

Rapidly Evolving Sanctions

An Alternative Analysis of Sanction Impacts on the US-China Rare Earth Elements Extractive Sector



2023
PUBLIC-PRIVATE
ANALYTIC EXCHANGE PROGRAM

Executive Summary

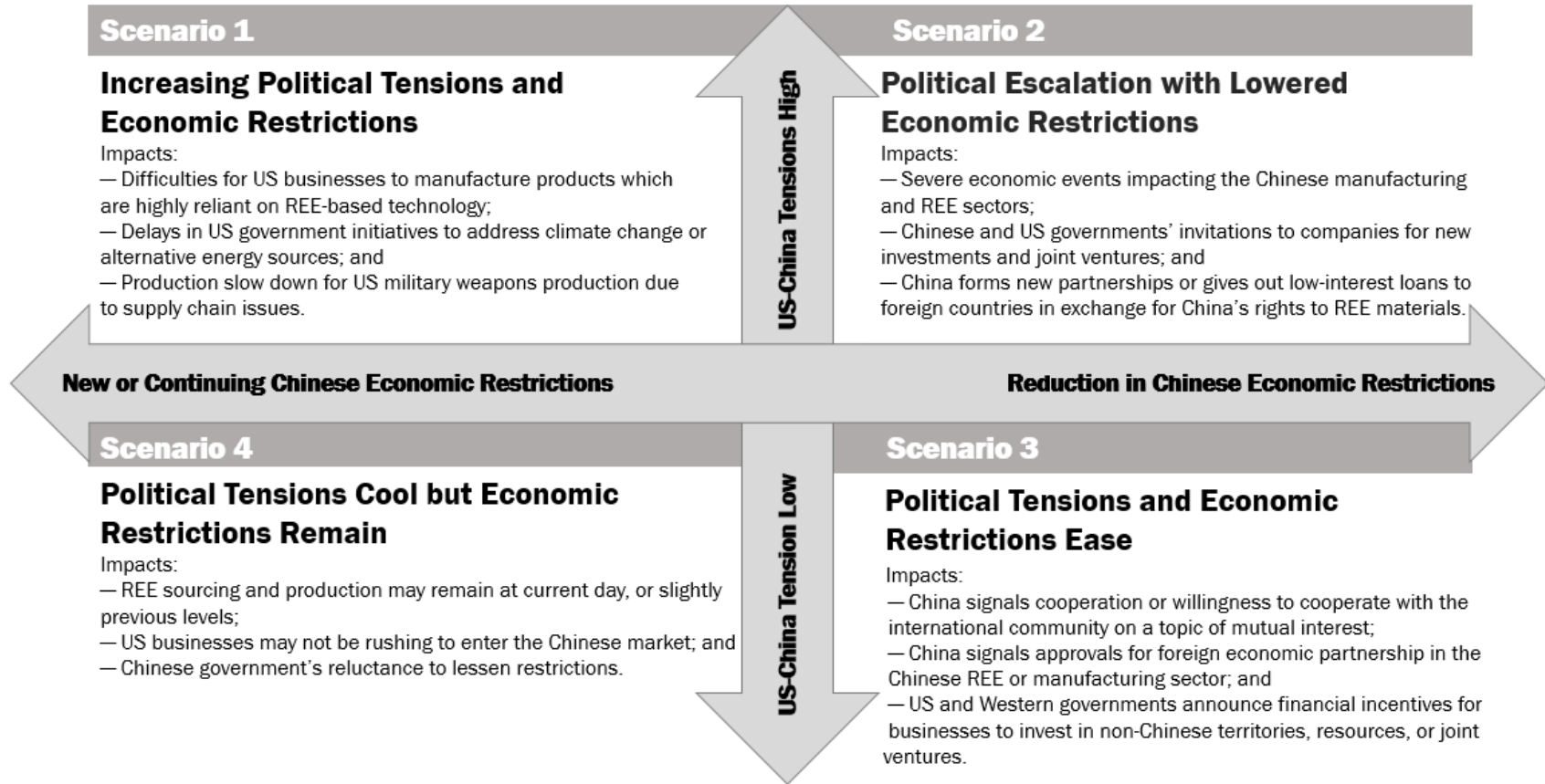
The Rare Earth Element (REE) extractive sector^a is a highly valued commodity industry and remains sensitive to supply chain disruptions. REEs are critical parts of US and Western supply chains in the high-tech, energy, aerospace, defense, and healthcare fields, among others. Specifically, we examined the role of the People's Republic of China (China), the world's leading supplier of REEs,^b and the potential implications of economically restrictive measures for the US government and US businesses with respect to market disruptions. We explored how varying tensions impacting industries dependent on REEs would evolve through four alternative analysis^c scenarios that focus on the risks and potential implications of changing geopolitical tensions to REE supply chains. We found that on one hand, US government and US businesses are preparing and executing planning for the escalatory nature of economic conflict with China despite the potentially severe negative economic implications for the global economy. We also found that even in the best-case scenario where political and economic tensions subside, the global economy will not revert to the level of economic efficiency that it enjoyed before the implementation of the Trump administration's trade restrictions on China in 2018. Regardless of tensions, US government and businesses could seek or plan to seek alternative REE resources to hedge against future uncertainties and unforeseen risks.

