Yahua Industrial, Lithium Americas Corp and Galaxy Resources have entered the market (Poveda Bonilla, 2020, p. 21). In the context of mineral pricing, further actors like commodity exchanges such as the London Metal Exchange (LME) can be considered as greatly relevant. Since the 1970s and the neoliberalisation and financialisation of commodity markets, so-called

Price Reporting Agencies (PRAs) have also become relevant actors in metals and mineral markets (Löf & Ericsson, 2019, p. 15; Seddon, 2020, p. 530). These developments will be discussed in the chapter on lithium price formation and price setting.

Specifically South American stakeholders have been part of a great deal of contention around how to best manage the region's lithium deposits. While some argue for greater state control, proponents of free markets especially argue to entirely deregulate the sector (Barandiarán, 2019, p. 381). Therefore, South American lithium production and its development will be discussed in the following.

4.1.5. Lithium extraction in South America

South American lithium is primarily sourced from brine deposits in the lithium triangle, spanning the North of Chile, north-western Argentina, and the South of Bolivia (Kingsbury, 2022, p. 4). This area of the Andean highlands is often referred to as the "lithium triangle" (see ibid.) and contains the world's largest lithium reserves (see Figure 8).

Figure 8 Lithium producing regions in the lithium triangle between Chile, Argentina, and Bolivia.

Source: Maxwell & Mora, 2020, p. 58

South American lithium comes from salt lakes containing lithium rich concentrates and is processed directly in its origin country into either lithium carbonate or hydroxide before being shipped for further treatment. This is a major difference from other lithium producers like Australia who source solely from hard rock mines and ship the lithium compounds directly to Japan, South Korea and China for further processing (Kingsbury, 2022, p. 4). Even though

lithium deposits in the form of brines on the earth's surface or under saline expanses like salt lakes or *salars* are located worldwide, only a few are big and concentrated enough to allow for extraction. Eighty percent of today's lithium resources in brines that is potentially exploitable, can be found in the lithium triangle. In general, the technology for extracting lithium from brines works as follows: the brine is pumped to the earth's crust into various open-air ponds where it is concentrated in several processes by solar evaporation and chemical treatment. Ultimately, soda ash is added to the concentrated brine bringing about lithium carbonate that is treated further to reach the desired materiality needed for battery grade. Although the different technologies and the details of these processes differ according to region, processing facilities etc., the general steps from pumping the brine to processing it are similar (Flexer et al., 2018, pp. 1189–1190).

Lithium production in the lithium triangle started in 1984 in Chile with the *Chilean Lithium Society* (SCL) (today Albemarle) and developed further with the entrance of SQM (back then called the Society for Chemistry and Mining) in 1998. In Argentina, lithium extraction started in 1997 with FMC and Bolivia is currently only developing pilot projects (Dorn & Gundermann, 2022, p. 342). Even though Bolivia holds around a quarter of the world's lithium reserves, private companies have always failed to settle there for extraction projects, due to Bolivia's strict model of lithium as a state commodity (Bos & Forget, 2021, p. 176; Dorn & Gundermann, 2022, p. 342). Since 2008, Bolivia has been following a strategy that aims at vertically integrating lithium production, from extracting over the production of Li-ion batteries to consumption. Therefore, the state is currently exploring the lithium reserves in Uyuni, Pastos Grandes and Coipasa in order to contribute to a public strategy focusing on the sovereignty of natural resources and a greater value creation (Bos & Forget, 2021, p. 176).

Lithium in Chile and Argentina also belongs to the state, but there are certain politics that allow private companies to invest in lithium projects (Barandiarán, 2019, p. 381). From the beginning on, early cooperation between public and private actors in Chile and Argentina, favoured the emergence of private pioneer companies. This early access to lithium reserves by a few companies, based on bilateral contracts with the state, allowed private stakeholders to support a vertical integration in the lithium GPN in South America. Increasing demand for lithium given its imaginary status as the "new oil" or "white gold" (see Barandiarán, 2019, p. 381) and its role in a socio-ecological transformation however, also attracts new stakeholders and creates a competitive environment between the three South American countries. In all of the three countries the state plays a central role in the lithium production network, since it has constantly

influenced production, both directly or indirectly, through regulations, contracts, research and knowledge support (Bos & Forget, 2021, pp. 175–176). Different state-firm regulations have then further contributed to a particular configuration of the lithium GPN. These network practices of states and stakeholders as well as their relation to one another are embedded in a certain territoriality that revolves around place-based coordination, local development outcomes and regulations (ibid., p. 169). Such an approach is particularly useful when investigating lithium production in Latin America to understand "the socio-spatial circuits through which natural resources are commodified, exploited and governed" (see ibid., p.169).

Specific phenomena of extractive activities therefore need to be considered in the lithium GPN. This includes, for instance, looking at the tensions between resource-holding and resource-seeking activities of states and firms, including tax and spending policies, as well as distributional struggles between producers and consumers in general (Radhuber, 2015, p. 7). The history of Latin America's extractivism and growing (inter)dependencies in South American countries rich in natural resources need particular consideration, as they lead to an unequal distribution of value costs, risks for different actors and various conflicts (Radhuber, 2015, p. 2). So far, 683 conflicts due to resource extraction were officially reported in South America by the Environmental Justice Atlas (status August 2022) (Environmental Justice Atlas, 2022). According to Radhuber (2021, p. 247), it is specifically in production networks for green technologies that social and ecological inequalities arise in the course of commodifying nature.

4.1.6. Lithium market trends

As stated before, the lithium market is highly concentrated in terms of geographical areas and actors involved and can thus be described as oligopolistic. However, an increasing degree of diversification could be seen in the last years due to the growing demand and increasing prices which leads to investment opportunities in new projects (Poveda Bonilla, 2020, p. 20). Lithium production globally increased by 21% in 2021 to around 100.0000 tons compared to 82.500 tons in 2020 while global consumption increased by 33% (U.S. Geological Survey, 2022, p. 100).

A current trend for lithium carbonate due to the increased demand in LFP batteries can be observed and is expected to continue (Interview 15). While five years ago mainly high-nickel concentrate batteries (specifically NMC 333) that predominantly need lithium hydroxide were demanded, today a trend of using LFP batteries can be seen. One reason for that, is that the chemistry of the NMC 333 contains a large amount of cobalt. Thereby, the Democratic Republic of Congo (DRC) is responsible for about 70% of global cobalt supply. Cobalt mining in the

DRC, however, has recently been associated with health, social and environmental risks. Therefore, there is currently a strive towards reducing the cobalt content in NMC batteries and a greater demand in LFP batteries (Arvidsson, 2022, p. 1107). The latter is reflected in an increasing demand in lithium carbonate needed specifically for LFP batteries and rapidly increasing carbonate prices.

Given the current supply squeeze due to rapidly increasing demand, cathode and battery producers usually prefer long-term contracts with lithium producers to secure their supply. Poveda Bonilla (2020, p. 24) thereby observed the average price of lithium carbonate used in long-term contracts to have increased 222% between 1999 and 2008 which accounts for an annual price increase of 13.8%. While lithium carbonate prices in contracts were still between 2.000 and 2.500 US Dollars/ton between 1999 and 2004, they increased to over 6.000 US Dollars/ton in 2006. From 2015 onwards, with the exploding demand for electro-mobility, the prices were constantly increasing, reaching about 13.700 US Dollars/ton in 2017 (ibid., p. 24). Meanwhile the spot prices, especially in China, were often a lot higher than lithium contract prices (Azevedo et al., 2018, p. 10). In November 2021, Benchmark Mineral Intelligence (BMI) reported an average lithium carbonate (CIF[9] Asia) price of 19.500 US Dollars/ton while spot lithium carbonate prices (CIF Asia) were at 26.200 US Dollars/ton (Benchmark Mineral Intelligence, 2022a; U.S. Geological Survey, 2022, p. 100). There is a distinct difference between the spot market and spot prices and the contract market and contract prices. A spot price on the one hand, can be defined as the price that is set in individual transactions for immediate delivery. On the other hand, the contract price refers to the price set in contracts together with premiums, discounts and further negotiations (Jorratt, 2022, p. 24). However, since there is not a functioning futures market for lithium (Comisión Nacional del Litio, 2013, p. 14; Poveda Bonilla, 2020, p. 24), the line between spot price and contract price can be blurry.

Besides lithium's price as well as the price of its co-products like potassium, the supply of lithium is influenced by input costs, the technological change, possible disruptions of the supply chain, governmental activities and the overall market structure (Maxwell, 2014, p. 101). All these factors are mutually dependent and one great problem when analysing the lithium market trends, is that the prices are not publicly available since there is not one frequently traded futures

[9] CIF stands for "cost, insurance, freight". In CIF the seller of the commodity is responsible for delivering the product to the nearest port and for loading and shipping it as well as paying the freight that needs be paid for the good to reach the port chosen by the buyer. It is contrary to FOB, which stands for "free on board", where the buyer is responsible for paying freight and transporting the good from the port the product was delivered to by the seller (Mansa, 2021)

price at an exchange, which will be analysed in the next chapter. Before shedding light on the lithium price determination, a general trend of the lithium prices will be pictured in the following. Figure 9 plots the prices that were being provided by a) Benchmark Mineral Intelligence (BMI) directly for this thesis and data that was retrieved from b) the LME and c) the Chilean Customs Service *Chile Adunas.*

Figure 9 Lithium price trend 2017-2022.

Source: Author, data retrieved a) from (Benchmark Mineral Intelligence, 2022a) b) the LME (London Metal Exchange, 2022b) and c) Chile Aduanas Customs, 2022 (see Appendix II).

The Chilean export prices have been calculated from the export values as weights of lithium[10]. Even though the three prices are hard to compare since they picture different lithium products, all three lines show that prices have reached enormously high levels in 2022. While the BMI carbonate prices were still at 21.000 US Dollars/ton by the end of 2021, (and the LME price at 31.480 US Dollars/ton and the Chilean export prices at 8.348 US Dollars/ton), they more than doubled by August 2022 to 50.500 US Dollars/ton BMI price (75.640 US Dollars/ton LME

[10] The lithium export prices from Chile must be treated with caution since it is not defined which lithium product is included in the data and export prices usually lack in transparency (Bacchetta et al., 2012, p. 37; Carrère & Grigoriou, 2014, p. 1). As the graph shows, export prices are well below the other two prices. This will be discussed later.

price, 45.256 US Dollars/ton Chilean export price). Benchmark Mineral Intelligence considers the lithium prices as an outcome of high demand and the supply squeeze, both of which being circumstances that will not change in the near future (e-mail contact with a European Price Reporting Agency (1). This illustration shows not only the great volatility of lithium prices and its trend of rising constantly but also pictures the issue of a missing uniformed price, which is why these prices in Figure 9 also need to be treated with caution. Hence, the next sub-chapter provides an analysis of the background of lithium price determination and aims to provide a base to further investigate price setting processes in the lithium production network in Chile.

4.2. Lithium price determination

4.2.1. Price determination in metal and mineral markets

International trade of minerals and commodities in general has intensified greatly since the beginning of this century. Production capacity could simply not cope with the rapid increase of demand anymore due to economic advances in countries of the Global North and China, who's economy has been undergoing an enormous commodity-intensive stage of economic development. As a result, most commodity prices in all categories, including the metals and mineral sector increased dramatically (Radetzki & Wårell, 2020, pp. 1–2). It is therefore crucial to investigate the general price determination mechanisms in the mineral sector before being able to apply the analysis to the lithium sector and specifically lithium extraction in Chile. As stated before, throughout this thesis the terms price determination and price setting are used. *Price determination* means the processes and institutions that determine prices before these prices are being used in bilateral contracts between buyers and sellers (*price setting*) (Wojewska et al., unpublished draft).

Most minerals are traded globally under bilateral contracts. This process involves two "agents" (see Radetzki & Wårell, 2020, p. 105) and specific terms they agree on to carry out the trade. These terms not only include the price but also commodity specifications, like metal grade specification, quantity and place and time of delivery. However, bilateral contracts greatly differ in mineral trade and can be based on short-term or long-term transactions. Contracts range from including only one transaction over repeated deliveries stretching over a couple of months to twenty or more years (Greenberg & Rozycka, 2021, p. 2; Radetzki & Wårell, 2020, p. 108). This is also the case for mines, that aim to find a balance between short and long-term offtake

agreements[11] (Greenberg & Rozycka, 2021, pp. 2–3). In general, longer-term contracts[12] create a higher value both for the mine and the buyer because the longer the contract the more secure both the income and the supply. Short-term contracts on the other hand can be advantageous for the producer in terms of attracting new investors and profiting from sudden price increases. Due to intense price fluctuations, the influence of Chinese firms, and further market conditions, a shift from long-term towards shorter term contracts in the mining sector can be seen in commodity markets. With longer-term contracts it is often more difficult to foresee how pricing develops, and buyers and sellers are often more flexible in price adaptation with shorter-term contracts (ibid., p. 3).

Term contracts often base their prices on prices published on public commodity exchanges or published by independent index price providers (Johnson, 2018, p. 53; Löf & Ericsson, 2019, p. 19). Examples of exchanges include the London Metal Exchange (LME) or COMEX in New York (Greenberg & Rozycka, 2021, p. 3). The LME is the world's largest centre for trading non-precious metals like copper, nickel, aluminium, and tin. The original purpose of the LME and exchanges in general was to facilitate physical trade on a non-profit basis (Seddon, 2020, p. 526). There, price determination (via settlement prices of futures contracts) that provides benchmarks to be used as a global reference in term contracts and on the spot market, as well as risk management via hedging takes place (Radetzki, 2013, pp. 268–269). However, exchanges are often solely interested in listing commodities that are liquid, meaning that they trade frequently (Johnson, 2018, p. 3). Price determination for illiquid, not frequently traded commodities, or commodity markets with a small number of buyers and sellers is more "tricky" as Radetzki and Wårell (2020: p.110) put it.

As mentioned before, both agents must agree on the price that will be referenced in their contract. Because it is often too time-consuming and expensive for commercial users such as producers, refiners and buyers of the respective metal or mineral to establish contract prices on a case-by-case basis, they refer to prices published by specific index providers when no public prices on exchanges are available (Radetzki & Wårell, 2020, p. 108). In this context, popular index providers are so-called Price Reporting Agencies (PRAs). They assess and publish commodity prices, such as metals and minerals prices and allow access to their prices against a certain fee. They can therefore be seen as important actors in the global physical commodity

[11] An offtake agreement can be defined as a contract between the supplier and buyer of a natural resource to sell and buy the product of a future production from the respective project (Segal, 2021).
[12] The length of contract depend on the commodity market; Löf and Ericsson define a long-term contract as being longer than one year (Löf & Ericsson, 2019, p. 18)

market infrastructure, as well as in the financial sphere, as they are also involved in consultancy and related businesses (Johnson, 2018, p. 23).

There are other ways in the minerals and metals markets to structure bilateral deals. For manganese, for example, it is a commercial practice that the major supplier enters into negotiations with a major buyer, while the rest of the industry then base their contract and price negotiations on these prior discussions as a guideline (Radetzki & Wårell, 2020, p. 108). Similar practices have also been applied in the arrangement between Sweden as exporter for most of the iron used in German steel mills. Sweden and Germany have set the base for further price discussions in this case, until China started to have a bigger market share in iron since 2000, and therefore wanted to contribute more to price negotiations as well. Today iron is mostly traded on a short-term basis using spot prices, mainly because supply could no longer keep up with the greatly increasing Chinese demand (ibid., p. 109). Furthermore, up until the 1980s, the US copper sector used prices in their contracts set by producer cartels. There are different kinds of producer cartels but in general, the issue of producer cartels is for producers to control production and price through for instance agreements on production limits or on the distribution of wealth (Mares, 2022, p. 4). These prices are usually more stable than LME prices as it was the case in the copper cartels. However, when the copper sector expanded in the 1980s, the position of producers and producer cartels in the USA was weakened, and prices started to be predominately based on the LME (Mikesell, 2017, pp. 49–51).

4.2.2. The London Metal Exchange

The London Metal Exchange (LME) is the world's most important commodity market for trading non-ferrous base metals like aluminium, copper, nickel and zinc (Park & Lim, 2018, p. 1; Seddon, 2020, p. 526). The LME was founded in 1877, which makes it the oldest exchange worldwide. For most of the minerals and metals quoted in contracts between buyers and sellers, the LME prices serve as a basis or a benchmark. A *benchmark* in this context can be defined as a reference price that is used and accepted throughout the respective industry (Wojewska et al., unpublished draft). Besides price determination, commodity exchanges like the LME offer price risk management like hedging opportunities, the possibility to invest in commodities, as well as physical trade (Löf & Ericsson, 2019, p. 15). Its services are therefore used by producers and users of commodities pursuing physical spot transactions or using the LME's metal price as a basis for their trade deals. Exchanges like the LME are also used for so-called "paper deals" (see Radetzki, 2013, p. 268) in futures and options (ibid.). These are financial instruments that have evolved alongside physical trade to manage price risks on a listed exchange like the LME. Löf and Ericsson (2019) define the term futures as follows: "a futures contract is a security

whose owner undertakes to sell goods of a specific quantity and quality at a later date to a customer who in turn undertakes to pay for the good at a price fixed in advance" (see Löf & Ericsson, 2019, p. 18). Hence, different actors like mining or trading companies can lock in prices by employing futures to hedge against the risk of sudden price increases or decreases (ibid., p. 17). Löf and Ericsson (2019) understand option to be "the right to purchase a commodity an agreed price on a given date. The owner of the option decides […] whether to exercise the option or not" (see ibid., p. 18).

Today, futures and options are mostly settled financially rather than physically – hence, most of the price formation on exchanges today takes place on the basis of trading financial instruments and not physical commodities (ibid., p. 17). Additionally to physical transactions conducted by mineral and metal producers, refiners and traders, today actors of the financial sphere like speculators and financial investors form the main actor group on commodity exchanges. Speculators for example use futures not to hedge against price risks but to be exposed to price volatility, speculating to profit from sudden price increases (Seddon, 2020, pp. 541–542). These market-structural changes can be associated with what researchers call the "financialisation" of commodity markets (Adams & Glück, 2015; Newman, 2009; K. Tang & Xiong, 2012).

In the case of the LME, Seddon (2020), explains this transformation with several changes at the political and the institutional level that weakened the LME's physical-trade oriented structure. In 2017 only thirty percent of the contracts at the LME were physical contracts (the rest were settled financially), compared to eighty percent of physical contracts in the 1970s (Seddon, 2020, p. 527). Following Seddon (2020, p. 528), physical traders on the LME were marginalised by the entrance of powerful banking groups to the LME such as JP Morgan and Goldman Sachs and trading desks of banks and hedge funds had arrived at the places of miners, manufacturers, and end users. This process was accompanied by electronic trading and algorithms and the market's structure had been transformed from physical trade and long-term price risk management tools to financial activities with investment and speculative purposes. One of the key drivers behind this transformation of market conditions can be drawn on the expanding globalisation with the start of the neoliberal era in the 1970s and the increasing financialisation that came with it (Seddon, 2020, p. 530). Against this background Seddon (2020) conceives the financialisation of commodity markets as a "particular regime of capitalist accumulation, […] associated with neoliberal deregulation, the rising power of rentier classes and the structural power of capital markets" (see ibid., p. 529).

