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Science Diplomacy: De-coupling US and Chinese Sciences

By

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Science Diplomacy: De-coupling of US and Chinese Sciences

Mohammad Al-Abbas

ABSTRACT

Science diplomacy has emerged as a new tool for international diplomacy, providing a platform for cooperation between states where traditional diplomacy has failed. However, the use of science in diplomatic efforts raises concerns about the objectivity of science. Using a mixed-method methodology, this study examined the impact of political rhetoric on scholarly collaboration between the US and China from 2008 to 2022. The thesis finds a strong correlation between negative political rhetoric and the current state of deteriorating scholarly collaboration between the US and China. It contends that the largely government-funded and overseen US-China scientific agenda has long been subject to political influence, but the Trump era's rhetoric has solidified anti-Chinese science, both in terms of sentiment and proposed legislation. This thesis concludes that despite the benefits of science diplomacy during times of international crises, such as COVID-19, it remains subject to political influence and a tool for states to compete for their national interests on the global stage. Furthermore, this study highlights the need for further research on science diplomacy, including investigations into the relationships between global powers and the internal science diplomacy within regional entities, which can widen the scope of how scientific knowledge is produced and managed globally.

Keywords*:* Science Diplomacy, China, United States, Science and Technology Agreements, Political rhetoric

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LIST OF ABBREVIATIONS

AAAS……………………………American Association for the Advancement of Science

CRDF…………………………………Civilian Research and Development Foundation

OES…….……..Bureau of Oceans and International Environmental and Scientific Affairs

SD………………………………………..…………………..…Science Diplomacy

STAs…………………………..………………....Science and Technology Agreements

CCP………………………………………………………..…Chinese Communist Party

NLP……………………………………...…………..Natural Language Processing

ITER…………………………………International Thermonuclear Experimental Reactor

DoS……………………………………………………………Department of State

STAS………...The Office of the Science & Technology Adviser to the Secretary of State

OSTP……………………………White House Office of Science and Technology Policy

NSTC……………………………………The National Science and Technology Council

USAID……………………………..United States Agency for International Development

NSF……………………………………………………….National Science Foundation

NAS…………………………………………………..….National Academy of Sciences

GIST…………………………………Global Innovation through Science and Technology

STI……………………………………………..Science, Technology, and Innovation

CSD……………………………………………………...Center for Science Diplomacy

MOST……………………………………..…..The Ministry of Science and Technology

MoE…………………………………………………………The Ministry of Education

CAS……………………………………………………...Chinese Academy of Sciences

CAST……………………………..….Chinese Association for Science and Technology

CSTEC…………………………………China Science and Technology Exchange Center

PNC-PSA…………………..Chinese National Committee for Pacific Science Association

CAE………………………………………………….Chinese Academy of Engineering

CISTCC………………..China International Science and Technology Cooperation Center

NNSFC……………………………………National Natural Science Foundation of China

DoE……………………………………………………………Department of Energy

CHAPTER ONE

CONTEXTUALIZING SCIENCE DIPLOMACY

1.1 Introduction

The aim of this study is to examine recent developments in the field of Science Diplomacy (SD), with a particular focus on US-Chinese relations. Hailed as the newest and most prolific form of soft power in the modern era, it saw continuous deployment during the recent pandemic. However, despite its perceived success in dealing with world crises, SD has blurred the lines between scientific and political agendas. Therefore, this study wishes to investigate to which extent have political agendas and rhetoric encroached on the scientific agenda.

The American political scientist Joseph Nye described the concept of soft power as the "power of co-optation" by which a country can influence others through seduction and persuasion (Nye, 1990). The primary objective of soft power is to attract other nations and transfer the influencing nation's values, reproduce its models, and *"think like it"*. Towards this, countries often leverage their image, prestige, communication skills, culture, natural wonders, and science and technology profile (Ruffini, 2017). More often than not, soft power can take on a combination of a country's traits and manifest in seemingly infinite forms. Consider the filmmaking industry of Hollywood, it combines the United States of America (U.S.) prestige (the American dream), along with their communication skills (acting talents), natural wonders (landscape and backdrops), and technology (cinematography) to allow the United States to influence other countries through movies (De Zoysa & Newman, 2002).

In this light, Science undoubtedly appears to be a conduit of soft power. Science can and has helped a country establish a formidable reputation even when all other remaining conduits of soft power were unusable. Consider the success of the Soviet Union (USSR) in space exploration, it elevated the USSR to the status of a great science country (Walter, 1985; Brown, 2011). The USSR was then able to project an image of being the technological competitor of the United States, reaping positive benefits from non-aligned states during the cold war (Ruffini, 2017). Among its most prolific and effective deployments, science has seen usage in the realm of international diplomacy. When all other forms of dialogue had been blocked between nations, science is often leveraged as a bridge for communication/collaboration (Ruffini, 2017). In other instances, science was at the heart of international collaboration to mitigate the effects of global crises such as climate change (Özkaragöz Doğan, Uygun, & Semih Akcomak, 2021) or COVID-19 (Sharma & Varshney, 2020; Rahimi & Abadi, 2022). On the other hand, diplomacy has also been deployed for the sake of science. Diplomatic and consular networks are traditionally in charge of supporting scientists' and scholars' mobility when abroad. Similarly, if major scholarly networks are to be formed, diplomatic corps are often at the head of such negotiations (Wagner & Simon, 2022). Accordingly, a symbiotic relationship between diplomacy and science began to take shape. This form of soft power has been coined to be SD (Ruffini, 2017; Fedroff, 2009). While effectively non-existent prior to the present millennium, SD has become a new battleground for nations aiming to dominate this new international forum.

The U.S. is one such country that places great importance on SD within its foreign policy (Hormats, 2012). Often deploying it when political tensions between countries do not allow for traditional diplomacy. The U.S. demonstrated its intent to embed SD in its foreign policy during the "Cairo speech" of 2009 delivered by President Barack Obama. In that speech, the president emphasized the need to build innovative partnerships in the field of science and research between the US and the Muslim world (Obama, 2009). After the president's call, government departments, such as USAID, and the U.S. diplomatic corps launched or facilitated numerous programs that expanded partnerships in the fields of science and technology. For several generations, the United States stood alone as the sole leader of science and technology on the world stage (Guile & Wagner, 2021). But the quality and amount of research innovation outside the United States have rapidly grown over the past few decades. More troublesome for the U.S., is that the highest amount of growth can be seen in China, an emerging power that has the potential to rival U.S. on the world stage (Serger, Cao, Wagner, Beldarrain, & Jonkers, 2022; Wagner, Poland, & Yan, 2021). This rising competitor has forced the United States to pass legislation such as the CHIP act in 2022, pledging nearly $150 billion towards science and technology, with the sole aim of ensuring the continued competitiveness of US sciences on the world stage (Wood, 2022; White House, 2022). Additionally, the diplomatic corps formed dedicated offices within the Department of State. Namely, the Office of Science and Technology Cooperation, which *"promotes and protects American scientific leadership and uses science, technology, and innovation to advance American foreign policy interests"* (Department of State, 2022).