^a See Appendix A: Rare Earth Element Extractive Sector.

^b See Appendix B: Rare Earth Element World Mine Production and Reserve in 2022.

^c Alternative analysis is the systematic evaluation of differing hypotheses and the integration of alternative perspectives and traditional assessment.

Four Alternative Scenarios for US-China Rare Earth Element (REE) Extractive Sector



This is a graphic representation of the four alternative analysis scenarios for the US-China REE Extractive Sector.

Source:

(U) US Department of Homeland Security | This graphic was created by the US Department of Homeland Security 2023 Analytic Exchange Program's Rapidly Evolving Sanctions team, based on information from the scenarios in this product.

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MEMBERS	COMPANY
Patrick Dierfield	Western Union
Jenny F.	Federal Bureau of Investigation
Stephanie G.	National Security Agency
Ashley Halabi	Amazon
Matthew H.	US Department of Treasury
Natalie Hughes	Amazon Air
Tara Kelly	TD Bank, AMBC
Stephanie Kreizenbeck	Citibank
Jessica L.	US Department of Treasury
Steven Pryor	Federal Home Loan Bank Chicago
Alec Woloszyn	National Insurance Crime Bureau
<i>Champion</i>	<i>Champion Agency</i>
<i>Michael Neufeld</i>	<i>US Department of Treasury</i>
<i>Carl Von Kessler</i>	<i>US Department of Treasury</i>

Analytic Methodology and Scope

Our research included assistance from the FBI Red Cell,^d who conducted two separate Structured Analytic Technique (SAT) sessions with the team to explore potential drivers or factors that could influence the decision-making process and impact of US sanctions. During these sessions, we considered the analytical question, “what US industries, especially those with international touchpoints, are most vulnerable to sanctions by a foreign adversary and how would they and policy makers respond to, adapt, or prepare?” Our team also consulted with the staff and faculty of San Jose State University. These experts provided insights into how sanctions and export restrictions impact REE supply chains and the manufacturing sector. Further, we conducted interviews with a senior executive at a US microelectronics manufacturer and an attorney serving Fortune 500 clients regarding the US’ dependence on Chinese REEs, sanctions impacts, and worldwide REE supply chain vulnerabilities. We are grateful to these subject matter experts for their time spent to assist our team on this project.

This alternative analysis evaluates the likely scenarios where US-China political tensions and economically restrictive measures would impact US industries and businesses that depend on the REE sector and supply chains. We assume REE resources would remain limited due to the amount of REEs available worldwide and the limited numbers of companies and producers available to mine, refine, and process the REEs. We also assume REEs would continue to be highly demanded commodities due to its use in many products and sectors. We further assume China would leverage its economic resources and policies to achieve its long-term foreign policy goals. Indicators that, if observed, would decrease the likelihood determined for these scenarios include new discoveries of REEs in non-Chinese territories, identification of alternative resources to replace REEs in manufacturing and other products, changes in environmental laws and restrictions on REE mining and production, or extreme price changes in REE resources.

Perspective: Current US and China Economic Restrictive Measures

The Executive Branch of the US Government, through authorities primarily assigned to the Department of the Treasury (Treasury) and the State Department (State), has imposed hundreds of sanctions on persons located in China. While no specific China executive order for blocking sanctions currently exists, Treasury and State have imposed economic and diplomatic restrictions on China-based actors under other authorities and for multiple reasons to support US foreign policy – such as sanctioning entities related to China’s support to Russia’s military-industrial complex,^e its support to Democratic People’s Republic of Korea (North Korea) and Iran, its undermining of Hong Kong’s autonomy, and its role in the global supply chains of illicit drugs, such as fentanyl.

^d The FBI Red Cell produces and facilitates the production of plausible alternative analysis that challenges conventional analysis and its underlying assumptions to provide its customers with perspectives beyond those offered in traditional reports.

^e The term military-industrial complex describes the relationship between a country's military and the defense industry that supplies it, seen together as a vested interest which influences public policy.

The US Congress has also imposed additional restrictions and prohibitions on Chinese trade and investment. For instance, Congress has prohibited the use of Chinese sources within the national defense supply chain of REE magnets,¹ and enacted China-related restrictions through the CHIPS and Science (CHIPS) Act by prohibiting taxpayer funds from being used in ways that could materially expand China's semiconductor industry.^{2, 3}

Under the authority given to the President through the International Emergency Economic Powers Act,^f Treasury has also imposed prohibitions on the purchase or sale by US persons of any publicly traded securities of certain Chinese companies that are part of China's military-industrial complex or surveillance technology sector.⁴ The Committee on Foreign Investment in the United States (CFIUS) has led to the blocking of Chinese acquisitions,⁵ and the US Trade Representative has imposed tariffs on billions of dollars of Chinese imports.⁶ Additionally, the Department of Commerce (Commerce) has issued restrictions on China's ability to purchase and manufacture certain high-end microchips used in military applications.⁷ Commerce has also identified various Chinese entities on the Entity List,^g which restricts their access to dual-use goods.⁸