When taking the specificities of natural resources into account, one must also consider that this shift from "real commodities" (see Asiyanbi, 2018, p. 532) to abstract financial activities has led to material commodification processes that not only underpin but fuel the main ideas of a green economy (ibid., p. 531). This transformation of the interplay between the physical and financial sphere at the LME and other commodity markets governing capital accumulation as well as price determination and risk management are reflected in different structural changes. Firstly, market-based pricing systems have marginalised pricing controlled by commodity producers. Secondly, commodity markets have become globalised and thirdly, the market infrastructure of the LME has undergone a structural revolution from a non-profit to a for-profit basis (Seddon, 2020, p. 530). Regarding infrastructural changes, Seddon (2020) criticises the narrow view on the nation state towards extending the "boundaries of financial markets" (see ibid.). A closer view needs to be put on the "backstage politics" (see ibid), such as the growth of private exchanges, the embeddedness of state structures in wider institutional contexts, the influence of credit rating agencies and the impact of so-called price reporting agencies (ibid.).

4.2.3 Price Reporting Agencies

Price Reporting Agencies (PRAs) can be considered an important part of structural changes at commodity markets and play a central role in modern economies (Johnson, 2018, p. 1; Seddon, 2020, p. 530). PRAs function as price providers in commodity markets with a small number of buyers and sellers. They furthermore predominantly serve markets that trade commodities difficult to standardise in terms of quality and material characteristics and are therefore not ideally suited to trading on derivative markets like the LME. PRAs originally saw themselves as media companies, publishing market trends and news for energy and agricultural commodities as well as numerous minerals and metals. Only within the last few years have these companies started to be more involved in providing financial data and prices for different commodities. While most PRAs were predominantly specified in only a small number of commodities, within the last years, many of these companies have expanded their businesses to assess more and more commodities within a greater span of geographical area. Their original business model of selling market information to customers has not changed greatly, but most of the PRAs became more diversified and profitable (Johnson, 2018, pp. 1–3). They have started to fill the information gap of commodities that are not traded on exchanges.

Johnson (2017) defines PRAs as "firms that report the price of commodities that are difficult to assess" (see Johnson, 2018, p. 3). When acknowledging that prices are not only a matter and outcome of supply and demand in abstract markets, but additionally influenced by further effects such as governmental interventions and other institutional regulations (Beckert, 2011,

pp. 11–13; Johnson, 2018, p. 3), the importance of prices in the modern economy becomes evident.

Information about prices is thereby especially important for commercial users in commodity markets and since determining prices on a case-by-case basis is an expensive and complex process, market participants of sectors with little maturity and trade volumes today predominantly use the price data of PRAs as a reference price in their contracts (Radetzki & Wårell, 2020, p. 108). The largest and most important PRAs in the mineral and metal sector in Europe are Argus Media, Benchmark Mineral Intelligence (BMI), Fastmarkets MB, S&P Global Platts, Thompson Reuters and CRU International Limited (Johnson, 2018, p. 9, Interview 13, 14). For assessing prices, they develop specific methodologies that are publicly accessible on their websites. Even though the respective methods differ for each market depending on its preferences and characteristics, a similar structure can be observed in all of them (Johnson, 2018, pp. 4–5). To assess prices, price reporters talk to numerous market participants like mining and chemical companies, cathode and anode producers, traders, refiners, converters and car manufacturers (Interview 2) via phone, direct messaging services and e-mail (Johnson, 2018, p. 112). Through this process, they gather information on recently concluded long-term contracts and spot trading deals and ask the respective market participants about the prices used in these transactions as well as their geographical basis, material specification and further incoterms. Apart from actual transactions, price reporters also take the specific conditions of potential future deals as well as bids and offers into account (Interview 3). Regarding incoterms, PRAs usually ask the different market players to deduct specific transportation costs from their prices and create a net back to well-known ports such as Rotterdam (Interview 16).

The next step would then usually be the normalisation process of the collected prices by removing outliers and their online disclosure (Benchmark Mineral Intelligence, 2022b, p. 3). Against a certain fee, market participants can then use these published prices as a reference price with possible premia and discounts (Interview 2, Interview 3) or renegotiations after a certain time span in their term contracts or spot transactions (Fastmarkets, 2018).

PRAs consider their role in the mineral and metals markets as being the actors providing more transparency to the rather opaque price determination processes (Interview 2, Interview 3). Johnson (2018) explains the transparency argument as follows: “buyers of commodities usually want lower prices and so they will tend to pass on information that shows the market is oversupplied and that prices are weak. In contrast, natural sellers will [...] be reporting high

prices deals [and] shortages of material […]. Meanwhile, speculative commodity traders will flip between one side and the other depending on their position on any given day or week" (see Johnson, 2018, p. 4). Following Johnson's (2018) argument, the methodology of PRAs will therefore "[…] steer a path through these conflicting sources in order to reach an assessment of where the market really values a particular commodity" (see ibid.). Scepticism comes from commodity traders who criticise the rising PRA subscription fees (Johnson, 2018, p. 25), as well as from online trading platforms who criticise the PRAs journalistic rather than precise market analytical approach (Interview 4). Another critique targets the methodology PRAs are using, especially in terms of immature markets. If there are only few transactions it can be difficult to normalise prices, especially when considering that large offtake agreements are on a long-term basis and only small transactions whereas short-term agreements are more frequent. The latter are concluded without any discounts, which is why there is strong criticism for the PRAs publishing these prices, that are consequently higher than the prices set in large volume long-term agreements (Interview 1).

The LME can cooperate with PRAs by licensing PRA price assessments in order to use their commodity price as an underlying price reference for cash-settled derivatives, mostly futures. On top of that, PRAs can approach the LME to suggest a certain commodity future according to their market trend insights (Johnson, 2018, p. 132). A price level published at an exchange – which is considered the most important price determination institution in metals markets – is seen to have a great potential to become a benchmark price throughout the respective industry. Hence, PRAs hope to profit from their cooperation with the LME because it may increase their value of subscription in case the cash-settled derivative is frequently traded (Interview 14). The LME on the other side, also hopes to profit working together with a PRA, since it is a cost-efficient way for exchanges to introduce new contracts without creating a cost-intensive physical infrastructure of warehouses (Johnson, 2018, p. 132).

Summarising the above, it can be concluded that subscribers use price data assessed and published by PRAs for both physical and financial transactions. The role of PRAs as information and price providers in mostly immature commodity markets, is thereby essential to their profitability due to their subscription fees. Many of the PRAs have developed additional businesses such as consultancy activities or organising conference and data training (Johnson, 2018, p. 15). Their central role in price determination and setting processes in the mineral and metals industry and their activities both in the physical as well as the financial sphere of this

market is key when analysing the price setting mechanisms of minor metals like lithium. How exactly they play a role in lithium pricing will be analysed in the following.

4.2.4. Lithium price chain

The pricing of lithium doesn't have the same level of transparency as other minerals and metals like copper or gold, because it is not widely traded publicly on an exchange and until today there exists no global benchmark for lithium (Comisión Nacional del Litio, 2013, p. 14; Jorratt, 2022, p. 39; Poveda Bonilla, 2020, p. 24). The immature market and a rather small amount of lithium traded globally compared to other metals are two reasons for that (Radetzki & Wårell, 2020, p. 110). The difficulty in standardising lithium as a result of different geographical and climate conditions of the brines and hard rock mines, as well as the struggles to store lithium, contribute to the lack of standardised lithium prices as well as the lack of an industry benchmark in the lithium market (Poveda Bonilla, 2020, p. 24, Interview 14). Furthermore, different lithium products are needed for different battery technologies.

Nonetheless, in June 2021 a cash-settled futures contract for lithium hydroxide monohydrate 56.5% battery grade[13] was introduced at the LME. The underlying price of this futures contract is the lithium hydroxide price published by the PRA Fastmarkets MB. The original motivation by the LME to introduce this contract – against the background of the known difficulties to have a standardised lithium product that is frequently traded – was to create a room for small firms in particular, to reduce their risks of being exposed to volatile lithium prices by performing hedging practices (Interview 14). However, since its inception, this contract has not been traded at all (London Metal Exchange, 2022c, 2022d) which leads to the question of why this is the case and how or why this price is not being used as a reference price in contracts between physical actors along the lithium GVC.

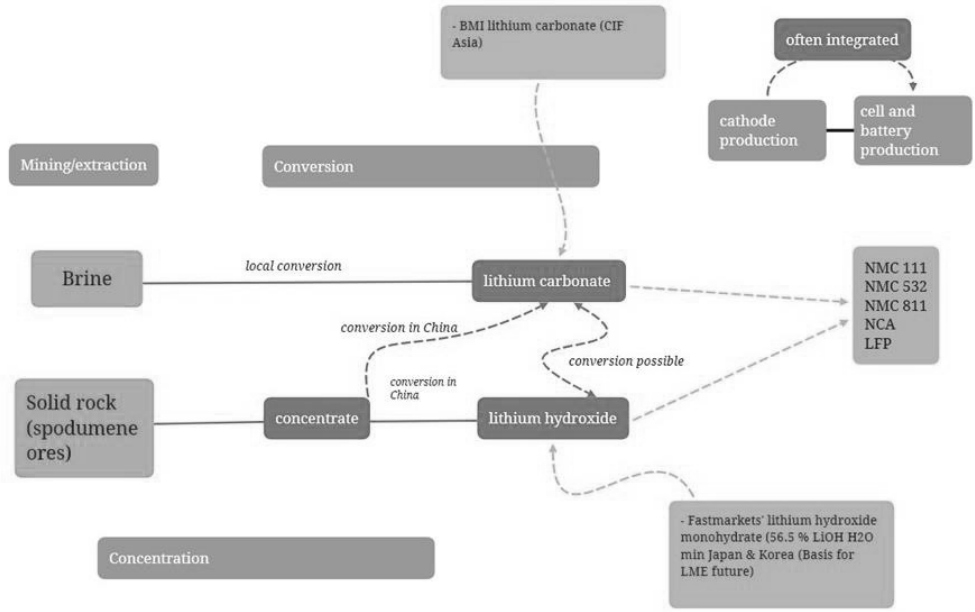
To this day, the lithium price is considered to be the outcome of bilateral direct negotiations between producers and consumers (Comisión Nacional del Litio, 2013, p. 14). According to Azevedo et al. (2018, p. 10), lithium contracts are typically priced quarterly and based not on a fixed price, but instead on the volume. Market participants and academia see a tendency to use reference prices[14] published by PRAs for contract or spot deals (Interview 2, 13). In the case of using reference prices published by PRAs, it seems as if for carbonate the key grades in the

[13] It can be differentiated between technical grade lithium products, battery grade lithium and lithium metal and specialty products (Maxwell, 2015, p. 94).

[14] In this thesis fixed price is defined as the number determined in a contract (e.g., 20 US Dollars/kilo) (Löf & Ericsson, 2019, p. 50) and reference price means that there is a price posted by an institution like an exchange or a PRA and seller and buyer use this price in negotiations to set a fixed price or build a floating price formula (for example reference price plus premia and discount) on the contract or the spot market (Johnson, 2018, pp. 19–20).

lithium market recently are the Benchmark Mineral Intelligence (BMI) lithium carbonate prices (CIF Asia) (e-mail contact with a European Price Reporting Agency (1)). For lithium hydroxide, it can be assumed that the lithium hydroxide price monohydrate 56.5% battery grade by Fastmarkets MB (that was launched at the LME last year) has been recently used throughout the industry as well. One expert in this context however also states that the Chinese spot price for lithium hydroxide is also greatly influenced by the Australian spodumene price, since this product is the most used feedstock for Chinese converters (e-mail contact with a European Price Reporting Agency (1)). For better illustrations these primary findings are illustrated in Figure 10.

Figure 10 Lithium price chain



Source: Author, based on Figure 7 and Interviews 2, 3, 13, 15

When considering prices as being political and as being influenced by governments and institutions that are political per se (Bargawi & Newman, 2017, pp. 167–168; Beckert, 2011, pp. 1–2) the complexity of the price determination process becomes significant.

The analysis of lithium price determination processes on a global level shows that there is little transparency in the pricing of lithium, and it can only be assumed which prices are being used in lithium trade. With the recently settled futures contract on the LME, the emerging importance of PRA reference prices and the steadily increasing market volume of lithium products, it can be assumed that lithium pricing is currently in a transition phase. With the example of lithium production in Chile, this thesis aims at taking a deeper look not only at the lithium price determination processes on a global level but also the price-setting processes in contracts on a local level by looking closer at one node of the price chain. Analysing pricing through the lens of Critical Political Economy and in the context of the GPN framework and considering the specificity of extractive industries as outlined in the second chapter, price-determination and setting processes need to be seen as contested processes embedded in local regulations, constitutions, and historical developments. Therefore, in the following a background is given on lithium production in Chile.

5 Case Study background: lithium extraction in Chile

The following chapter contains a detailed case study background mainly based on literature reviews. According to Kingsbury (2022, pp. 1–2) many of the causes of unequal distributional outcomes in Chile can be traced back to the interests of only a few political and economic elites in Chile, as well as social and ecological processes that cannot be analysed separately. What follows is a historical overview of the Chilean Political Economy and the lithium sector, before providing an outline of the recent developments in the national lithium production network in Chile. Afterwards there will be an analysis of the fiscal regime in the Chilean lithium sector and light will be shed on the social, political, and ecological environment of the lithium brines in the Salar de Atacama in the North of Chile. Together with chapter 4, chapter 5 will support the analysis of contested processes around and beyond price determination and setting in the lithium global production network, specifically focusing on Chile.

5.1. Historical overview: the development of the lithium sector

The topic of lithium in Chile first came up in the 1960s, when the *US Anaconda Company* conducted the first studies about water in the Atacama Desert in the North of Chile (Dorn & Gundermann, 2022, p. 343). In particular, they undertook explorations in the Salar de Atacama which today is the most important of several salars[15] in Chile in regards to lithium reserves (Perotti & Coviello, 2015, p. 34). Back then, the US Anaconda Company was an important player in the Chilean copper sector, as they controlled the Chuquicamata copper mine in the Atacama Desert. During their studies in the salars, they realised the salt flat's high saline substrate and towards the end of the 1960s, the *Institute for Geological Research* started to undertake further explorations and measures by request of the Chilean authorities. However, the actual start of lithium extraction and production only took place in the 1980s under three special laws and mining codes (Dorn & Gundermann, 2022, p. 343).

5.1.1. Mining codes and laws

Even though Chile's first Mining Code from 1932 stated that lithium was concessible, this law changed in 1983 with the new Mining Code, Law 18.248. From then on, no lithium concessions could be granted for the exploitation of lithium. Another important regulator was Law 18.097 from the year before (1982), the *Organic Constitutional Law on Mining Concessions* that stated that the right to exploit and commercialise is reserved only for the Chilean state. However, this law included a clause saying that non-state companies were allowed to explore non-concessible

[15] Salt lakes or brines rich in lithium are called salars (Flexer et al., 2018, p. 1189)

minerals within a so-called exploration concession by the state. In particular, this meant that they had to pay a fee to the state and in return they received permission to exploit lithium for a time span of four years, (Perotti & Coviello, 2015, p. 35). The third regulation was the law 2.886 from 1979, declaring lithium a strategic mineral for nuclear power, due to its potential use for nuclear fusion (Barandiarán, 2019, p. 386). With this regulation they followed the US government and according to Dorn and Gundermann (2022), this highlighted "Chile's alignment with the US Cold War policy on potential nuclear resources" (see Dorn & Gundermann, 2022, p. 344). Consequently, lithium could only be exploited directly through the state or state companies, by means of exploration commissions or so-called special operating contracts granted to private parties with sales having to be authorised by the *Chilean Nuclear Energy Commission* (CCHEN). These Codes are still in force today which is why lithium extraction has been regulated by the state ever since (Perotti & Coviello, 2015, p. 35).

5.1.2. The era of the dictatorship

These three laws, anchored in the still valid Chilean constitution, had a great impact on the governance of lithium as a natural resource in Chile. It is crucial to note, that all of these laws were created in the dictatorship of Augusto Pinochet (1973-1990) (León et al., 2020, p. 30). Even though Chile got back to civil rule in 1990, the regulations continued after the end of the dictatorship. Several rounds of privatisation and deregulation processes were implemented by the so-called *Chicago Boys* – a group of technocrats from Chile who studied under Milton Friedman at the University of Chicago – during the dictatorship. By privatising the Chilean economy to a great extent, this process of neoliberalisation increased the country's dependence on natural resource extraction and exports (Kingsbury, 2022, p. 2). Outside of Chile, other states like the United Kingdom (UK) under the Thatcher administration and the Reagan administration in the USA applauded, as these developments meant "ending the threat of a democratic road to socialism proposed by [Pinochet's] predecessor Salvador Allende" (see ibid.). The objective of this privatisation was to reduce state interventions and to counter the economy's deficit. A Great Depression followed in 1982 and 1983, to which the government reacted by buying back numerous previously privatised companies (Aldunate et al., 2020, p. 4). A second wave of privatisation followed and was characterised by a lack of information and low sales prices. Many of the private buyers were Pinochet's allies, the most popular example is the acquisition of SQM by Julio Ponce Lerou, Pinochet's son in law at that time. He was the head of *Corfo* before, Chile's Production Development Corporation (ibid., p. 5), the state body that from 1977 had been responsible for managing the lithium mining properties (Dorn & Gundermann, 2022, p. 344).

According to Aldunate et al. (2020, p. 1), this second wave of privatisation paved the way for the dominance of pyramids; business-groups with complicated and opaque ownership structures. A pyramid can be defined as follows: "In a pyramid, an ultimate owner uses indirect ownership to maintain control over a large group of companies […]. The ultimate owner owns enough shares to control firm A. Firm A in turn owns enough shares to control B, and so on. This chain of ownership allows the ultimate owner to control all the firms, even the ones in which he has no direct ownership" (see Bertrand & Mullainathan, 2003, p. 478). Hence, in the case of Chile, several business groups with pyramidal structures were built around privatised firms due to the poorly-regulated conditions under which firms got sold to private parties after 1983, most of them with connections to Pinochet (Aldunate et al., 2020, p. 4). This kind of control facilitates (illegal) insider trading[16] due to low interest rate loans, exchanges of certain outputs under market-price and the lease of assets between different companies in one business group (Bertrand & Mullainathan, 2003, p. 480). After the 1990s, when Chile got back to democratic rule, many of these companies used strategies like illegal political financing or hired former politicians of Pinochet's regime to hold on to their power (ibid., p. 6). These actions under Pinochet thus have great relevance not only for Chile's economy today but also for its lithium sector as discussed below in the part on controversies in the Corfo contracts.

