Critical Minerals Monitor

Capitalight Research Inc.

March 2025

Recent U.S. trade policies have introduced significant tariffs on critical metals – including rare earth elements, copper, nickel, and lithium – triggering a complex web of global economic and geopolitical repercussions. Below are key recent developments.

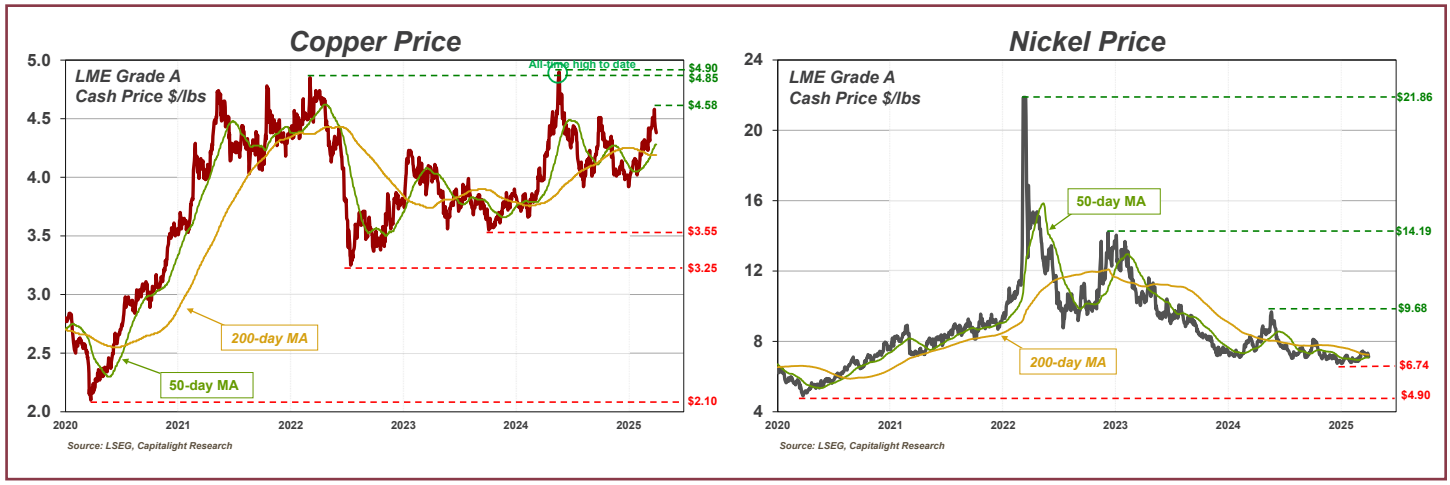
Copper

The U.S. administration has initiated an investigation into copper imports, citing national security concerns. This move has led to market volatility, with the copper price experiencing significant fluctuations as traders anticipate potential tariffs. The copper price reached a year-to-date high of $4.58 per lbs on March 25. The increase in copper prices during March 2025 can be attributed to several factors: anticipation of U.S. tariffs on copper imports led to stockpiling by buyers, contributing to price surges. Additionally, China's economic stimulus measures boosted demand, further influencing price movements.

Nickel

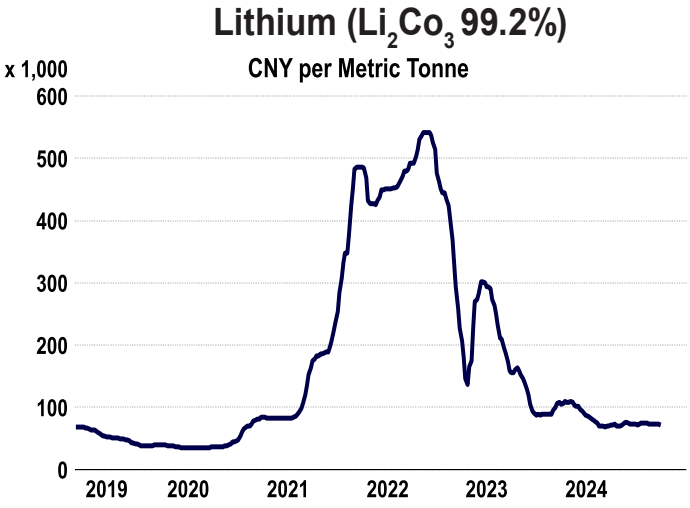
The imposition of a 25% tariff on imports from Canada could potentially add approximately $260 million in costs to U.S. firms due to increased prices of Canadian nickel. Consequently, U.S. companies may seek alternative sources, such as Indonesian nickel, which is predominantly controlled by Chinese firms, inadvertently increasing U.S. reliance on Chinese-dominated supply chains.