China has similarly enacted economic and diplomatic restrictions on US persons and entities, as well as US allies for various foreign policy reasons. China sanctioned a US congressman⁹ and a Lithuanian Minister¹⁰ for visiting Taiwan pursuant to China's Anti-Foreign Sanctions Law.^h Various nongovernmental organizations found themselves blacklisted by the Chinese government after they advocated for legislation in support of Hong Kong's protesters¹¹, and 10 researchers at 4 European research institutions that study Chinese-European relations were prohibiting from travelling to China.¹²

In addition to the early July 2023 export restriction of REEs germanium and gallium to the US,¹³ China has imposed import and investment prohibitions without freezing assets via its Unreliable Entity List,ⁱ which has been used against major US defense contractors. In March 2023, China's cybersecurity authority initiated a probe against a US chipmaker, ultimately imposing restrictions on the company's ability to conduct sales in China.¹⁴ China has also imposed economic restrictions against persons in Taiwan, the European Union (EU), Australia, Lithuania, Japan, and others.¹⁵ In May 2020, deteriorating political relations with Australia led China to block the import of certain Australian goods in which the Chinese market held an outsized share.¹⁶

^f The International Emergency Economic Powers Act, also known as "IEEPA," codified presidential national emergency powers to investigate and impose controls on transactions as well as freeze foreign assets under the jurisdiction of the United States.

^g Entities on the Entity List are subject to US license requirements for the export or transfer of specified items, such as some US technologies. However, US persons or companies are not prohibited from purchasing items from a company on the Entity List.

^h China's Anti-Foreign Sanctions Law furnishes the legal basis for China to take retaliatory measures including countersanctions against persons or entities instigating or implementing sanctions.

ⁱ China's Unreliable Entity List, introduced in 2019, allows China to impose punitive measures on designated foreign entities, including companies, other organizations, or individuals, for conduct that is contrary to China's national interests.

Scenario 1: Increasing Political Tensions and Economic Restrictions

In this scenario, the escalation of political and economic tensions between the US and China results in a dramatic and punitive increase in bilateral economic restrictive measures, thus limiting US and Western businesses' access to Chinese REEs and supply chains. In this scenario, the supply chain restrictions would cause many US and Western businesses to seek alternative sources from non-Chinese REE producers simultaneously. In the near-term, this would result in a significant decrease in available REE for US and Western businesses, potentially culminating in extreme REE price spikes, multiple market pricing, as well as Western market competition for non-Chinese owned REE sources, and global economic downturn. Investment in alternative extraction, recycling, and processing facilities outside of China would also spike.

- As noted above, in early July 2023, the Chinese government announced that it would enact export controls on two critical rare earth metals, germanium and gallium on national security grounds, according to Reuters.¹⁷ A former Chinese official stated that China would step up countermeasures if the US imposes more high-tech restrictions, according to China Daily.¹⁸ This announcement came after a late June 2023 report that the US and the Netherlands were considering restrictions on sales of semiconductor chip making equipment to China. Also, the US proposed an export control rule designed to slow the flow of Artificial Intelligence (AI) product equipment sold to Chinese chipmakers. This was in addition to additional US export restriction discussions on limiting Chinese companies' access to US cloud-computing services, according to a separate Reuters report.¹⁹
- On 4 July 2023, the President of China, in a virtual speech to the Shanghai Cooperation Organization leaders, called on nations to spurn decoupling and the cutting of supply chains from China, one day after China imposed limits on exports of two key metals used to make chips to counter Western restrictions on China. This speech came just days before the US Secretary of Treasury's visit to China to discuss US-Chinese trades, according to Bloomberg.²⁰
- On 10 June 2021, China's National People's Congress passed the Anti-Foreign Sanctions Law on an accelerated basis, arguably sending a signal to the 2021 G7 Summit. The law allowed China to take retaliatory measures against those implementing sanctions, including the US, the EU, and other countries. This law could put companies all over the world doing business with the US, EU, and China in an untenable position: complying with Western sanctions would mean violating Chinese law and exposing those companies to countersanctions by China and other liabilities, according to a nonpartisan organization.²¹

We expect in this scenario to include increased near-term difficulties for US businesses to manufacture products which are highly reliant on REE-based technology, especially in the automotive, technology, and energy storage sectors. This will result in delays in US government initiatives to address climate change or alternative energy sources, and

production of US military and defense weapons would shift sourcing to rely on stockpiles as well as domestic and allied production due to supply chain issues. US and allied economies would likely suffer in the near-term as supply chain and price volatility would disrupt businesses' productive capacity and established business relationships.