In the past two decades, China has become a leading scientific contributor and innovator at the international level. As of the early 2000s, China sore past its status as a below global average contributor to become the second highest contributor by virtue of quantity and quality surpassing all 27 countries of the European Union (Liu, Hu, Tang, & Wang, 2015; Wagner, Cao, Jonkers, Seger, & Goenaga, 2021). China's estimated domestic research expenditure was $514.8 billion in 2019, only second to U.S.'s $612.7 billion and almost double that of the European Union (Wagner & Simon, 2022). Concurrently, Chinese universities and research institutes have begun to penetrate international rankings with some claiming prestigious top ranks (Robert, Wang, Shi, &

Chang, 2014). The former Communist Party leader Deng Xiaoping described science and technology as one of the four forces of modernization (Hsu, 1990). During his time in office, 1978 to 1989, President Xiaoping encouraged Chinese scholars to travel outside China to attain higher educational degrees and expertise. While many of these scholars remained outside China, the Chinese government did not consider them "wasted" or "lost" rather they were seen as distributed resources (Wagner, Cao, Jonkers, Seger, & Goenaga, 2021; Francoise, 2016). Recently, due to the return migration programs within China, these very scholars have returned along with their profound knowledge and experience (Tai & Truex, 2015; Ruffini, 2017). This triggered a scholarly revolution that saw innovation in academic curriculums, research institute agendas, and even governmental grant procedures. The transformed science and technology infrastructure has propelled China to its current comfortable second position with continued rapid growth posing it as a real threat to continued U.S. scientific dominance (Sun H. , 2019; Wagner, Cao, Jonkers, Seger, & Goenaga, 2021; Wagner & Simon, 2022).

The rise of China has presented an option for non-aligned countries to cooperate with an entity other than the U.S. or EU. One that several countries appear to have chosen to take. China has emerged as one of the most collaborative nations as countries negotiate and sign formal scientific and cooperation agreements. It has signed 51 science and technology agreements with various middle- and lower-income countries, garnering political goodwill (Liping, 2011; Wagner, Bornmann, & Leydesdorff, 2015). Additionally, China has 64 agreements with various other countries that specify some form of science and technology (S&T) cooperation. Traditionally, science and technology agreements (STAs) are negotiated by high-level diplomats with their counterparts or political leaders of foreign governments (Dolan, 2012; Wagner & Simon, 2022). The agreements can be bilateral or multilateral, with various technical or academic agencies under their purview.

At their core, STAs are political tools to ensure cooperation, protect intellectual property rights, and ease mobility barriers for scientists, equipment, and samples across signatory states' borders.

At first glance, STAs might seem to be the product of political will to ensure international scientific collaboration. Yet, many scholars warn that the lines between science and diplomacy/politics have become too blurry (Colglazier W. E., 2020; Shrestha, Parajuli, & Shrestha, 2022). The scientific agenda is at risk of perversion into a political agenda.

The concern is not unfounded. The border between science and politics has been blurred. This especially applied during the 20th century two world wars and the ensuing cold war (Engerman, 2010). During the cold war the world witnessed the inauguration of a military-industrial-academic union, that is often accredited with the acceleration of scientific progress during that era (Solovey, 2013). To date the ramifications of that union and the cold war, on the scientific community, is yet to be fully understood by scholars. However, what is understood, is that the scholastic acceleration was fueled primarily by political agendas, heavily classified, and attempts to freely disseminate findings were heavily suppressed (Engerman, 2010; Solovey, 2013). For example, USSR scholars were prohibited from traveling, publishing outside of the Soviet Union, and accessing foreign publications without case-by-case government approval. The politically propelled scientific community found itself integrating civilian and military research in troubling ways (Geiger, 2017). Scholars and politicians, fearful of what one US Senator in the 1960s called the “over militarization” of the social sciences, wondered if this branch of higher learning had not, in fact, become a new weapon in the American military arsenal, and thus subservient to powerful extra-university patrons (Solovey, 2013).

This research aims to investigate the level of political encroachment on the scientific agenda. To achieve this aim, we map the effects of high-level political speeches on collaborative works published between the U.S. and China, the two largest producers of scientific research. The analysis is carried out across the period from 2008 and 2022 with two categories of collaborations, those that received government funding and those that did not. Changes in rates based on political rhetoric could note that political encroachment may have a foothold on the objectivity of science.

1.2 Research Question

This study aims to investigate the impact of political influence on the objectivity of science by examining *"how high-level political rhetoric affects scholarly collaborations between the US and China from 2008 to 2022."*

1.3 Research Methodology

To properly answer the research question posed above, the methodology is divided into two sections. The first section focuses on the quantitative aspect of the methodology while the second is on the qualitative. The purpose of the divide is to ensure that this thesis approaches this work from a mixed-methodology technique.

1.3.1 Quantitative Analysis

Quantitative analysis is at the heart of this thesis. Leveraging natural language processing (NLP) and a scholarly indexing database, we carry out an in-depth analysis of the correlation between political rhetoric and scholarly collaborations. First, the NLP is deployed to extract the sentiment (Mehdat, Hassan, & Korashy, 2014) of high-level political figures within the U.S. and CCP. Doing so allows for the categorization of speeches across a "spectrum of animosity". The spectrum ranges from: (1) Complimentary, which would include speeches that praise the counterpart, a sentiment range of $]+0.5,+1]$; (2) Positive, would include speeches that are somewhat positive towards China, not necessarily praise, a sentiment range of $]+0.25,+0.5]$; (3) Neutral, are benign speeches where no negative or positive comments are made about the counterpart, a sentiment range of $[-0.25,+0.25]$; (4) Negative, are speeches that are somewhat negative towards China, a sentiment range of $]-0.25,-0.5]$; and (5) Inflammatory, these speeches are likely to contain racist rhetoric, a sentiment range of $]-0.5,-1]$. Once the sentiment is extracted, a timeline is constructed that showcases a timeline ranging from 2008 to 2022 of speeches and the sentiment of each speech.

Then, Clarivate's InCites scholarly indexing database is queried for publications. This study focuses on publications that had at least one Chinese collaboration with an affiliation in China or at least one US collaborator with an affiliation in the US. After the database lists the publications of interest, a crawler is allowed to categorize articles based on their funding declaration. The crawler is an algorithm that mines the data to locate articles within our conditions and parameters set forth by the user. Articles that declared funding from governments are then aggregated based on the funding government, with publications that received Chinese funding in category one and those that received US funding in category two. Category three are articles that either received funding from non-governmental sources or no funding at all. After the publications are categorized both in terms of funding sources and geographical origin, they are superimposed onto the speech timeline.

The timeline now contains the speeches by day, the estimated number of initiated scholarly collaborations, and the three categories of those publications. This allows us to draw trends and correlate the rates of publication in various fields with the sentiment of speeches.

1.3.2 Qualitative Analysis

As highlighted above the quantitative section serves as the heart of the thesis, providing the basis for analysis and correlation. However, the qualitative analysis elevates the thesis from correlation to causality. In this analysis, we restrict the work to focus on the period between 2008 and 2022, which involves three US administrations and the Communist leadership in China. For this study we treat states according to the rational actor model. Accordingly, the US would be represented by the president's rhetoric, official communications from the white house, as well as the head of the OSTC. Conversely, the CCP leadership will be represented by their president as well as their diplomatic press releases.

To establish a direct causal relationship between political rhetoric and scholarly collaborations, we will undertake the following steps. First, we will examine the "Science and Technology Agreements" (STAs) between the United States and China, focusing on areas of collaboration and clauses related to intellectual property protection. Second, we will scrutinize the science and technology legislation and bills introduced or passed by both the United States and China to identify regulations governing scholarly collaborations. Third, we will review executive orders issued by the U.S. president, which will provide insight into policy and funding regulations by the executive branch of the government. Finally, we will survey the archives of former U.S. President Donald Trump's Twitter feed from 2017 to 2021 to identify any potential bias towards or against China. By analyzing these documents, we aim to establish causal relations between political rhetoric and regulatory/funding policies.

1.4 Organization of the Thesis

The purpose of this chapter is to introduce the topic and research question of the thesis, explain its importance, and provide an overview of the following chapters. Chapter

II examines the current state of literature on SD and situates it within the traditions of Realism, Liberalism, and Marxism in order to demonstrate its relevance in International Relations (IR) discourse. Chapter III focuses on the US SD system, its historical usage, and the agencies involved in protecting and advancing US science on the global stage. Chapter IV mirrors Chapter III by exploring SD in China, its more recent employment, and the government-led SD apparatus. Chapters III and IV set the stage for exploring the differences in how the Chinese and US governments approach SD and scientific collaboration as a whole. Chapter V discusses the unique interpretation and utilization of SD by the Obama, Trump, and Biden administrations, and their relations with China. Chapter VI examines the contributions of funding agencies to scientific collaboration, quantifies the collaborative relationship between the two scientific communities and their funding agencies, analyzes political rhetoric during the Trump era, and highlights extraordinary scholarly behavior during the COVID-19 pandemic. The chapter concludes with a discussion of US legislation and its impact on scholarly collaboration. Finally, Chapter VII provides concluding remarks and suggests areas for future research.

