

**HOW IS THE CHINESE DOMINATION OF THE SUPPLY CHAIN OF RARE EARTH  
ELEMENTS AFFECTING THE RELATIVE POWER OF CHINA COMPARED TO THE  
US?**

**BY**

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## **Abstract**

Research study assessing whether the Chinese Domination of the Supply Chain of Rare Earth is Affecting the Relative Power of China Compared to the United States. The paper explores the linkage between natural resource monopolies and power. A Literature Review was conducted researching scholarship for Defining Power in International Relations, Technology and Power, Rare Earth Elements in China, Natural Resource Monopolies and US policy regarding rare earth. Five variables were defined and developed to answer the hypothesis. The five variables used in the assessment included the following: Industry, Innovation, Strategic Reserves, Weapons Systems and Research and Development (R&D). The assessment concluded there was clear evidence of China gaining relative power due to its monopoly in rare earth, but the values were not as overwhelming as the author initially expected.

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## **1 Introduction**

Natural resources, and the drive to secure them, have played a tremendous part in the history of great power politics. It was the search for spices and precious metals that brought about European colonialism. Oil and natural gas powers the industrialized world. It is clear that natural resources are an integral component to driving a state's economy and are critical to the country's overall security. The makeup of these key resources changes overtime as technology advances. While the key resources might have changed, the competition to secure them has not. States will always look after their own interests, and the securing of critical resources for domestic use is at the top of their concerns.

A prime example of this changing interplay between states and natural resources can be seen in rare earth elements (REE). Rare earth elements make up the bottom 17 elements on the periodic table. The common name for this group of elements is somewhat misleading. They are not exactly rare, as the quantity of the elements in the earth's crust is quite large. What makes them rare is the lack of large concentrations of these elements that lend themselves to mining. The low concentration of the elements makes "extraction and processing both difficult and costly."<sup>1</sup> Even with the high cost of REE production, rare earth elements have become integral in the technology of the 21<sup>st</sup> century. Rare Earth Elements are unique in that they are very light and carry strong electromagnetic properties. They are in almost every modern piece of technology to take advantage of these special qualities, and are used in everything from iPhones to laser

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<sup>1</sup> Grasso , V. (2013). Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress . *Congressional Research Service* .

targeting weapon systems. The scarcity of these unique properties has dramatically driven up their market value.

The global supply chain of rare earth elements has been dominated by the People's Republic of China, since the early 2000's. This domination is the culmination of many years of strategic planning. Going back to the 1940's, China began putting resources into the study of rare earth. The US was also putting resources into the study of rare earth in the latter half of the 20th century, but was greatly out-funded by China. "China, on the other hand, has established entire laboratories and teams devoted to the study of REEs."<sup>2</sup> China deemed the supply chain of REE's critical to both the national security and economic future of their country, as Chinese leader Deng Xiaoping stated upon his visit to a Chinese rare earth mine, "There is oil in the Middle East; there is rare earth in China."<sup>3</sup>

This research study will examine how this domination of the rare earth supply chain will affect China's relative power. By conducting secondary analysis of documents, the paper will explore the variables pertaining to power, which include industry, innovation, strategic reserves of natural resources, weapons systems and levels of R&D expenditure.

We are at the cusp of a new era of great power competition between the US and China. While still lagging behind the US both economically and militarily, China has a key advantage in this new era of geopolitics. It holds a monopoly over the mining and refining of rare earth elements.

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<sup>2</sup>Hurst, Cindy. "China's Ace in the Hole Rare Earth Elements." *Joint Force Quarterly* , no. 59 (2010).

<sup>3</sup>Ibid 124

The US has been at the top of the international community of states for the last several decades.

The fall of the Berlin wall and the breakup of the USSR ended nearly a half century of great power competition. This competition spawned many proxy wars and shaped many of the security threats that we are still dealing with today. The US stands as the last global superpower.

However, China is taking strategic steps to increase their relative power in an effort to supersede the US.

## 2 Literature Review

### 2.1 Defining Power in International Relations (IR)

The scholarship surrounding the discussion of power in International Relations theory is vast and offers theories and opinions that are often opposed to one another. The research question asks how a natural resource, rare earth elements, can affect the power of a state. What makes this discussion surrounding power complex is that each branch of the international political theory spectrum has a unique idea about its definition. Yet, it is still critical to set up a framework for what ‘power’ means for this study.

Max Weber’s definition is one of the more influential discussions of power in the field of social sciences. Weber’s definition of power is, as summarized by Aigerim Raimzhanova, “According to Weber, power is a zero-sum game and is an attribute that derives from the qualities, resources and capabilities of one subject.”<sup>4</sup> While this definition allows us to glance at the wider discussion of power, it does little to understand how power is defined by IR theorists.

The scholarship on power in IR defines two main parts of power, “hard” and “soft.” The terms were initially constructed by Joseph Nye. However, the basic principles of hard power were defined earlier by the realist scholar Hanz Morgenthau. Morgenthau calls his definition the “elements of the national power approach.”<sup>5</sup> This approach, “depicts power as property of states.”<sup>6</sup> Essentially, Morgenthau believes that power comes from the resources of the state, such

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<sup>4</sup> Raimzhanova, A. (2015). POWER IN IR:HARD,SOFT, AND SMART. *Institute for Cultural Diplomacy and the University of Bucharest.*

<sup>5</sup> Ibid 3

<sup>6</sup> Ibid 3

as the “level of military expenditure, size of the armed forces, gross national product, size of territory, and population.”<sup>7</sup> While natural resources play a large part in the economic security of a nation, it is rarely discussed by Morgenthau and other IR scholars. However, natural resources play a key role in Morgenthau’s definition as they directly contribute to the GNP and military aspects of his definition of power as a state cannot build the guns and ships it needs without first having the steel to do so.

Natural resources also play a role in soft power. Abraham Kaplan argues that soft power, in its simplest form, is the ability of a nation to influence others without resorting to force. Kaplan uses his “relational power approach,” which “depicts power as an actual or potential relationship.”<sup>8</sup> Where Morgenthau sees power as the combined resources of the state, Kaplan believes that power is a state’s ability to exercise influence over others. Moreover, Joseph Nye expands on Kaplan’s idea that power is a relationship by noting that while most policy decisions are still based on the idea that the military is the ultimate use of power, there is a trend towards a diffusion of power.<sup>9</sup> As Nye states, “at least five trends have contributed to this diffusion of power: economic interdependence, transnational actors, nationalism in weak states, the spread of technology and changing political issues.”<sup>10</sup> It is in this diffusion of power where scholars must consider that REE’s, a key natural resource, could play a major role in soft power, particularly in the spread of technology and economic interdependence.