- In 2019, Japanese export controls on three industrial gases required for the manufacture of high-tech items produced in South Korea detrimentally impacted supply chains, increased costs, and disrupted established economic relationships, according to the Korea International Trade Association.²²
- In 2011, the Fukushima earthquake,^j tsunami, and nuclear disaster negatively affected Japan's economy and global value chains. The Japanese automotive sector was especially hit hard as it relied on just-in-time sourcing of electronics and other parts and equipment from the Fukushima area. The loss of Fukushima-based supply chain nodes adversely impacted industrial capacity in certain industries in Japan and its trade partners for months following the disaster, according to an analysis by the Government of Australia.²³

We expect in the medium to long-term that businesses and states will adapt to Chinese restrictions on REE through building new supply chains and sources of essential inputs. These will likely entail government support and much higher costs initially but likely remain higher than during the pre-restriction time period. However, the expected long-term investment in scalable production outside of Chinese control will probably yield supply chain resiliency and eventual cost benefits once initial up-front costs are recouped.

- In 2010, China restricted exports of REEs to Japan following a territorial dispute, sending prices soaring and Japan scrambling to find alternative sources. China claimed the restrictions were based on environmental concerns. This event led Japan, which had previously relied on China for virtually all of its REEs, to find alternative suppliers. Japan began to invest in an Australian REE producer and had reduced the share of its REE imports from China to 58 percent by 2018, according to Reuters.²⁴
- As of late March 2021, after the Fukushima disaster, a Japanese automaker changed its sourcing and warehousing protocols to reduce its reliance on just-in-time sourcing of key inputs in its manufacturing supply chains to reduce the risk of a similar disaster. As automotive supply chains became stressed to secure certain inputs, such as computer chips during the COVID-19 pandemic, the automaker was well-positioned to continue production as it had built stockpiles of key inputs, according to a supply chain management news website.²⁵

^j On March 16, 2011, a strong earthquake struck off the coast of Fukushima, Japan. The earthquake had a magnitude of 9.0, according to the Japanese Meteorological Agency. Immediately after the event, a tsunami was reported.

Scenario 2: Political Escalation with Lowered Economic Restrictions

In this scenario, the escalation of political and economic tensions between the US and China leads to reductions in economic restrictions for Chinese exports. US and Western countries would continue to diversify their REE supply chains away from Chinese REE resources at a lesser pace than scenario one. During the same period, China's economy would experience market contractions due to a negative external or domestic economic environment, such as high state debt, liquidity issues, or high unemployment, driving the Chinese government to enact pro-growth policies. In this scenario, the Chinese government would lessen economic restrictions on REE in order to improve its economy as well as maintain its global market share. These restrictions imposed by the Chinese government would also be an attempt to persuade US and Western businesses to continue their investments in China, furthering China's long-term foreign policy goals of maintaining or increasing Western dependence on Chinese resources and manufacturing.

- As of late May 2022, China has imposed coercive economic actions against Lithuania for allowing the November 2021 opening of a "Taiwan Representative Office" in Vilnius. In retaliation, China blocked all bilateral exports and imports from Lithuania and imposed informal secondary sanctions on Lithuania. In December 2021, China warned businesses that sourced products from Lithuania that they too could find their commercial relations with China restricted, according to a bipartisan nonprofit policy research organization.²⁶
- As of late March 2022, China has adopted a new strategy—Dual Circulation—which aims in part to make domestic manufacturing more self-sufficient by reducing reliance on foreign technology in the face of heightened external uncertainty and volatility, according to *The Economist*.²⁷ Even China, which has 77 percent of the global lithium cell manufacturing capacity, was highly reliant on imports of raw lithium, according to a US management consulting firm.²⁸
- In late February 2022, the White House's "Made in America" initiative encouraged major investments in domestic production of key critical minerals and materials, ensuring these resources benefit the community, and creating good-paying, union jobs in sustainable production. This initiative was the result of Executive Order 14017, "America's Supply Chains", which was signed in 2021 and directed departments to conduct a review of vulnerabilities in US critical mineral and strategic material supply chains.²⁹ The Department of Defense's (DOD) Industrial Base Analysis and Sustainment program awarded a US company \$35 million in February 2022 to separate and process heavy REEs at its facility in Mountain Pass, California, establishing a full end-to-end domestic permanent magnet supply chain. This project would establish the first processing and separation facility of its kind for REEs in support of both defense and commercial applications in the US, according to a DOD press release.³⁰

- In late April 2021, India, Japan, and Australia partnered to enhance the resilience of the Indo-Pacific supply chains. Under their Supply Chain Resilience Initiative, these nations agree to share best practices on resilience and hold investment promotion and buyer-seller matching events to encourage businesses to diversify their supply lines, according to Bloomberg.³¹

In this scenario, in the near-term, the negative economic events in China would lead to supply chain stress, disruptions, and increased costs worldwide, especially on the Chinese manufacturing and REE sectors. Also, US and Western businesses would utilize existing REE supplies and burn through its inventory until new resources could be identified, causing price increases for consumers. The consumer wait for products would also dramatically increase as supply decreases. US and Western governments would work to enact legislations aimed to bolster economic development and manufacturing within their own countries.