This month we feature the second of a series of research articles in collaboration with the Colorado School of Mines. The deep dive article starting on page 4 titled ***Copper – The Most Critical Critical Mineral*** *was written by London Spivey (london_spivey@mines.edu), whom is a graduate student in the Mineral and Energy Economics program at the Colorado School of Mines.*



Lithium

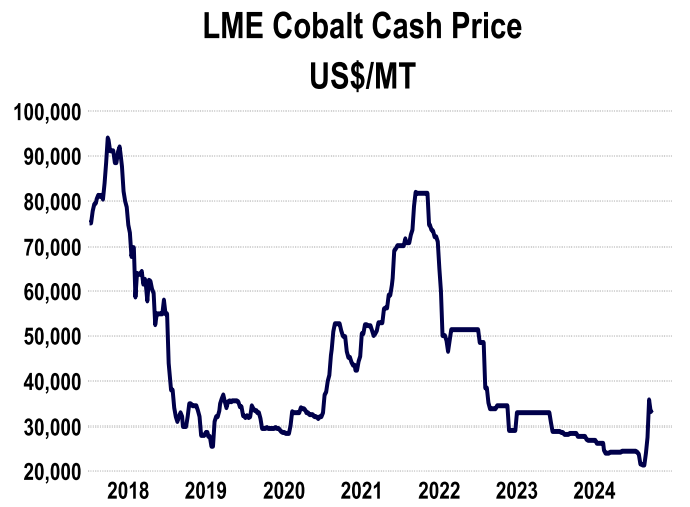
The U.S. has increased tariffs on lithium-ion batteries imported from China, with rates set to rise from 7.5% to 25% by 2026. This escalation aims to bolster domestic production but may also lead to increased costs for electric vehicles and energy storage solutions. In response, China has proposed restricting exports of lithium processing technologies, potentially hindering global production capabilities outside its borders.



Source: LSEG Datastream, Shanghai Metal Market, Capitalight Research

Cobalt

The U.S. imposed 10% tariff on Chinese imports increases the cumulative tariff on Chinese-origin cobalt used in electric vehicle batteries and defense equipment to 35%. This has prompted U.S. importers to seek alternative sources.



Source: LSEG Datastream, Capitalight Research

On Chinese company Lygend Resources has effectively circumvented U.S. tariffs on Chinese-origin cobalt by establishing production operations in Indonesia. This strategic move allows Lygend to supply cobalt directly from Indonesia to U.S. firms without incurring the tariffs imposed on Chinese imports. By situating its production facilities in Indonesia, Lygend benefits from the country's tariff-free status with the United States, making its cobalt more competitively priced for U.S. buyers. This could change as Trump unrolls more tariffs in April however.

This example underscores the complexities of global supply chains, where companies can navigate trade barriers by diversifying their production bases. It also highlights Indonesia's growing significance as a critical player in the global cobalt market, offering alternative sourcing options for U.S. firms seeking to avoid tariff-induced cost increases.

Rare Earth Elements

Given China's dominance of the rare earth elements market, supplying approximately 85% to 95% of global demand, President Trump's new tariffs have heightened concerns over supply chain stability for industries reliant on these materials, such as electronics and defense. In retaliation, China announced export controls on five metals used in defense and clean energy sectors, aiming to leverage its market position.

The current trade policies highlight the intricate interplay between economic objectives and geopolitical strategies. While the U.S. aims to bolster domestic industries and reduce reliance on foreign sources, particularly China, the immediate effect has been an escalation of trade tensions and retaliatory measures.

The tariffs and countermeasures have introduced significant volatility into the critical metals markets. Industries dependent on these materials, such as automotive, electronics, and renewable energy sectors, face increased production costs and potential supply chain disruptions. Companies are now compelled to reassess sourcing strategies, potentially accelerating efforts to diversify supply chains and invest in domestic production capabilities.

Stakeholders must navigate this evolving landscape carefully, considering both the immediate impacts and long-term strategic implications.

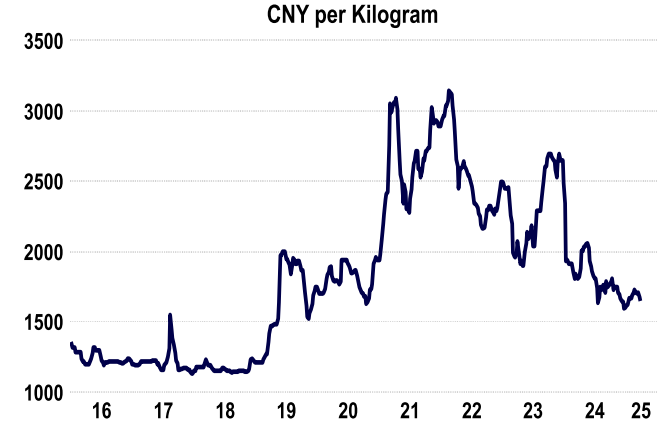
The tariffs and countermeasures have introduced significant volatility into the critical metals markets.