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<sup>7</sup> Ibid 3

<sup>8</sup> Ibid 3

<sup>9</sup> Nye, J. (1990). *Soft Power. Foreign Policy* , 80.

<sup>10</sup> Ibid 160



## **2.2 Technology and Power**

Ricardo Hausmann puts it best, “In economics, it is widely accepted that technology is the key driver of economic growth of countries, regions and cities. Technological progress allows for the more efficient production of more and better goods and services.”<sup>11</sup> Hausmann’s idea is not unique to him, as the idea that technology drives growth is widely accepted. In fact, Zia Qureshi argues that, “Technology-enabled innovation is the major spur to productivity growth.”<sup>12</sup> Qureshi does not dispute Hausmann’s idea, rather he gives more insight into what specific part of economic growth technology affects.

Technology has greatly reduced the cost of information sharing. According to Joseph Nye, “The current information revolution, sometimes called “the third industrial revolution,” is based on rapid technological advances in computers and communications.”<sup>13</sup> To Nye, access to information is a major aspect of soft power. He states that, “Information can often provide a key power resource, and more people have access to more information than ever before.”<sup>14</sup> This diffusion of information has changed the way power is projected; Nye argues that a navy, while helpful for patrolling sea routes, “(does) not provide much help on the internet.”<sup>15</sup> Technology has changed the way soft power is projected; however, technology's role in hard power should not be overlooked.

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<sup>11</sup>Hausmann, Ricardo, and José Domínguez . “Knowledge, Technology and Complexity in Economic Growth.” Real Colegio Complutense. Accessed November 1, 2021. <https://rcc.harvard.edu/knowledge-technology-and-complexity-economic-growth>.

<sup>12</sup>Qureshi, Zia. “Technology and the Future of Growth: Challenges of Change.” *Brookings* , February 25, 2020.

<sup>13</sup> Nye, Joseph S. 2014. The Information Revolution and Soft Power. *Current History* 113(759): 19-22

<sup>14</sup> Ibid

<sup>15</sup> Ibid

Technology in war, and the key position it holds, seems to be apparent, but it is downplayed or completely overlooked in some scholarships. Warren Chin in his *International Affairs* article writes, “Clausewitz missed the importance of technology as a variable in his analysis of war.”<sup>16</sup> While Chin points to Clausewitz’s omission, he also explains how it could be overlooked. Chin states, “The omission is understandable, because the history of war is characterized by long phases of technological stagnation punctuated by occasional spasms of revolutionary change caused by a variety of forces.”<sup>17</sup> Alex Roland of the Foreign Policy Research Institute would likely agree that Clausewitz deserves a pass for his omission and argues that “Technology shapes *warfare*, not war. War is timeless and universal.”<sup>18</sup> Technology does not change the nature of war, it only changes the way it is fought. But military power is only one aspect of power, and the economy of a country is just as much an aspect of its power as its ability to field a military force, and technology is the main driver of both.

### **2.3 Rare Earth Elements in China**

The scholarship discussions surrounding rare earth in China are often one of alarm and a call to action. This tone is expressed not only in the scholarship, but also in the views of the states that

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<sup>16</sup> Warren Chin, Technology, war and the state: past, present and future, *International Affairs*, Volume 95, Issue 4, July 2019, Pages 765–783, <https://doi.org/10.1093/ia/iiz106>

<sup>17</sup> Ibid

<sup>18</sup> Roland, Alex. “War and Technology.” *Foreign Policy Research Institute*, February 27, 2009.

have become dependent upon Chinese rare earth. As Nicholas Jepson states in his essay, “The narrative usually attached to discussion of rare earths is one of aggressive Chinese mercantilism in the service of geo-political goals and apparent Western complacency and vulnerability.”<sup>19</sup> The panic of the dependent states is not without cause, as China has a virtual monopoly over all aspects of the rare earth supply chain. Jepson continues by stating, “China now accounts for 97% of the world’s rare earth mining. It enjoys similar dominance at all points of the supply chain up to the manufacturing stage.”<sup>20</sup> China has been transparent with their objective to monopolize this resource. As stated by China’s former President Jiang Zemin in 1999, China will “Improve the development and application of rare earth, and change the resource advantage into economic superiority.”<sup>21</sup> China did not always have a monopoly over rare earth, as stated by the American Geoscience institute, “in 1993, 38 percent of world production of REEs was in China, 33 percent was in the United States, 12 percent was in Australia, and five percent each was in Malaysia and India.”<sup>22</sup> The reason for the drop off of rare earth mining in countries outside of China is twofold, lower labor cost and environmental concerns. A World Affairs article noted, “the decline in U.S industry was due in part to lower labor costs in China, combined with environmental issues at the Mountain Pass Mine.”<sup>23</sup> The Mountain Pass Mine was an open pit

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<sup>19</sup> Jepson, Nicholas. “A 21st Century Scramble: South Africa, China and the Rare Earth Metals Industry.” *South African Institute of International Affairs*, March 2012.

<sup>20</sup> Ibid 6

<sup>21</sup> Kalantzakos, Sophia. *China and the Geopolitics of Rare Earths*. New York, NY, United States of America: Oxford University Press, 2018.

<sup>22</sup> “What Are Rare Earth Elements, and Why Are They Important?” *American Geosciences Institute*, February 1, 2018. <https://www.americangeosciences.org/critical-issues/faq/what-are-rare-earth-elements-and-why-are-they-important>.

<sup>23</sup> Butler, C. (2014). Rare Earth Elements: China's Monopoly and Implications for U.S. National Security. *Fletcher Forum of World Affairs*, 38.

mine of rare earth elements in California, but closed in 2002 because of environmental concerns. The mine was sold and reopened in 2008. The government of China currently holds a 8% stake.<sup>24</sup> The scholarship is very unified in their account of China's complete domination of the rare earth supply chain. Where they differ is how this domination affects the power of the US. Most scholars agree that the Chinese domination of the REE supply chain threatens both the military and economic security of the US. While the scholarship agrees that these two security aspects are important, they disagree on which one is the most important. Candace Rondeaux, believes that the economic security aspect is the most important. She states that, "There is no debating that the coming shift to electric vehicles and greater reliance on renewable energy will drive up competition over rare earths... The only real question is how the rest of the world outside China, and especially the U.S. is going to cope with the coming competition over rare earths."<sup>25</sup> Rondeaux focuses on how REE's, or the lack of them, would affect the manufacturing capabilities of the US. Christine Parthemore, who still focuses on manufacturing, believes that the supply chain of rare earth will affect the energy industry in the US more. She writes that, "Governments around the world are promoting a more sustainable, lower carbon energy paradigm that includes increasing adoption of renewable energy sources... rare earths are critical to manufacturing wind turbines, solar energy systems and efficient batteries."<sup>26</sup>

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<sup>24</sup> "Mountain Pass Rare Earth Mine, San Bernardino County, California, USA." NS Energy. Accessed November 3, 2021. <https://www.nsenergybusiness.com/projects/mountain-pass-rare-earth-mine/>.