5.1.3. The beginnings of lithium production in Chile

Coming back more concretely to lithium, the 1980s were also crucial for the beginnings of lithium production. Still under the dictatorship, the Chilean Lithium Society (SCL) was formed to mine the Salar de Atacama. Since the state company Corfo had owned most of the property mines since 1977 and lithium was amongst the few natural resources that did not get privatised during the Pinochet regime (Bustos-Gallardo et al., 2021, p. 182), SCL concluded a contract with Corfo to receive concessions to exploit and extract lithium (Dorn & Gundermann, 2022, p. 344). They concluded this contract still before the Law 18.097[17] was established in 1982. Most importantly, this meant that they received the permission from the state – through Corfo – to exploit lithium until either ~1.065 thousand metric tons (kMT) of lithium equivalent (LCE) are exploited or until 2030 (Perotti & Coviello, 2015, pp. 35–39). Furthermore, these permits

[16] Insider trading involves "trading in a public company's stock by someone who has non-public, material information about that stock for any reason. Insider trading can be either illegal or legal depending on when the insider makes the trade. […] Insider trading is illegal when the material information is still non-public, and this sort of insider trading comes with harsh consequences." (Ganti, 2022)

[17] Organic Constitutional Law On Mining Concessions (Perotti & Coviello, 2015, p. 35)

didn't contain any royalties[18] (Perotti & Coviello, 2015, p. 39). After several acquisitions as well as processes of merges, SCL (now owned by the US-American company Albemarle) now has full ownership over the lithium deposits where they have extracted lithium from since they bought them from Corfo. This illustrates well that one cannot apply the model of full nationalisation to the lithium mines in Chile, even though in theory this was originally the idea.

Albemarle is one of the two companies producing in Chile today, while the other one is the Chilean Mineral Company SQM, that was privatised during the dictatorship as mentioned above. Just as SCL they received concessions by Corfo before the Mining Code in 1982 came into force but started production only in 1998 in the Salar de Atacama. In comparison to Albemarle, Corfo still owns the mineral rights and only leased them to SQM (Bustos-Gallardo et al., 2021, p. 182). SQM were granted an extraction quota until they have exploited either ~960 kMT LCE or until 2030 (Dorn & Gundermann, 2022, p. 344; Perotti & Coviello, 2015, p. 39). In contrast to SCL, who only extracted lithium carbonate from the brines in Salar de Atacama, SQM additionally exploited potash and boron (Poveda Bonilla, 2020, p. 40). The strategy of SQM when they entered the market in 1998 was to place high discounts on the previous lithium prices with the objective of gaining market share and generating large profits. Consequently, with the market entrance of SQM, lithium prices became very opaque and stopped being reported (Maxwell, 2015, p. 93). The market shifted from being a "cooperative oligopoly to non-cooperative oligopoly" (see Maxwell, 2015, p. 92), since neither producers nor consumer negotiating prices, reported them officially anymore.

The 2000s were then characterised by a great boom in lithium demand. While lithium was mainly used in the military sector until the early 1970s, this focus first shifted in the 1980s, when the private sector started to demand lithium for products such as batteries, grease and glasses (Bos & Forget, 2021, p. 175). Together with the booming demand of lithium to be used in researchable batteries in electronic devices and EVs, the lithium sector in Chile therefore has experienced a steady growth since the early 2000s (Ebensperger et al., 2005, p. 219).

5.1.4. Different political administration and their impact on lithium regulations

The booming demand of lithium led to the creation of new lithium projects worldwide, but specifically Australia, Argentina and China announced new brine and solid rock extraction

[18] Royalties just like taxes are payments to the state. However, taxes are managed either on a local or federal level and then used by the government for basic tasks. Royalties on contrary are not based on particular rates but are the result of specific territories and land leases (Argent et al., 2021, pp. 1–2). They are payments made to governmental organisations in exchange for the right to extract a non-renewable resource, that is located on the territory of the state (Löf & Ericsson, 2019, p. 45).

projects. In Chile, the first Piñera government (2010 – 2014) aimed to respond to this increased lithium demand, the announcement of new projects in other producer countries and the high prices, by fostering greater lithium production with two initiatives (Dorn & Gundermann, 2022, p. 344). Both initiatives came along with Piñera's proposal of privatising lithium in Chile, so that any private company could more easily exploit the mineral, which caused a lot of opposition in the Chilean society (Perotti & Coviello, 2015, p. 37). The first initiative that failed, contained lax regulations that aimed at attracting capital of national and international investors.

The second initiative took place in 2012, when the Piñera administration announced a new lithium production licence to attract lithium projects (Dorn & Gundermann, 2022, p. 344). They requested international bids for a so-called *Special Contract for Lithium Operations* (CEOLs). The winner would get permission to extract 532.000 tons of lithium carbonate under specific environmental requirements. There were three bidders: The South-American based Li3-project or rather its main holder, the South Korean steel company POSCO (Bnamericas, 2012), NX Uno de Peine (Samsung) and SQM (Dorn & Gundermann, 2022, p. 345). The first place was awarded to SQM, the second to POSCO and the third to Samsung. Soon after the winner SQM was declared, the Li3-project realised that SQM didn't comply with the requirements, because they were still in the process of a pending lawsuit with the Chilean state. They therefore claimed SQM as an illegal participant of the auction. Consequently the deputy mining minister – who was responsible for the CEOL tender process – resigned, the award was withdrawn and the entire initiative got cancelled (Bnamericas, 2012; Dorn & Gundermann, 2022, p. 345).

The next Chilean president Eva Bachelet from the *Socialist Party of Chile* (PS) took a very different approach in terms of lithium regulations in comparison to her predecessor. In 2014, the first year of her second administration (2014 – 2018), the *National Commission on Lithium* was formed, led by the Minister of Mining. The commission included lithium experts, researchers, the president of the *Committee of Atacama Peoples* (CPA) and other representatives. They created a report with several proposals on regulations as well as challenges in the Chilean lithium market. The final report was published in 2015 and in 2017 the first recommendations were put into practice. According to Dorn and Gundermann (2022), the report's suggestions "have become the roadmap for public policy on lithium. For the first time, a reasoned and comprehensive position on salt flat mining was achieved" (see Dorn & Gundermann, 2022, p. 345). One of the main goals of the regulations proposed in the report was the sustainable and inclusive governance of the salt flats. The National Commission on Lithium therefore suggested the introduction of a body responsible for conducting geological

studies in the salt lakes, higher rents to be paid by the producing firms, revenues to be shared with the communities in the salars, as well as the protection of other substances that are extracted when producing lithium (Comisión Nacional del Litio, 2013, pp. 7–9). The report rejected the ideas of privatising lithium, stressing the active role of the state but encouraging a model of public-private partnerships. This model was based on the idea of fostering shared values, with private companies extracting lithium alongside a national company extracting lithium as a counterpart to the private firms. They also suggested maintaining lithium's status as a strategic mineral due to its potential for electric applications, and urged Corfo to renew their existing contracts with SQM and Albemarle due to the contract's weak regulations (Perotti & Coviello, 2015, pp. 40–41).

Consequently, contracts were being conducted between lithium producers and the indigenous communities in the salars affected by the lithium extraction (Dorn & Gundermann, 2022, p. 345) which will be discussed in Chapter 5.4. Furthermore Corfo, the Mining Ministry and CCHEN joined together at the Board of Directors, responsible for managing the salt flats. At the same time further concessions to extract lithium were given to state-companies. Hence, Codelco, the national copper company, now had holdings in the Pedernales and Maricunga salt flats in the Atacama Desert. Moreover, Corfo renewed and updated their contracts with Albemarle and SQM to including conditions that aimed at supporting higher economic returns to the state as well as ecological and social sustainability.

5.1.5. Controversies in the context of the renewed Corfo contracts

The new contract with Albemarle was finished at the beginning of 2017, giving Albemarle the permission to produce 262.132 tons of lithium metal equivalent (LME) until the year 2043 which increased their annual production from 26.000 to 82.000 tons. This contract also included higher rents to be paid to the Chilean state (Dorn & Gundermann, 2022, p. 345). Therefore, Corfo negotiated a royalty with Albemarle (between 6% and 40%) (Poveda Bonilla, 2020, p. 62). Before, the contract between Corfo and Albemarle – or Rockwood Lithium (SCL) – did not contain any royalties at all (Perotti & Coviello, 2015, p. 39). Furthermore, the reviewed agreement also included a clause saying that there is an option to obtain *preferential prices* for lithium when creating value-adding lithium products in Chile (see Table 3). The objective of this clause was to attract foreign direct investment and manufacture lithium products within the country that boost the Chilean economy, by allowing for the export of products with higher value (InvestChile, 2017; Poveda Bonilla, 2020, p. 62). However, when negotiating this clause, Corfo realised that Albemarle was selling their products to their main holding in the USA up to

30% lower than SQM was selling lithium for (Orellana, 2017; Terrel, 2017, Interview 6), and accused Albemarle of using transfer prices (Interview 6, 7, 8).

Transfer pricing describes the practice of determining the value of related-party transactions like trading arms or main holdings. The risk is that these transactions are used to shift the profits from the country of origin to avoid taxes (Löf & Ericsson, 2019, p. 44). This transfer pricing abuse has been become an important topic in Chile, while at the same time Albemarle has denied all accusations (Terrel, 2018). They claim that their prices were lower than SQM's export prices because their lithium products have different specifications. They sell to different end-users and they sell via long-term contracts instead of spot sales, which are able to achieve higher prices (Terrel, 2018).

The other process of renegotiations, the process of renewing the contract between Corfo and SQM was even more complex. Since 2014, Corfo and SQM have been publicly disputing because Corfo accused SQM of ecological damage and not aligning with the financial contract conditions by blocking competitors from the salt lakes (Dorn & Gundermann, 2022, p. 345). In 2010 Corfo has realised anomalies in SQM's payments to Corfo. In 2012 it was estimated that SQM had been paying US$8 million less than agreed upon in the contract. Since SQM refused to pay retroactively, Corfo initiated arbitration proceedings for non-compliance in the lease agreements during the end of Piñera's first presidency (the lawsuit that also came in the way during the CEOLs tender process in 2012 mentioned earlier). This consequently led to two claims filed against SQM in 2014 and 2016, requesting them to stop their lithium extraction in the Salar de Atacama. These files also contained accusations of falsifying certificates and reporting lower revenues, also in the context of extracting more than the quota allowed.

In addition, SQM had been facing several crime proceedings related to illegal financing of politicians (Poveda Bonilla, 2020, p. 64). As part of these investigations, SQM's main shareholder at that time, Julio Ponce Lerou, Pinochet's former son-in law, has been fined by the governmental institution responsible for regulating market price values – the *Chilean Securities Market Supervisory Agency* (SVS) – for market manipulation. They accused him of illegal insider trading with other companies, which was possible because of the power of the pyramidal business groups in Chile (Perotti & Coviello, 2015, pp. 37–38). Ultimately, between 2015 and 2018 the arbitration processes against SQM failed and the fine by SVS towards SQM as well as Julio Ponce Lerou were drastically reduced (Weissmann, 2020). Even if Ponce Lerou stepped back from his leadership position in SQM in 2015, he is still an important shareholder in the company (Kingsbury, 2022, p. 9). In 2018 for instance, he tried to prevent the Chinese

company Tianqi from acquiring stakes of SQM. Even if this action was unsuccessful in the end, Ponce Lerou was able to "push[ing] Tianqi into a silent role as investor" (see ibid., p. 14).

Ultimately, after all these scandals SQM agreed to the conditions of the renewed contract two weeks before the end of Bachelet's presidency in 2018. Following Poveda Bonilla (2020, pp. 64-65), this was an extremely convenient situation for the next president, who was again Sebastian Piñera, since he did not have to deal with these sensitive political topics.

The revised contract contained, for example, a new extraction quota, a permission to extract until 2030, higher royalties as well as financial resources for research and technology development. For better understanding, Table 3 shows a shortened comparison between the conditions in the renewed Corfo contracts between SQM and Albemarle. Main differences in the two contracts can be seen in the extraction quota, the contributions to research and development as well as the payments to the communities in the Salar de Atacama.

Table 3 Summary of the renewed Corfo contracts (2017 and 2018) with Albemarle and SQM

Concepts	**Albemarle**	**SQM**
Extraction quota	262 132 tons plus the remaining 110 000 tons of the previous quota of 200 000.	349 553 tons plus the remaining 64 816 tons of the previous quota of 180 001.
Extracting brine and water	Maintained at 442 litres/second and 23.5 litres/second	Maintained at 1500 litres/second and 240 litres/second
Royalties	6.8-40% on the lithium price and exports (didn't exist before)	6.8-40% on the lithium price and exports (before: fixed at 5.8% on exports)
Contributions to Research and Development	Between US$6 million and US$12.4 million (didn't exist before)	Between US$10.7 million and US$18.9 million (Previously 0.8% of 5.8%)
Added-Value Incentive	Up to 25% of production at preferential price	Up to 25% of production at preferential price
Contracts with communities in the Salar de Atacama	3.5% of the sales	Between US$10 million and US$15 million
Control	Access to operational, financial and environmental information	Access to operational, financial and environmental information

Source: Translated from Table 12, Poveda Bonilla (2020, p. 67)

The producer firms SQM and Albemarle have since then been operating under these renewed contracts including in the following second presidency of Piñera (2018-2022). However, in 2021 a new president was elected in Chile who has been in administration since March 2022 (Gob.cl, 2022a).

In the following, an overview of the developments in the lithium production network in Chile will be discussed, including the new administration of Gabriel Boric, the process of rewriting the constitution and the proposal of a national lithium mining company.

5.2. Recent developments in the national lithium production network in Chile

On December 19th 2021, Gabriel Boric won the second round of elections against his far-right rival Jose Antonio Kast (Ramo & Villegas, 2022). The thirty-six-year-old is currently the youngest president worldwide. Besides quoting Salvador Allende in his first speech as president outside of the Moneda Palace in Santiago on March 22nd, 2022, he said: "[...] the Chilean people have led this process. We wouldn't be here if you hadn't mobilised. […] We're here to give body and soul to our commitment to make life better for our country" (see Gob.cl, 2022a). According to the Economist (2022), he subsequently referred to the country-wide demonstrations in 2019. Since the end of the dictatorship, there has been much social unrest in Chile, with protests against the still valid Constitution, the social injustice and the market-driven economy (Funk, 2012, pp. 126–127). These protests peaked with the student protests in 2011, where students all over the country went on the streets to stand up for a more just educational system (ibid., p. 132). Gabriel Boric was an important figure in this movement as he led the *Federation of Students* at the University of Chile in Santiago (Cambero, 2021). The last wave of social unrest then took place in 2019, in response to a raise of the subway fee in Santiago; thousands of people went on the street in several Chilean regions protesting social inequality and demanding Piñera's resignation (Gonzalez & Morán, 2020, p. 229).

With Boric's victory he forms the most left-wing government since Salvador Allende, that is structured around two coalitions; on the one hand the *Frente Amplio* with the *Social Convergence* (CS) of Gabriel Boric and other minor parties like the *Apruebo Dignidad* and on the other hand a social-democratic alliance (Luna, 2022, p. 46; The Economist, 2022). Gabriel Boric aims at restructuring the Chilean society and economy with several planned plans of action. For example he wants to conduct a pension reform, set up a *State Development Bank* and a *National Lithium Company* (The Economist, 2022).

One of his first actions, a proposal for a planned tax reform, was published at the end of June 2022 and is currently being discussed in congress (Gob.cl, 2022b). The discussions already started in April 2022, when the *Treasury Ministry* opened a call for *Social Dialogues* that should involve civil society via public hearings and discussions to create this reform in a decentralised manner. Boric wants to raise the tax collection rate from 20,7% of GDP - which is well below the OECD median - to 26%, as well as the personal income tax and mining royalties (Ramo & Villegas, 2022; The Economist, 2022). The latter is mainly targeted towards the copper industry and the world's largest copper producing companies like Codelco and BHP. On the one hand it includes a so-called *ad valorem* tax of 1 to 2% for those firms that produce 50.000 to 200.000 tons of fine copper annually and up to 4% for those producing more than 200.000 tons a year.

On the other hand the proposal includes a rate on profits (between 2 and 32%) for copper prices between two and five dollars (Reformatributaria.cl, 2022, p. 8). Lithium is not mentioned in the new proposal – probably because the taxes and royalties for lithium are fixed in the contracts SQM and Albemarle have with Corfo (Interview 7, 9, 10).

However, what will have an impact on the lithium industry is Boric's plan to establish a National Lithium Company. The overall task of this state company will be the management and observation of the salt lakes, where lithium is extracted in the north of Chile in order to achieve a more equal value distribution. However, that model of managing the lithium reserves will still include private companies producing lithium due to their know-how. This process is planned to be realised with the inclusion of civil society and the communities in the Atacama Desert affected by lithium extraction. How exactly the National Lithium Company may operate in the future is still unclear (Interview 17, Senado.cl, 2022). The Chilean government, however, plans that this company "will be vertically integrated" (see Lewkowicz, 2022), hopefully covering activities from extraction to battery manufacturing.

Another major part of Boric's objective was to influence the independent process of rewriting the Chilean constitution of 1980 (The Economist, 2022). This process was an outcome of the massive social unrests in 2019, when people blamed the government – together with the weak social rules imposed by neoliberal politics and the dictatorship with its constitution – for the fragile educational and health system (Contesse, 2020). A plebiscite held a year later followed and was accepted by 80 percent of public, who approved the call to rewrite the constitution. In May 2021, society voted for independents and civil society to be part of the process to rewrite the constitution. This process is also the first constitutional convention worldwide to be realised by 50 percent women (Kingsbury, 2022, p. 11).

The first draft of the new constitution was made public by the constitutional assembly in spring 2022. The proposal challenged "Chile's neoliberal and extractivist model" (see Kingsbury, 2022, p. 11) by addressing the ecological impacts of mining and extraction. More concretely, the latter was being targeted in the draft by declaring Chile as "plurinational" (see Buschschlüter, 2022) and thereby addressing land and water rights as well as the rights of indigenous communities. *Article 79* of the proposal recognised and guaranteed "the right of the indigenous communities over their land territories and resources" (propuesta de texto de Nueva Constitución Política & de la República de Chile, 2022, art. 79). According to a member of the Committee of Atacama Peoples (CPA) this article would have had great impact on the way Albemarle and SQM currently extract lithium, since access to land and resources would have

changed to be more restricted (Personal Communication with member of Committee of Atacama People). Hence, as stated by Kingsbury (2022, p. 11), mining companies feared that if the new constitution had been approved, it would have been to the disadvantage of their practices. Other big changes in the draft addressed Chile's institutions by replacing the *Senate* with a *Chamber of Regions* as well as women's rights, such as abortion and a quota requiring women to hold at least 50 percent of the position of state institutions (Buschschlüter, 2022).

On 4 September all Chilean citizens had to vote either in favour or against the proposal (OHCHR, 2022). Even though 80 percent of Chile's population had voted in favour of writing a new constitution in 2020, the draft was rejected by almost 62 percent in September 2022 (Buschschlüter, 2022). This rejection is considered a major defeat for the Boric administration, indigenous communities – that account for around 13 percent of Chile's population – feminist ideas as well as all Chileans that were hoping for profound changes (Palomino, 2022; Rojas, 2022). There are different possible reasons for the rejection and one major reason can be seen in the political origins of the draft. Many right-wing and conservative citizens considered the draft as an utopian idea of left-wing politics and Boric's administration. The right-wing opposition had even launched extensive counter-campaigns and many people feared the new constitution could endanger Chile's economy, which is dependent on exports of natural resources (Jungehülsing et al., 2022).