Heavy Rare Earth Prices

Terbium Oxide (TREO 99%)

Source: LSEG Datastream, Shanghai Metal Market, Capitalight Research

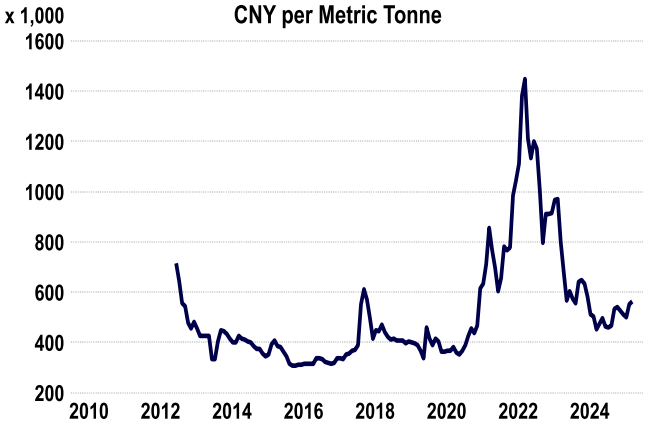
Dysprosium Oxide (TREO 99%)



Source: LSEG Datastream, Shanghai Metal Market, Capitalight Research

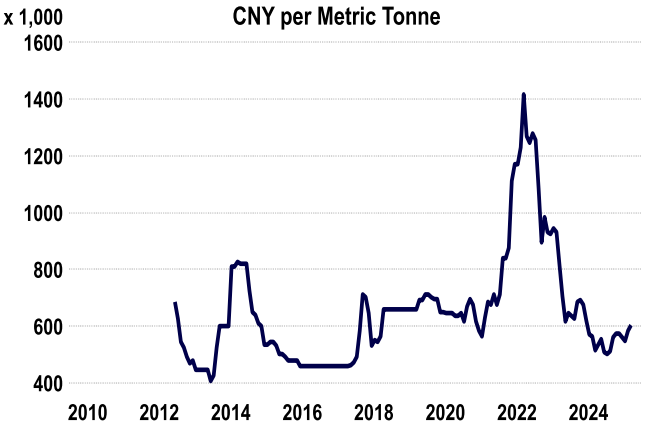
Light Rare Earth Prices

Neodymium (REM 99%)



Source: LSEG Datastream, Shanghai Metal Market, Capitalight Research

Praseodymium (Pr/TREM 96-99%)



Source: LSEG Datastream, Shanghai Metal Market, Capitalight Research

Copper – The Most Critical Critical Mineral

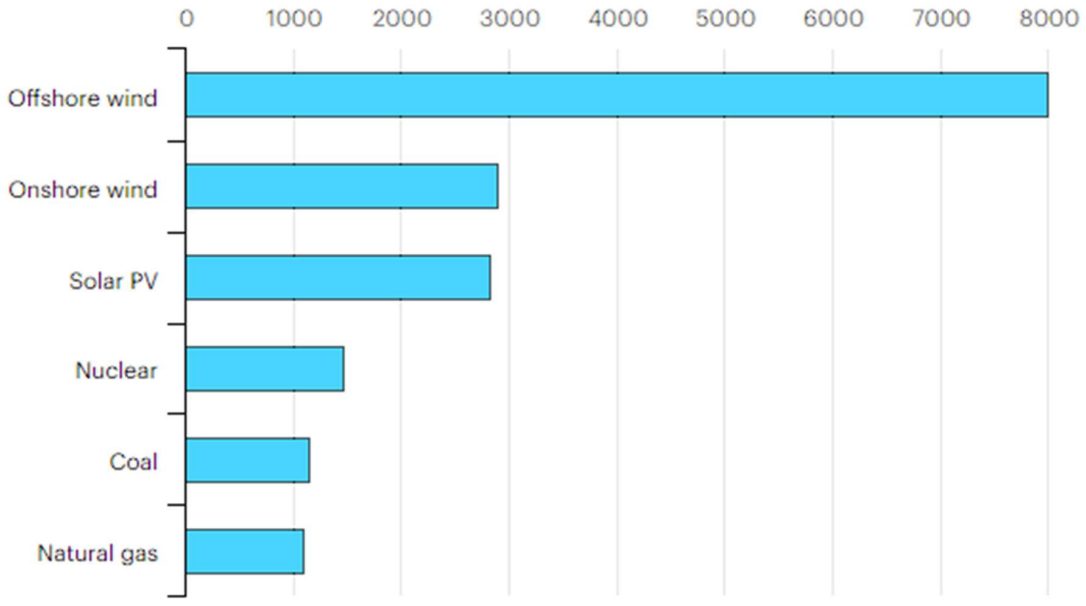
The importance of copper to the global economy has been continuously growing in recent decades. In this article, we discuss how this importance appears only set to increase, how copper's price in the past has behaved, and how we might expect western governments, such as the United States, to position themselves to secure their copper supply chain moving forward into the future.