CHAPTER TWO

CONCEPUTALIZING SCIENCE DIPLOMACY

2.1 Introduction

Soviet leader Mikhail Gorbachev (1985-1991) and U.S. President Ronald Reagan (1981-1989) held their first meeting on November 19, 1985, in Geneva, Switzerland, to discuss nuclear disarmament (Atomic Heritage Foundation, 2018). This was a significant moment as it marked the first time the leaders of the two superpowers engaged in high-level talks. While both leaders pursued their respective interests, Gorbachev proposed an ambitious research and experimentation program to investigate the feasibility of nuclear fusion as an alternative energy source (Barbarino, 2020). This proposal was a peaceful application of nuclear energy and symbolized a long-term commitment by both countries to sustainable and clean energy production (Ruffini, 2017). The program, which was later named the "International Thermonuclear Experimental Reactor" (ITER), was joined by the United States, the European Union, Japan, China, India, South Korea, and the Soviet Union, and had significant economic potential (ITER, 2023). On November 17, 2020, almost 35 years after the Geneva summit, the foundation stone for the experimental reactor was laid in Cadarache, France.

The 2009 Cairo speech delivered by President Obama was a significant event, occurring at a time of heightened tension between the US and the Muslim world. The President's goal was to improve relations with the Muslim world by addressing key issues that had caused the tension. The speech was a clear attempt to reach out to the Muslim world and demonstrate that America could communicate in ways other than through force (Ruffini, 2017). One of the key announcements made in the speech was the creation of a new fund to support scientific and technological development within the region. Additionally, the President promised the establishment of centers of excellence and the dispatch of a science envoy to Muslim countries. Within weeks, the science envoy consisting of Bruce Albert, Ahmed Zewail, and Elias Zerhouni arrived in the region to examine areas of cooperation (Otero, 2010). They recommended the establishment of scientific centers focused on water, climate, and political science.

In September 2014, the “Intergovernmental Panel on Climate Change” (IPCC) held a four-day meeting in Stockholm that brought together over 400 people, including representatives and delegates from 116 governments, UN climate experts, and observers from various organizations. During this meeting, the IPCC approved the Summary for “Policymakers (SPM) of the Working Group II report for the Fifth Assessment Report (AR5)”, which assessed the impacts, vulnerability, and adaptation to climate change (IPCC, 2014). The SPM, which was only thirty pages long, underwent careful scrutiny by government representatives before it was signed. The release of the report, along with the other two working groups' reports, formed the basis of the AR5 and played a vital role in raising awareness and creating political momentum for action on climate change.

SD is situated where the interests of science and those of foreign policy intersect. The three anecdotes above describe its three dimensions. The ITER is a global project that transcends the specific interests/conflicts of each country involved. At its core the ITER project was envisioned by the scientific community, it was the sciences that aimed to harness the energy of atoms to produce virtually endless and clean energy. Only specialists in nuclear sciences could dream of such an idea, but it is politicians who made the project a reality (Ruffini, 2017). Evgeny Velikhov, the Russian scientist and current chair of the ITER council (since 2009) claimed that the 1985 meeting between Russia and US in Geneva was the true start of turning a scientific theory into practice. The Royal Society and the "American Association for the Advancement of Science" (AAAS) published a pioneering study in 2010, in which they described the ITER as an example of diplomacy supporting sciences dubbing such instances as "diplomacy for science" (Royal Society, 2010).

Whereas the Cairo speech portrays science as a bridge for diplomacy, dubbed as "science for diplomacy" by the AAAS (Royal Society, 2010). The political tensions between US the Muslim-Arab world could not allow for traditional vehicles of diplomacy, however, scientific relations in the forms of funds and centers were used to bridge and amend links. The US President emphasized the importance of scientific collaboration to mend relations and change the image of the US within the region. To an extent, the Cairo speech marked a change from the American language of violence to that of science (Ruffini, 2017).

In the 21st century, global challenges are abundant such as climate change and pandemics that require scientific expertise to properly mitigate. The IPCC illustrates how sciences inform diplomatic choices. Climate experts engaged with representatives of various governments to discuss the knowledge and sciences behind climate change. Governmental representatives would weigh the conclusions made by climate experts and then negotiate them, not to challenge their scientific credentials, but rather to adapt them to policy initiatives. The representatives left the IPCC with clear science-backed policy directives and later went on to negotiate on behalf of their countries' efforts, in international forums on issues of climate change. The IPCC illustrates the third and final dimension of SD, as coined by the AAAS, "science in diplomacy" (Royal Society, 2010).

To conclude, the term SD has only appeared in the past three decades. Yet, the essence of SD can be felt as far back as the 18th century when countries would send out exploratory voyages to uncover new lands and resources. These voyages had scientific purposes but were heavily influenced by geopolitical goals. More recently, the atomic bombs were manifestations of sciences at the service of politics and war. Historically, most of the writings that deal with science and politics in international relations were in the context of armed conflict. Scientists had knowledge usable by military personnel. Governments would leverage their power and resources to materialize their knowledge into actionable advantages in war. In times of conflict, the universality of sciences is overshadowed by patriotic duties and its relationship with foreign policy becomes intense. However, the framing of SD sheds light on the usage of science in times of peace and stability. When the choice of dialogue and cooperation takes precedence over that of violence and conflict, the relationship between science and foreign policy gains richness, complexity, and constructiveness for what it loses in intensity.

2.2 Science Diplomacy as a Concept

The conceptualization of SD is found in the theoretical framework of soft power. The American political scientist and Harvard professor Joseph Nye described soft power as the "second face of power" and "power of co-optation" (Nye, 1990). He frames it as the ability of states to attract and influence other states to "think and act like it". To achieve this, the state leverages its prestige, image, reputation, attractiveness of culture, and science and technology profile, etc. In this respect, soft power becomes an integral tool of diplomacy of influence. Although the terms are not synonymous, in that diplomacy of influence can and has leveraged hard power to establish a country's image. Secretary of State Hillary Clinton's once stated: "We must use the full range of tools at our disposal – diplomatic, economic, military, political, legal and cultural – picking the right tool, or combination of tools, for each situation" (Clinton, 2009). Her statement lies at the essence of diplomacy of influence, in that a combination of approaches or powers are used to further a country's agenda.

The soft power framework, when viewed in the context of diplomacy of influence illustrates it as an integrated part of foreign policy that does not contend with the logic of confrontation, but rather propagates the logic of influence and renews diplomatic action (Ruffini, 2017). Consider the first of the American envoys dispatched after the Cairo speech helmed by Prof. Ahmed Zewail. After visiting Egypt, Turkey and Qatar, he published an article stating: “by harnessing the soft power of science in the service of diplomacy, America can demonstrate its desire to bring the best of its culture and heritage to bear on building better and broader relations with the Muslim world” (Zewail A. , 2010). In this light science appears to have established itself as a form of influence. One that countries can employ to alter their reputation and perception. The U.S. is not alone in utilizing science as a tool of influence. Consider the case of Russia’s ITER following the Cold War or their extensive space program during the Soviet Union era that established Russian sciences as among the most prominent (ITER, 2023).