This is because Chile's neoliberal system relies not only on resource extraction but also on primary product exports (ibid., p. 2) and as such can be considered an export-driven economy. The leading industry is copper and besides that mainly wood pulp, fish, wine and pitted fruits are exported from Chile (status 2019). Estimated exports in 2020 were at $79.8 billion, while the value of their imports was at $66.43 billion (CIA - The world factbook, 2022). Just like many other Latin American states, Chile's reliance on the exports of natural resources is often considered indispensable for national development and a "successful integration in the global economy" (see Perotti & Coviello, 2015, p. 5). Recent debates in Chile, between different actors like politicians, investors, stakeholders and civil society revolved around how the state should grow, which level of harm against nature it tolerates and who should profit from that (Barandiarán, 2019, p. 381).

Global discussions like the decarbonization of the economy and the energy transition are being brought to the local level by these debates in primary product producer countries like Chile. Following the argumentation of Kingsbury (2022, p. 4), the struggles over natural resources like copper or lithium in Chile can be pictured in a triangle with extractivism, the

decarbonization of the world economy and neoliberal processes. The lithium sector in Chile which can be seen as a resource-based production network, is therefore based on different perspectives, embedded in certain territories as well as power and governance structures (Dorn, 2021, p. 73). The rejection of the constitutional draft on September 4 shows the extent to which the perspectives on regional development, political ecology and economy are contested within the Chilean society. To analyse the latter in more detail, the debate on governance structures as illustrated in this section on the national level will be brought to a regional one. Therefore, light will be shed on lithium extraction in the Salar de Atacama in section 5.5. Beforehand, a detailed overview of the fiscal regime in the lithium production network in Chile will be given in order to best analyse the (un)equal distributional outcomes and economic gains that influence prices and vice versa.

5.3. The fiscal regime in the lithium production network in Chile

The fiscal regime, including tax instruments, non-tax instruments and other contributions should be evaluated in the course of any mining sector analysis (Jorratt, 2022, p. 19). Fiscal instruments are of great relevance when looking at prices, because institutional regulation influence price determination through, for example, restrictions, property rights, taxes and royalties (Beckert, 2011, pp. 11–13). Consequently, they also impact distributional and power struggles. Therefore, the fiscal regime of lithium production in Chile and its relation to price determination and struggles beyond will be described, in the following.

Tax instruments like the *Corporate Income Tax* (CIT) as well as non-tax instruments like mining royalties play an important role in the mining sector. For the producer country, these instruments aim to benefit the national economy by capturing the wealth created by mining (Löf & Ericsson, 2019, p. 45). In Chile, almost all taxes are paid directly to the central government and not to the different regions and communities. One exception here is the *Mining Patent*, a fee that is directly paid to the region where the mine is placed. However, this rule only applies to concessible metals and minerals which is why this kind of tax is not applicable to lithium (Perotti & Coviello, 2015, p. 40). Both lithium producers (Albemarle and SQM) have to pay a CIT. Unlike income tax, CIT is a standard rate imposed on the net profits of corporations (Kagan, 2022). In the lithium sector it is based on the top rate of CIT of 27%.

Regarding royalties, it can differ between three types of royalties. The specific royalty or *Specific Mining Tax* contains a fee charged per unit of volume or weight of the mineral. It is not based on price, production costs or other values and not easy to apply to non-homogenous mineral products (Jorratt, 2022, pp. 14–16). However, the materiality of lithium is not the only

reason why it is not applied to the lithium sector. Since the Specific Mining Tax or Royalty is only applicable to concessible minerals, lithium production in Chile is not affected by this regulation (Comisión Chilena del Cobre, 2013, p. 42; Perotti & Coviello, 2015, p. 39). In the case of the *ad valorem royalty*, the taxable base is the respective value of the mineral sold or extracted according to the market price. Therefore, it is of great relevance to consider how the value of the mineral is calculated. Most of the time it is based on either the price of the invoices and export price FOB. However, in order to prevent possible evasion via transfer pricing, some countries prefer to use reference prices from derivatives markets like the London Metal Exchange. In the case of lithium production, the ad valorem tax rate is fixed in the Corfo contracts at a rate of 6.8 – 40% on the lithium price and exports (Jorratt, 2022, p. 16). Hence, the materiality of lithium and opaqueness in pricing is greatly intertwined with part of the fiscal regime in Chile and has a great impact on the value distribution. The third royalty is a 5 – 14% tax rate on the operating profit, that was introduced after the big earthquake in Chile in 2010 to the entire mining sector to profit from the high copper prices (Bnamericas, 2020, Interview 9).

As shown in Table 3, further rental obligations are included in the non-tax instruments on top of the royalties. These are rents that the lithium producers have to pay to Corfo. While Albemarle is free of payment, SQM has to pay 15.000 US Dollars to Corfo each year (Corfo, 2018, p. 70). Further instruments are the payments to the communities in the Salar de Atacama that are directly affected by the lithium extraction in the North of Chile. These instruments were an outcome of the processes of renewing the Corfo contracts. While Albemarle now pays 3.5% of their sales to the Committee of Atacama Peoples (CPA) each year, SQM only indirectly pays 10 to 15 million US dollars via Corfo, regardless of their profits and prices (Personal Communication with member of Committee of Atacama People). The fiscal regime in the lithium GPN in Chile with its different instruments is illustrated in Table 4.

Table 4 Fiscal instruments relevant for the lithium sector in Chile.

Company	SQM	Albemarle
Tax instruments		
Top rate of Corporate Income **Tax** (CIT)	27%	
CIT deduction allowed for	Depreciation of ores, buildings, and machinery allowed over the lifetime of the mine, with no limit of tax %. Import taxes.	
Level at which CIT is applied	Federal	
Non-tax instruments		
Lithium **Royalty** (on Li2CO2, LiOH, and lithium brines)	Ad valorem: 6.8-40% on the lithium price and exports. On operating profit: 5-14%	
Quarterly fixed **rental obligations** (in US $)	3.750 (15.000 per year	Free of payment
Other instruments		
Expiration of exploitation contracts	Until 2030	Until 2043
Concession granted by	Corfo	
National concession status	non-concessible after Mining Code of 1983. Law 18.097: Lithium in Chile is a strategic mineral of national interest	
Ownership of lithium	Chilean state (regulated by CCHEN).	
Payings to communities	Between 10 and 15 million US$	3.5% of their sales
Instruments not applicable to lithium concessions of SQM and Albemarle		
Specific Mining Tax (royalty)	Introduced in 2006, paid by mining companies depending on their production and based on operating margins, which are sales minus direct costs and expenses	
Mining Patent (protection regime)	Mining firms are obligated to pay an annual mining patent, in order to keep the mining concession. Patent rates vary, but for an exploration concession it is generally ~US$160 per km2, and ~US$800 per km2 for exploitation concessions	

Source: based on Table 16 in Perotti & Coviello (2015, p. 39) and updated with information retrieved from Corfo (2018, p. 70) and Jorratt (2022, pp. 59–62)

According to Otto et al. (2006, pp. 7–8), it is important to consider the relation between surpluses for the society provided by mining taxes and royalties and the incentive for companies to develop new mines[19]. The more the mineral sector is taxed by the state, the lower the flow of wealth to the companies but ideally the higher the wealth for the society. Following the argumentation of Jorratt (2022, p. 22), a best practice taxation and royalties scheme should therefore only affect investment decisions as little as possible, should minimise administration costs and be able to adapt to changing market decisions like achieving proportionally more rents in times of price booms. In order to achieve these objectives, fiscal regimes need to be

[19] From a perspective of Critical Political Economy, it is important to say that developing new mines need to be considered critically per se, since it fuels ecological degradation and impacts conditions of people living close to extraction sites.

transparent, simple and politically feasible. However, due to the unpredictability of future resources and volatile mineral prices, specifically in resource-dependent countries like Chile, stable taxation policies are in general hard to achieve (Barma et al., 2012, pp. 105–106).

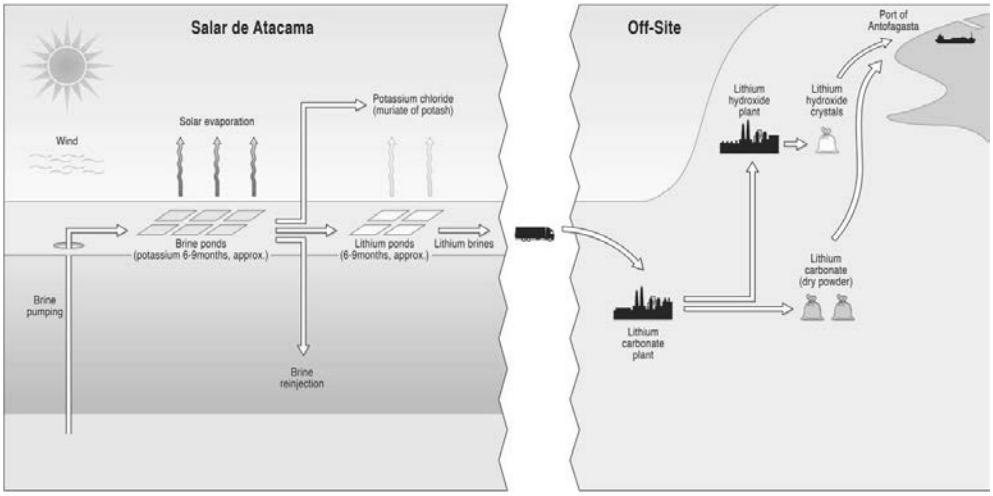
When looking at fiscal regimes, one also needs to consider the specificity of extractive sectors and the ecological degradation that comes with them. Critiques in the context of royalties are, for example, that they are solely based on the quantity of lithium that is exported but not on the salty water that is pumped out of the salt lakes. Additionally, reparation costs for the ecosystem in the Salar de Atacama are not included (interview 11, 12). Moreover, in order to avoid under invoicing as observed before with SQM, people highlight the need for a national lithium royalty's scheme, as is now discussed for copper. However, due to the Corfo contracts that are currently in place, regulating royalties differently would be very complicated (Interview 8, 9, 11). Furthermore, since Chile has a very centralised structure and taxes are paid to the federal state and not the respective regions where the extraction takes place, risks like unequal distribution of revenues need to be considered within these "socio-spatial politics of royalties" (Argent et al., 2021, pp. 1–2). Fiscal instruments influence how value and risk are distributed not only between the state and private investors, but also between the state and civil society (Jorratt, 2022, p. 22). Accordingly, each tax regime's design, like the one in Chile, is influenced by several decision-making processes, distribution of power, certain narratives around natural resources and governance patterns. On top of that, factors on a global level, like the missing global benchmark for lithium, complicate the determination of the financial value of the mineral (Barma et al., 2012, p. 106; Jorratt, 2022, p. 16).

5.4 Lithium brines in the Salar de Atacama

Most of Chile's current lithium reserves are located in the Salar de Atacama, where the two big companies SQM and Albemarle are currently operating under the Corfo contracts. However, there are around 60 other salt brines in Chile, with the Salar de Maricunga and Salar de Pedernales currently attracting attention due to their high-grade lithium (Maxwell & Mora, 2020, p. 58). The copper corporation Codelco obtained permits for both salt lakes, and in 2017 they created the subsidiary company *Salar de Maricunga*. Two years later, Codelco started working together with *Salar Blanco Mining* to operate its subsidiary under the above mentioned CEOL, which they obtained from the Ministry of Mining in 2018 (Dorn & Gundermann, 2022, p. 346). However, they haven't started operating the lithium brines yet and are still in the course of "understanding the potential concentration of lithium in the brine" (e-mail contact with governmental organisation in Chile). Hence, the two currently operating lithium producers in Chile are SQM and Albemarle.

Besides lithium operations, two big copper projects currently take place in the Salar de Atacama and the installation of solar technologies for renewable energy production increased significantly in the last years (Babidge & Bolados, 2018, p. 175). The Salar de Atacama is located in the Atacama Desert in the North of Chile. It is one of the driest deserts worldwide (Jerez et al., 2021, p. 9) that receives a lot of high-radiation sunlight (Barandiarán, 2019, p. 388). It is about 3.1 km^2 large and contains the world's largest and most concentrated lithium reserves from brines. Despite the increasing importance in the narrative of decarbonizing the world-economy, the fragility of the eco-system and the cultural value of the salar should not be underestimated. The brines or hypersaline lakes from where the lithium carbonate gets extracted, are embedded in unique ecosystems and besides mining, they provide noneconomic services like important waterbird habitats (Gajardo & Redón, 2019, pp. 1–3). The final report of the National Commission on Lithium where also the CPA participated already stressed the fragile character of the ecosystems with a major focus on the freshwater use in the salt lakes (Dorn & Gundermann, 2022, p. 345). Extracting lithium from the salt lakes in the Atacama Desert involves pumping salty water from beneath the Salt Lake (see Figure 11).

Figure 11 'Lithium from brine' - process in the Salar de Atacama



Source: Bustos-Gallardo et al. (2021, p. 183)

Afterwards the lithium is concentrated in several stages in so-called evaporation ponds (see Figures 12 and 13) until a concentrated brine with more than 6% lithium (see Figure 14) is obtained (Bustos-Gallardo et al., 2021, p. 183).

Figure 12 Satellite photograph of lithium evaporation ponds in the Salar de Atacama

Source: Bustos-Gallardo et al. (2021, p. 184)

Figure 13 Photo of an evaporation pond of SQM in the Salar de Atacama

Source: Author, picture taken in the Salar de Atacama, Chile

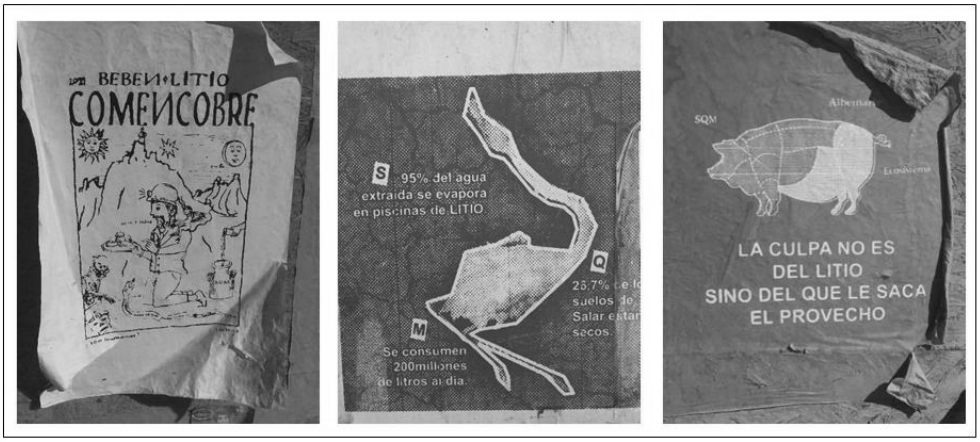
This process takes between 1 – 2 years and afterwards the brine (see Figure 14) is transported to another chemical plant to purify it and turn it into carbonate or hydroxide (Comisión Chilena del Cobre, 2013, p. 8). In the case of SQM, the brine gets shipped to their chemical plant in *Salar de Carmen* close to the city of Antofagasta (around 262 km distance), where they either directly ship the final product lithium carbonate to China, the Republic of Korea or Japan or SQM transforms is to lithium hydroxide (Bustos-Gallardo et al., 2021, p. 184, interview 13).

Figure 14 Photos of the ponds in the Salar de Atacama with concentrate of 4% lithium

Source: Author, pictures taken in the Salar de Atacama, Chile

Extracting lithium from the brines in the Salar de Atacama thereby greatly relies on physical conditions that regulate the evaporation, concentration and finally the productivity of lithium extraction. However, lithium production in the salar today is enormously commercialised. The valuable concentration of lithium also brings large quantities of liquid to the surface of the salt lakes. This process thereby uses a great quantity of water, which is why it is also called *water mining* (Bustos-Gallardo et al., 2021, pp. 182–184). Through the process of pumping the brine to the Earth's crust, the depression cone is extended, which can lead to a collusion with freshwater sources from the diminishing river San Pedro and underground water from the High Andes. Consequently, the influx of fresh water to the brines will cause its use in the pumping and evaporating process as well. This use of freshwater due to mining activities, together with the increasing hyper dryness in the Atacama Desert due to low rainfall leads to sincere ecological problems (Bustos-Gallardo et al., 2021, p. 185; Gajardo & Redón, 2019, p. 3). Additionally, the human and animal population in the Salar de Atacama are confronted with an increasing lithium content in the ground and drinking water as well as foodstuffs (Figueroa et al., 2013, p. 122). The water problem in the Salar de Atacama is mainly a conflict between interests between the lithium producers, the state and the local population. The following photos (Figure 14) contain protest signs placed in town centre of the village San Pedro de Atacama, and show the prominence of this dispute.

Figure 15 Photos of posters in San Pedro de Atacama, Chile



Source: Author, pictures taken in San Pedro de Atacama, Chile

The phrase on the left-hand photo can be translated to “drink lithium eat copper”, the centre photo says beneath others “200 million litres [of water] are consumed per day” and the picture on the right-hand side says, “It is not the fault of the lithium, but of the one who takes the profit from it”. The last two pictures also allude to the two lithium producing firms SQM and Albemarle. While these photos cannot be attributed to a particular group of persons, especially the conflicts between the lithium producers, the state and the indigenous communities located around the extraction sites have been greatly discussed in the last years.

At present there are 20 Atacamenian communities that are affected by the lithium extraction of SQM and Albemarle. After the 1990s, these indigenous communities and other ones from other places, together with the *National Indigenous Development Corporation* (CONADI) were able to demand land transfers that contained the control of land and water that partly returned to the communities. However, in the case of the Salar de Atacama these land transfers only included land from outside the SQM and Albemarle construction sites (Dorn & Gundermann, 2022, p. 348). Furthermore, an important milestone in this context was the inclusion of the CPA – which is a merge of eighteen Atacamenian communities – in the process of writing the report of the National Lithium Commission. Additionally, the CPA contributed to the renewed contracts between Corfo and Albemarle and SQM. As shown in Table 3 in sub-chapter 5.1.5 the indigenous communities have also started to profit from lithium extraction since 2017 and 2018, by concluding agreements with SQM and Albemarle. The latter makes the relation between communities, producers and state who sets the legal framework even more complicated. Hence,

interviewees highlighted the need to differentiate between different communities and individuals within them, since attitudes, opinions as well as the degree of profit by receiving revenues of lithium production or a secure job in the mines greatly influence the relationships and narratives (Interview 10, 21).

Together with the historical overview, recent developments in the national lithium production network and the fiscal regime that determines how costs of lithium extraction are (not) mirrored in national royalties, taxes, ecological and social costs, the embeddedness of the Salar de Atacama in a network of power structures, Chapter 5 illustrated the complexity of the embeddedness of lithium extraction in Chile's Political Economy. Building on that, the next chapter presents the analysis of the critiques of the global lithium pricing system, price determination and setting on a local level and further contestation and power struggles in the lithium GPN. It thereby specifically draws upon the research questions, that were guiding this thesis.