This month's article is written by London Spivey (london_spivey@mines.edu), whom is pursuing a Master's degree in Mineral and Energy Economics at the Colorado School of Mines.

Copper's Importance is Increasing

Copper's durability, high electrical conductivity, and corrosion resistance make it an essential component of items across the economy. As demand for mineral-intensive items such as electric vehicles, alternative power generation, and data centers grows, the demand for copper will grow with them. For example, currently, an electric vehicle requires 53 kg (117 lbs.) of copper per vehicle in the form of wiring, batteries, and charging stations, while conventional vehicles require only 22 kg (48 lbs.) per vehicle.[1] Additionally, as nations seek to diversify their methods of power generation in order to utilize more Clean Energy Technologies (CETs), the amount of copper needed per megawatt-hour (MWH) of electricity generated is increasing, as shown in Chart 1 taken from the 2021 International Energy Agency (IEA) report on "*The Role of Critical Minerals in Clean Energy Transitions.*"

Chart 1: Copper Intensity (kg) per MWH of Electricity*



*1kg=2.205 lbs.

Source: International Energy Agency (IEA)

1. International Energy Agency; *The Role of Critical Minerals in Clean Energy Transitions*

Table 1: Minerals and Their Importance to CETs

	Copper	Cobalt	Nickel	Lithium	Chromium	Zinc	Aluminum
Solar	High	Low	Low	Low	Low	Low	High
Wind	High	Low	Moderate	Low	Moderate	High	Moderate
Hydroelectric	Moderate	Low	Low	Low	Moderate	Moderate	Moderate
Concentrated Solar Power	Moderate	Low	Moderate	Low	High	Moderate	High
Bioenergy	High	Low	Low	Low	Low	Moderate	Moderate
Geothermal	Low	Low	High	Low	High	Low	Low
Nuclear	Moderate	Low	Moderate	Low	Moderate	Low	Low
Electricity networks	High	Low	Low	Low	Low	Low	High
EVs and battery storage	High	High	High	High	Low	Low	High
Hydrogen	Low	Low	High	Moderate	Low	Low	Moderate

Source: International Energy Agency (IEA)

Table 1, taken from the same IEA report, further demonstrates this point as copper was marked as being of high or moderate importance in 8 of 10 CETs analyzed by the IEA. Of all the minerals analyzed by the IEA in this table, copper was marked as being of high importance more than any others, including its main substitute aluminum.

Copper was marked as being of high or moderate importance in 8 of 10 Clean Energy Technologies analyzed by the IEA.

Copper's Historical Pricing and Volatility

Copper futures were first traded on the London Metal Exchange (LME) in 1877. Today copper trades on many exchanges around the world, the largest three being the LME, the CME Group (CME), and the Shanghai Futures Exchange (SHFE). Table 2 shows the relative monthly volume of copper traded on these exchanges. When adjusting the contract numbers to represent the actual weight of copper traded, the LME trades more copper than the CME and SHFE by a factor of over 20.