<sup>25</sup> Rondeaux, Candace. "The Coming Battle Over Rare Earths." *World Politics Review* , March 5, 2021.

<sup>26</sup> Parthemore, C. (2011). Elements of Security: Mitigating the Risks of U.S. Dependence on Critical Minerals. *Center for a New American Security*

No scholarship denies the importance of REE's for the economic security of the US. However, most scholarship focuses on the potential effects to the development and manufacturing of military technology. Nicholas Sanders puts the issue into perspective, he states, "Without rare earth metals, missiles and smart bombs would not hit targets and satellite communication systems would not work."<sup>27</sup> Ryan Carpenter agrees with Sanders sentiment, Carpenter takes it a step further and describes a nightmare scenario where "it is not too imaginative to envision a situation in which China halts rare earth exports at a time when the U.S. military is engaged in a mission that requires heavy use of rare-earth-dependent weapons systems."<sup>28</sup>

The concern that the scholarship raises on the issues of Chinese domination of the supply chain are poignant. Differences begin to emerge in the voice of the scholarship when it comes to addressing the challenges of the Chinese REE monopoly. Sander's believes that Congress must do more to secure domestic supply. As he writes, "In my view, fostering and supporting the development of domestic rare earth metal sources is the rational and prudent risk mitigation approach."<sup>29</sup> The development of a domestic rare earth industry seems not only the most prudent move, but also the most likely to occur. However, there are risks involved with the reinvigoration of the industry. The environmental impact of rare earth mining is chief among these risks. As laid out by Carpenter, "Despite the many benefits of having a reliable domestic industry for rare earth supplies, serious dangers are created during rare earth mining. Although not radioactive

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<sup>27</sup> Sanders, Nicholas. "A RESPONSE TO RYAN P. CARPENTER'S 'THE BOTTOM OF THE SMART WEAPON PRODUCTION CHAIN: SECURING THE SUPPLY OF RARE EARTH ELEMENTS FOR THE U.S. MILITARY' ." *Public Contract Law Journal* 41, no. 4 (2012).

<sup>28</sup> Carpenter, Ryan. "THE BOTTOM OF THE SMART WEAPON PRODUCTION CHAIN: SECURING THE SUPPLY OF RARE EARTH ELEMENTS FOR THE U.S. MILITARY." *Public Contract Law Journal* 41, no. 2 (2012).

<sup>29</sup> Sanders, Nicholas. *Public Contract Law Journal*

themselves, rare earth element deposits are almost always found with varying levels of the radioactive element.”<sup>30</sup> As stated previously, one of the main causes of the shutdown of the US Mountain Pass Mine was environmental degradation.

## **2.4 Natural Resource Monopolies**

Predicting how China will choose to use their monopoly of REE’s is difficult; but we can look at the scholarship for other resource cartels to see how a more aggressive China policy might play out. The Organisation for Economic Co-operation and Development (OECD) defines a cartel as “firms (that) create a formal agreement to raise or fix prices and to reduce output in order to increase profits.”<sup>31</sup> Cartels have existed throughout history, in industries such as steel, railroad and transportation. One of the most powerful recent iterations of a resource cartel is OPEC. The purpose of OPEC is to “control oil output in order to influence prices.”<sup>32</sup> During the 1970’s, in response to the US support of Israel during the Yom-Kippur war, OPEC embargoed oil exports to the US. Supply shortages resulted and oil prices rose. This embargo caused, “a shift in global political and economic power as now the OPEC countries (largely centered in the Middle-East) could influence powerful nations such as the UK and U.S by manipulating oil supplies.”<sup>33</sup> The turmoil that the event caused was significant. As OPEC did not have a complete resource monopoly, the US and other embargoed countries were able to obtain oil from other sources. The monopoly China has in rare earth appears to be more complete, and

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<sup>30</sup> Ryan P. Carpenter: Public Contract Law Journal

<sup>31</sup>“Oil and Gas Industry: A Research Guide: Organizations and Cartels.” Research Guides. Library of Congress. Accessed November 2, 2021. <https://guides.loc.gov/oil-and-gas-industry/organizations>.

<sup>32</sup> Ibid

<sup>33</sup> Lyndon, G, and Jason Donev. “Oil Crisis of the 1970s.” Oil crisis of the 1970s . Energy Education. Accessed November 2, 2021. [https://energyeducation.ca/encyclopedia/Oil\\_crisis\\_of\\_the\\_1970s](https://energyeducation.ca/encyclopedia/Oil_crisis_of_the_1970s).

an embargo could be more devastating than the oil crisis of 1970. China, as stated previously, has cut exports, but has not embargoed rare earth exports to the US. If tensions continue to rise between the two countries, an embargo could be implemented as it was in Japan in 2010 when China used their monopoly to coerce a country to comply with their will.

China used their monopoly in the past to force countries into compliance with their will. On Sept. 7, 2010, a Japanese Coast Guard vessel in the East China Sea spotted a large Chinese fishing vessel off the coast. It was not the first time Chinese boats encroached into an area governed by Japan. The Japanese claimed these East China Sea islands in 1895 when the country annexed them following the Sino-Japanese War. China also asserted claims to these islands. The fishing boat repeatedly rammed the Japanese Coast Guard vessels. Japan arrested and later released the crew. The fishing boat captain was held for trial. Exactly two weeks later, on Sept. 21, authorities of Japan's Ministry of Economics, Trade and Industry learned that China had refused to fill Japanese orders for RE elements. These elements were the exact materials required for Japan's high-tech industry and were mainly produced in China. No other country reported such delays.<sup>34</sup> As stated by Keith Bradsher in a New York Times article, "Sharply raising the stakes in a dispute over Japan's detention of a Chinese fishing trawler captain, the Chinese government has blocked exports to Japan of a crucial category of minerals used in products like hybrid cars, wind turbines and guided missiles."<sup>35</sup> A few days later, Japan released the captain. Restricting RE was an affective move of China to escalate the political conflict between the two

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<sup>34</sup> Abraham, David S. *The Elements of Power: Gadgets, Guns, and the Struggle for a Sustainable Future in the Rare Metal Age*. New Haven: Yale University Press, 2016.