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6 Contestation around and beyond lithium price determination and setting

The objective of this chapter is to illustrate the findings of the research conducted in Chile and to picture findings from prior research by specifically targeting the research questions of this thesis. First, light will be shed on the global pricing system for lithium and its drawbacks before discussing price setting processes and general pricing trends in the sector of lithium extraction in Chile. The analysis shows the contestation around lithium pricing on a global and local level and how they intersect with ownership structures, historical developments, and current politics in Chile. The analysis ends by portraying challenges in the Chilean and global lithium market as well as political implications. Major findings are summarised in a graphic representation of the lithium production network in the end.

6.1. Critiques of the global lithium pricing system

Before 1998, lithium trade had predominantly been based on bilateral contracts with fixed producer prices, which were announced in annual summaries like the *Minerals Yearbook*. The market entrance of SQM in the end of the 1990s changed this situation and it became more difficult to obtain lithium price information. SQM's strategy of placing high discounts on the previous lithium prices in order to gain more market power, shifted the market from being a "cooperative oligopoly to non-cooperative oligopoly" (see Maxwell, 2015, p. 92). Lithium pricing became very opaque, and producers usually did not publicly report the prices they were negotiating on a case-by-case basis with their clients. Since 2010, when more companies entered the market and new lithium projects evolved worldwide, price levels have been reported again, competition has increased, and pricing has become more decentralised. However, to this day different price regimes exist in the lithium market. Lithium compounds and products have been priced in different ways, ranging from more transparent to rather opaque contracts (ibid., p. 93). There is not one single benchmark price that is being used in contracts throughout the industry (Comisión Nacional del Litio, 2013, p. 14; Jorratt, 2022, p. 39; Poveda Bonilla, 2020, p. 24). Not having one benchmark price makes investing in lithium projects risky due to uncertainty of where the prices are going, and it impedes risk-management practices due to a lack of price consistency along the GVC (Interview 14). As illustrated in Chapter 4, many metals are priced on derivative markets like the London Metal Exchange (LME).

The LME is interested in listing commodities that have already reached sufficient liquidity and are easy to standardise. Standardised commodities are easier to make derivatives on because they can be used by different actors in the GVC and thus bring large volumes from which revenues for the derivative market – in this case the LME – follow (Johnson, 2018, pp. 131–

132). As mentioned before, lithium is not easy to standardise because both brines and hard rock are embedded in different climate and geographical conditions, and different products are used for different battery technologies (Johnson, 2018, p. 3; Poveda Bonilla, 2020, p. 24). Nonetheless, the LME consulted with the LME Advisory Committee on lithium – that includes producers like Albemarle and Tianqi, as well as large OEMs like Tesla and Ford Motor Company and financial institutions like Goldman Sachs – and decided to launch a cash-settled lithium hydroxide futures contract at the LME (London Metal Exchange, 2022a). The original motivation to even have a futures contract, occurred from the idea that start-up companies and small firms in particular can reduce the risk exposure of the volatile lithium prices by performing hedging practices. On top of that – as one interviewee states – without a futures market, also the big producers – even if they profit from high prices – have hard times to get finance from banks when the price development is so uncertain:

"The lithium market is quite concentrated. So, a handful of big producers are sharing the market. They love the market being fragmented and opaque. As they go to Tesla, and they dictate the terms. Then what happens like we saw two years ago? The price drops by 60 percent. They have a massive cash crush; they can't raise any more money. They can't convince their bankers that there is any certainty over the future price because there is no futures market. Then they come back, running, and saying 'oh, actually it would be very nice if the market were a bit more transparent' (Interview 14).

Furthermore, market participants and sector experts realised that "EV production goes through the roof and the price of lithium becomes an increasing proportion of the total cost of manufacturing a car" (Interview 14). Hence, the LME hoped to profit trading this futures contract and financial investors and speculators aimed at making profits from the rising lithium prices and the opportunity to speculate on the LME (ibid.). The PRA Fastmarkets provide the underlying price of the LME lithium hydroxide future. The choice by the LME to take this price as reference was unexpected, since another PRA - Benchmark Mineral Intelligence (BMI) - was considered the most referenced price on the market at that time (Interview 2). On top of that, the decision (a process that took four years) to launch lithium hydroxide instead of lithium carbonate was a strategical one made by the LME (Interview 14). Back in 2017, mainly high-nickel batteries (specifically NMC 333) that predominantly need lithium hydroxide were demanded. However, today, mainly LFP[20] batteries that need lithium carbonate are sought after for two reasons. Firstly, NMC 333 contains a high cobalt content and due to the risks related to the cobalt mining in DRC like child labour, consumers and OEMs have started to move away

[20] LFP batteries are currently only produced in China, which gives China a monopolistic position in that market and big OEMs like Tesla have stated to introduce electric cars using solely LFP technologies (Burrow, 2021; Mattke, 2021).

from producing NMC 333 batteries (Interview 13). Secondly, the production of LFP batteries is much cheaper than the production of NMC batteries.

The choice of taking the Fastmarkets lithium hydroxide price index as the underlying price for the future contract has been contested ever since its inception, especially because it has not been traded at all since its launch in 2021 (Interview 6, 7, 9). This means that neither physical actors, nor financial ones have been using the futures contract for hedging and risk management as a means of risk exposure and speculation. A Chilean lithium producer states that they neither use the LME futures contract of lithium hydroxide for hedging, nor do they pursue any risk management at all. How they would react in the case of lower lithium prices is still under investigation (Interview 13), but due to the high demand, it doesn't seem as if prices will decrease in the near future (Interview 15). Because of the supply squeeze and the very high demand now, together with the high prices that are determined and set in a very opaque manner, the lithium producers in Chile generate a lot of profit (Interview 8, 10, 11, 12). These findings indicate that the current producers seem to accede to the current price determination and setting form. In the future, however, prices can decrease again because new technologies, recycling capacities and more can influence the supply and demand for primary lithium products. Hence, it should be crucial for lithium producers to explore risk management strategies and strive for more transparent pricing in the medium-term future.

However, it needs to be highlighted that despite current opaque pricing mechanisms in the lithium market, a liquid futures contract at the LME would not solve the contestation around lithium pricing. The different interests of financial investors and big banking groups hoping to profit from the highly volatile prices at the LME need to be recognised when criticising the lack of transparency due to missing price regulations on a global level. There is increasing academic consensus regarding the influence of financial investors as well as physical actors on the increased volatility of mineral prices, which has important distributional implications (Adams et al., 2020; Adams & Glück, 2015; Cheng & Xiong, 2014).

Despite the trend to use reference prices, the missing liquidity of the LME's lithium futures contracts raises the question of which lithium prices are then being used in global lithium trade. The dominant reference price in the lithium market seems to come from PRAs (Interview 7, 13, 15). The PRAs whose lithium prices are most often referred to, are all publishing a lithium carbonate (99.2-5% min. lithium, battery grade, CIF Asia) price which is considered one of the

key grades[21] to be used as a reference price in bilateral contracts at the moment. Table 5 illustrates how different PRAs (here Asian Metal Benchmark, Fastmarkets MB and BMI), publish different lithium carbonate prices (99.2-5% min, battery grade).

Table 5 Lithium carbonate (99.2-5% min, battery grade) prices by Asian Metal Benchmark, Fastmarkets MB and Benchmark Mineral Intelligence

Asian Metal Benchmark	Fastmarkets MB	Benchmark Mineral Intelligence
• Lithium Carbonate 99.5% min Delivered China RMB/mt • Lithium Carbonate 99.5%min CIF China USD/kg • Lithium Carbonate 99.5%min Delivered EU USD/kg • Lithium Carbonate 99.5%min US USD/kg • Lithium Carbonate 99.5%min FOB South America USD/kg	• Lithium carbonate 99.5% Li2CO3 min, battery grade, spot prices cif China, Japan & Korea, $/kg • Lithium carbonate 99.5% Li2CO3 min, battery grade, spot price range exw domestic China, yuan/ tonne • Lithium carbonate 99.5% Li2CO3min, battery grade, spot price ddp Europe and US, $/kg • Lithium carbonate 99.5% Li2CO3min, battery grade, contract price ddp Europe and US, $/kg • Lithium carbonate 99.5% Li2CO3 min, battery grade, contract price ddp Europe and US, $/kg	• Benchmark Minerals, Lithium Carbonate, 99.2%, CIF Europe, USD/tonne • Benchmark Minerals, Lithium Carbonate, 99.2%, CIF Asia, USD/tonne • Benchmark Minerals, Lithium Carbonate, Battery Grade, 99.5%, EXW China, RMB/tonne

Source: Author, based on Asian Metal, 2022; Benchmark Mineral Intelligence, 2022; Fastmarkets, 2022.

Against this background, the methodologies used by PRAs to determine their prices need to be observed critically. In the lithium market, a difference can be distinguished between the spot market where spot prices are used and the contract market using contract prices. Michelle Jorratt (2022) defines the spot price as the price that is set in individual transaction contracts that are traded for immediate delivery. The price set in (long-term) contracts together with premiums, discounts and more negotiations between lithium producers and their clients on the other hand is defined as the contract price (Jorratt, 2022, p. 24). Both prices can thereby be referenced in relation to any kind of price level. For spot transactions in metal markets, the price is usually referenced to the price level at a given day from a derivative market (Chen, 2021). The copper spot price for example is referenced against the copper Grade A contract on the LME, that is published every day at 12:35 p.m. GMT (U.S. Security and Exchange Commission, 2013). Due to the low liquidity and the missing trade on derivative markets, the spot market in the lithium trade functions differently. A representative of a Chilean state agency notes:

[21] In lithium hydroxide, also due to its basis for LME futures, the Fastmarkets' lithium hydroxide monohydrate 56.5% min. battery grade, cif China, Japan & Korea price level is considered important. On top, especially the hydroxide spot market is greatly influenced by the Australian spodumene price because the Chinese cathode converters currently prefer using the Australian feedstock for spodumene (e-mail contact with a European Price Reporting Agency (1)).

"And the spot prices are from China. The prices in China are unknown. Nobody knows where they come from. Only the major price reporting agencies publish these reference prices. Asian metals is the most followed China price agency in this market" (Interview 18).

However, even if spot prices in the lithium market originate from the reference prices published by Price Reporting Agencies like the Chinese PRA *Asian Metal Benchmark* or the European PRAs Benchmark Mineral Intelligence (BMI) and Fastmarkets, their price assessment can be seen as problematic. Table 5 shows that all three PRAs publish different prices and although Fastmarkets for example differentiates between spot and contract prices, they are not elaborating publicly how this differentiation materialises itself in their methodology (Fastmarkets, 2022, p. 8).

Furthermore, even though all PRAs are publishing different prices depending on the destination or origin of the delivery, the prices are lacking in a comprehensive classification of specific transport costs and trading conditions, which can be seen as a large generalisation. The lithium prices at the spot market in China are currently the world's highest and represent a more volatile market than average prices of more thoroughly analysed time periods (Interview 6, 15, 18). Today, spot prices for lithium are up to 60% higher than contract prices (Azevedo et al., 2018, p. 10). Hence, producers at the upstream stage make profit from selling lithium products on the spot market, while actors of the mid- and downstream stage like converters, cathode producers, or battery manufacturers need to secure their supply at whatever price right now, at times where the supply is so squeezed (Interview 6, 13, 15). Despite PRAs claiming to bring transparency to the pricing system of lithium, their methodologies lack detailed information about which actors exactly are engaged in the price assessment process. Johnson (2018) in this context states: "Methodologies matter. Almost every time a commodity market has changed from using one PRA's assessment as a benchmark to another rival provider, the root cause has been users' preference for a different type of methodology from the one that the incumbent provider was either using or suggesting" (see Johnson, 2018, p. 104). Hence, methodologies can influence pricing according to the engaged actors and their interests in the market.

Against this background one interviewee brought forward the example of the different contract making practices between LG and Albemarle on the one hand, and any small cathode producer and Albemarle on the other hand. While LG negotiates with Albemarle a yearly contract price with a discount on top due to large trading volumes, smaller cathode producers or converters would for instance negotiate prices every six months without any discount. Due to this higher frequency these latter are then probably the reported ones:

"*it's a small portion of the total business. So, then it does not necessarily reflect what a big buyer is going to consume. Or going to pay…so, at the end of the day when you report prices, you want to have a good idea, what a negotiated contract today would mean. And that's when I say, uff, that really depends so much in this case on who has negotiated that month, or that quarter or that semester...what did the big boys really negotiate? […] It's a difficult number to grab for a Price Reporting Agency. Because as I said, these transactions are not so many during the year"* (Interview 1)

Moreover, it has an impact on pricing; the amount of data points included in the different price assessments, how often prices are published and how bids and offers are considered in methodologies besides actual transactions that took place (Interview 1, 2).

Summarising the above, it can be observed that lithium pricing is currently in a transition phase. Higher demand for lithium carbonate due to the changes in the battery technologies, the increased transactions of spot sales due to the supply squeeze, and a move towards reference price indices published by PRAs are major observations. Even if in this context the LME doesn't seem to play a major role in lithium pricing right now, the LME is expected to have more influence in the future (Interview 6, 9). The LME is a powerful actor on the global level of lithium trade and pricing. PRAs profit from cooperation with LME, since pricing on derivative markets generally is seen as a major price determination process in the metal sector (Johnson, 2018, p. 58). So, if in the future the lithium hydroxide contract is going to be used by physical as well as financial actors, Fastmarkets will profit, since it increases their value from subscription fees. Automatically, this also shows the competition between PRAs. Moreover, the LME wants EV products to be traded there, given the high hopes placed in battery technologies (Interview 14). Partnering with a PRA is a cheap way for exchanges to introduce new contracts without creating the cost-intensive physical infrastructure of warehouses (Johnson, 2018, p. 132).

While PRAs do not act transparently in terms of their methodologies, they are just like exchange-based pricing systems linked to powerful interests. PRAs have the power to decide which actors in the respective industry they include in their price assessments. Exchanges like the LME are increasingly dominated by financial motives and actors, and in the case of lithium powerful producers and OEMs are part of decision-making processes due to their role in the LME Committee. As the failure of the lithium hydroxide contract at the LME shows, price determination by the LME and PRAs mostly focuses only on short-term fundamentals of supply and demand. However, this runs the risk of not taking into account long-term ecological and social risks. How and by whom lithium prices are determined mirrors which interests and specifically whether for example social and ecological costs are reflected.

Looking in the future is also important to discuss topics of recycling and circular economies and how they will impact supply and thus pricing. Currently, less than one percent of lithium is being recycled, even though growing attention within this area can be observed (Bae & Kim, 2021, p. 3234). The recycling capacities for Li-ion batteries are not greatly developed since the costs of recycling still exceed the costs of producing. Moreover, the diversity in materials used for Li-ion batteries brings further difficulties in creating a cheap and safe recycling technology (Huang et al., 2018, p. 274). However, increasingly strict regulations by the EU on battery recycling (Interview 13) as well as upcoming recycling projects like the recycling hub for Lithium-ion batteries in Germany that will start operations in winter 2022 (Fortum, 2022) will potentially shift this situation.

While on the one hand, bigger recycling capacities need the participation of governments, they will have an impact on battery technologies[22] (Huang et al., 2018, p. 274). Advancement in technologies will further have an impact on supply. Discussions about a new technology called *Direct Lithium Extraction* (DLE) might impact supply soon. DLE technologies use filters to remove lithium from brines without using much time or water. Currently DLE technologies are partly ongoing in Japan and New Zealand (Stringfellow & Dobson, 2021, p. 11) but they are forecasted to have a major impact in the future and contribute to developing "sustainable lithium production" (see Stringfellow & Dobson, 2021, p. 1). These developments will influence lithium prices since prices at the upstream stage might decrease drastically with a change in the supply of primary products (Interview 11) and will thus shift power relations along the GVC. Accordingly, in the future lithium producers as well might have an interest in pursuing risk-management via hedging.

The transformation of ownership structures the LME is undergoing and the infrastructural changes that come with it – like the presence of financial actors at the original 'physical commodity exchange' as well as the relation between the LME and PRAs – can be seen as part of the financialisation of commodity markets. Against this background, several interviewees mentioned the rising interest in the lithium sector by financial investors (Interview 5, 7). However, currently the tools to invest in lithium are very limited[23] compared to gold, silver or copper, because the market is still extremely small and not very diversified which means

[22] Despite the current high demand for LFP batteries, NMC batteries can more easily be recycled than LFP batteries. Hence, it looks as if the current competition between LFP (lower cost and simple to produce) and NMC (higher cost but better performance and recycle capacity) can be won by NMC batteries in the future, at least for the European end market for EVs (Interview 13).

[23] Usually, one can invest in minerals via for example exchange-traded funds (ETFs) – baskets of derivatives – or buying shares of mineral producing companies like Albemarle or SQM (Interview 5, 7).

investing in lithium is still considered to be risky due to high price volatility (Interview 5). Nonetheless, the Goldman Sachs Report on *Green Metals* that was published in June 2022 forecasted the price of lithium to go down to 16.000 dollars/ton (Goldman Sachs, 2022, p. 1), due to oversupply by Chinese lithium producers. Consequently, lithium stocks collapsed in the beginning of June (Interview 7) and lithium analysts were concerned this forecast would discourage companies of the upstream part to invest in new lithium projects. A large part of market participants disagreed with this forecast, saying Goldman Sachs would overestimate supply and underestimate demand (Barrera, 2022; Home, 2022, Interview 7). However, this kind of disagreement cannot be analysed without considering different market interests. How the microstructures of the LME and futures markets in general will develop due to increasing financialisation processes, as well as the potential willingness to conduct risk management, therefore needs to be observed further in the future.

6.2. Price determination and setting on a local level

Receiving information from the two lithium producing firms in Chile – SQM and Albemarle – is rather tough, and the two companies have been in the spotlight for their opaqueness several times as illustrated in Chapter 5. Therefore, it was not easy to gather information on the pricing of lithium in Chile during field work. On top of that, most of the interviewees didn't question where prices came from, and price determination was often considered as "given" by the (abstract) market (Interview 5, 13, 15, 18) and not as the contested process that it is.

Looking at the process of price setting, what quickly becomes evident, is the power of lithium producers in Chile, that can be illustrated by several examples. In 2020 for instance, battery and EV producers started to approach Chilean lithium producers because they wanted to buy the raw material directly from them to ensure supply. However, they couldn't close contracts because the battery and EV producers wanted to buy the products for low prices in order to be competitive with Internal Combustion Engine (ICE) cars. At that time lithium producers mainly had contracts with cathode makers. However, according to one lithium producer in Chile, they are currently negotiating contract terms with EV and battery producers at higher prices (Interview 13). In 2021 supply contracts with cathode producers were negotiated using fixed prices but the lithium producers came back to their clients in the beginning of 2022 to renegotiate pricing terms, since they knew how tight the market was and that they had the power to obtain higher prices from which higher profit followed (Interview 13). According to a European PRA "automakers and cell-manufacturers are the price takers rather than the price setters" (Interview 15). Consequently, it can be said that one reason for the producer power is the imbalance between demand and supply which can be derived from – among other factors –

lithium's territoriality (high concentration of lithium reserves), materiality (cannot be stored) and the narrative around electro-mobility and the high hopes placed in lithium-ion batteries to counter the climate crisis (by especially governments in the Global North and China). Additionally, one interviewee challenged the argument on the difficulties to create a standardised scheme for lithium regarding its materiality:

"Albemarle always said: Well, there is no single product called lithium. Well, of course, but that's an excuse in order to have a market which is not transparent. Because you have lithium carbonate, technical degree, or you have lithium carbonate battery degree. […] And they said, any product we have has specific requirements but that's nonsense. You could have a standardised scheme and to trade this in the London Stock Exchange and have transparency or whatever. The producers don't want to generate transparency." (Interview 6).

