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"CRITICAL MINERAL FUTURES MARKETS: A BRIEF INTRODUCTION"

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Critical Mineral Futures Markets: A Brief Introduction

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Critical minerals will be an increasingly important part of the global economy (Collins *et al.*, 2024; IEA 2024; Boer *et al*., 2021). The rise in demand for critical minerals begs the question of how to develop effective market-based pricing signals that encourage new supplies. Futures markets for many critical minerals are non-existent; those that do exist like lithium and cobalt, however, remain relatively small and less liquid in the U.S. compared to other commodity markets. Thinner and illiquid markets tend to face higher levels of volatility (Redlinger and Eggert, 2016), which makes them less effective in providing pricing signals for investors to effectively allocate capital.

Efficient pricing mechanisms support long-run decisions in allocating capital through price discovery and transparency. One way for investors, companies, and traders to understand how commodity prices will behave is via the futures markets.

Current Critical Mineral Markets

There are three main exchanges in the world on which critical mineral futures trade: the Chicago Mercantile Exchange (CME), the London Metal Exchange (LME)[1], and the Guangzhou Future Exchange (GFEX) in China. Minerals such as aluminum and nickel are widely traded and well-established, but lithium and cobalt—key battery minerals—futures contracts are in their nascent stages of development.

Futures markets enable market participants to buy and sell commodities at predetermined prices and on fixed dates. In other words, market actors can engage in hedging, which is a practice to mitigate downside risk by ensuring a future price to sell or buy the mineral of interest.

Given that the majority of minerals expected to increase in use are manufactured in China—from EV batteries to solar panels—many contracts are priced relative to the cost of insurance and freight to China and delivered there. As a result of the high level of concentration in manufacturing activity, the most heavily traded critical mineral markets are in China.

A challenge for effective pricing for critical minerals comes from the nature of minerals themselves. Minerals can come in different chemical forms and grades that have different applications. Take the example of the CME's lithium hydroxide futures contract and compare it to the GFEX's lithium carbonate contract. Lithium hydroxide is broadly used for nickel-based battery cathode chemistries while carbonate is used in lithium-based cathode chemistries.[2] This difference, as we will see later, leads to arbitrage opportunities between markets (Till, 2024).

Different forms of minerals can make it difficult for the market to understand which one is most important. For example, there are different contracts for different grades and end-uses (see Table 1 on the next page). One of the key issues in hedging, for instance, is basis risk, wherein the price performance of a futures

contract can differ from the physical commodity. As a result, if a buyer of cobalt sulfate does not have a futures contract that effectively replicates the price risk of the underlying commodity, they may not be able to hedge effectively. The standardization of lithium, nickel, cobalt, manganese, and others would be a challenging yet important step towards critical mineral market future maturity.

Hedging enables buyers and sellers up and down the supply chain to manage price risk. Generally, speaking, sellers of a commodity can fix their price risk to avoid selling at a lower price. Buyers of a commodity can fix the price of a commodity to minimize their input costs. Purchasers of cobalt and lithium, for instance, could be electric vehicle battery manufacturers, while sellers are either mining companies and/or commodity traders.

Hedging activity happens through the futures market, where buyers and sellers are matched. One key feature of the futures market is the interaction of producers, speculators, and end-users. The interaction of these three broad groups is what enables efficient price discovery. Speculators are important in the provision of liquidity for both producers and consumers of commodities. For instance, a speculator can take on the other side of a producer hedging, so effectively betting that prices will rise vs. fall. This enables the producer to fix its selling price, while the speculator has the potential to earn a profit through its hedging service and if they are right about the direction of prices.

Having different forms of minerals, traded on different exchanges can open the door to potential arbitrage opportunities. As Till (2024) notes, for example, in an analysis of the lithium market, CME lithium hydroxide futures are being spread in the U.S. market versus GFEX lithium carbonate contracts.

Table 1

Selected Mineral Contracts

Mineral	Contract	Specification	Delivery Location	Pricing
Cobalt	Cobalt alloy grade	>99.8%, in warehouse Rotterdam	Europe	$/lb
	Cobalt Standard Grade	>99.8%, in warehouse Rotterdam	Europe	$/lb
	Cobalt 99.8% Co min Basis	>99.8%	China	Yuan/tonne
	Cobalt Sulfate 20.5%	Cobalt Sulfate	China	Yuan/tonne
	Cobalt tetroxide 72.6%	Cobalt tetroxide min 72.6%	China	Yuan/tonne
	Cobalt hydroxide payable indicator	Cobalt hydroxide	China	$/tonne
	Cobalt Hydroxide index	30% Co min, Cobalt hydroxide, cif	China	$/lb
Lithium	Lithium carbonate min 99%	99% LiCO3 technical & industrial grades	China	$/kg
	Lithium carbonate 99.5%	99.5% Li2CO3 min, battery grade, cif China, Japan, & Kprea	China	$/kg
	Lithium carbonate 99%	99% LiCO3 technical & industrial grades, ddp Europe & US	Europe	$/lb
	Lithium carbonate 99.5%	99.5% min, battery grade, ddp, Europe & US	Europe	$/kg
	Lithium hydroxide monhydrate min 56.5%	LiOH.H20 56.5% LiOH min, technical & industrial grades, cif,	China	$/kg
	Lithium hydroxide monhydrate min 56.5%	LiOH.H20 56.5% LiOH min, battery grade, ddp, Europe & US	Europe	$/kg
Nickel	Nickel 4x4 cathode	Nickel 4x4 cathodes	Rotterdam	$/tonne
	Nickel briquette	Nickel Briquettes, delivered Midwest US	US	$ cents/lb
	Nickel 4x4 cathode all-in price	Nickel 4x4 cathodes, Midwest US	US	$ cents/lb
	Nickel min 99.8%	>99.8% briquette, cif Shanghai	Shanghai	$/tonne
	Nickel mixed hydroxide	Mixed hydroxide precipitate, cif, China, Japan & S. Korea	East Asia	$/tonne
	Nickel mixed hydroxide	Mixed hydroxide precipitate payable indictaor %, LME, cif	East Asia	$ cent/tonne
	Nickel mixed hydroxide	Mixed hydroxide precipitate, fob, Indonesia	Indonesia	$/tonne
	Nickel Sulfate	Min 21%; max 22.5%, cobalt 10ppm max, exw, China	China	Yuan/tonne