This interdependence between science and diplomacy is not by happenstance. The sciences have long been linked to foreign affairs and now, as illustrated, they are linked to influence, persuasion, and reputation (Ruffini, 2017). The ultimate goal of diplomacy is to promote one’s interests and values on an international stage, in this goal, diplomacy finds an ally in science. Towards this end a clear conceptualization of SD emerges, one that is best articulated by Prof. Pierre-Bruno Ruffini “At the intersection of science and foreign policy, a country’s SD refers to all practices in which actions of researchers and diplomats interact” (Ruffini, 2017). In this conceptualization of SD there exists three dimensions: (1) diplomacy for science; (2) science for diplomacy; and (3) science in diplomacy.

2.2.1 Diplomacy for Science

Diplomacy for science refers to the use of diplomatic efforts to advance scientific research, knowledge and collaboration. It involves the integration of scientific goals and objectives into diplomatic discussions and decision-making, and the use of diplomatic tools and strategies to support scientific collaboration and advancement. This can include activities such as the negotiation of international science and technology agreements (STAs) and partnerships to support scientific research, the use of diplomatic channels to facilitate the exchange of scientific information and knowledge, and the use of diplomacy to advocate for increased funding and resources for scientific research (Patil, 2020).

2.2.2 Science for Diplomacy

Science for diplomacy refers to the use of scientific collaboration as a means of advancing or amending international relations. Leveraging global problems and scientific collaboration, states use the sciences as a tool for building trust and cooperation among nations. This can include activities such as the establishment of multinational scientific funds, technology transfers, foreign research exchange, and internationally backed scientific centers such that of the hydron collider (Rungius & Flink, 2020).

2.2.3 Science in Diplomacy

Science in diplomacy refers to the integration of scientific knowledge, expertise, and collaboration into diplomatic decision-making and dialogue to address global challenges. This encompasses the use of science to inform and shape foreign policy. Studies have shown that the integration of science in diplomacy can lead to more effective and efficient ways of addressing complex issues such as climate change and human mobility (Zewail A. H., 2010).

2.3 Science Diplomacy and International Relations Theories

Science has become an established tool of diplomacy of influence. Yet, SD and sciences as a whole have been largely absent from international relations theories, particularly mainstream theories. Krishna-Hensel highlighted the lack of theorization towards scientific and technological advances within sciences, stating “there is as yet no systematic examination within the field of IR as to how these changes are going to influence the debates on power, deterrence, diplomacy, and other instruments of international relations” (Krishna-Hensel, 2010). The continued absence of SD from mainstream theories has caused difficulties in framing its effect on or role in international relations.

As the role of SD becomes more varied in application and representation, it becomes imperative to discuss it within the context of mainstream theories. For this purpose of this, we leverage three theories of international relations to contextualize SD. Three of these theories are perhaps the most well-known and developed theories within this discipline: Realism, Liberalism, and Marxism. Towards this, the following sections present brief background information on each theory, their main assumptions, and contextualize SD within their framing.

2.3.1 Realism and Science Diplomacy

Realism is regarded as the “definitive tradition in the field of international relations” (Kaufman, 2022). Political realism has continued to evolve and be refined by its practitioners, and to date remains one of the most dominant paradigms in international relations. Due to its evolution, realism has different variants with each having slight alterations in its perception of state behavior (Kaufman, 2022). However, according to Robert Gilpin, "all realist writers – neoclassical, structural, or what have you – may be said to share three assumptions regarding political life” (Gilpin, 1984). The first assumption is that the final arbiter of politics is power; the second is that the essence of social reality is the group and in the modern world that is the “nation-state”; and the third is that “the primacy in all political life is power and security” (Dunne & Schmidt, Realism, 2011). These three assumptions allow the variations of realism to co-exist while not contradicting each other. However, this section focuses on classical realism and to a lesser extent neo-realism.

Classical realism is based on the views of Edward H. Carr and Hans Morgenthau[1]. In their writings, states are in a constant struggle to increase their capabilities. Any actions by states perceived otherwise are a human failure and bad policymaking. Additionally, classicalists view states as rational actors making rational choices. In Morgenthau's interpretation of realism, he emphasized the importance of survival for states and the variety of tools to ensure it. In an anarchic international structure, conflict is inevitable, so states could use any kind of diplomatic or non-diplomatic method if it facilities their survival and national interests (Lebow, 2007). According to Morgenthau, diplomacy has four main functions: (1) establishing the primary objectives of a state and the ability to achieve them; (2) evaluating the objectives of other states using the same standards; (3) analyzing the compatibility of these objectives; and (4) utilizing the necessary means to pursue these objectives (Speer, 1968). These means are persuasion, agreement, and the threat of the use of force. For the classical realist, the self-interest of states takes precedence over overall moral principles and considerations of justice. They view national interest and justice as inseparable. In other words, for states to act in their interest is justice towards themselves.

On the other hand, neo-realism stems from Kenneth Waltz's work titled "Theory of International Politics." Waltz highlights two concepts within the international system, anarchy, and self-help. He theorized that the international system could be unipolar, bipolar, and multipolar. Although Waltz argued that a multipolar system is the least stable variant with multiple power centers competing (Wohlforth, 1999; Elman, 2008). Neo-

[1] In this context, Edward H. Carr's "The Twenty Years' Crisis and Hans Morgenthau's "Politics among Nations: The Struggle for Power and Peace" are considered the seminal works for Classical Realism

realism shares several fundamental assumptions with classical realism, including: (1) States exist in an anarchical international system lacking a centralized authority; (2) the structure of the system influences the behavior of states/actors; (3) states/actors are rational and self-interested, aiming to maximize benefits and minimize losses; (4) survival is the primary concern in an anarchical system; and (5) states/actors perceive each other as adversaries, leading to a security dilemma (Lamy, 2011).

In whichever form realism presents itself, it often frames states as actors in an anarchic international system vying for survival using their security and power. Post the Cold War period, the concept of security and national interest changed. It evolved from a simple hard/militaristic security to an aggregate concept of security against social, economic, and environmental threats. Yet despite the variety and progressive changes within the conceptualization of security, realism continues to argue from a survival perspective. In that, regardless of the issue or tool, diplomatic or otherwise, states do whatever it takes to survive (Morgenthau, 1946). This perspective informs the view of realism in SD.

Realism, in the context of international relations theory, describes SD as a tool for states to advance their national interests through the use of scientific and technological cooperation with other states. States have been shown to engage with certain states to develop their scientific relations, as international scientific collaborations are made strategically (Royal Society, 2010). This can be seen from the intertwinement of EU and US scientific collaborations. Realists would argue that states engage in SD as a means of enhancing their economic, military, and political security relative to other states, rather than for the sake of scientific advancement or global cooperation.

2.3.2 Liberalism and Science Diplomacy

Liberalism is the second most popular paradigm within international relations. It emerged in the late 1970s as a criticism of realism. In contrast to realism, liberalism puts value on the individual. The individual is an important actor and is moral. This value does not take away from the value of states but introduces other actors within the international system that could have an impact. Perhaps the core tenants of liberalism are liberty, justice, and tolerance all of which ought to be protected (Dunne, 2011). Liberalism's roots can be traced to the fourteen principles of the League of Nations, which enshrined these very tenants.

In contrast to realism, conflict is not inevitable it is avoidable. For liberals, cooperation and collective action can inform state behavior, increasing trust (Kaufman, 2022). Michael Doyle published an article in 1983 that argued democratic states, those who enshrine the liberal tenants have never waged war against each other. This is rooted in the argument that democracy and peace are natural complements, otherwise known as Democratic Peace Theory. This theory goes on to justify conflict by arguing that conflict arises between democratic and authoritarian regimes in an attempt to spread liberal democracy throughout the world (Burchill, 2005).

Another important variation of liberalism is institutionalism. On a fundamental level, this variation argues if a group of states pool their resources together and funnel them into a common institution, peace and prosperity can be achieved (Dunne, 2011). The European Union is one example of such a successful integration – well rather the only one. Prof. Keohane and Prof. Nye are the biggest contributors to the field of institutionalism. Their arguments revolved around the interdependence of actors within the international system, economic or otherwise (Kaufman, 2022). Additionally, institutionalists argue that through international institutions, states can achieve greater insight into each other's mannerisms. This insight would help states overcome the dangers of security competition.