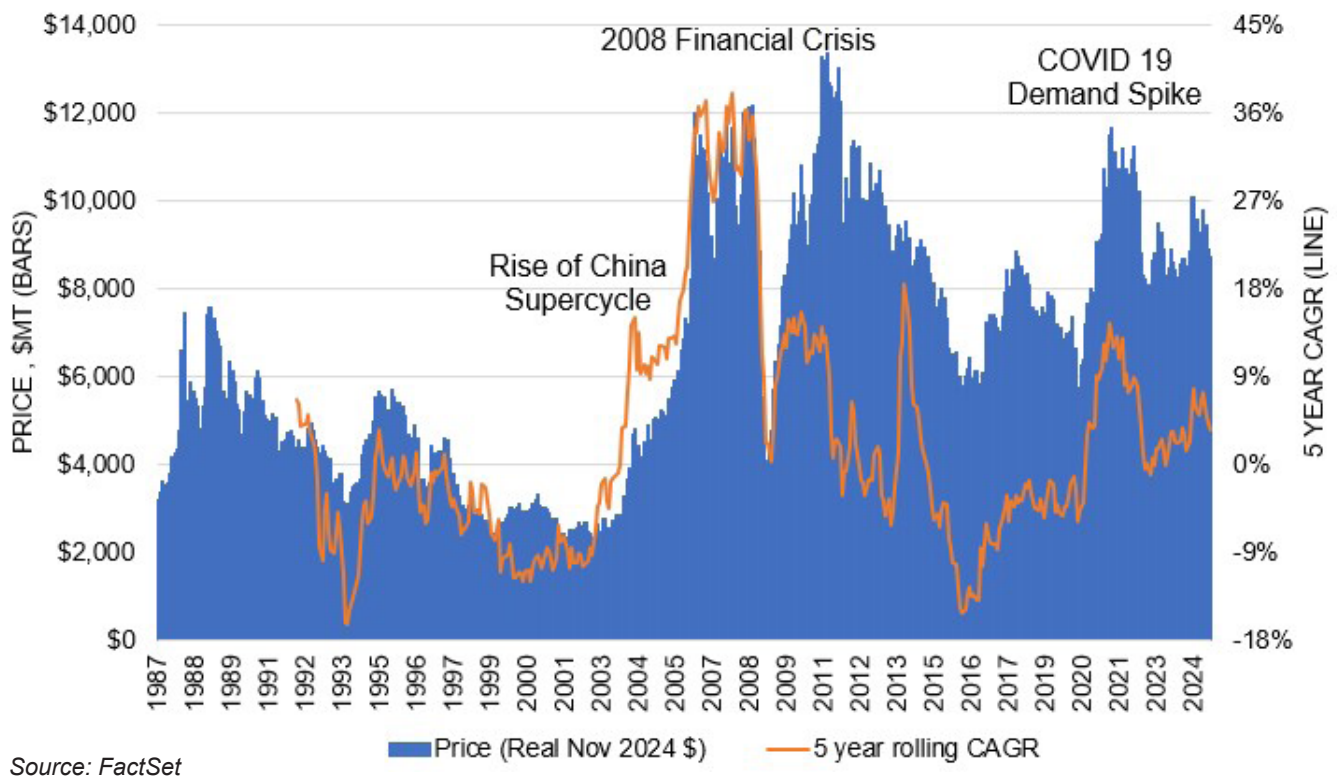
Given the LMEs dominance of the trading market, we will analyze copper's historical pricing and volatility using LME pricing.

Table 2: Monthly Copper Futures Volume on Exchanges and Their Respective Weight

	Monthly Volume (December 2024)	Contract Size (MT)†	Physical Copper Amount (MT)†
LME[2]	12,290,000	25.0	307,250,000
CME[3]	1,234,000	11.3	13,993,560
SHFE[4]	2,612,000	5.0	13,060,000

† Physical Copper Amount is calculated as the Monthly Contract Volume*Contract Size
Sources: London Metal Exchange, LME Volume Report; CME Group, CME Volume Report; Shanghai Futures Exchange, SHFE Volume Report

Chart 2: Copper Price History (LME Copper Price – Real Nov 2024$)



Source: FactSet

Chart 2 presents the historical price data for copper on the LME in real November 2024 dollar terms as well as a 5-year compound annual growth rate (CAGR). While the overall price trend has been clearly upward there have also been periods of sharp decreases, such as the period immediately following the Great Financial Crisis. This volatility indicates that the market remains sensitive to cyclical factors as well as susceptible to supply and demand shocks.

Table 3 shows the cumulative real returns of copper against its main substitute, aluminum, as well as gold, silver, and general inflation over select time periods. Over the entire 37-year period, copper has outperformed gold, silver and aluminum, though gold and silver have been competitive with copper in recent years. Gold and silver have proven their status as inflation hedges, handily increasing above the inflation rate in all the periods analyzed. Notably, copper prices have steadily declined in real terms since 2010, when the industrialization of China began slowing. However, with the increased focus on the green revolution, data centers, and renewed Chinese expansion of industrial and residential building, copper has recently seen a resurgence in pricing during the post-COVID era, posting cumulative returns since 2020 rivalling gold and silver.

However, with the increased focus on the green revolution, data centers, and renewed Chinese expansion of industrial and residential building, copper has recently seen a resurgence in pricing during the post-COVID era, posting cumulative returns since 2020 rivalling gold and silver

Table 3: Cumulative Real Return of Copper Against Substitutes (Real November 2024 $)