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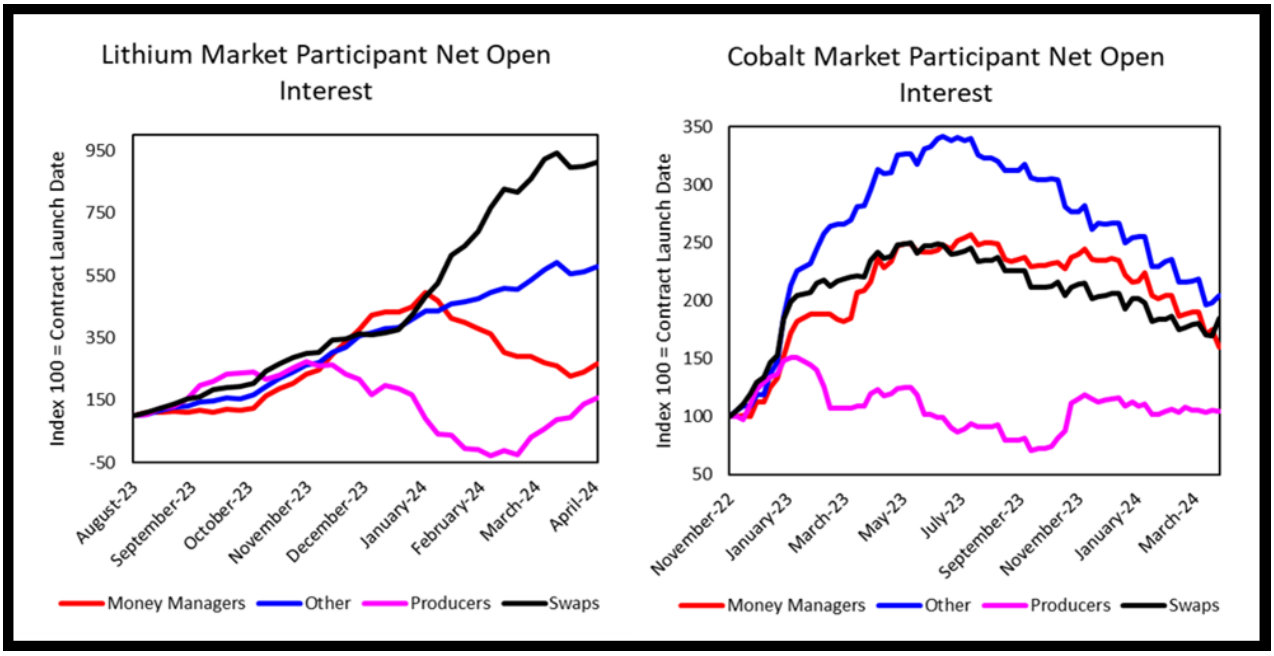
Notes: delivered = delivered duty paid
cif = cost of freight and insurance
ddp = delivered
fob = free on board

Lithium & Cobalt Futures Markets

Current cobalt and lithium futures markets at the CME remain underdeveloped relative to other critical mineral contracts such as aluminum. Data from the U.S. Commodity Futures Trading Commission (CFTC) show the recent relative changes in open interest across types of market participants for the lithium hydroxide and cobalt metal cash-settled contracts. In particular, Figure 1 illustrates the relative lack of participation by producers.

Figure 1



Sources: CFTC, Author's calculations.

Today's lithium and cobalt markets face a lack of liquidity, which restricts the ability of participants to use the futures market for improved price discovery and transparency of price movements. In contrast with aluminum futures where producers make up most of the activity, in the case of cobalt, producers make up the smallest share. This distinct lack of producer hedging in the market for cobalt is a limiting factor in the market's path to maturity and ultimately, new cobalt mines through reduced price uncertainty.

Cobalt and lithium's dearth of producer hedging limits these markets' potential for growth. In the U.S. for instance, there is over 850 GWh worth of battery cells that are either under construction or planned between 2023 and 2030—much of which will be for nickel-based cathode chemistries (Turner, 2024). As a result, there will be an increasing need for hedging up and down the supply chain to lock in investment of new producers of nickel but without an improvement in liquidity, lithium and cobalt projects could face difficulty finding investors due to concerns with the impact of low prices on project profitability.

The Path Forward

The stepwise shift in demand for critical minerals in the following decades necessitates an equal supply response. For the investors and companies to effectively allocate capital towards increasing the supply of minerals, the market must improve pricing efficiency. Deepening critical mineral futures markets will be an important step in the path to the renewable energy transition.

Furthermore, differentiating products such as lower carbon aluminum or nickel are important and necessary steps in monitoring the environmental footprint of these minerals. Shoring up critical mineral futures markets, however, remains the key issue. Developing efficient lithium, cobalt, and other critical mineral futures markets should be paramount and will be a bedrock for the energy transition.

Endnotes

1 Voyles (2024): "The London Metal Exchange, which has long served as the main venue for price discovery and risk transfer in industrial metals, has listed futures on cobalt and lithium, but so far neither has gained much of a following."

2 Nickel-based cathodes are the dominant battery chemistries in the U.S. while lithium-based cathodes are more prevalent in China.

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