<sup>35</sup> Bradsher, Keith. "Amid Tension, China Blocks Vital Exports to Japan." *The New York Times*, September 23, 2010. <https://www.nytimes.com/2010/09/23/business/global/23rare.html>.

countries without the use of force. This move by China served as a wakeup call to the rest of the world.

In 2012 the US along with the EU (European Union) and Japan filed a complaint with the World Trade Organization (WTO) against China. This dispute was over China's manipulation of the rare earth supply chain by lowering export quotas, which created a spike in world prices for rare earth and caused disruption in the global market. The WTO dispute settlement panel found in favor of the US position that China had wrongly imposed export quotas on rare earths to manipulate world markets.<sup>36</sup>

## **2.5 US Policy Regarding Rare Earth**

For some time, the US was content to let China control the rare earth trade. Recent concerns over this apathy has pushed the US government to take action. In 2010, Congressman Mike Coffman introduced a bill that would “reestablish a competitive RE minerals production industry, a domestic RE processing...RE-based magnet production industry and supply chain”<sup>37</sup> for the purposes of national defense. The bill died in committee. One year later, Senator Lisa Murkowski, alarmed at the natural resource scarcity and its impact on defense and security, introduced the Critical Minerals Policy Act in 2011. It, too, died in committee. Since then, close to a dozen bills have been introduced in Congress, but legislative attempts to respond to the United States' dependence on foreign imports from China have yet to produce results.

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<sup>36</sup> “United States Wins Victory in Rare Earths Dispute with China: WTO Report Finds China's Export Restraints Breach WTO Rules,” n.d. <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2014/March/US-wins-victory-in-rare-earths-dispute-with-China>.

<sup>37</sup> The Restart Act(H.R.4866) 2010



Ten years after Congressman Coffman’s legislation failed, President Trump signed an executive Order “Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries and Supporting the Domestic Mining and Processing Industries.”<sup>38</sup> In this order, he specifically addressed one country, China, as an “adverse foreign government” whose monopoly on rare earth must be reduced for “our national security, foreign policy and economy require a consistent supply of these minerals.”<sup>39</sup> The President declared this as a national emergency.

Five months later, President Biden addressed in his Executive Order policy changes in protecting “America’s Supply Chain” and ordered his administration to seek outside shareholders of “industry, academia, non-government organizations, labor unions and State, local and Tribal governments” to “revitalize and rebuild domestic manufacturing capacity, maintaining America’s edge in research and development.”<sup>40</sup>

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<sup>38</sup> Federal Register, Publication Date 10/05/2020. Executive Office of the President, Executive Order 13953

<sup>39</sup> Ibid

<sup>40</sup> Federal Register, Publication Date 03/01/2021, Executive Office of the President, Executive Order 14017

### **3 Hypothesis**

**Study hypothesis: The Chinese domination of the rare earth supply chain will cause an increase in the relative power of China compared to that of the US.**

Any analysis of Chinese power must include a comparison to the US, as these two powers are driving the greater geopolitical picture. Similar to the importance of fossil fuels in the recent history of the industrialized world, rare earth elements have become a critical resource. Rare earth is critical to the US, both economically and militarily, and this dependency gives the Chinese domination of the supply chain an ever-increasing strategic value. A strong Chinese monopoly could cause key industries to leave the US in favor of China, as companies would rather be nearer to a key resource and ensure its availability to shorten their transportation lanes and reduce costs. An increase in the domestic rare earth industry in China could also lead to more technological breakthroughs, thereby giving China a distinct advantage in innovation, for both civilian and military applications. The variables that will be used to measure this great power tug-of-war are an array of variables that investigate the economic and military aspects of power.

### **4 Methods**

This study will use qualitative methods, specifically secondary research of journals, articles, government reports and policy statements to determine if the Chinese monopoly of rare earth affects the relative power of China. The data for this study will focus on the underlying aspects of relative power and the interplay of hard and soft power. As there are many definitions of power, the study will be using a variation of a 'realists' definition. The study will define power

as a states' use of its economic and military resources to coerce other states' cooperation or submission.

The relative power of China will be measured by using two variables for its economic resources (**Industry** and **Innovation**) and two for military resources (**Systems** and **Research & Development**). The study will also use an additional variable assessing the implementation of a strategic reserves policy or the stockpiling of rare earth for in-state consumption. This variable will have applications to both the economic and military aspects of power. (**Strategic Reserve**) This variable will determine if China is developing a strategy or actively stockpiling rare earth to build a strategic reserve.

As the hypothesis states, this study may find that the domination of the rare earth supply chain by China will result in an increase of the relative power of China. If the hypothesis is correct, distinct patterns in the variables will emerge.

## **4.1 Economic Resources.**

### **4.1.1 Industry.**

The study will identify cases where manufacturing or other parts of industry are relocated to China to be closer to a stable supply of rare earth. This variable will measure the amount of manufacturing moved to China, due to industry concerns over securing a rare earth supply. The movement of industry to China would directly affect its economic power, granting them a larger industrial base. For the variable **Industry**, the study expects to see a large amount of industry relocating to China. This variable will only look at industry that moves to China for natural

resource reasons, not other reasons such as lower worker wages or less environmental regulations. If the study finds either limited or no industry moving to China to secure REE necessary for their production, then this variable would not contribute any gain to China's relative power.

#### **4.1.2 Innovation.**

The study's second economic variable observes the level of innovation concerning rare earth elements and technology. Specifically, this variable will measure the number of patents that each country, China, and US, have developed related to the mining, extraction, or use of rare earth. Innovation is key to growing a country's economy and new technologies will be an important advantage in the power competition between the US and China. For the variable **Innovation**, a disparity between the number of patents pertaining to rare earth technology in China compared to the US could indicate a positive movement of China's relative strength.

#### **4.2 Military Resources.**

This study will use two variables to measure the effect of China's monopoly on military resources, **Systems** and **Research and Development**. The variables on the military aspect of power will focus mainly on the technology gap.