It is not a coincidence that the conceptualization of SD in soft power is done through the same theoretical work of the pioneer of institutionalism Prof. Nye (1990). In this regard, institutional liberalism can be created as the theory that gives the most consideration to SD. Consider the science for diplomacy dimension of SD, whereby countries would employ science as a language of influence when traditional diplomatic routes are unavailable. The Cairo speech was a speech that founded entire institutions within the middle east with the sole purpose of sustaining and improving diplomatic ties between multiple states. In that regard, whether we take the micro-level institutions or the macro-level institution of knowledge production, both converge to the usage of sciences to sustain peace and development.

In summary, Liberalism describes SD as a way to use scientific cooperation to promote international understanding and cooperation. The idea is that by working together on scientific projects, countries can build trust and reduce tensions, which can lead to more peaceful and stable international relations. This can include collaborating on research projects and sharing scientific information and resources. Additionally, SD can also provide opportunities for scientists and researchers from different countries to build professional relationships, which can further promote cooperation and understanding.

2.3.3 Marxism and Science Diplomacy

Marxism views SD from a critical and skeptical perspective, as it views the current social and economic system as inherently unjust and unequal (Thomas, Marx and Science, 1976). Marxism argues that capitalism is an economic system based on the exploitation of the working class by the ruling class and that this exploitation is reinforced by the institutions and systems that uphold it (Thomas, 2008).

From this perspective, Marxism views SD as a tool used by capitalist countries to further their interests and maintain their dominance in the international system. Marxists argue that SD is often used to promote the economic and strategic interests of the ruling class, rather than the needs and interests of the working class and oppressed people (Thomas, 2008). They argue that scientific knowledge is often biased and used to justify the status quo, rather than to promote the well-being of all people (Burawoy, 1990). That is to say from a Marxist perspective, SD is often used to promote the interests of the ruling class rather than the needs of the working class and oppressed people.

2.4 Chapter Conclusion

The limited integration of SD in mainstream international theories has led to fragmented framing. For example, institutionalism in the European Union showcases independent states pooling resources for scientific research, while realist tradition prioritizes the state in diplomatic talks and scientific cooperation. Marxism discredits SD as a means to maintain the status quo, evident in the lack of technological sharing with Least Developed Countries. SD remains undefined in the international relations realm. Analyzing SD as a soft power without preconceived assumptions of the international system or state motives can reveal its use in diplomacy. Exploring the responsible agencies and offices can aid in leveraging SD as a soft power.

CHAPTER THREE

U.S. SCIENCE DIPLOMACY

3.1 Introduction

The United States recognizes that its excellence and leadership in "Science, Technology, and Innovation" (STI) are critical to its national interests and international efforts to promote prosperity, peace, and security. Therefore, the U.S. STI landscape must be adaptable to new challenges and opportunities in the global scientific community (Colglazier & Lyons, 2014).

In the latter half of the 20th century, the U.S. was dominant in scientific research, but the STI landscape has since become more multipolar (Shih, 2023). Although the U.S. remains a significant player in the global STI arena, data from the National Science Board's Science and Engineering Indicators (2014) suggested it is less dominant. To maintain its leadership in STI, the U.S. needs to establish "synergistic partnerships" to leverage scientific expertise, facilities, and funding worldwide (Colglazier & Lyons, 2014). This requires attracting the best talent, training a globally engaged workforce, forging new research and industrial partnerships, exploring new markets, cultivating robust international relationships, and driving innovative solutions for international development (Flink & Schreiterer, 2010; NSF, 2014).

The primary goal of U.S. Science Diplomacy (SD) initiatives is to gather information and establish networks (Aranda, 2022). SD can also be realized through non-governmental means, such as the Academy of Sciences or the Frontiers of Science programs. According to a report by the "National Science Board" (2014), the U.S. is no longer the unquestioned leader in certain Science and Engineering (S&E) fields, such as national cyber-infrastructure networking, and must increasingly rely on and learn from other countries. Effective use of SD is essential to achieving this.

This chapter aims to analyze the U.S. SD system defined by decades of historic refinement, various governmental and non-governmental offices, as well as independent entities/actors within the academic and corporate sectors. It begins by providing a detailed historical background and subsequently delves into the analysis of the overall structure and key governmental and non-governmental offices and actors involved in US SD. Furthermore, the chapter aims to establish the interconnectivity between these offices and agencies to provide insight into the management and execution of US SD.

3.2 Historical Background of U.S. Science Diplomacy

The United States has frequently used science as a diplomatic tool throughout its history. Drawing from this experience, the US has refined its SD to align with its core national interests of security and economic prosperity while building it to suit its foreign policy agenda (Chalecki, 2008). The benefits of SD were well understood by US foreign policymakers, and as such, federal scientists, engineers, and other experts provided scientific and technological advice to the Presidents. Since the 1930s, advisory boards and committees have been established in the fields of science and technology to provide such advice, albeit not on a permanent basis (Sargent & Shea, 2013). Whenever the need arose, new advisory boards and committees were established. In 1949, the “Central Intelligence Agency” (CIA) established its “Office of Scientific Intelligence” (Richelson, 1997), and in 1950, the “Office of Science Adviser and Special Assistant to the Secretary of State” was created (STAS, 2023). This office became an official bureau in 1965 with the new name of the “Office of International Scientific and Technological Affairs” (STAS, 2023).

During the Cold War era, the United States utilized SD to reduce tensions and promote dialogue between the Soviet bloc and the Western community (Ruffini, 2017; Turekian, 2018). This approach began with the internationalization of nuclear energy control through the “Baruch Plan” in 1946 (Gerber, 1982). In 1953, President Eisenhower delivered his famous “Atoms for Peace” speech at the “United Nations General Assembly” (IAEA, 1953). The “International Geophysical Year” of 1957-58 was another significant milestone (NASA, 2005), where the US cooperated with the Soviet Union and over 60 other nations in the field of satellite surveillance. The success of this cooperation demonstrated that if nations could work together in scientific matters, they could potentially cooperate on other issues, reducing the likelihood of conflict.

Starting from the 20th century, many countries, such as the United States and United Kingdom, started appointing science attachés, also called science officers or science diplomats, to their embassies or consulates as a customary practice (Loftness, 1955). These officers were usually scientists or engineers, responsible for promoting scientific collaboration between their home country and the country of their assignment (Forbes, 1957). The appointment of the first U.S. science attaché to Germany in 1898 marked the first step towards the country's science attaché system and direct involvement of scientists in foreign policy (Linkov, Trump, Tatham, Basu, & Roco, 2014). However, it wasn't until World War II that the US established a formal science attaché program in 1943 to coordinate scientific research with allies and keep an eye on the scientific progress of enemies (Linkov, Trump, Tatham, Basu, & Roco, 2014). Initially, the primary role of US science attachés was not to promote the country's R&D or improve inter-institutional scientific relations (Loftness, 1955; Forbes, 1957). SD was only one of many issues they handled, which also included space, women in science, energy, and green technology.

Consequently, SD was often a secondary concern that was addressed as needed (Forbes, 1957).

The Berkner Report, commissioned by James Forrestal, the inaugural US Secretary of Defense in 1950, was tasked with analyzing the possible military uses of nuclear weapons and devising a plan to build a nuclear deterrent against the Soviet Union (Berkner, 1950). Despite this focus, the report also emphasized the value of international scientific cooperation, recommending that the US government establish official channels to facilitate such collaboration. The report recognized the significance of science in US foreign policy, proposing the creation of a Science Office within the Department of State and the continued support of the science attaché program through funding (Ruffini, 2020).