- As of late March 2023, the COVID-19 pandemic caused a semiconductor chip shortage. The automotive industry faced a 52-week wait to get the chips the automakers needed to produce the entertainment and driving assistance systems within their automobiles. When the chips finally reached the factor floors, the automakers' manufacturing capacities were finally restored to pre-pandemic level by the end of 2022, according to a professional technology organization.³²
- As of late March 2023, the US government passed the CHIPS Act, yielding a multibillion investment pool, some of which was dedicated to ramping up American manufacturing of the mature-generation^k chips upon which many industries—automotive and otherwise—are so dependent. The aim of the \$50 billion expenditure was to prevent US industrial concerns from falling victim to similar semiconductor supply chain shortages in the future. The EU was also considering a similar CHIPS Act legislation, designed to bolster its constituent nations' resilience in the face of such supply-chain interruptions, according to a professional technical organization.³³
- As of late April 2022, China's COVID-19 zero infection policy caused component supply constraints on the microchip sector. Manufacturers continue to use and burn through its existing inventory. Component makers also stockpiled inventory, including personal computer (PC) makers, who were simply choosing to build PCs based on available inventory. A US PC maker expected to lower its production costs and raise prices in certain segments of their business, according to a technology news website.³⁴

In the medium and long-term, the US and Chinese governments would compete to have manufacturers invest in opportunities and joint ventures within their countries. Additionally, we expect the Chinese government to develop new partnerships or negotiate low-interest

^k Mature generation chips are generally defined as chips with node size at 40 nanometer and above, and require older manufacturing processes.

loans with foreign countries in order to secure China's exclusive rights to mine and resource REE materials from those countries.

- As of mid-February 2022, some of the largest US and Taiwanese semiconductor companies were planning large US fabrication projects in Texas, Ohio, and Arizona totaling \$99 billion. One US company suggested that it could grow its Ohio plant to a \$100 billion investment over the next 10 years- but only if it received government assistance, according to a large professional technical organization.³⁵
- As of early June 2023, as a part of China's Belt and Road Initiative (BRI),¹ China has taken to invest in the Democratic Republic of Congo (DRC). In 2020, the DRC was the world's largest cobalt miner, producing 41 percent of all cobalt resources in the world. China has a significant presence in the cobalt mining industry in the DRC, owning 15 out of the 17 cobalt mining operations in the country as part of its BRI, according to an academic research center.³⁶

Scenario 3: Political Tensions and Economic Restrictions Ease

In this scenario, US-China tensions ease due to a pause or reduction in US and Western restrictions on Chinese access to US and Western advanced manufacturing materials, including export-controlled items such as advanced microchips used in AI. At the same time, China's economy would experience an economic contraction due to several domestic factors. This would cause China to remove restrictions on REEs in order to improve its economy and further its long-term economic and foreign policy goals. We judge that US and Western governments and businesses, despite reduction in tensions and restrictions, will continue to diversify their REE resources and expand investments in US-based REE production outside Chinese ownership as growth of the sector is essential to long-term energy transition and climate change goals.

- As of late July 2020, the COVID-19 pandemic exposed core weaknesses in a lean global supply chain model that prioritizes costs reduction, just-in-time production, and forecasting strategies that do not typically consider major disruptions such as natural disasters, pandemics, or other geopolitical crises, according to a US nonprofit policy research organization.³⁷ The COVID-19 pandemic also was the initial catalyst for the worldwide chip shortage in 2020. At the beginning of the pandemic, car companies canceled orders, but as production ramped up again toward the end of 2020, there was no semiconductor supply available. This was compounded by increased demand particularly at the higher end of the automotive market, as low interest rates aided affordability, according to research from a US investment bank.³⁸

¹ The BRI is a global infrastructure development strategy adopted by the Chinese government in 2013 to invest in more than 150 countries and international organizations.

- As of early July 2021, in response to the COVID-19 pandemic, China’s central bank enacted monetary policies to support and safeguard its financial market stability, to include injecting liquidity into the Chinese banking system via open market operations, expansion of re-lending and re-discounting facilities to support manufacturers of medical supplies and daily necessities, firms, and the agricultural sector, and expansion of policy banks’ credit line to private firms, according to the International Monetary Fund.³⁹

In the near-term, China would signal cooperation or willingness to cooperate with the international community on a topic of mutual interest. Furthering that cooperation, China would signal approvals for foreign economic partnerships in the Chinese REE or manufacturing sectors. In a worldwide effort, US and Western governments would explore financial incentives for businesses to invest in non-Chinese territories, resources, or joint ventures.