##### **4.2.1 Systems.**

The first variable looks at the weapon systems that use rare earth elements. This will be a difficult variable to measure for this study, as most systems of interest would most likely be

classified. However, it will be important to look at the prevalence of rare earth in use in China's military. This variable will tell us if China has used its dominance of rare earth to build advanced weapon systems that have the potential to change the power dynamics between the US and China. The **Systems** variable should show that China has started to develop more weapon systems that require rare earth. As there is already a major gap between the US and China regarding weapon systems, this variable will not be looking to see if China eclipses the US but rather if they have narrowed the gap. The effectiveness of these weapon systems will not be under consideration for this study as there are too many weapon systems to look at for this paper, and any tests of these systems would be classified. This study will look at two of the most common uses of rare earth in weapon systems, permanent magnets and advanced armor. If the study finds that China has not used rare earth in new weapon systems, then this variable would not contribute to China's relative power gain.

#### **4.2.2 Research and Development (R&D).**

The second variable will be measuring the amount of expenditure used by each country to fund research and development (R&D). As rare earth elements are so crucial for new technology, the R&D budgets for each country could give the study valuable insight on the technology gap. Technology is one of the main pillars of American power, a narrowing of the technology gap could show a shift in power. **R&D** will look to see if China has increased its spending on research and development to narrow the gap with the US. R&D is critical to economic growth, as it allows the development of new products or the improvement of old ones. R&D expenditure by governments and businesses is necessary for a state to grow its technological abilities. If this

study finds that China has not increased its expenditure on research and development, then this variable will not contribute to China's relative power gains.

#### **4.2.3 RESERVES.**

The **Reserves** variable should demonstrate growth in stockpiled resources and identify an effort to grow their strategic reserves by cutting exports of rare earth. If the study finds that China has not attempted or will not attempt to build a strategic reserve of rare earth, then this variable will not contribute to the relative power gain of China.

## **5 Data**

### **5.1 Industry.**

The variable **Industry** measures if manufacturers moved to China specifically to ease their access to rare earth. Auto manufacturers have become major users of rare earth and are a good indicator to see if rare earth dependent industries are willing to move to China. A Bloomberg article, written by Elisabeth Behrmann establishes the auto manufacturers interest in stabilizing the supply chain. She states that, "European automakers are in discussions with Australian rare earths explorer Arafura Resources Ltd. about sourcing elements that help power electric cars from outside China, which dominates global supply."<sup>41</sup> Behrmann continues by stating, "The miner is developing the A\$1 billion (\$728 million) Nolans project in Australia's Northern

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<sup>41</sup> Behrmann, Elisabeth. "Automakers Look to Hedge Against China Rare Earth Dominance." Bloomberg, September 22, 2021. <https://www.bloomberg.com/news/articles/2021-09-22/automakers-look-to-hedge-against-china-s-rare-earth-dominance>.

Territory that will cover as much as 10% of global demand for the type of rare earths used in permanent magnets for electric motors.”<sup>42</sup> European auto manufacturers are not the only ones looking to secure other supply chains. In Ryan Carpenters article for the Public Contract Law Journal, he states, “In response to the supply problems of rare earth elements, Toyota's trading arm, Toyota Tsusho Corp., absorbed the rare earth importer Wako Bussan in 2009 and quickly formed a joint venture with Sojitz Corp. and a Vietnamese state-run miner. Toyota now has control of its production line...”<sup>43</sup>

While some auto manufacturers have invested in a new supply chain, other companies in Germany and the US are reducing their use of rare earth, rather than suffer from a disrupted supply chain. Behrmann continues that “carmakers including BMW and General Motors Co. have sought to reduce the amount of rare earths.”<sup>44</sup>

Most of the rare earth used in auto manufacturing, and in other advanced industries, are used to create permanent magnets. Permanent magnets maintain their magnetic properties and produce massive energy relative to their weight and size and due to these unique properties, are an integral part of many technology-laden industries.<sup>45</sup> Controlling the creation of these magnets will increase a state's relative power. According to a U.S Department of Energy white paper, “Since 1995, the U.S. permanent magnet manufacturing sector has been reduced by half through

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<sup>42</sup> Ibid

<sup>43</sup> Ryan P. Carpenter: Public Contract Law Journal

<sup>44</sup> Behrmann, Elisabeth. Bloomberg

<sup>45</sup> Hui, Mary. “Why Rare Earth Permanent Magnets Are Vital to the Global Climate Economy.” Quartz, n.d. <https://qz.com/1999894/why-rare-earth-magnets-are-vital-to-the-global-climate-economy/>.

industry consolidation, relocation, and closure.”<sup>46</sup> A large portion of this industry has been moved to China, as stated in the same report, “Sumitomo Special Metals Corporation merged with Hitachi Metals, Ltd and the division at General Motors became Magnequench, which was bought by Chinese investors and relocated to China.”<sup>47</sup> Both the Sumitomo Special Metals Corporation( Japan) and the division of General Motors Corporation (US) were designing and manufacturing NdFeB magnets. The NdFeB magnets were originally designed and manufactured in the US. They are one of two rare earth magnets that are “particularly useful to military application....because of their thermal stability.”<sup>48</sup>

While China has been successful in moving some industry to its shores, it has competition from countries with mineable REE resources, such as Malaysia and Vietnam. Ryan Carpenter shows several international companies choosing to move to Malaysia rather than China. He states, “Japanese companies move refineries to less developed countries like Malaysia.”<sup>49</sup> Japan is not the only country that is moving the refining industry to Malaysia, Carpenter continues, “Lynas (Australian mining firm) will mine the elements in the Australian desert but then transport those elements 2,500 miles away to Malaysia for refining.”<sup>50</sup>

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<sup>46</sup>“Critical Materials Rare Earths Supply Chain: A Situational White Paper.” *U.S Department of Energy: Office of Energy Efficiency & Renewable Energy* , 2020.

<sup>47</sup> Ibid

<sup>48</sup> Kalantzakos, Sophia. *China and the Geopolitics of Rare Earths*. New York, NY, United States of America: Oxford University Press, 2018. pg. 120

<sup>49</sup> Ryan P. Carpenter: *Public Contract Law Journal*

<sup>50</sup> Ibid 430



## **5.2 Innovation.**

The variable code **Innovation** studies the number of patents that have been filed in both China and the US related to rare earth technology, since patents are an indicator of a healthy innovation center in an economy. Technological innovation drives economic expansion, and the US has had a key advantage in innovation. This advantage created a large technological gap between itself and China. The driving force for this gap are the large innovation centers, such as Silicon Valley and Research Triangle Park. China has historically lacked these innovation centers. This study will not be able to validate each patent, as they number in the tens of thousands. However, the total number of patents could indicate the relative health of a country's innovation sector.