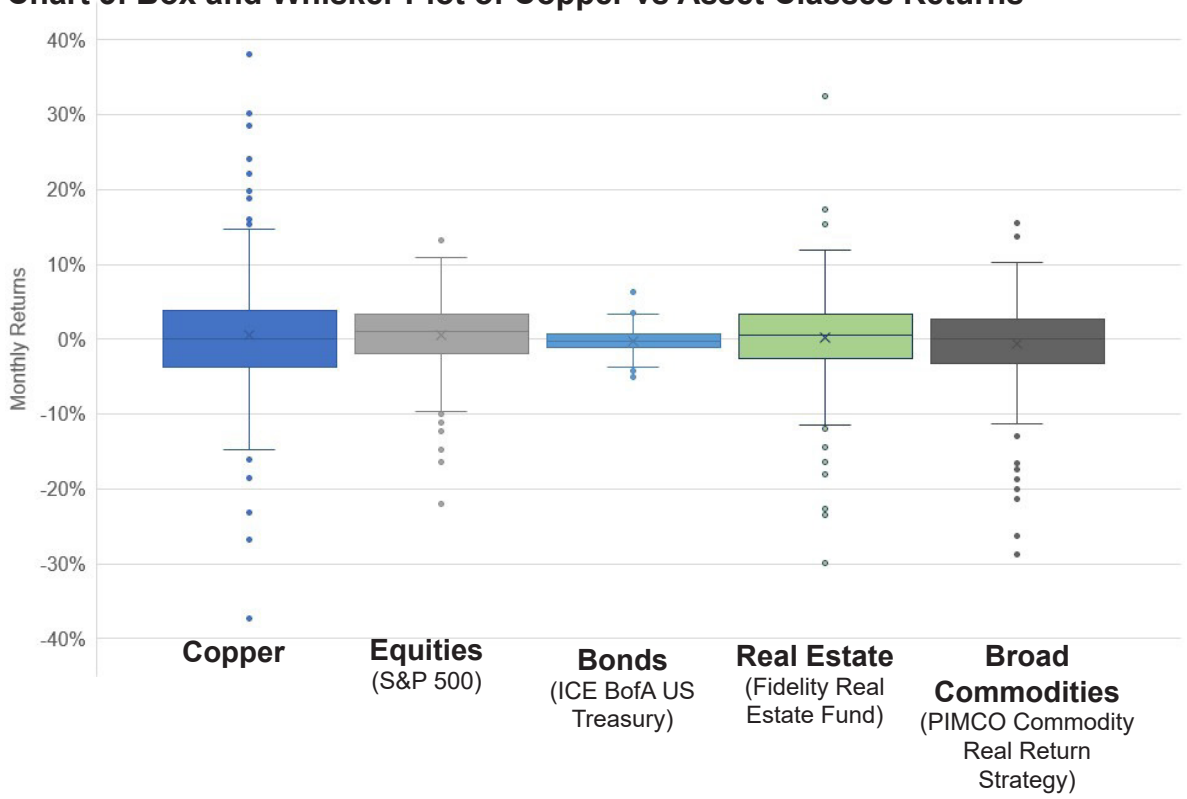
	Copper	Gold	Aluminum	Silver	Inflation
1987-2024	179.92%	176.17%	-9.06%	130.78%	139.68%
2000-2024	182.53%	225.86%	-12.43%	163.37%	99.08%
2010-2024	-18.26%	121.13%	-9.64%	61.80%	65.99%
2020-2024	70.75%	79.59%	18.94%	70.63%	38.46%

Source: FactSet, FRED

Copper Performance Against Other Assets

Another area of interest when analyzing copper returns is how copper compares to other asset classes in general. Chart 3 plots the monthly returns of copper against equities, bonds, real estate, and a broad commodity fund over the period January 1987 to November 2024. Chart 3 shows that copper is unique from other asset classes in that its mean return is higher than its median return, indicative of a positively skewed distribution.[t] None of the asset classes analyzed, including the broad commodity fund, exhibited this statistical trend. Investors tend to prefer positive-skewed investments, as a positive skew implies that the asset tends to have more variation to the upside than downside during volatile periods. This contrasts with the

Chart 3: Box and Whisker Plot of Copper vs Asset Classes Returns



[t]In Chart 3, the mean of the monthly returns is marked by the X on the box and whisker chart. The median is marked as the line in the center of each box. The top and bottom of the box mark the 75th and 25th percentile, respectively, of the returns. The upper and lower lines on the chart represent the statistical upper and lower limits. Points outside of these lines represent outlier returns.

Table 4: Summary Statistics of Asset Class Returns vs Copper

	Mean Return	Median	Standard Deviation	Person Skew Coefficient	Excess Kurtosis
Copper	0.50%	0.06%	7.42%	0.18	0.98
Equities	0.59%	1.03%	4.36%	-0.30	-0.92
Bonds	-0.23%	-0.21%	1.43%	-0.04	-2.04
Real Estate	0.27%	0.52%	5.40%	-0.14	3.29

other assets exhibiting varying degrees of negative skew, which means that the returns of these assets tend to be exposed more to downside risk during times of high volatility.

Further statistical analysis of the asset return profiles, shown in Table 4, confirms and further quantifies the results shown in Chart 3. From 1987 to 2024 the average monthly return of copper was 0.5%. This compares favorably to the other asset classes and is only slightly surpassed by equities but a caveat is that copper has a much larger standard deviation of returns than other asset classes. The higher standard deviation of copper tells us that copper is a riskier investment with more volatile returns. Real estate stands out as an asset class due to its wider range of returns, which is indicated by the high level of excess kurtosis, with large movements from the mean being more probable but, as the negative skew shows, more likely to be to the downside.[§]

A Critical Future

Copper's role as a Critical Metal

In November 2024, the United States House of Representatives passed the Critical Mineral Consistency Act of 2024, that would add copper to the United States' list of critical minerals.[5] The bill is currently awaiting a vote in the Senate but has bipartisan support and is likely to pass. With this new designation, we expect more emphasis from Western countries on protecting the value chain of copper. For example, the United States will likely implement regulations to ensure that more copper is sourced from within the U.S. and ally countries.