However, even if lithium producers would not strive for creating more transparency at the moment, because they largely profit from high prices that are determined in a very opaque manner, a bust cycle with decreasing prices is likely to follow in the future. Moreover, new technologies like recycling capabilities will influence the producer's market power sooner or later (Interview 22).

There is no information publicly available by SQM or Albemarle themselves on how they conclude their contracts and which prices they would use. However, outcomes of the interviews indicate that traditionally, it was common in the lithium market to use long-term contracts of around three years with fixed prices or price floating formula, hence, fixed prices with the opportunity to renegotiate after a couple of months in case of high price volatility. These prices were negotiation-led prices often taken from import and export statistics (Interview 5, 18). In Chile for example, the National Customs Service *Chile Aduanas Customs* and the export data (weight of lithium exported and value in US Dollars exported), that is accessible publicly, served as a reference point for pricing in many contracts (Interview 8, 11, 15). Import and export statistics often even seem to legitimise the "given nature" of prices, as stated by this interviewee:

"Well, you take the prices that are in the market, because […] there is data where you can find where the prices are at a certain point. You know how the market moves at that time, that's how you put the price" (Interview 11).

Also noticeable in this context is that the export prices are most of the time well below the lithium spot prices and the lithium contract prices (Interview 6, 13, 15). While, for example, the lithium price (FOB) calculated from export value and weight in January 2018 was at 11.486 US dollars/ton and at 6.062 US dollars/ton in May 2021, the BMI price for lithium carbonate (CIF Asia) was at 20.750 US dollars/ton in January 2018 and at 11.000 US dollars/ton in May

2018 (Appendix II, Benchmark Mineral Intelligence, 2022). There is criticism towards export statistics for being very opaque and there is no information on whether taxes and further fiscal costs are included (Bacchetta et al., 2012, p. 37; Carrère & Grigoriou, 2014, p. 1). In the case of lithium specifically, export data does not include information on the lithium grade and further material specification.

Another potential reason for the low export prices is the possible presence of transfer pricing of Chilean lithium producers. As illustrated in Chapter 5, Albemarle has been accused of using transfer pricing and selling a large volume of their product to their holding in the USA, thereby avoiding paying Chilean taxes. However, they have denied all accusations. Since Argentinian authorities have also presumed transfer pricing in the lithium market in Argentina, they have fixed a reference price for lithium carbonate exports from Argentina at 53.000 dollars/ton in June 2022. According to their National Tax Administration, this was done to prevent under-invoicing and thus lower royalties as well as bring transparency to the lithium market (J. Tang, 2022). Following one interviewee, the setting of this reference price by the Argentinian authorities was not based on any other reference price or price statistics (Interview 11) and according to S&P Global Platts, the contract prices under which Argentinian lithium producers were usually trading much lower than 53.000 dollars/ton. This raises the question as to costs and calculations which this price is based on. Any shipments now that are below the introduced reference price will be fined (J. Tang, 2022). Nonetheless, Argentinian lithium producers are not concerned about their profitability (Fastmarkets, 2022). It remains to be seen whether introducing a reference price for lithium exports will be an option in Chile in the future, following the example of Argentina.

Coming back to the contracts and pricing for lithium products in Chile, six main trends can be observed in this context.

Firstly, there is a general trend for lithium producers to move towards **[1] more medium and short-term contracts** with cathode, battery and EV producers in China, Japan and the Republic of Korea. The exact length of contracts differs from metal to metal, but in the lithium market, long-term contracts are usually contracts of around three years (Interview 5) and short-term contracts can range from a couple of months up to one year (Interview 13, 18). Even if Chilean lithium producers still prefer long-term contracts with their clients, price volatility makes them either **[2] use floating price formula in their (long-term) contracts instead of fixed prices,** or shorter bilateral contracts also based on floating price formula (Interview 13). These floating price formulas are then more and more frequently **[3] based on a PRA reference price**, while

moving away from using export prices that are usually lower than the reported PRA prices. (Interview 7, 13, 15). One lithium producer confirmed the common use of Fastmarkets and Benchmark Mineral Intelligence (BMI) reference price indices in their contracts with buyers. Additionally, he stated that his company uses those PRA prices that their clients are demanding to use. While they are rather indifferent[24] which PRA prices to reference in their contracts, specifically Chinese clients would want to use Chinese PRA price indices (Interview 13). Usually, according to a European PRA, South American producers are using the average PRA price that is published across a year for a certain product, or they use a price that is down to a *M – 1 basis*, meaning that the price used in contracts mirrors the average PRA reference price(s) that was/were published the month before. Using either discounts or premia on top of that is common, but recently, just premia are mainly being used due to the producer power (Interview 15). According to a Chilean governmental organisation active in the lithium sector, **[4] Albemarle in particular is selling in the contract market, while SQM is moving towards selling more and more of their products on the spot market**. This is because SQM has a huge producing capacity, and they can be opposed to risk at the very volatile spot market, and thus currently profit from the high spot prices inside China. At the same time Albemarle, who have lower production capacity, use the more stable contract prices (Interview 6, 18). It remains to be seen how these trends will develop in the future. Even though the Chinese spot market seems to be of great relevance (Interview 11, 15, 18) and was mentioned rather frequently during interviews, nobody knows exactly how these spot prices inside China are determined, since there is no liquid, functioning spot market for lithium, as illustrated before. It would therefore need further investigation on the mid- and downstream part of the lithium GVC that mostly takes place in China, Japan and South Korea. Even though there is a move towards reference pricing in bilateral contracts in the lithium market, to this day there is **[5] no established benchmark**. In lithium GPN with focus on Chile however, it can be said that **[6] the lithium carbonate price (99.2-5% min. lithium, CIF Asia) in particular** is of major importance now.

Not having a global benchmark in commodity sectors can have different distributional consequences. It firstly contests the competition among PRAs as well as between the LME and PRAs (Johnson, 2018, pp. 131–133). Secondly, a common benchmark is necessary for risk management activities like hedging because actors need the same price level to avoid price risks (ibid., p. 21). Thirdly, a common benchmark lowers the transaction costs for different market

[24] This statement needs to be considered with caution, since it is unclear why the company would be indifferent about which reference price by which PRA they would use. This needs further research.

participants and renegotiations (Johnson, 2018, p. 6). On the other hand, a common benchmark could possibly ignore local social and environmental cost structures like location specific labour and characteristics of the respective ecosystem and environmental costs at the expense of extraction. This shows the contradiction of (not) having a standardised global pricing system and how this impacts the local production system of lithium. The current pricing practices in the lithium market are contested due to their opaqueness and embeddedness in power asymmetries. However, besides questioning the current pricing system, exchange-based pricing systems and PRA practices often pursuing short-term strategies which fail to consider geographic specific environmental and social costs need to be criticised. Therefore, the following sub-chapter specifically tackles the struggles in the Political Economy of Chile around and beyond price determination and setting practices.

6.3. Contestation, power and ownership structures

Literature and outcomes of the interviews conducted in Chile illustrate the degree to which lithium production in Chile still stands in the shadow of the dictatorship and Chile's neoliberalisation. This is especially well illustrated with the connections between one of the largest lithium producers worldwide – SQM – and the former dictator Pinochet via Julius Ponce Lerou, as well as the scandals surrounding him, like the accusations of illegal political financing and market manipulation by Ponce Lerou. Regarding this topic, several interviewees remarked the large media coverage of the topic between 2017 and 2019. During this period, the high lithium prices were especially an issue in Chilean society, whereas today only minimal attention is given to the sky-high lithium prices by those not directly affected by lithium extraction (Interview 6, 11).

Apart from the dictatorship, the other lithium producer Albemarle has also been in the spotlight for illegal economic transactions. The accusations towards Albemarle of using transfer pricing have been depicted as "aggressive against the Chilean tax system" (Interview 6) during the research. Moreover, one interviewee highlighted that

> *"The issue of transfer pricing is a very old discussion in Chile. […] Lithium has a very different market behaviour because, as I said, it is not traded on the stock exchange. So, there is an opacity of the market itself that is beyond what Chile can do" (Interview 8).*

Hence, the relation between Chile's governance of lithium production to the era of the dictatorship on the one hand and the possible transfer pricing on the other, show how the well-established lithium producers SQM and Albemarle are intertwined with political and economic power in Chile. As the quote above shows, one interviewee even suggests a relation between possible transfer pricing and the missing regulation of lithium determination processes at

derivative markets like the LME. According to this interviewee, lithium producers in Chile are only able to sell their products under transfer pricing due to the missing pricing regulations on the London Metal Exchange.

Even if producers seem to have a lot of (bargaining) power in the Chilean lithium market, specifically in terms of price levels and pricing, further power structures can be observed. Despite the large lithium reserves, the strict regulations and extraction quota of the Corfo contracts hinder a sudden increase of lithium extraction. People fear that China in particular, a country that has large production capacities from brines and hard rocks, will catch up greatly in terms of production. Hence, lithium production from China would gain market share and put pressure on prices. Since many processing steps from extraction to battery manufacturing currently take place in China, the largest percentage of value adding activities is pursued there, giving China important market insights and power in the lithium GPN (LaRocca, 2020, p. 23)

Another important aspect of Chile's lithium governance and consequently an acute topic during the interviews, was the discussions about setting up a National Lithium Company in Chile, one of the proposals of Gabriel Boric. One of the biggest concerns regarding this state company targets knowledge, since SQM and Albemarle currently have all the information and know-how of the lithium extraction in the Salar de Atacama (Interview 6, 13, 15). Furthermore, some interviewees feared that investment in Chilean lithium might drop in case of an active National Lithium Company (Interview 6,13,15,20):

"Could […] be better off to have commercial organisations doing that and investing quickly and making things happen? Which typically in terms of nationalisation, you have seen that may not be the case. Historically if you look at nationalised mining companies, they weren't that successful as commercial enterprises" (Interview 15).

In general, however, the voices declaring themselves in favour of a National Lithium Company specifically highlighted a more equal distribution of value it could bring about and that it could introduce more value adding processes than just extraction, because the state would be interested in making profits through value adding technologies that benefit the society later (Interview 11, 17). Which strategy a nationalised company would choose in terms of pricing is still unclear and doesn't seem to be prioritised in the planning process (Interview 17). Hence, the perception of price determination is again perceived as given by the market and is embedded in hegemonic neoclassical economic thinking of how markets work perfectly to bring together individual demand and supply, leading to the aggregation of certain prices. Ultimately, PRAs were not worried about the possible creation of a national company controlling the lithium extraction, since their role as price deliverers would probably not change (Interview 15).

The biggest concern for producers in this context was the possible non-renewal of their contracts with Corfo after 2030 and 2043 (Interview 11, 12, 13, 15). However, it is still unclear exactly what a nationalised lithium model would look like, but the idea until now is to possibly "have different joint-ventures with private companies, on different levels - in the exploration, exploitation, manufacturing. This is more or less the idea. But in all these processes, the control is in the national company" (Interview 17). The goal of such a strategy would be to better control lithium extraction and to contribute to social and environmental justice and consider local specific social realties.

Therewith, it is referred specifically to the communities in the Salar de Atacama, whose territory is directly impacted by lithium extraction. Since the process of renewing the Corfo contracts in 2017 and 2018, both SQM and Albemarle must make payments according to their revenues to the communities. Hence, they profit from lithium extraction and from high lithium prices, just like the employees of the chemical companies (personal communication with an employee of a lithium producing company in Chile). However, at this point it needs to be highlighted that the relationship between the lithium producers and the communities in the Salar de Atacama shouldn't be generalised and class affiliations need to be considered (Interview 21). While some people directly affected by lithium production might approve the extraction due to the financial advantages they receive or jobs that occur from lithium extraction, others have a different perception. Many people have also opposed the renewed Corfo contracts and cooperation with the lithium producing firms (Interview 21) and still oppose this kind of green extractivism – that endangers the fragile ecosystem in the Atacama Desert – with strong resistance (ibid.). While there are communities who sell fresh water to the mining companies, others are protesting the way in which the lithium producing firms as well as the transnational companies who control the fresh water supply operate in Chile (Interview 12,21). In this context Anita Carrasco states:

"Mining companies are sufficiently powerful to transform the political economy of a region as profoundly as they can transform its land contours and hydrology. They create demands that sometimes lead native Atacameños to respond by shifting—not innocently—away from the sacred domain and toward treatment of water as a commodity, which is what the mining corporations aim to achieve." (Carrasco, 2016, p. 131)

On top of the payments to the communities, the renewed Corfo contracts also contained liabilities for research and development contributions. However, what is criticised sharply by activists, academia and NGOs in this context is that the process of extracting lithium still doesn't sufficiently include any social and ecological costs. These involve, for instance, reparation costs for the salt lakes, that should be somehow reflected in the lithium prices

(Interview 12). Additionally, the royalties the companies pay are solely based on the exported lithium quantity and not on the salty water pumped out of the salar. Here, a political incentive is needed and according to one interviewee, lithium extraction permits should instead be given out to companies that want to add value to the lithium extraction in Chile (Interview 11). This comes along with the vision of many Chileans of moving away from only being "a country that delivers natural resources" (Interview 17). However, it seems quite challenging to establish steps from the downstream end like producing cathodes directly in Chile. Firstly, because of the complex regulatory system for extracting lithium and secondly because Chile "is too far from the centre of consumption" (Interview 17). The rather deregulated and centralised economy in Chile doesn't contribute to adding more value at the regional or at the technological level (Interview 12). Furthermore, through the complex relation between producers and communities in the Salar de Atacama, communities gain power because they profit financially from the lithium extraction and block further investors from the salt lakes (Interview 10).

The neoliberal governance regimes in the territories of lithium extraction can be traced back to the harsh neoliberalisation Chile has been undergone during the dictatorship. Together with the sudden "lithium rush" (Dorn, 2021) that has hit Chile, they shape narratives and ideas on lithium on a global and local scale (Interview 21) and lead to contested processes on lithium, lithium prices and ownership structures. The politically difficult situation in Chile due to the still noticeable relics of the dictatorship, the rejection of the new constitution and scepticism towards the left-wing president, only strengthen these developments. The biggest challenges for Chilean people regarding lithium extraction are the difficulties in increasing value-added products in the country (Interview 7, 17) as well as the opaqueness of not only the financial sector (Interview 5, 8) but also the politics and economy in general (Interview 6, 21).

6.4. Synopsis

The analysis of the research conducted in Chile shows the embeddedness of lithium extraction in Chile, in the world economy and its production patterns in the EV sector. The high demand and supply squeeze due to highly concentrated lithium reserves globally, illustrate the negotiation power of lithium producers in price setting processes. While market participants in the upstream part of the GVC are observed to be "price setters", those in the downstream part can be called "price takers" according to an interviewee (Interview 15). The participation of lithium producers like Albemarle and Tianqi in the LME Committee – responsible for the cooperation with specific PRAs, and their reference price indices – furthermore solidifies the power of producers in the lithium GPN.

The lack of a global benchmark leads to competition among PRAs (and the LME) for providing a dominant price level on a global level and to difficulties for actors to pursue risk management despite the highly volatile lithium prices. Furthermore, although this illustrates the opaqueness of lithium pricing and prices in terms of social and ecological costs, it needs to be questioned whether one global world price for lithium could sufficiently take into account locally specific realities of labour, ecosystems, territories and ownership structures. PRAs do not act transparently and are hardly democratically legitimised and metal exchanges like the LME are increasingly pursuing short-term strategies thereby ignoring long-term risks like ecological degradation. Hence, even if in the future, there will be a move towards more transparent pricing by establishing a function futures market, this is still underpinned by powerful interests ignoring social and ecological costs of lithium extraction. The high lithium prices are indeed an outcome of high demand and low supply but additionally greatly influenced by the particular market – and thus by different institutions and powerful interests – they are "made" in.

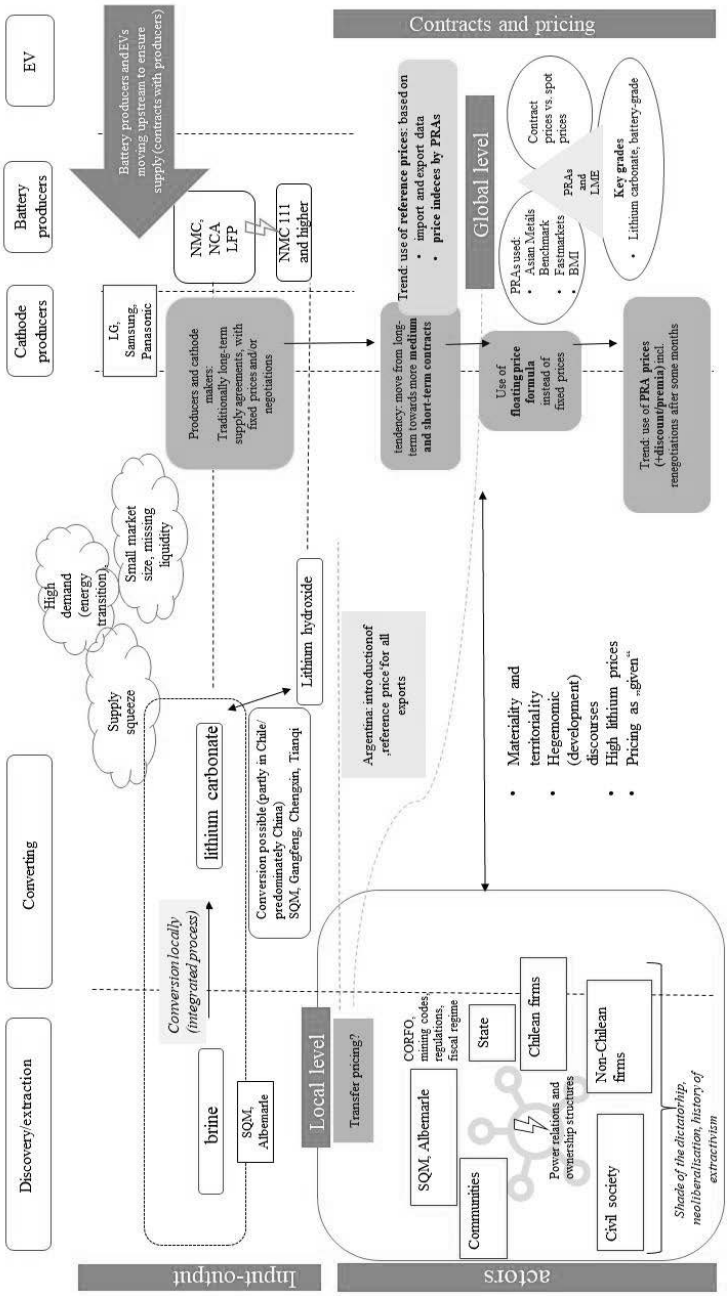
On a local level, despite the power at the upstream part of the lithium GPN, the low degree to which Chilean producers perform value-adding activities might shift this power to the downstream stage. Cathode and EV producers try to invest more and more frequently in new lithium projects in South America, now specifically in Argentina due to the strict regulations in Chile (Interview 5, 9, 18). Still, the largest part of value-adding activities along the lithium GPN takes place in China and this tendency seems to continue (LaRocca, 2020, p. 23).The degree to which lithium extraction in Chile today is embedded in national regulations and policies and still operates under laws and mining codes that date back to the Pinochet regime, influences the distribution of risks, costs and value in the Chilean lithium production network. The still centrally organised state leads to a lack of transfers of financial resources on a regional level, namely the Atacama Desert where extraction takes place. Furthermore, the ecological risks from lithium extraction are not sufficiently mirrored in royalties and the overall lithium price, thereby putting pressure on the fragile ecosystem in the Salar de Atacama. The communities directly affected by extraction practices in the Atacama Desert are more and more embedded in extraction, due to the renewed Corfo contracts that oblige producing companies to make payments to the villages located there. However, due to the different perceptions on green extractivism by the communities, this kind of value distribution can be seen as contested. It is not only a question of fair prices and compensation payments, but a question of hegemonic processes in the complex human-nature relationship. Hence, class struggles, and labour need to be a major objective when conducting further research within this field.