According to Eric Ng of the South China Morning Post(a State-run newspaper), “China had filed for 25,911 rare earth patents compared to 9,810 from the US as of October last year (2019).”<sup>51</sup>

William Mansfield confirms this trend towards large numbers of Chinese patents, as he states, “In terms of absolute numbers, China is leaps and bounds ahead of the US and Japan, its two closest competitors, when it comes to patents owned in this technology.”<sup>52</sup> While both Mansfield and Ng agree that China has shown impressive overall numbers, there may be soft spots.

Mansfield states “the overall strength of Chinese patents in rare earths still lag behind those of Japan and the US.”<sup>53</sup> The work of others appears to corroborate his point. A study conducted by Zhihui Leng and Han Sun for the Resources Policy Journal found that, “China's rare earth

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<sup>51</sup> Ng , Eric. “China's Rare Earth Patents Give an Insight into Industry Domination.” South China Morning Post, July 20, 2019. <https://www.scmp.com/business/companies/article/3019290/chinas-war-chest-rare-earth-patents-give-insight-total>.

<sup>52</sup>Mansfield, William. “China in Rare Earth Elements - Top Supplier, Major Patent Developer, Yet Portfolio Strength Still a Concern.” PatentSight, September 2019. <https://www.patentsight.com/en/ip-analytics-blog/china-in-rare-earth-elements-top-supplier-major-patent-developer-yet-portfolio-strength-still-a-concern>.

<sup>53</sup> Ibid

industry technological innovation ability has continued to increase in terms of the breadth and depth, and the industrial chain has shown the characteristics of “strong upper and weaker lower”.<sup>54</sup> Most of China’s innovation is coming in upper stream technologies related to the actual mining and refining of rare earth. The study continues by stating, “Through analysis of the global rare earth industry's technological innovation competition pattern, it is found that China's rare earth industry has outstanding innovation capabilities in raw ore mining (upstream) and smelting separation (midstream), but its downstream innovation capabilities are insufficient.”<sup>55</sup>

### **5.3 Strategic Reserves.**

The variable **Strategic Reserves** will evaluate the attempts by China to develop a reserve of rare earth. Securing a domestic supply of a critical resource, like rare earth, is not a new idea. Oil and fuels have been held in strategic reserves by states for many years. A strategic reserve ensures that a country will have the critical resources necessary if a supply chain fails.

China began cutting exports of rare earth to build a strategic reserve to protect its own domestic needs. “(I)n 2020, China’s total export volume of rare earths reached 35,447.5 tons for the whole year, down by 23.5 percent year-on-year, and the lowest figure in the last five years.”<sup>56</sup>This reduction of exports has been overseen by the Department of Natural Resources of the State

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<sup>54</sup>Leng, Zhihui, Han Sun, Jinhua Cheng, Hai Wang, and Zhen Yao. “China's Rare Earth Industry Technological Innovation Structure and Driving Factors: A Social Network Analysis Based on Patents.” *Resources Policy* 73 (2021): 102233. <https://doi.org/10.1016/j.resourpol.2021.102233>.

<sup>55</sup> Ibid

<sup>56</sup> Baruzzi, Sofia. “How China Is Tightening Its Control over Management of Rare Earths.” China Briefing News, June 2, 2021. <https://www.china-briefing.com/news/china-tightens-control-over-management-of-rare-earths/>.

Council. According to an article in China Briefing, this council “defines a strategic reserve of rare earth resources and rare earth products.”<sup>57</sup> The article continues by stating, “The State Council’s industry and information technology authorities, together with the State Council’s development and reform, natural resources, and other departments, will establish targets for rare earths’ mining, smelting, and separation.”<sup>58</sup>

China is attempting to curb exports which has been met with mixed results, as stated in a Financial Times article, “China began setting rare earth production limits in 2007 to keep prices high and reduce pollution but the policy is not legally binding and many miners regularly exceed their output quota.”<sup>59</sup> New rules have been recently implemented by the Chinese government giving them more power to enforce the bans. The article continues by quoting The Ministry of Industry and Information Technology, “MIIT said the new law would help “protect national interest and ensure the security of strategic resources”.”<sup>60</sup>

China’s large domestic demand for rare earth has also hampered their attempts to build a strategic reserve of the elements. The Financial Times article continues by stating, “According to government statistics, China’s demand for rare earths is so high that it has consistently exceeded domestic supply over the past five years, prompting a surge of Chinese imports from miners in the US and Myanmar.”<sup>61</sup> In order to meet their domestic demands, China has taken steps to

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<sup>57</sup> Ibid

<sup>58</sup> Ibid

<sup>59</sup> Sevastopulo, Demetri, Sun Yu, and Tom Mitchell. “China Targets Rare Earth Export Curbs to Hobble US Defence Industry.” Financial Times, February 16, 2021. <https://www.ft.com/content/d3ed83f4-19bc-4d16-b510-415749c032c1>.

<sup>60</sup> Ibid

<sup>61</sup> Ibid

secure reserves of rare earth outside of its borders. Eva Bartekova summarizes some of China's policy initiatives. "China's *“go global policy”* targets the acquisition of strategic resources abroad by means of outbound direct investment in the mining sector.”<sup>62</sup>Bartekova continues by adding, “These (potential bottlenecks) have been addressed by broadening the scope of China's mineral policy from targeting domestic investment in the past, to nowadays facilitating the access of Chinese companies to sources of minerals abroad.”<sup>63</sup>

China has a two-prong policy, both attempting to find outside sources of rare earth to service the growing domestic demand, as well as working to grow its stockpiles of rare earth. Mary Hui writes in her article that while China already has an impressive stockpile of rare earth, they may have it in the wrong elements. “China has accumulated stockpiles of certain individual rare earth elements that are in low demand, and therefore sell at depressed prices.”<sup>64</sup>

#### **5.4 Systems.**

The **Systems** variable will observe the number of weapon systems that China has created using rare earth. To have an efficient and effective 21<sup>st</sup> century fighting force means that a country must be able to create and manufacture cutting edge weapon systems. These cutting edge systems all rely on rare earth. Rare earth elements have a number of military applications, this

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<sup>62</sup> Barteková, Eva, and René Kemp. “National Strategies for Securing a Stable Supply of Rare Earths in Different World Regions.” *Resources Policy* 49 (2016): 153–64. <https://doi.org/10.1016/j.resourpol.2016.05.003>.

<sup>63</sup> Ibid

<sup>64</sup> Hui, Mary. “China's Rare Earth Hub Is Rolling out Massive Subsidies to Fix the Industry's Achilles Heel.” Quartz, July 2021. <https://qz.com/2031940/chinas-rare-earth-hub-baotou-introduces-massive-subsidies/>.

study will concentrate on advanced armor and the missile guidance systems that require permanent magnets.