In November 2024, the United States House of Representatives passed the Critical Mineral Consistency Act of 2024, that would add copper to the United States' list of critical minerals.

[§] Kurtosis is the measure of how high ("fat") the tails on the distribution chart are. Higher kurtosis implies that results which lie far from the mean are more likely to occur. A normal Gaussian distribution has a kurtosis of 3, so excess kurtosis is mathematically defined as [Kurtosis – 3].

5. Congress.gov; House Bill 8446

Table 5: Top Copper Mining Countries and Their Status With the US

Country	Production (MT)[5]	Percent of World Total	Free Trade Agreement with US?[6]	Defense Agreement with US?[7]
Chile	5,000,000	22.73%	Y	Y
Peru	2,600,000	11.82%	Y	Y
Democratic Republic of Congo	2,500,000	11.36%	N	N
China	1,700,000	7.73%	N	N
US	1,100,000	5.00%	-	-
Russia	910,000	4.14%	N	N
Indonesia	840,000	3.82%	N	N
Australia	810,000	3.68%	Y	Y
Zambia	760,000	3.45%	N	N
Mexico	750,000	3.41%	Y	N

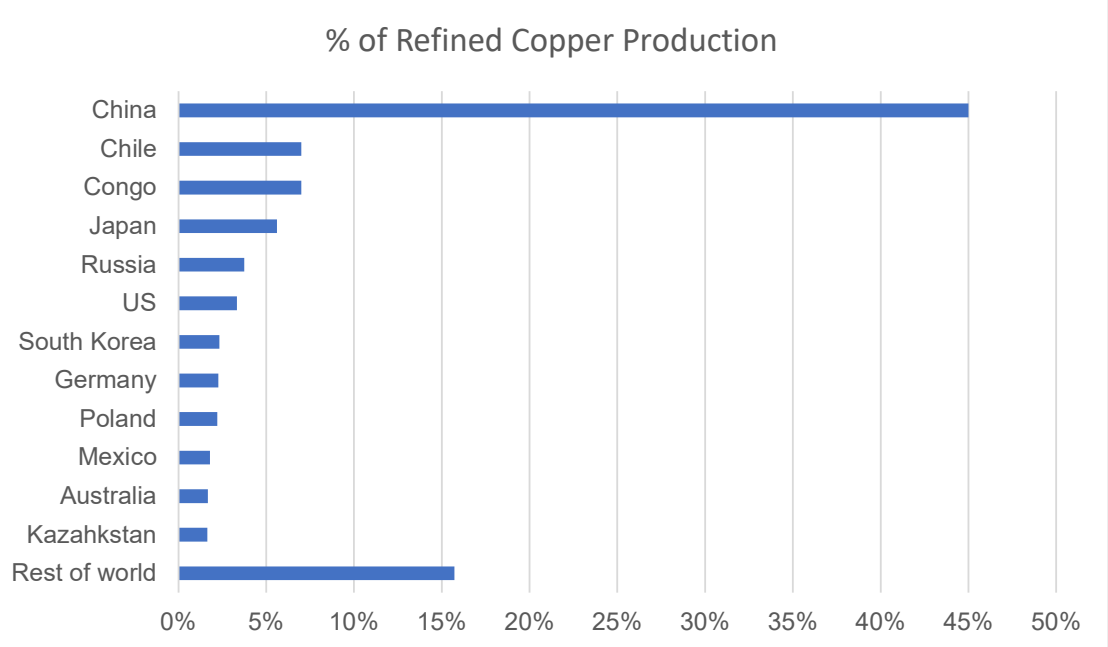
Sources: *INN - Top 10 Copper Producers by Country; USTR.gov, Free Trade Agreement; state.gov, US Collective Defense Arrangements*

Table 5 shows the top 10 copper mining countries in the world in 2023 and whether these countries have a trade or defense treaty with the US.**

Copper mining countries that have defense and/or free trade agreements with the US, including the US itself, account for approximately 42% of copper mined in the world.

However, the refining of mined copper is largely concentrated in China. Chart 4 demonstrates the influence China currently has over the refining of copper.