- As of late October 2022, although China’s Dual Circulation policy has been impeded by the COVID-19 pandemic, China’s trade diversification proceeded as planned. The volume of trade with BRI participating countries grown to reach USD \$1.6 trillion in 2021 from USD \$1.1 trillion in 2014. This almost doubled the trade volume between China and Association of Southeast Asian Nations (ASEAN) countries at USD \$878 billion. These ASEAN countries participated in the BRI to various degrees, so the comparison highlighted the trade relationship with two overlapping blocs of countries. In comparison, China’s trade with the EU was at USD \$695 billion and the United States at USD \$657 billion. The resulting ranking of trade partners gave China some room for maneuvering in the face of economic pressures, including sanctions, from the West—by increasing trade with the rest of the world, according to a nonpartisan organization.⁴⁰
- As of late October 2022, China has taken steps to diversify the sources of supply of key inputs it needs to import—including buying oil, gas, and grains from Russia, iron ores from Guinea and Cameroon, and bauxite from Guinea and Ghana. China aimed to reduce its dependence on oil from the volatile Middle East and on iron ore from Australia, which China deems politically unreliable, according to a nonpartisan organization.⁴¹

Similar to scenario 2, in the medium and long-term, the US and Chinese governments would compete to have manufacturers invest in opportunities and joint ventures within their countries. The Chinese government would utilize their state-owned enterprises (SOEs) to jumpstart its domestic economic development, while strengthening their foreign partnerships and initiatives to secure REE resources.

- As of early March 2023, Chinese SOEs began to sideline their overseas investments when they were tasked with more pressing domestic missions. As US-China competition intensified in recent years, the US pressure to decouple has forced Chinese SOEs to become more self-reliant. SOEs has to help maintain the security and

stability of the Chinese industrial chain and supply chain by investing more in critical areas at home, according to a nonprofit organization.⁴²

- As of early March 2023, over two-thirds of EU member countries have formally signed on to the BRI with large Chinese infrastructure investment responsible for projects such as the renovated port of Piraeus in Greece and the Budapest-Belgrade railway in Hungary. China has also funded several projects on the continent in non-EU countries. These investments have made it harder for the EU to craft a united approach to China, and Greece and Hungary have obstructed bloc-wide efforts to criticize China, according to a nonprofit organization.⁴³

Scenario 4: Political Tensions Cool but Economic Restrictions Remain

In this scenario, tensions between the US and China begin to ease due to a pause or reduction in US and Western restrictions on Chinese access to US and Western advanced manufacturing materials. However, China would entertain new restrictions or maintain its restrictions on US and Western access to REEs due to several factors, including the lack of economic incentives for China and efforts to prevent perceived embarrassment to their country. By maintaining, but signaling that China would not escalate restrictions, it would encourage US and Western businesses to consider new investment in the Chinese economy further to such businesses' risk calculus. If China signals that it would be imposing new restrictions on US and Western access to REEs, then these companies would source REEs from non-Chinese REE producers instead.

- As of mid-August 2022, due to China's zero-tolerance COVID-19 policy, the Chinese economy was in its worst shape since early 2020. The Chinese economy barely expanded in the second quarter of 2020 when compared to the same quarter in 2021. Amid surging global inflation, China's price increases were moderate, reflecting poor consumer demand. In addition to economic problems, air travel in and out of China remained nearly nonexistent. Hundreds of thousands of international students enrolled at Chinese universities were unable to obtain Chinese visas and were locked out of the country for more than two years, according to an independent nonprofit, nonpartisan research organization.⁴⁴
- As of late March 2023, China was the biggest buyer of Russian oil and gas exports, despite Western sanctions imposed on Russia over its invasion of Ukraine. However, China has avoided doing anything that might trigger US or Western sanctions against Chinese banks or other companies or shut them out of Western export markets, according to the Associated Press.⁴⁵

In this last scenario, we would expect manufacturing production to remain at current day or slightly previous levels in the near-term for US and Western businesses, despite changes or increases in Chinese REE production quotas. Despite the arguably favorable sanctions and restrictions levels, potential US businesses or those businesses who have not established any

existing ventures within China for REE may wait and delay its entrance into the Chinese market.

- In July 2023, the Chinese government announced that it would enact export controls on two critical rare earth metals, germanium and gallium on national security grounds, according to Reuters.⁴⁶
- In late March 2023, the Chinese Ministry of Industry and Information Technology announced its first 2023 REE quotas, with the mining output quota increased by 19 percent from 2022 to 120,000 tons. The smelting and separation quota for REEs was set at 115,000 tons, an increase of 18 percent from 2022. Chinese producers were not allowed to exceed REE quotas because the Chinese government considered REEs as state-controlled resources, according to Reuters.⁴⁷

In the medium to long-term, US and China would seek compromises and middle-grounds palatable to suit its foreign and economic policies. Although rhetoric would flare between certain US and Chinese officials at times, both countries would seek to minimize tension and work to develop policies in the best interest of both countries, as decoupling US and Chinese markets would be difficult for both countries.