While many still speak of a vertically integrated GVC and the power of lithium producers pursuing extraction as well as processing activities, the main value-adding activities don't take place in Chile. This leads to the question of how lead firms would be characterised within the lithium GPN. Can the lithium producing firms be considered lead firms as they control price determination processes and further manufacturing steps of unprocessed lithium products, even if only to a certain degree? Or are powerful OEMs like Tesla leading the direction to which the market moves in terms of their hegemonic power position in the energy transition? Are these OEMs controlling the GPN by normative sense and ideological ideas? Which kind of role in controlling the GPN do different companies processing or converting lithium products like cathode, battery and EV producers have?

Even if most of the value adding takes place in the mid and downstream end of the lithium GPN, this sector is not yet vertically integrated as all process steps in the downstream part are being done by different companies. However, it can be observed that Chinese companies in the downstream part are growing their businesses in the upstream stage of the lithium GVC (van Wyk, 2022). The analysis illustrated that lithium prices are indeed an outcome of high demand and the current supply deficit. However, it becomes clear how price determination and setting processes are embedded in a complex political economy in Chile, that links economic development to political processes and class struggles on a local as well as global level.

Additionally, price determining processes are contested due to the Chilean constitution overrules property rights and interests of indigenous communities. Furthermore, the picture of Chile as an exporting country of natural resources still shapes the production network. Transparency in pricing, considering related social and ecological costs of lithium extraction, as well as transparency in the political system would help to further reveal the unequal distribution of risks, costs and value in Chile and how these transmit along the lithium global value chain to Asia and ultimately Europe. What follows is a graphic illustration of the lithium global production network with focus on the extraction in Chile, including key findings.

Figure 16 Lithium production network (global and local level)



Source: Author based on findings.

7 Conclusion

The research in this thesis has shed light on lithium price determination on a global level and relevant institutions and actors like the LME, PRAs and lithium producing companies in Chile and has analysed struggles around pricing and beyond on a local level, being intertwined with Chile's national policies, opaque contracts between different actors and the political economy of lithium extraction in the Salar de Atacama. The overarching theme guiding this thesis was the way in which price determination processes must be seen as a contested process, embedded in a capitalist world-system striving to transform major CO_2-intensive industries on the way to a climate-neutral future. The starting point of this thesis was the discussion of the climate crisis and the resource-intensive technologies needed for the transformation of major industries like the mobility sector. High hopes are placed in electric cars powered by lithium-ion batteries especially by countries of the Global North and China. Thereby lithium as the "white gold" (see Barandiarán, 2019, p. 381), has been part of much political and academic discourse over the last few years, centring around its perceived great electrochemical potential in a certain narrative about a socio-ecological transformation on the one hand, and its social and environmental downsides on the other. The embeddedness of lithium's socio-economic value in a globally scattered system of institutions responsible for commodity price determination like the LME and PRAs, as well as the impact of national policies in consumer and producer countries on pricing illustrate lithium's complex trading system.

The theoretical approaches show how important an analysis of the upstream part of global value chains of natural resources is. When examining ecologically unequal exchange within the current world system, a special focus needs to be put on primary production of natural resources and the extractive regime it is embedded in. Despite the importance of prices, the theoretical lens of the GPN framework combined with critical price theory and the broader financialisation literature helped answer the research questions. The focus on one node of the GPN, namely the focus on lithium extraction and production in the most important export country for lithium carbonate – Chile – helped to explore the logic behind prices for electro- mobility. Because this topic has not been addressed widely by researchers, contributing to the research gap by conducting semi-structured interviews across scales and with different actors in the lithium GPN, namely Chile and Europe was of great importance. This method furthermore allowed insights into price determination and specifically price setting processes and contracts which would not have been possible only by reviewing literature.

There were two research questions – broken down into several ones – guiding this thesis: ***How are prices determined and set in the lithium GPN across scales from 'world prices' to production in Chile?*** *Which prices are used by firms in the lithium GPN from Chile to Europe? What is the role of the London Metal Exchange and Price Reporting Agencies? What is the role of the regulatory and institutional context in Chile?* ***What are the struggles in the Political Economy in Chile around and beyond price determination?*** *What power struggles and different interests determine price levels at the local level in Chile? What are further contestations around social and environmental struggles in Chile?*

The findings suggest that the contestation around and beyond price determination and setting practices in the lithium sector in Chile are greatly influenced by global developments. In the lithium market, there is no global benchmark yet but powerful institutions like the LME and PRAs are competing to provide lithium price levels what has important outcomes for the industry because they use different ways to establish prices. These institutions will probably gain even more importance in the future. Their operations, however, lack transparency and are influenced by powerful interests such as the interests of lithium producing companies who gained in power due to the current hype around EV and Li-ion batteries and who are interested in high lithium prices as they profit from the current peak in demand. Furthermore, the LME has undergone a structural change with powerful financial actors and banks dominating international trade what influences price levels. Even though the PRA's methodologies are public, how they practice them in real life is very discretionary and greatly influenced by certain narratives of the industry as well as powerful actors. On top of that these prices are very exclusive due to the subscription fees that need to be paid in order to access price assessments.

More transparency in lithium pricing can be generated in the future by implementing a frequently traded futures contract at the LME, which can also ease physical transactions and can lower market entry barriers due to the opportunity for smaller market participants to pursue risk management via hedging. Nonetheless, the LME as an institution needs to be seen as problematic since it is underpinned by powerful interests and financial motives, and actors pursuing short-term trading strategies to generate profit, rather than considering the social and ecological costs of lithium extraction. Because lithium products are not easy to standardise and are embedded in different social realities and ecosystems in their place of extraction, not only current pricing but also the desire to move towards one global benchmark needs to be seen as a contested process. Global benchmarks in general ignore geographically specific production structures, social realities and ecosystems.

On a local level in Chile, it can be summarised that due the high demand and the supply squeeze – that originates from the narrative around transforming the transport sector – together with the high degree of concentration and control in the upstream part of the lithium GVC, lithium producing firms acquire a lot of power. They are considered as price setters while the mid-stream and downstream part as price takers. In Chile, these lithium producers are further embedded in a political economy, characterised by current political turmoils and lingering effects from the era of colonisation and the Pinochet regime. The opaqueness of lithium's production system and its control by only two companies, together with a political system where almost all power originates from the centre, weakens the opportunities of alternative production systems. It also weakens the voices of those criticising the model of green extractivism, fighting for including ecological and social costs in lithium prices. Different political agendas in Chile during the last decades showed how widely the governance of lithium can be practised.

The contracts between SQM and Albemarle with the CPA illustrate the degree to which costs and value transfers can take place as an outcome of political interests and discussions. However, lithium prices still do not include any social and ecological costs of extraction practices and ignore the unstable ecosystem in the Salar de Atacama. The relation between the centralised state, the privately owned, large lithium producing companies as well as civil society needs to be seen as highly complex and is permeated by asymmetrical power relations, narratives of territories as well as different development discourses. The findings indicate that within a discourse of regional development, value adding activities of lithium production are missing in Chile, which is why experts see the production in Chile as potential new resource curse. What needs to be asked here is, how political incentives could contribute to a process of economic upgrading and how this could eventually even contribute to social upgrading and higher wages for workers in the mining sector. The plans by the Chilean government to create a vertically integrated National Lithium Company could change the situation in the near future.

Besides criticising the current contested pricing system, price determining institutions like the LME and PRAs as well as price setters in the producer country Chile, the analysis suggests that the model of green extractivism needs to be considered as highly problematic. Instead of further promoting "green" mining, a major question revolves around the extraction of natural resources and its relation to humankind and the planet per se. Green extractivism must be seen as part of a certain narrative about a socio-ecological transformation and as part of the imperial mode of living propagated by countries in the Global North. The commodification of nature, technological advancements and the exploitation of new geographical areas through mining and

other extraction practices create new capitalist accumulation regimes (Wissen, 2013a, pp. 6–8). The latter are embedded in asymmetrical power structures that are intertwined globally and locally, as illustrated by the example of lithium extraction in Chile.

The EV sector and the public discourse around it in, for instance, the EU show that often political strategies in the neoliberal capitalism today neither question structural problems of extraction nor capitalistic production and consumption patterns (Klauke, 2019, p. 252). Cars in particular have always been part of massive state subventions, as they are one of the most important means of transport in Europe. In this context Haas and Schütt (2020, p. 550) claim that the enforcement of the car has been a contested process within modern society from the beginning on, and would not have been possible without public investments and tax privileges. The electric car has also been largely subsidised in European countries like Germany, which can be evidenced well with the introduction of the buyer's premium for BEVs in 2016 (ibid., p. 551). This shows how the narrative about a particular version of a socio-ecological transformation is underpinned by powerful interests and national policies.

Thereby political regulations and plans partly consider the environmental damages of natural resource extraction like cobalt and lithium that are necessary for the battery production, but pricing is hardly a topic in these discussions. However, the "basic premise of economic price theory" (see Beckert, 2011, p. 1) – the premise of price being an outcome of supply and demand in abstract markets – needs to be challenged by governments, researchers, (state) institutions and civil society. As the thesis showed, price determination processes are contested processes taking place in an environment of competition and asymmetric power struggles on a global level. Questions like *Whose interests are really expressed and mirrored in certain prices?* need to be asked.

Furthermore, the embeddedness of lithium extraction in financialisation processes that follow a new logic of industrial capitalism in the form of both, green extractivism and new forms of capital accumulation, needs to be discussed. Powerful actors of the lithium GPN like OEMs are increasingly dominated by a narrative of maximising shareholder value. Just recent developments illustrate this: In September 2022, the shares of the sports car manufacturer *Porsche* started trading in the Frankfurt Stock Exchange with 84 euros, which immediately exceeded the issue price of 82 euros. It was valued at 76.5 billion euros at its stock market debut and they specifically want to raise capital and finance electro mobility with their revenues from the sale of shares, in particular BEVs (Tagesschau, 2022; Theile & Müßgens, 2022). The creation of a new financial market segment in the sector of electro-mobility thereby comes with

further ecological degradation on the one side. On the other side it can be seen as a part of the financialisation of everyday life, and of increasing participation of households owning financial assets, thereby making finance a fundamental class issue that leads to an increasing individual exposure to risks and underlines that finance can never be neutral (Van der Zwan, 2014, pp. 111–114). Both, finance, and prices need to be seen as highly political and as forming a part of these narratives.

In Chile, the recent change of government, the rejection of the new constitution that aimed at replacing a charter made during a dictatorship, and recent discussions about establishing a National Lithium Company, greatly shape the contestation around and beyond lithium price determination and setting. I believe a comprehensive consideration of topics around pricing of critical raw materials would be of great importance in political debates in order to make pricing more transparent and just across scales. The energy prices right now illustrate how prices are not neutral and the state needs to play a leading role in paving the way to more transparency within this topic.

Furthermore, trade policies must include regulations on transparent and fair price making. While the EU law for example aims at promoting ecological protection and labour rights in all policies (European Commission, 2022b), transparent pricing need to be promoted on an agenda to foster sustainable development in international trade as well. Prices and costs as well determine social justice, environmental protection and respect for human rights and labour. Cooperation forums like the *Trade and Technology Council* (TTC) – announced in 2021 (European Commission, 2022a) – coordinating trade and technology between different economic areas, can be a further regulator to strengthen international standards on democratic price determination processes if there is a political will.

Additionally, the current pricing system of lithium needs to be replaced with alternative ones. An alternative pricing system should be transparent, calculate social and environmental costs and consider the scarcity of natural resources. Ideally, alternative pricing systems include all actors in the GVC in a democratic manner, fostering just decision-making processes. Society needs to emphasise the necessity to change consumption patterns in countries of the Global North and include price determination processes in this discussion. Together with recycling and other strategies of circular economies, this could contribute to a more sustainable use of natural resources, even though it needs to be highlighted that the extraction of critical minerals needs to be seen as unsustainable per se. From a climate policy point of view, it is extremely difficult to put a monetary price on ecological costs, because “what price should be put on the extinction

of a species? How much for the salination of drinking water thousands of kilometres away from the mining area?" (see Heinrich-Böll-Stiftung, 2014).

This thesis was a first attempt to shed light on the black box of lithium prices and pricing, as well as the struggles around and contestation beyond it. A focus was put on the extraction and production system in Chile and how it is embedded in an unequal world-economy. Further research needs to be done in Chile and Argentina but also in newly emerging lithium producing countries like Zimbabwe, DRC or Ghana. During this thesis a second black box emerged. When analysing pricing along the global value chain of lithium from Chile to Europe – or any other centre of consumption – the role of China seems to be of relevance. At the same time, this role is of great opaqueness and complexity. Hence, further research on processing steps of lithium products in China and how they impact the global pricing system urgently need to be conducted.

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9 Appendix

Appendix I: Price Data retrieved from LME

Contract name	**LME Lithium Hydroxide CIF (Fastmarkets MB)**
Contract code	**LH**
Currency/unit	**USD/mt**
Jul-21	$ 15.500,00
Aug-21	$ 16.070,00
Sep-21	$ 20.100,00
Okt-21	$ 24.630,00
Nov-21	$ 29.380,00
Dez-21	$ 31.480,00
Jan-22	$ 38.600,00
Feb-22	$ 51.870,00
Mrz-22	$ 69.580,00
Apr-22	$ 81.170,00
Mai-22	$ 79.730,00
Jun-22	$ 75.000,00
Jul-22	$ 75.000,00
Aug-22	$ 75.640,00

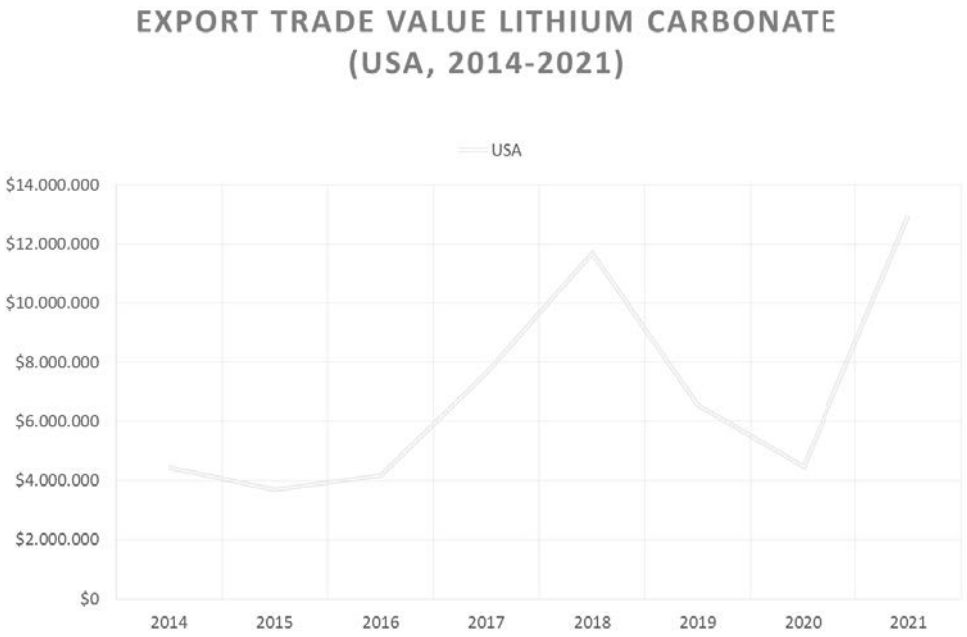
Source: LME, 2022

Appendix II: Export data from Chilean Customs Service (2017-2022)

Month	lithium exported in US Dollars (FOB)	lithium exported in weight (kg)	Lithium FOB price per unit(kg) in US Dollars	Lithium FOB price per unit(ton) in US Dollars
Jan 17	72.440.908,10	8.468.242	8,554	8554,42
Feb 17	71.070.059,50	8.923.559	7,964	7964,32
Mrz 17	56.191.427,10	6.863.658	8,187	8186,80
Apr 17	102.118.827,80	10.656.462	9,583	9582,81
Mai 17	70.580.347,60	6.494.834	10,867	10867,15
Jun 17	50.642.988,60	4.954.653	10,221	10221,30
Jul 17	51.295.346,40	4.817.941	10,647	10646,74
Aug 17	72.263.048,20	6.557.277	11,020	11020,28
Sep 17	68.335.146,10	6.379.136	10,712	10712,29
Okt 17	80.777.603,90	7.129.007	11,331	11330,84
Nov 17	87.212.817,30	8.332.199	10,467	10466,96
Dez 17	54.384.495,80	4.670.275	11,645	11644,82
Jan 18	96.818.739,80	8.429.037	11,486	11486,33
Feb 18	86.687.115,80	6.660.614	13,015	13014,88
Mrz 18	62.492.103,90	4.964.485	12,588	12587,83
Apr 18	120.890.110,60	9.378.357	12,890	12890,33
Mai 18	76.048.169,90	5.834.200	13,035	13034,89
Jun 18	110.413.345,90	7.994.207	13,812	13811,67
Jul 18	94.955.645,50	7.184.505	13,217	13216,73
Aug 18	111.092.734,30	8.529.572	13,024	13024,42
Sep 18	63.340.798,50	4.941.992	12,817	12816,86
Okt 18	88.978.036,40	7.301.755	12,186	12185,84
Nov 18	86.281.203,70	6.510.737	13,252	13252,14
Dez 18	76.979.651,50	6.161.753	12,493	12493,14
Jan 19	120.006.066,10	8.767.566	13,688	13687,50
Feb 19	67.010.350,60	6.175.564	10,851	10850,89
Mrz 19	100.183.269,50	8.366.812	11,974	11973,89
Apr 19	62.717.637,90	5.733.825	10,938	10938,18
Mai 19	82.636.387,20	9.214.741	8,968	8967,85
Jun 19	77.488.103,80	8.825.063	8,780	8780,46
Jul 19	81.794.112,20	10.127.073	8,077	8076,78
Aug 19	71.104.982,20	8.975.203	7,922	7922,38
Sep 19	34.654.951,70	3.949.227	8,775	8775,12
Okt 19	67.274.586,90	9.244.887	7,277	7276,95
Nov 19	65.151.005,60	7.868.779	8,280	8279,68
Dez 19	70.619.638,40	8.459.483	8,348	8347,99
Jan 20	67.947.657,80	7.756.962	8,760	8759,57
Feb 20	43.667.082,90	6.949.190	6,284	6283,77
Mrz 20	49.482.600,20	7.606.655	6,505	6505,17
Apr 20	61.918.845,50	11.121.951	5,567	5567,26
Mai 20	50.853.135,30	9.181.444	5,539	5538,69
Jun 20	93.115.059,80	13.616.272	6,839	6838,51
Jul 20	41.684.660,60	5.000.124	8,337	8336,73
Aug 20	53.018.816,70	9.296.613	5,703	5703,03
Sep 20	48.146.388,10	8.614.078	5,589	5589,27
Okt 20	62.469.539,50	11.669.780	5,353	5353,10
Nov 20	37.119.270,80	7.426.311	4,998	4998,35
Dez 20	61.320.785,40	12.087.979	5,073	5072,87
Jan 21	64.623.450,10	12.317.014	5,247	5246,68
Feb 21	40.639.187,10	7.069.596	5,748	5748,45
Mrz 21	46.611.088,30	9.041.002	5,156	5155,52
Apr 21	110.974.146,10	20.802.447	5,335	5334,67
Mai 21	69.254.148,30	11.423.368	6,062	6062,50
Jun 21	75.309.667,90	10.956.116	6,874	6873,76
Jul 21	92.235.020,20	14.849.640	6,211	6211,26
Aug 21	69.379.623,20	9.964.429	6,963	6962,73
Sep 21	112.796.604,80	15.579.294	7,240	7240,16
Okt 21	91.910.048,80	12.474.357	7,368	7367,92
Nov 21	111.437.397,70	14.216.617	7,839	7838,53
Dez 21	95.691.314,00	11.462.451	8,348	8348,24
Jan 22	317.583.208,90	19.577.983	16,221	16221,45
Feb 22	299.430.905,20	19.041.400	15,725	15725,26
Mrz 22	254.024.681,30	13.113.998	19,370	19370,50
Apr 22	781.634.607,20	19.301.579	40,496	40495,89
Mai 22	1.458.382.626,00	27.956.240	52,167	52166,62
Jun 22	657.974.390,40	13.565.963	48,502	48501,86
Jul 22	852.759.199,70	20.321.208	41,964	41964,00
Aug 22	758.506.277,80	16.760.169	45,256	45256,48

Source: Author, data retrieved from Chile Aduanas Customs, 2022

Appendix III: Export trade value lithium Carbonate (2014-2021), USA



Source: Author, data received from Figure 6

Appendix IV Questions – Guidelines

Lithium producers & mining/refining companies (state-owned and private)

Introduction: Interviewee and Organisation Profile

Could you please give me background on your company?