China has been using rare earth elements to strengthen armor for vehicles since the 1960's. As Cindy Hurst stated in her article for *Joint Force Quarterly*, "The country (China) produced special rare earth armor steels that became beneficial in manufacturing tanks."<sup>65</sup> More specifically they "created rare earth carbon steel, the transverse impact value of which was a 70 to 100 percent improvement over the raw carbon steel originally used."<sup>66</sup> Recently, China has developed new light tanks for high altitude combat in mountain regions. "The Chinese People's Liberation Army (PLA) Xinjiang Military Command recently received delivery of and commissioned its first batch of China's newly developed Type 15 light tanks."<sup>67</sup>

The use of rare earth in armor is one of the more important uses of these elements in military applications, but it pales in comparison to its use to create permanent magnets which is a key component to missile guidance systems. China has developed an advanced anti-ship ballistic missile that utilizes rare earth permanent magnets, and this missile could by itself change the balance of power in the Pacific. Retired Rear Admiral Eric McVadon asserted, this missile is "the strategic equivalent of China's acquiring nuclear weapons in 1964."<sup>68</sup> The complete system

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<sup>65</sup>Hurst, Cindy. "China's Ace in the Hole Rare Earth Elements." *Joint Force Quarterly* , no. 59 (2010).

<sup>66</sup>Ibid

<sup>67</sup> Xuanzun, Liu. "PLA Xinjiang Military Command Commissions First Type 15 Light Tanks." *Global Times*, February 2021. <https://www.globaltimes.cn/page/202102/1214633.shtml>.

<sup>68</sup>Hagt, Eric. "CHINA'S ANTISHIP BALLISTIC MISSILE: Developments and Missing Links." *Naval War College Review* 62, no. 4 (2009).

of this anti-ship missile would have a wide variety of technologies “from penetration aids on board the missile, space-based and other sensors, data processing and exchange networks, and other infrastructure to achieve a high degree of integration of both the weapon platform and its command and control.”<sup>69</sup>

### **5.5 Research and Development .**

This variable will study the expenditure on research and development. The importance of research and development (R&D) cannot be overstated, as technology is integral to both the economic and military power of a country. This variable, perhaps more than any other, can give us insight into the health of technological innovation in a state.

R&D expenditure can give us a better understanding of the relative power of China in comparison to the US. The Global Times article states that, “Last year (2020), China invested a total of 2.4 trillion yuan (\$372 billion) in R&D, up 10.2 percent compared with the previous year.”<sup>70</sup> This investment in R&D has led China to be ranked second globally in total R&D spending, behind the US. R&D spending in the US is much larger than China. As stated by the National Center for Science and Engineering Statistics the “United States totaled \$606.1 billion in 2018. The estimated total for 2019, based on performer-reported expectations, is \$656.0 billion.”<sup>71</sup> The US total R&D expenditure, although larger than China's, is growing slower.

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<sup>69</sup> Ibid 89

<sup>70</sup> “China's R&D Spending Narrows Gap with Us, Ranking Second in World: NBS.” Global Times, 2021. <https://www.globaltimes.cn/page/202109/1234914.shtml>.

<sup>71</sup> Boroush, Mark. “U.S. R&D Increased by \$51 Billion, to \$606 Billion, in 2018; Estimate for 2019 Indicates a Further Rise to \$656 Billion.” *National Center for Science and Engineering Statistics* , April 2021.

“China's average yearly R&D input growth reached 11.8 percent between 2016-2019, significantly higher than the US' 7.3 percent.”<sup>72</sup>

## **6 Discussion**

### **6.1 Industry.**

For the variable **Industry**, the study theorized that manufacturing reliant on rare earth would move closer to secure a source of rare earth necessary to meet production. With the Chinese domination of the rare earth supply chain, the study should find an increase in the movement of industry towards China. If this was the case then it could be an indicator of China's growing industrial base, which could challenge the US place as the world's largest economy. From the data it seems that while there has certainly been some movement, it was not as much as expected. While most companies seek to have a more secure supply chain of rare earth, there appears to be a hesitation to relocate to China, which may be due to a lack of trust in Chinese intentions. This distrust is evident in industries' continued efforts to secure and invest in a new supply chain as companies are funding the construction of new mines and refineries, as well as simply reducing rare earth components in their products. Companies are also making a business decision, by spending money, to redesign their products with an objective to limit rare earth in their component designs.

For the variable **Industry**, there does not appear to be a major shift of industrial capital to China. The monopoly of rare earth has many positives for China but attracting a large influx of outside

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<sup>72</sup> China's R&D Spending Narrows Gap with Us, Ranking Second in World: NBS." Global Times

capital that could radically improve its relative power does not seem to be one of those. This variable does not show movement in China's relative power.

## **6.2 Innovation.**

The variable **Innovation** compared the number of new patents that pertain to rare earth that were filed in each country. The data shows that China has filed far more patents targeting rare earth than the US. However, upon further research, the data suggests that most of the patents filed in China were made in the upstream of the rare earth supply chain, directed more towards mining rather than industrial uses. The upper stream consists of mining and refining the rare earth ore rather than the more lucrative downstream technology. It is innovation in the downstream of the chain, where new technologies are being developed, and it is in this area where states such as the US and Japan are strongest.

The findings for the variable **Innovation** are mixed. China's concentration on upper stream rare earth patents gains them efficiency in mining technology which should give them a competitive advantage by lowering their cost of production, and similar to OPEC, control over the resource on the open market. While this concentration of patents in the upper stream does increase China's relative power, the lack of patents downstream of the supply chain hinders their relative power gain.

## **6.3 Strategic Reserves.**



China is building strategic reserves of rare earth minerals and are building these reserves using a variety of methods. It appears that China's attempts have had some drawbacks. China's ambition to administer a strategic reserve is compromised by its domestic demand, which requires vast quantities of rare earth. In fact, the economy of China requires more rare earth than is currently being produced domestically. China's dilemma is threefold; they can build a strategic reserve, supply their own economy, or maintain their export dominance. China will have to navigate these three conflicting strategies. They can continue to be the world's provider of rare earth or they can cut exports and supply their own economy. Their strategy would be to do this without losing their influence over the rare earth supply chain. While China must choose what their policy will be, the variable does show that they are attempting to build a strategic reserve that will be an overall gain in their relative power.