In addition to the historical examples, there are several other successful instances of SD that underscore its significance in contemporary US foreign policy. One particularly intriguing example is the scientific collaboration between the US and North Korea, which would be difficult to achieve through conventional diplomatic means (Thorson, 2012; Shelton & Lewison, 2013). Through the efforts and scientific activities of the "U.S. Civilian Research and Development Foundation" (CRDF) Global, the "American Association for the Advancement of Science" (AAAS), and the "Korea Society", science was demonstrated to be a "positive attractor force" in US-North Korea relations. One notable example of their efforts occurred in 2008, when they organized a workshop on "Public Health and Agriculture in North Korea" in Pyongyang (Taylor & Manyin, 2011). The workshop aimed to bring together experts from the US and North Korea to share knowledge and discuss collaborative research opportunities in the areas of public health and agriculture. Similarly, in a (1999) report by the U.S. "National Academy of Sciences" (NAS), it was observed that 13 out of 16 US foreign policy objectives were linked to science, technology, and health. This highlights the critical role that science plays in shaping US foreign policy goals.

The use of SD in US foreign policy has varied depending on the administration and foreign policy goals. In fact, the role and structure of SD has continued to expand and contract over time. In the 1950s, there was a scientific advisor role within the US Department of State which emphasized the importance of nuclear security and military technology during the Cold War (Soman, 2000). However, by 1974, the focus had shifted to include civilian research (Flink & Schreiterer, 2010) and the US Congress created the position of “Assistant Secretary of State for Oceans, International, and Environmental Affairs” (OES), demonstrating the US's commitment to global scientific and environmental issues (OES, 2023). OES continues to be one of the primary offices involved in SD, although they mainly manage the "Diplomacy of Science" activities through bilateral agreements (Flink & Schreiterer, 2010).

In the late 1980s, the United States faced a mounting national debt and policymakers believed that reducing public spending was necessary to restore fiscal stability (Henderson, 2015). This was compounded by the end of the Cold War in the early 1990s, which prompted a reassessment of defense priorities and a reduction in military spending. As a result, other areas of government spending, including scientific research and diplomacy, came under pressure (Henderson, 2015). A 1995 report by the AAAS found that "budget cuts and organizational changes have diminished the State Department's ability to carry out its scientific and technological responsibilities" (AAAS, 1995). The report noted that the number of science attaché positions had declined from a high of 43 in the early 1980s to just 14 by 1995. Despite its success in promoting international collaboration, the science attaché program was discontinued as a permanent position in the mid-1990s (Linkov, Trump, Tatham, Basu, & Roco, 2014).

The 64th Secretary of State Madeleine Albright, 1997 - 2001, commissioned a study from the U.S. NAS in 1998 to analyze how the U.S. could be more effective in science and foreign relations. The study recommended that the Secretary appoint a highly qualified Science, Technology, and Health (STH) Senior Advisor to provide expert advice on emerging issues (NAS, 2000). Following the report's recommendations, a task force was established, resulting in the 2000 policy statement "Science and Diplomacy: Strengthening State for the 21st Century" (Albright, 2001). This led to an increase in scientific capacity and the establishment of a scientific advisory position within the Department of State. To date, seven advisers have held this position, including Norman Neureiter, George Atkinson, Nina Fedoroff, William Colglazier, Vaughan Turekian, Mung Chiang, and Allison Schwier (Pincus, 2014).

Furthermore, the United States has implemented various large-scale fellowships and programs aimed at enhancing their scientific capabilities. One such program is the “Embassy Science Fellows Program”, which places scientists in U.S. governmental organizations like the Department of State or Department of Energy for up to one year, with costs shared between participating institutions (DoS, 2023). There are also the AAAS diplomacy fellowships and “Jefferson Science Fellowships”, which bring together young scientists.

The development and application of SD is a testament to the US's ongoing belief in its significance. Its history has been instrumental in shaping its structure, offices, and role both domestically and internationally. The upcoming section delves into the current form and latest advancements of this structure that pertain to this discussion.

3.3 Offices & Agents of U.S. Science Diplomacy

The United States has a complex SD system involving various governmental, research, and private sector organizations responsible for developing different dimensions of science policies. While the White House Office of Science and Technology Policy (OSTP) is in charge of coordinating science and technology activities, there is no single entity that represents a uniform US stance on S&T policies (Flink & Schreiterer, 2010). As a result, the US has diversified international science and technology policies, with each institution within the system having its own policy agenda based on institutional interests.

Due to a lack of funding, the US Department of State cannot directly support international scientific partnerships and is not deeply involved in institutional research and scientific agendas (Dolan, 2012). However, the Department of State does play a critical role in negotiating and managing bilateral International STAs. These agreements establish a foundation for other US institutions to participate in international S&T cooperation, often addressing issues related to intellectual property, research funding, and equipment, and specifying areas of cooperation while limiting others. Although the Department of State does not have the resources to govern research programs and activities, it has significant influence over how, where, and to what extent other institutions can engage with foreign countries (Dolan, 2012; Ruffini, 2017). This enables the Department of State to maintain its sway over the nation's international scientific policies and use SD to exert soft power when needed.

The current legal guide for the US's international science and technology policy is “Title V of the Foreign Relations Authorization Act, FY1979 (P.L. 95-426)”, which designates the Department of State as the lead federal agency in developing S&T agreements. According to the National Science and Technology Policy, Organization, and

Priorities Act of 1976 (P.L. 94-282), the Director of the OSTP advises the President on international S&T cooperation policies and the role of S&T considerations in foreign relations. The OSTP is a staff office within the "Executive Office of the President" (EOP) that does not fund domestic or international programs. The "Assistant to the Director for International Relations" liaises with other federal agencies, such as the "National Security Council", "Department of State", and international offices of federal agencies like the "National Science Foundation", as well as science liaisons from foreign country embassies in the United States.

Apart from the DoS and OSTP, there are numerous agencies that participate in international S&T collaboration with foreign entities. However, in this context, we are only interested in federal agencies that receive funding through congressional budgeting. Moreover, many of these federal agencies rely on the Department of State's STAs as channels for collaboration or pre-existing networks of academic and research institutions (Ruffini, 2020). Essentially, these federal agencies serve as grant managers, ensuring that grantees, whether domestic or international, are in line with their institutional goals. Nine agencies fit this description, with both the Department of State and OSTP functioning as non-funding oversight entities. In total, the US SD system can be examined through the actions of eleven agencies that operate independently but in alignment with US foreign science policy. Table 1 below lists these agencies alongside their leadership appointment process as well as their primary function towards SD.

Table 1 - Agencies of U.S. Science Diplomacy

Agency Name	Leadership	Mission
Department of State (DoS)	Nominated by the president and confirmed by the senate	Plays a crucial role in shaping S&T policy for the US, by connecting federal agencies with SD tools to facilitate international scientific cooperation. One such tool is Science and Technology Agreements (STAs), which serve as a means for nations and entities to collaborate and promise to facilitate

		cooperation between ratifying parties (Dolan, 2012). Most of the STAs entered into by the US do not provide financial commitments, except for those with Egypt, Pakistan, and India, and the STA with Israel differs from traditional STAs in its structure.
The Bureau of Oceans and International Environmental and Scientific Affairs (OES)	Appointed by the President of the United States and confirmed by the Senate.	Established in 1974 to advance SD efforts and coordinate international S&T activities related to environmental, scientific, and technological issues. OES works closely with other federal agencies, foreign governments, and international organizations to shape and implement the US government's foreign policy objectives. Additionally, OES manages a range of international scientific and environmental programs and initiatives, such as the U.S. Science Envoy program and the International Coral Reef Initiative, which vary in their roles and agendas under each administration (OES, 2023).
The Office of the Science & Technology Adviser to the Secretary of State (STAS)	Appointed by the Secretary of State, with the approval of the President of the United States	Established in 2000 by former Secretary of State Madeline Albright in response to a study on how the Department of State could integrate science, technology, and health expertise into foreign policy. STAS serves as a valuable resource to the Department of State, bridging the gap between the Department and the broader science and technology community. The Science and Technology Adviser aims to enhance the Department's understanding of science and technology, build partnerships within the U.S. government and internationally, and shape a global perspective on emerging developments that may impact U.S. foreign policy. The STAS is also an advisor to USAID and the Senior Advisor to the STAS should have knowledge and experience in science, technology, and health issues, as well as international experience to link them with foreign policy issues (STAS, 2023).
The White House Office of Science and Technology Policy (OSTP)	Appointed by the President of the United States and confirmed by the Senate	Created by Congress in 1976 to coordinate federal science and technology policy and provide expert guidance to the President. OSTP's goal is to enhance the well-being of Americans in areas such as health, security, prosperity, environmental quality, and justice by advising the President, collaborating with departments and agencies, engaging with external partners, and ensuring inclusivity and integrity in science and technology. The OSTP comprises the Director's Office and six core policy teams focused on various areas, but their mission remains the same, which is to maximize the benefits of science and technology for all Americans (OSTP, 2023).