- What are your main fields of operations?
- More concrete: What are the key activities of your organisation within the lithium sector in Chile?
- Which extraction projects does your company operate in Chile?

What is your role in this company?

A Lithium GVC

A1. Can you describe the operations of your company in the lithium GVC?

- What type of companies are your (suppliers) and buyers?
- What is your relationship with other actors of the lithium GVC?

B Contracts and Pricing

B1. What types of contracts and prices do you mostly use?

1. What are the typical contract types and contract durations that your company uses for buying and selling transactions?
    - Which type of agreements (term agreements?) are dominantly used throughout the value chain?
    - Do you prefer long-term or short-term contracts? Why?
    - Do you use different contracts depending on clients, countries, lithium characteristics, etc.? Which factors influence the choice of contracts?
    - Do other companies pursue a similar or a different approach to your company in the lithium value chain? If different, in what way and why?
2. How are prices determined in your contracts?
    - How does the process of determining a price in a contract look like? Do you use any reference prices, if so, which ones and how? If not, why not?
    - What is part of the pricing formula? Is it common to use discounts and premia?

B2. How do you perceive the role of Price Reporting Agencies in lithium price-setting?

- What are the factors that make a PRA price being applied as price benchmark in bilateral contracts?

B3. Are there differences in types and durations of contracts as well as pricing across geographical locations?

- Are there any particularities in the Chilean lithium market?
- Do you see a change in the types of contracts and pricing in the last 5-15 years?

C Price volatility and risk management

C1. How do you deal with price volatility?

- What price risk management techniques does your company apply?

- How do you see the more recently introduced lithium hydroxide futures contracts at the LME? Why is it not traded?
- Do/would you use derivatives for risk management operations?
- Do you see recent change regarding price volatility?
- Do you see recent changes regarding price volatility and actors' behaviour in the GVC and if yes how do these changes relate to PRAs and the LME (e.g. activity of more financial investors)?

C2. Which actors in general use price risk management techniques in the lithium GVC and why?

- Have there been any significant changes in the way price-related risks are managed? What changed and why?

C3. How do you perceive the evolution of lithium prices?

1. How do you perceive the recent spike in lithium prices?
   - How would you forecast the price development in the next months and years?

2. How do actors react when prices increase?
   - Which adjustments in the price formula are made in the case of increasing (or falling) prices?
   - Is arbitrage over pricing popular in this context?

3. Do you see any alternative pricing policies in the lithium sector?
   - Are there currently any thought on alternative price setting in South America (e.g. cartel price setting through Argentina/Bolivia/Chile?)

D Chilean mineral policies

D1. How do you perceive the debate on privatisation of natural resources?

- How do you perceive privatization of most natural resources in Chile?
- How do you perceive the state ownership of lithium in Chile?
- How do you perceive the possible changes in Chile's new charter that address the topic of nationalizing lithium mines?
- Are there any differences to other countries, in particular Bolivia and Argentina?

D2. What is the role of licenses for brine extraction?

- Who is involved in the decision on who gets mining licenses?
- How often and to which criteria are these licenses granted to firms?
- Are there different regulations in granting licenses to mining companies (CEOL, Corfo, CCHEN?)
- What components are included in the licensing process? (i.e. environmental/social aspects)?
- What role do the licenses play for your company?

D3. How do you perceive the new proposed Mining Royalties Law?

- How will it influence the lithium sector in Chile?
- Higher taxes are planned. How does that correlate with the licenses?

- How will it influence the future of foreign investment in Chile? In your opinion will these changes have an impact on the electro-mobility sector?
- Will it have an impact on the global lithium sector in general?

D4. Are there any specifies in the Chilean mineral policies in comparisons to other producer countries and if yes why do you think this is the case?

- Are there any other current debates about the regulation of the lithium sector (in Chile?)

D5. How does the strategy of your company relate to the strategy of the Chilean state? *(question specifically for state-owned enterprises)*

- Have there been any significant changes in the last year?

D6. How do you perceive the role of state-owned companies in the lithium sector?

- What is your opinion on the Chilean state strategy in the lithium sector? *(question specifically for private enterprises)*

E Different interests in the lithium GVC

There are different interests in the lithium sector and the lithium GVC. Could you please elaborate on that.

- Which development impacts do different interests the lithium sector have (in Chile?)
- How do you perceive local conflicts in the Chilean lithium sector? How does your company cope with these?
- What role do prices play in conflicts and different interests in the lithium sector?

F Future Outlook

F1. What are the main changes/developments on the lithium market in recent years?

Please list the top 5 changes/developments

F2. How do you perceive the future of lithium brines in South America?

- What effect does the long development from lithium discovery to extraction (2 years?) have on the future of lithium brines?
- Which type of specification / lithium grade do you see the most important to be used in contracts along the lithium GVC?
- How important do you see lithium chloride as intermediary product from brines? Is it traded/priced at all?
- How do you perceive the development of new brine projects? As useful and successful?
- How would you elaborate on the future of lithium brines versus lithium hard rock mines? What is Zimbabwe's role in the lithium sector?

F3. How important do you see the development of new technologies in the lithium sector?

- Will difficulties in storage influence lithium in the future?
- How will the role of recycling influence the lithium market?

1. Will new extraction technologies be able to satisfy demand in the future?

- How do you perceive the growing popularity of Lithium Clay Salt Extraction processes?
- What is your opinion on the Direct Lithium Extraction (DLE) technology?

2. How do you perceive technological developments in Europe and China?
    - How do you perceive current developments of lithium refining and converting practices in Europe?
    - How do you perceive the growing influence of China in the lithium upstream stage?
    - Could you imagine that the processing of cathodes is becoming more important in Chile directly?
    - Do you see any changes in the battery section in general? Do you see changes in who the buyers of (Chinese) battery manufacturers are?

Snowballing and Triangulation

Based upon what we've discussed today, is there any additional information you have that might be useful for this study? Who else do you recommend that I might speak to?

Policy actors and associations

Introduction: Interviewee and Organisation Profile

Could you please give me background on you and your organisation?

- What are the key activities of your organisation within the lithium sector in Chile?
- Do you corporate with other organisations?
- How long have you been working in the lithium industry?
- What is your role in this organisation?

A Chilean lithium sector and national policies

A1. Could you please elaborate on the history of lithium regulations in Chile?
- What are the main regulations of lithium in Chile?
- What is the approach of the state of regulating lithium and (how) has that changed?
- What is the approach of the state in regulating other metals in Chile?

A2. How do you perceive the debate on privatisation of natural resources?
- How do you perceive the privatisation of most natural resources in Chile?
- How do you perceive the state ownership of lithium in Chile?
- How do you perceive the possible changes in Chile's new charter that address the topic of nationalizing lithium mines?

A3. What is the role of licenses for brine extraction?
- Who is involved in the decision on who gets mining licenses?
- How often and to which criteria are these licenses granted to firms?
- Are there different regulations in granting licenses to mining companies (CEOL, Corfo, CCHEN?)
- What components are included in the (different) licensing processes? (i.e., environmental/social aspects)?
- How does this model of licenses differ from other countries?

A4. Could you please elaborate on the new proposed Mining Royalties Law?

- How will it influence the lithium sector in Chile?
- Higher taxes are planned. How does that correlate with the licenses?
- How can different state policies impact the development (economic, ecological) in Chile?
- How will it influence the future of foreign investment in Chile? In your opinion, will these changes have an impact on the electro-mobility sector?
- Will it have an impact on the global lithium sector in general?

A5. What are the specifies in the Chilean mineral policies in comparisons to other producer countries?

- Are there any differences (to Bolivia and Argentina) in terms of policies on royalties?
- Are there any differences (to Bolivia and Argentina) in terms of the licensing process?
- Are there any differences (to Bolivia and Argentina) regarding privatisation issues?
- How do differences in mineral policies influence the metal flows?

A6. Are there any other current debates about the regulation of the lithium sector (in Chile?)

B Different interests in the lithium sector in Chile

There are different interests in the lithium sector and the lithium GVC. Could you please elaborate on that?

- Which development impacts do different interests in the lithium sector have (in Chile?)
- What are the main reasons for conflicts in the lithium sector in Chile?
- Where do the main conflicts take place?
- What is the state doing to stop these conflicts?
- What instruments would be the most effective in preventing/abolishing unsustainable practices in the supply chain?

C Industry trends and lithium prices

C1. Which factors (fundamental/financial) influence the level as well as volatility of lithium prices most?

- Do you broadly agree that the influence of financial investors on lithium prices has in general increased?
- Would you say there has been a change in the degree of engagement in financial activities by commercial actors in the last 10-20 years? If so, could you elaborate on the types of activities pursued?

C2. How do you perceive the evolution of lithium prices?

1. How do you perceive the recent spike in lithium prices?

- How would you forecast the price development in the next months and years?

- How do actors reach when prices increase? Is arbitrage over pricing popular in this context?

2. Which factors influence price volatility?
   - Are any policies used to manage risk due to price volatility?

C3. How do you perceive price-setting in contracts in the Chilean lithium sector?

- How are prices determined in a contract? Is it common to use reference prices?
- Which types of agreements are dominantly used throughout the value chain?
- What is the role of PRAs in the current price-setting?
- What is the role of LME regarding prices and price-setting?
- Do you see alternative pricing policies in the lithium sector as realistic (e.g. cartel price setting through Argentina/Bolivia/Chile?)

<u>D Future outlook</u>

D1. What major trends do you expect in the lithium market in the coming years?

- What are the main changes/developments on the lithium market in recent years? How are actors dealing with that (producers/refiners/traders/consumers)?
- What drivers and challenges for the lithium industry do you see in relation to socio-ecological transformation?
- What's your organisations long-term strategy considering these trends? Are there any planned developments?
- How do you see the future of Chilean lithium brines in the global lithium sector and compared to other countries?
- How will the role of recycling influence the lithium market and lithium pricing?

D2. How do you perceive the future of lithium brines?

- What effect has the long development from lithium discovery to extraction (2 years?) have on the future of lithium brines?
- How do you perceive the development of new brine projects? As useful and successful?
- How would you elaborate on the future of lithium brines versus lithium hard rock mines? What is Zimbabwe's role in the lithium sector?

D3. Will new extraction technologies be able to satisfy demand in the future?

- How do you perceive the growing popularity of Lithium Clay Salt Extraction processes?
- What is your opinion on the Direct Lithium Extraction (DLE) technology?

D4. How do you perceive technological developments in Europe and China?

- How do you perceive current development of lithium refining and converting practices in Europe?
- How do you perceive the growing influence of China in the lithium upstream stage?
- Could you imagine that the processing of cathodes is becoming more important in Chile directly?

- Do you see any changes in the battery section in general? Do you see changes in who the buyers of (Chinese) battery manufacturers are?

Snowballing and Triangulation

Based upon what we've discussed today, is there any additional information you have that might be useful for this study? Who else do you recommend that I might speak to?

Civil Society: NGOs, social movements, local communities and individuals

Introduction and lithium sector in Chile

- Who are you and what are your connections to the lithium sector in Chile?
- How important do you perceive the lithium sector in Chile for the population and the country? What is the culture around it and what kind of value does it have?

A Chilean lithium sector and broader development implications

A1. Can you please elaborate on the current local conflicts due to the lithium extraction?

- What are the particular drivers of conflicts due to lithium extraction?
- How do these conflicts relate to other conflicts in Chile?
- Have the conflicts changed over time? Why?
- Who is mostly part of the conflicts?

A2. Can you please elaborate on the movement you are a part of?

(question specifically to persons who are part of counter movements/ local community)

1. What are their goals and challenges?
2. What is the relation of the countermovements to the Chilean state and the mining companies?
3. Which achievements can be observed?

A3. What instruments would be the most effective in preventing/abolishing unsustainable practices *(ecological problems/ social problems etc.)* **in the supply chain?**

B National policies

B1 How do you perceive the debate on privatisation of natural resources?

- How do you perceive the privatisation of most natural resources in Chile?
- How do you perceive the state ownership of lithium in Chile?
- How do you perceive the possible changes in Chile's new charter that address the topic of nationalizing lithium mines? (What are the key pros and cons in your opinion?)

B2. What is your opinion on the model of mining licenses in the Chilean lithium sector?

- What are the pros and cons of mining licenses in your opinion?

- Can you elaborate on the different regulations in granting licenses to mining companies (CEOL, Corfo, CCHEN?)

B3 Could you please elaborate on the new proposed Mining Royalties Law?

- Higher taxes are planned. How will it influence the lithium sector in Chile? Who in particular will be the most affected?
- How will it influence the future of foreign investment in Chile?

B4 What are the specifies in the Chilean mineral policies in comparisons to other producer countries?

B5 How do you perceive the media coverage of the lithium extraction in Chile?

B6. What changes would you like to see in the Chilean lithium sector?

C Lithium Prices

C1. How do you perceive the lithium price volatility? Are there ways people can protect themselves?

*C2. Question to **NGOs** who have expertise in this area: Does the civil society have access to how lithium is traded and what are the key issues in trade of lithium? Is pricing an issue at all?*

*C3. Question to **local communities**: how do people within your community perceive the price volatility and high lithium prices?*

Lithium prices have been exploded in the last years and months.
Could you please elaborate on that?

C4. Lithium prices are greatly increasing at the moment. How do you perceive this development?

- What are the top 3 reasons?
- Do you see the increasing lithium prices as opportunity or as a drawback? Why and for whom?
- How do companies react when prices increase? How does the Chilean state react?
- How do people react when prices increase? Are people changing their livelihood/income generating strategies? In which areas (work/everyday life) are they affected by increasing (or falling) prices?

C5. Are prices in general and price-setting an issue in the civil society?

- How do you perceive the role of PRAs and the LME in lithium prices and price setting?

D. Trends, drivers and challenges

D1. What major trends do you expect in the lithium market in the coming years?

- What are the main changes/developments on the lithium market in recent years? How are actors dealing with that (producers/refiners/traders/consumers)?
- What drivers and challenges for the lithium industry do you see in relation to socio-ecological transformation?
- How do you see the future of Chilean lithium brines in the global lithium sector and compared to other countries?
- How will the role of recycling and other technological advancements in batteries influence the lithium market?
- How will advancements in lithium extraction (i.e. DLE/lithium clay salt extraction) influence the lithium market?

Important: How does the future outlook link to the interviewee's specific point of view

Snowballing and Triangulation

Based upon what we've discussed today…

- Is there anything else you would like to tell me about Chile/lithium in Chile/ natural resources in Chile in general?
- Is there anything else I should know of the lithium sector in Chile
- is there any additional information you have that might be useful for this study?
- Who else do you recommend that I might speak to?

Appendix V: Interview List

Interviews		
Number	**Interview partner**	**Location**
1	Founding partner of a business consulting firm specialised in the lithium market, based in Chile	Online
2	Employee of a European Price Reporting Agency (1)	London, UK
3	Employee of a European Price Reporting Agency (2)	London, UK
4	Employee of a spot trading platform	Online
5	Employee of a former lithium producing company	Santiago, Chile
6	Former politician and head of a state-agency; University professor	Santiago, Chile
7	Lithium Economics Analysist	Santiago, Chile
8	Economist working for a NGO with a focus on sustainability,	Santiago, Chile
9	Chemical engineer and employee of a Chilean governmental organisation	Santiago, Chile
10	University Professor Chile (anthropology)	San Pedro de Atacama, Chile
11	University Professor Chile (environmental economics); former member of the National Lithium Commission	Online
12	Leader of a NGO with a focus on mining conflicts in Latin America	Santiago, Chile
13	Head of market at a lithium producing company in Chile	Santiago, Chile
14	Sector expert	London, UK
15	Employees of European Price Reporting Agency (1)	Online
16	Employee of a base metals trading company	London, UK
17	University Professor Chile (Physics); working for the current Chilean government	Santiago, Chile
18	Employee of a Chilean governmental organisation in Chile	Santiago, Chile
19	Employee of a technology and recycling group in Europe	Online
20	Director of a governmental organisation in Chile	Santiago, Chile
21	Accademia and activist in Chile	San Pedro de Atacama, Chile
22	Trading Association in Europe	Online
Personal Communication		
	Member of Committee of Atacama People (CPA)	San Pedro de Atacama, Chile
	Employee of a lithium producing company	Salar de Atacama, Chile
E-mail contact		
	European Price Reporting Agency (1)	September 9, 2022
	Governmental organisation Chile	April 27, 2022