#### **6.4 Systems.**

The data for the variable **Systems** shows that China has used rare earth to develop advanced weapon systems that could eventually lead to parity with the US military. This study was able to look at a few weapon systems, but it is important to note that the access for the study was very limited due to national security. Data was found for the variable, but it is not an accurate representation of the most advanced weapon systems in China. An example of data that was found, is the use of advanced armor technology in Chinese light tanks. The reliability and effectiveness of these tanks is still unknown. However, the use of advanced armor technology, like the rare earth armor steel, shows that rare earth is an integral part in the Chinese defense strategy. Another key component of China's strategy is the production of the anti-ship ballistic missile. This system could effectively limit the US Navy's operational capabilities near Chinese

shores, as it is designed to attack US carrier groups. The advanced technology needed for this system to work depends on rare earth. China is using REE's for military applications, thus increasing their relative power.

### **6.5 Research & Development.**

The variable **R&D** shows that China has spent large amounts of capital on decreasing the technology gap between itself and the US. China still spends only about half the amount of monetary resources on **R&D** compared to the US. This variable finds that China has increased spending on **R&D** and thus gains relative power.

### **6.6 US Policy Recommendations**

The US has options on how to respond to the Chinese domination of the supply chain. As stated earlier in this study, several executive orders have already been executed on this issue. However, congress still needs to act and bring legislation to the floor. This study will give several concrete policy recommendations that congress can assign to both the DOD and DOE. The DOE could be assigned to "Grow the American Critical Minerals Workforce."<sup>73</sup> The DOE would be responsible to, "Bolster education; Promote interdisciplinary collaboration among material and chemical science, computer science, and related disciplines to modernize the minerals supply sector industry."<sup>74</sup> In conjunction with an increase in education increases, congress could also the DOD to engage with allies. "Congress may encourage DOD to pursue joint ventures with other

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<sup>73</sup>U.S. DEPARTMENT OF ENERGY'S STRATEGY TO SUPPORT DOMESTIC CRITICAL MINERAL AND MATERIAL SUPPLY CHAINS." U.S. DEPARTMENT OF ENERGY, 2021.

<sup>74</sup> Ibid 2

nations, as many other nations are seeking alternatives to a near total dependence on rare earths from China.”<sup>75</sup> Specifically, both departments could participate in trade negotiations with Australia, “The United States-Australia Critical Minerals Working Group (organized by the State Department) held meetings in 2020 to begin discussions on how the partnership can strengthen global supply chains.”<sup>76</sup>

## **7 Conclusion**

Rare earth is all around us. From the phones we stare at to the cars we drive, from fighter jets to the ballistic missiles aimed at shooting them down, the modern economy and national security of states is reliant on rare earth. Without these elements, trillion-dollar industries would crumble. To say they are a critical resource seems like an understatement. Rare earth is not the first overtly critical resource to the world economy. Oil for decades was the foundation of economic power. While oil remains an important resource, its days as the driving force behind the economy is coming to an end, rare earth is taking its place.

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<sup>75</sup> Grasso , V. (2013). Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress . *Congressional Research Service* .

<sup>76</sup>“U.S. DEPARTMENT OF ENERGY’S STRATEGY TO SUPPORT DOMESTIC CRITICAL MINERAL AND MATERIAL SUPPLY CHAINS.” *U.S. DEPARTMENT OF ENERGY*, 2021.

When a natural resource is of such criticality, states will attempt to secure the resource and others will extend further and attempt to monopolize the resource. Similar to OPEC'S cartel over oil production, China has built a monopoly over the rare earth supply chain. China was able to undercut the prices of rare earth on the world market and force a majority of rare earth mines outside of China to close by paying lower wages to their workers and ignoring environmental concerns. In addition, China has also used quotas, price controls, incentives to domestic industry and strictly controlled foreign investments to achieve their monopoly. China now controls over 90% of the rare earth mining.

The purpose of this study was to see if this monopoly of rare earth had affected the relative power of China compared to the US. It was the thinking of the author that the evidence for the increasing relative power gain by China would be overwhelming. This does not appear to be the case. However, while there is no overwhelming evidence, the data does support the position that China has increased its relative power to the US. This relative power gain can be seen in several main areas, they are as follows; large investments both in research and development and the overall patent numbers in rare earth extraction, the use of REE's in advanced weapon systems (armor and ballistic missiles), and finally their creation of a rare earth strategic reserve.

On September 7, 2010 an incident in the East China Sea provided an empirical reference point and gave the world an indication of a shift in China's use of power as a critical resource cartel. In a power play, China gained the release of a fishing vessel Captain, by placing an embargo on rare earth being exported to Japan. This action resulted in Japan releasing the Captain on September 21, 2010. At the time of the incident, China's near monopoly on rare earth seems to

have left Japan with no place to turn, and Japan succumbed to China's will in a mere two weeks. Shortly after the incident, the US Congress initiated legislation to reestablish a competitive rare earth minerals domestic production and processing industry. The recent White House Executive orders follow this pattern of the US reacting and responding to China's demonstrated growing monopoly of REE.

China's power play in the Japanese incident coupled with the resultant US reactions (legislation, and the recent White House Exec Orders) are empirical evidence of the relative power gained by China due to their REE monopoly. As this new era of great power competition continues to escalate, rare earth may be the eye of the upcoming geopolitical storm.

Recommendations for further study. This study adds to a greater understanding of the issues that surround China's monopoly on REE metals. Also, as difficult as it might be to measure power, the use of the incident/response timeline could offer empirical evidence of growth in relative power. Questions remain and further research will be needed. Questions such as; How will the US build a secure supply chain of rare earth? Will China be able to meet the rare earth demands of its domestic economy while still maintaining its supply chain dominance? And, will China close the technology gap between itself and the US? While this study focused on the qualitative analysis of relative power a quantitative study could offer greater resolution to the effect of rare earth on power. In the meantime, China will continue their monopolistic strategy to control the price and flow of REE's and increase their relative power strength.

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## CV

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### Education and Academics

1. Johns Hopkins | *District of Colombia*

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Start date: January 2020 Target date for graduation: December 2021

Academic concentration: statistical analysis, security risk analysis and assessment,

2. San Diego State University | San Diego, CA

B.A. International Security and Conflict Resolution

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Academic concentration: analytical writing, Russian language, international economics

3. Semester abroad:

University of Johannesburg | Johannesburg, South Africa

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### Professional Experience

1. USAID Nigeria Feed the Future virtual internship. September 2021-Present
2. Support Center team Lead-Deval. August 2020- Present. Government contractor for the CARES act.
3. College of Professional Studies and Fine Arts- Internship for international programs. 2018