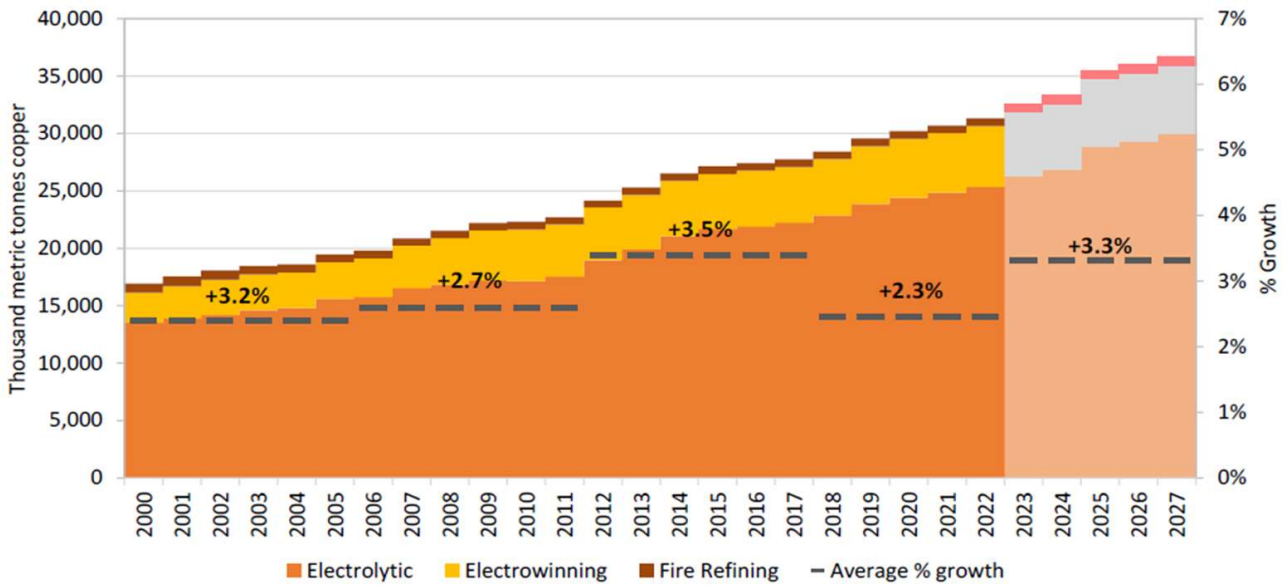
Chart 4: Refined Copper Production by Country
% of 2023 World Refined Copper Production



Source: USGS: Mineral Commodity Summaries 2024

**Defense agreement here is meant as any treaty which obligates members to defend, assist, or otherwise support other member countries in the event a member of the treaty is attacked.

Chart 5: Global Trends in Copper Refining Capacity (2000-2027)



Source: International Copper Group

China currently has over 60 copper smelters operating in the country, compared to 4 in all of North America (2 in the US, 1 in Mexico, and 1 in Canada).[9] As shown in Chart 4, in 2023 China produced 45% of the world's refined copper.

This competition from China is not a problem looming in the distant future. As shown in Chart 5, the International Copper Study Group (ICSG) anticipates annual copper refining capacity growth to average approximately 3.3% through 2027. As China has increased its smelting and refining capacity it has caused an overbuilding in the industry, overbuilding which does not seem to be slowing down anytime soon.

China currently has over 60 copper smelters operating in the country, compared to 4 in all of North America (2 in the US, 1 in Mexico, and 1 in Canada).

9. Fastmarkets.com; *Exposure to spot TCs key to China smelters, Rio tinto Copper CEO says; Hotter Commodities*

Disclaimer

The views expressed in the research report regarding any particular company, security, industry or commodity price are the independent and personal opinions of the research analysts and their associates. Views expressed herein should not be considered as a recommendation to buy or sell nor should they be relied upon as investment advice. Past performance is not a predictor of future results. Individual investment results may vary, and all investing involves risk of loss. You are responsible for your own investment decisions. Information contained in this report is current as of the date of publication and has been obtained from third party sources believed to be reliable. Capitalight Research Inc., and its affiliates, do not make any representations regarding the accuracy, completeness or reliability of any information contained herein and does not accept any responsibility or liability for any loss or damage caused by a reader's reliance on any information contained herein. Research analysts and their associates are prohibited from trading against their investment opinion, if any has been expressed. The compensation of the research analyst and their associates are not linked directly or indirectly to their opinions or to the performance of any particular company or security. Capitalight Research Inc. has not provided any consulting, advisory, investment banking or paid-for research services to any of the companies named in this research report. The research analyst or associate do not own shares of the companies named in this research report. Capitalight Research Inc. maintains a Restricted List of securities with pending research reports. Any employees, including their spouses and dependents, that are aware of pending research reports are restricted from trading securities on the Restricted List until the research report has been fully disseminated.

Anti-Spam

You are receiving this material from Capitalight Research Inc. located at 130 King St West, Suite 1940, Toronto, Ontario M5X 2A2. Capitalight Research Inc. respects your time and your privacy. If you no longer wish us to retain and use your personal information for the purposes of distributing newsletters, reports or other commercial electronic messages, please let us know via email. For more information on our Privacy Policy please visit our website at www.CapitalightResearch.com.