- On 4 July 2023, the President of China, in a virtual speech to the Shanghai Cooperation Organization leaders, called on nations to spurn decoupling and the cutting of supply chains from China, one day after China imposed limits on exports of two key metals used to make chips to counter Western restrictions on Beijing. This speech came just days before US Secretary of Treasury's visit to China to discuss US-Chinese trades, according to Bloomberg.⁴⁸
- As of early July 2023, during US Secretary of Treasury's visit to China, she stated that the US planned to discuss healthy economic competition with China. She also noted that the US will defend trade restrictions imposed by the US on security grounds. The US intended to express concerns about China's export controls on metals used in semiconductors and solar panels. The US did not support decoupling or disconnecting US and Chinese industries and markets, but the US wants a healthy economic competition, and will promote resilient supply chains and guard against excessive on suppliers in critical sectors, according to the Associated Press.⁴⁹

Impact to Government and Private Sector

Our team assesses that the relationship between the US and China will remain dynamic in the near-term, as historically, periods of both tension and cooperation have intertwined throughout the decades. However, recent events appear to have raised the global stakes as the relationship has strained. Given how interdependent both the US and the Chinese economies are, our team assesses that the two world powers would continue to work together as the US businesses would continue to provide an influx of capital to the Chinese economy,

while in return, China would continue to supply the US with inexpensive manufactured goods. Although we see a path for a win-win scenario for both nations, recent political developments have introduced significant risks that could jeopardize the working relationship between the parties. The partnership could destabilize and deteriorate due to factors such as geopolitical shifts, economic fluctuations, or changes in foreign policy. In the recent past, US and China leadership have not aligning on global events, such as the handling of Hong Kong's autonomy, origin country of the COVID-19 pandemic, and allegations of human rights violations against Uyghurs in the Xinjiang Province of China.

Certain current events could also increase the tensions between the US and China, including increased US policy changes regarding Taiwan or other Chinese interests. Additionally, China has floated the idea of purchasing oil and gas using Chinese Yuan rather than the US Dollar, which would likely increase the tensions between the US and China due to the global economic impact of a shift from the US Dollar. Another event that could increase US-China tensions would be any additional Chinese engagement with US adversaries such as Russia, Iran, or North Korea. Opportunities exist for US government and businesses to develop international partnerships and alliances to explore and cultivate REE mining resources, identify multiple REE supply streams outside of China, or expand existing REE mining locations inside and outside the United States.

Appendix A: Rare Earth Element Extractive Sector

The rare earth elements (REE) extractive sector refers to the production and sale of a group of 17 chemical elements with unique magnetic and electronic properties. These elements are critical components in a variety of high-tech products, including smartphones, electric vehicles, wind turbines, and military equipment. The 17 REEs are divided into two groups: the light rare earth elements (LREEs) and the heavy rare earth elements (HREEs). The LREEs include cerium, lanthanum, praseodymium, neodymium, promethium, and samarium, while the HREEs include europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, and yttrium.

Rare earth applications are broken down into eight end user categories. These categories are:

1. Battery Alloys;
2. Catalysts;
3. Ceramics, Pigments and Glazes;
4. Glass Polishing Powders and Additives;
5. Metallurgy and Alloys;
6. Permanent Magnets;
7. Phosphors; and
8. Other End-Uses and Applications.

The following industries are heavily dependent on REEs as part of their end product:

1. Electronics: used in a variety of devices including smartphones, computer hard drives, flat screen displays;
2. Automotive catalysts: help reduce emissions from internal combustion engines;
3. Hybrid and Electric vehicles: used in electric motors and batteries;
4. Energy: used in wind turbines and solar panels;
5. Aerospace: used in a variety of aerospace and defense applications, including guidance and control systems, radar systems, and aircraft engines; and
6. Healthcare: used in medical applications, including magnetic resonance imaging machines, X-ray machines, and radiation therapy.¹

Permanent magnets are the most valuable end use for REEs, comprising 90 percent of the total value in REE production, and they also account for the largest volume of REEs in consumption (35 percent). The second most common use for REEs is for the automotive catalysts found in gasoline and diesel-powered engines and additives used in crude oil refinement (26 percent).²

Chinese companies began competing in the 1990s for global market share in REE mining, processing, and production, and benefitted for decades from government assistance including restrictions on foreign mining and processing in China, favorable tax and tariff policies, low labor and energy costs, and relaxed environmental regulations.^{3, 4, 5, 6} As a result, as of 2022, China accounted for 80 to 95 percent of REE production globally, as well as a majority of REE mining, and it has the largest amount of worldwide REE reserves.^{7, 8, 9} The US imported over 80 percent of all REE derived products from China annually between 2010 and 2021, and much of the imported products from other countries were still derived from raw supply mined in China.^{10, 11}

After China demonstrated its ability to roil global supply chains and spike costs for REEs when it cut off supply to Japan in 2010 and enacted broader export restrictions in 2014, the US government began to act on a string of executive and legislative branch efforts to incentivize domestic REE mining, processing, and production and move US REE supply chains away from China, citing economic and national security concerns from multiple US agencies.^{12, 13, 14} Outside of China, Australia and Japan maintained REE mining and processing capabilities that the US has engaged in efforts to diversify supply and provide friend-shoring support in combating China's monopoly in REEs. Both countries has contracted with processing companies in Malaysia, Estonia, France, and Thailand.^{15, 16} Further, an Australia company has contracted several deals to create US-based REE processing facilities, including a 2019 deal with a US company, and a 2022, USD \$120 million agreement with the US Department of Defense to create a processing facility in Texas.¹⁷