The American Association for the Advancement of Science (AAAS)	Appointed through election by all members	Founded in 1848 with over 120,000 members. The AAAS aims to promote science, engineering, and innovation worldwide, while the AAAS's Center for Science Diplomacy (CSD) was established in 2008 to advance SD as a means of fostering global understanding and cooperation in science and technology. The CSD creates a platform for scientists, policymakers, and analysts to share knowledge, with a focus on encouraging scientific cooperation through diplomacy, especially between countries with limited political relations. It conducts research, advocates for education and training, engages in outreach, and supports initiatives to address global challenges such as climate change, food security, and infectious diseases. The CSD also runs several programs to promote international scientific collaboration and cooperation, including the Science & Diplomacy journal, the Science Diplomacy Education Network, and the AAAS-TWAS Science Diplomacy course (AAAS, 2023).
The National Science and Technology Council (NSTC)	Is chaired by the president of the US	Established in 1993 with the goal of setting goals for science and technology investment. The council, chaired by the President, oversees the coordination of research and development across federal agencies. In addition, the NSTC has been involved in SD, collaborating with global organizations on issues like health and leading joint research projects with other countries. The council consists of five main committees, each with subcommittees and ad-hoc committees (NSTC, 2023).
The United States Agency for International Development (USAID)	Appointed by the President of the United States and confirmed by the Senate	Responsible for providing foreign aid and development assistance to developing countries in various areas, including health, education, economic growth, and democratic governance. USAID also promotes SD and has a Science and Technology Advisor who helps identify scientific collaboration opportunities, provides technical expertise, and advises on scientific issues related to the agency's programs. The agency has multiple programs and partnerships focused on science, technology, and innovation, including the Global Development Lab, which deploys innovative solutions to global challenges. USAID collaborates with international partners such as the WHO and the UNDP to address global challenges (USAID, 2023).
The National Science Foundation (NSF)	Appointed by the President of the United States and confirmed by the Senate	An independent US government agency that supports scientific research and education across various fields. It plays a vital role in promoting economic growth, advancing scientific knowledge, and addressing global challenges by fostering international collaboration and cooperation in science and engineering. The NSF has created programs such as the PEER and BREAD initiatives to promote collaborations between US and developing

		country researchers, supporting agricultural research and strengthening scientific capacity in developing countries. Through these programs, the NSF promotes international collaboration, maintains the US's leadership role in the global scientific community, and advances scientific progress to address global challenges (NSF, 2023).
The U.S. Civilian Research and Development Foundation (CRDF)	Appointed by the board of directors	A non-profit organization that aims to promote international scientific and technological collaboration to support global peace and prosperity through grants, technical resources, and education. Initially established to foster scientific collaboration with Russia, it has expanded its scope to include other countries and regions worldwide. CRDF Global plays a crucial role in SD by facilitating international scientific cooperation, offering training and capacity-building programs, and bringing together scientists, policymakers, and other stakeholders from different countries to share ideas and best practices, ultimately promoting more productive and peaceful relationships (CRDF, 2023).
The National Academy of Sciences (NAS)	Elected by peers within the organization.	A non-profit organization that provides scientific advice to the nation. The NAS promotes international scientific cooperation and collaboration through various initiatives, including the U.S. National Committee for the International Union of Biochemistry and Molecular Biology (IUBMB), the Inter-Academy Partnership (IAP), and the Jefferson Science Fellowships (JSF) program. The NAS works to strengthen scientific cooperation, promote international understanding, and foster goodwill through these partnerships and initiatives (NAS, 2023).
The Global Innovation through Science and Technology (GIST) initiative	Appointed by the board of directors	A collaboration between the US Department of State's Bureau of Oceans and International Environmental and Scientific Affairs and VentureWell that aims to promote economic growth and entrepreneurship in developing countries through resources, training, and mentorship for science and technology-based startups. GIST also contributes to SD by fostering collaboration and partnerships between countries, promoting mutual understanding and goodwill, and addressing global issues such as climate change and healthcare through evidence-based approaches. Through its various programs, GIST helps entrepreneurs access funding and markets to build their businesses and realize their visions (GIST, 2023).

3.4 Chapter Conclusion

The US SD system involves a decentralized network of actors and institutions that advance foreign policy objectives through science and technology. This has made the US a leader in international scientific collaboration. However, the lack of a comprehensive S&T policy poses challenges, and SD efforts are significantly impacted by the policy priorities of each administration. The Biden administration has renewed the US commitment to SD, but the volatility of US SD policy creates challenges for building trust and sustaining partnerships, posing risks for US scientific leadership and SD efforts in the long run.

CHAPTER FOUR

CHINESE SCIENCE DIPLOMACY

4.1 Introduction

China has been actively promoting its scientific and technological achievements globally since the early 2000s, with a particular focus on science diplomacy (SD) in recent years (Wagner & Simon, 2022). The country has employed a multi-faceted approach to SD, utilizing significant investments in science and technology to establish partnerships with other countries (Gang, 2021). A key strategy has been the use of science and technology agreements (STAs), which involve bilateral or multilateral cooperation on scientific research and development, exchange of scientific personnel, joint research projects, and sharing of scientific data and information (Wagner & Simon, 2022). China began using STAs in the 1980s to build partnerships with other countries, attract foreign investment, and promote the dissemination of Chinese scientific knowledge (Wagner & Simon, 2022).

There have been several speeches and recent milestones that demonstrate China's commitment to SD. In 2006, China launched its "Science and Technology Diplomacy" initiative, which aimed to strengthen international cooperation in science and technology. In 2018, Chinese President Xi Jinping delivered a speech at the Chinese Academy of Sciences in which he emphasized the importance of science and technology in promoting national development and global cooperation (CAS, 2018). He called on Chinese scientists to "make greater contributions to the advancement of human civilization and the progress of human society" (CAS, 2018).

Another example is the “Belt and Road Initiative” (BRI), which is China's flagship foreign policy initiative that aims to build infrastructure and promote economic development in countries along the ancient Silk Road trade routes (Zhang, Zhang, & Xiao, 2021). The BRI includes a strong focus on science and technology cooperation, with plans to establish joint research centers, support technology transfer, and promote the exchange of scientific personnel (Gang, 2021; Zhang, Zhang, & Xiao, 2021).

China is also actively involved in global SD initiatives, including the United Nations Sustainable Development Goals (Xie, Wen, & Choi, 2021) and the Paris Agreement on climate change (Godbole, 2016). The country has pledged to work with other nations to achieve the SDGs and reduce greenhouse gas emissions as part of the “Paris Agreement”. Additionally, China is a member of several international science organizations, including the “International Science Council” (ISC), the “International Union of Pure and Applied Physics” (IUPAP), and the “International Astronomical Union” (IAU), enabling the promotion of scientific expertise and collaboration with other countries on scientific research.