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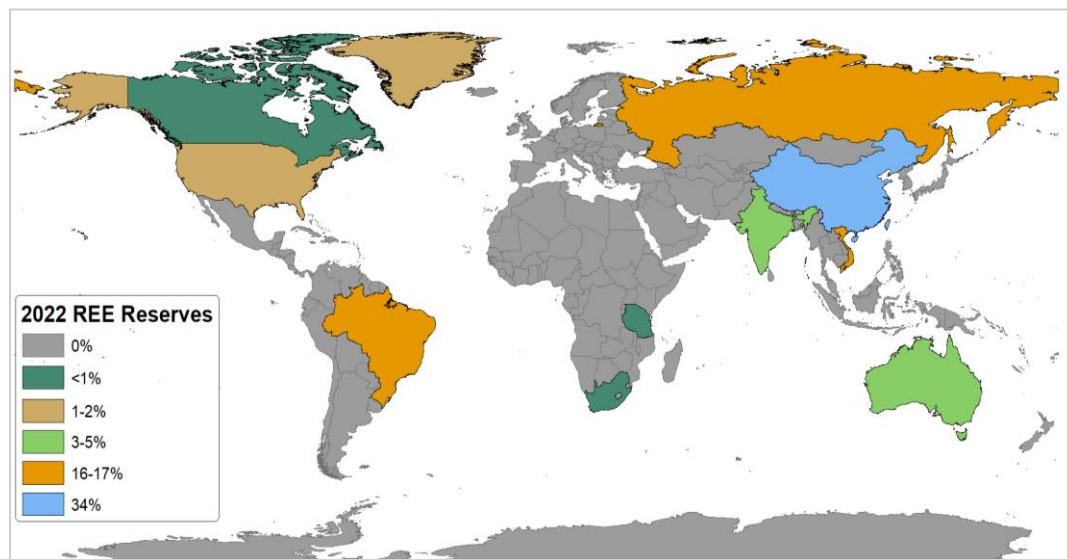
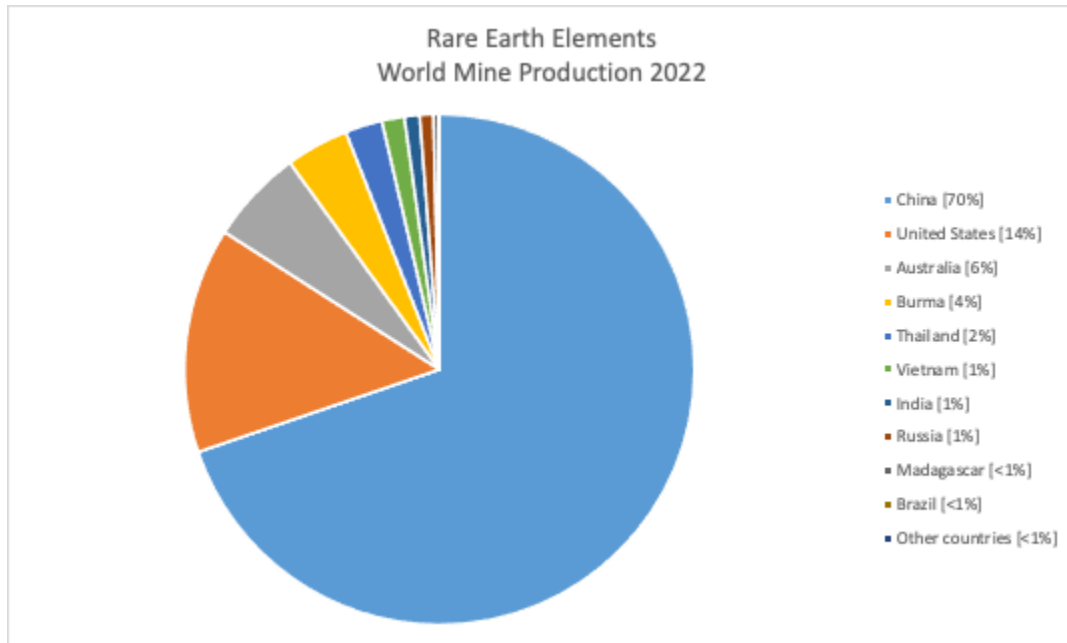
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Appendix B: Rare Earth Element (REE) World Mine Production and Reserves in 2022

According to the Mineral Commodity Summaries report published on 31 January 2023 by the US Geological Survey, the role of REEs contributed to USD \$3.6 trillion in the US. US' share of the worldwide REE mine production in 2022 was approximately 14 percent, while China's share was approximately 70 percent. In 2022, China's REE reserves accounted for approximately 34 percent of the world's REE reserves. US's share of the worldwide REE reserves was approximately 2 percent in 2022.



This is a graphic representation of REE World Mine Production and Reserves in 2022

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