In terms of perception, China's SD has been viewed with some skepticism by some nations. This is partly due to concerns about the transparency and accountability of China's scientific research, as well as its human rights record (Whetsell, Dimand, Jonkers, Baas, & Wagner, 2021; Wagner & Simon, 2022). Additionally, some countries view China's SD efforts as part of a broader strategy to expand its global influence and gain a competitive advantage in key areas like artificial intelligence, biotechnology, and other advanced technologies (Prieto & Scott, 2022). Despite these concerns, China's SD efforts have yielded some positive results. China has built strong partnerships with a number of countries in areas like renewable energy, space exploration, and environmental protection

(Gang, 2021). These partnerships have helped to advance scientific research and foster greater cooperation between nations, which could have long-term benefits for global development and diplomacy.

4.2 Historical Background of Chinese Science Diplomacy

China's SD efforts were initially focused on developing its own scientific and technological capabilities. Following the establishment of the People's Republic of China in 1949, the government launched a series of initiatives to boost research and development, including the establishment of the “Chinese Academy of Sciences” (CAS) in 1952.

During the Cold War, China's SD efforts were largely driven by political considerations (Wang, 2010). The country was isolated from much of the world due to its ideological differences with the United States and the Soviet Union, and it sought to establish scientific collaborations with other countries as a way to break out of its international isolation (Ross, 2015).

In the 1970s, China's SD initiatives shifted towards economic development with the launch of the "Four Modernizations" program. This program had a primary focus on modernizing China's agriculture, industry, national defense, and science and technology sectors (Baum, 2019). The government placed great importance on the science and technology aspect of the program, implementing various initiatives to promote research and development in China. Among these initiatives were the significant investment in research and development, which included the establishment and expansion of research institutions and the provision of necessary research infrastructure such as laboratories and equipment (Baum, 2019).

Furthermore, the Chinese government sought to establish partnerships with other countries to promote knowledge-sharing and technology transfer, encouraging international collaboration. The government also implemented policies to encourage innovation and entrepreneurship in the science and technology sector. This included offering tax incentives for high-tech industries, supporting start-ups, and setting up technology parks and incubators (Liu, Simon, Sun, & Cao, 2011). Additionally, the government invested in education and training to build a skilled workforce in the science and technology sector, expanding the number of universities and research institutions, and offering scholarships and training programs to students and professionals (Morrison, 2014; Gang, 2021). These initiatives enabled China to emerge as a global economic power in the following decades.

During the 1990s, China made significant strides in its SD efforts, thanks in part to its economic growth and political opening. The government of China recognized the value of building international scientific collaborations and establishing relationships with other countries in the science and technology sector (Wagner & Simon, 2022). As a result, China focused on several key aspects of SD during this period.

Firstly, the country increased its investment in science and technology, allowing for greater resources to be committed to scientific research and development. The government invested in building up the country's scientific infrastructure by establishing new research institutes and laboratory facilities (Sun & Cao, 2021). Secondly, China sought to expand its partnerships with other countries in the science and technology sector. This involved establishing joint research projects with foreign universities and research institutions, as well as sending Chinese scientists and researchers abroad to study and work (Hayhoe, 2019). Thirdly, China placed a strong emphasis on developing high-tech industries, such as telecommunications, biotechnology, and aerospace (Wagner & Simon, China's Use of Formal Science and Technology Agreements as a Tool of Diplomacy, 2022). This involved collaborating with foreign companies and research institutions to develop cutting-edge technologies and products.

Finally, China actively engaged in science and technology diplomacy to promote its image and influence in the international community. The government participated in international science organizations, hosted scientific conferences and workshops, and promoted China's achievements in science and technology to foreign audiences (Wagner & Simon, 2022). Overall, China's SD efforts in the 1990s laid the foundation for the country's continued growth and success in the science and technology sector in the years to come (Sun & Cao, 2021).

China's current efforts in SD are geared towards achieving its economic and political objectives, which includes establishing itself as a global leader in science and technology and promoting its national interests. One of the key components of China's SD strategy is the Belt and Road Initiative, a foreign policy initiative aimed at promoting economic development and infrastructure connectivity across Asia, Europe, and Africa. Science and technology is a significant focus area of the initiative, and China is actively seeking research partnerships and joint projects with countries along the Belt and Road route (Zhang, Zhang, & Xiao, 2021). Additionally, China is using SD to showcase its leadership in the global response to the COVID-19 pandemic by sharing scientific knowledge and resources with other countries and providing medical supplies and expertise (Lee & Haupt, 2021). The country is also seeking to address global challenges like climate change, public health, and food security through partnerships and joint research projects with other countries.

4.3 Offices & Agents of Chinese Science Diplomacy

China's SD system is a complex web of various institutions, associations, and initiatives that have a singular goal of advancing scientific cooperation and collaboration with other countries. However, unlike the SD system in the United States, the Chinese system is more structured and centralized, with multiple agencies working together to achieve a unified Chinese agenda. This approach reflects China's top-down governance structure and its emphasis on central control.

It is worth noting that some of the agencies within China's SD system are relatively new and not as established as their US counterparts. This lack of institutional history, combined with the opaque governance structure of the Communist Party, makes it challenging to fully comprehend the functions of these agencies or the leadership hierarchy within them. As a result, there is limited information available about how these agencies operate and the specific roles they play in promoting Chinese SD.

Table 2 - Agencies of Chinese Science Diplomacy

Agency Name	Leadership	Mission
The Ministry of Science and Technology (MOST)	Appointed by the President	Responsible for science and technology policies in China and plays a key role in SD efforts. Its oversight includes research and development, science education, technology transfer, and international cooperation. MOST leads China's efforts to establish and maintain international partnerships in science and technology through joint research projects, exchange programs, and international conferences. Working with other organizations like the Chinese Academy of Sciences and the China Association for Science and Technology, MOST aims to promote China's global position in science and technology and advance the country's scientific and technological development (MOST, 2023).
The Chinese Academy of Sciences (CAS)	Nominated by members of CAS, appointed by the central government of China	A prominent research institution in China that contributes significantly to the country's SD efforts. CAS conducts fundamental and applied research in various fields and has over 100 research institutes and more than 70,000 employees. Through partnerships, joint research projects, and exchange programs with foreign institutions, CAS promotes international scientific cooperation and exchange. By sharing knowledge and advancing research in multiple scientific fields, CAS plays a crucial role in promoting China's

		scientific and technological development and boosting the country's global influence through SD (CAS, 2023).
The China Association for Science and Technology (CAST)	Nominated by members of CAST, appointed by the central government of China	Represents China's scientific community and promotes science education, outreach, and public engagement within China and internationally. CAST collaborates closely with the Chinese government on science policy and provides expert advice and recommendations. Additionally, the organization establishes partnerships and collaborations with international scientific organizations to promote international scientific cooperation and exchange, engaging in joint research projects and exchange programs with foreign institutions and scientists. CAST plays a crucial role in advancing China's scientific and technological development and promoting SD to enhance China's global influence in the scientific community (CAST, 2023).
The China Science and Technology Exchange Center (CSTEC)	Nominated by the Minister of Science and Technology, appointed by the central Chinese government	Founded in 1978 under the Ministry of Science and Technology (MOST) with the aim of facilitating international scientific cooperation and technology transfer to enhance China's global influence in science and technology. CSTEC collaborates with international scientific institutions and organizations to support joint research projects and exchange programs. Moreover, CSTEC also promotes domestic scientific and technological innovation by providing services such as technology transfer, entrepreneurship training, and public engagement with science and technology. In addition to this, CSTEC organizes scientific conferences and workshops, manages scientific databases, and offers consultation on science and technology-related issues, serving as a critical platform for promoting global scientific cooperation and advancing China's scientific and technological development (CSTEC, 2023).
The Chinese National Committee for Pacific Science Association (PNC-PSA)	Nomination and election by its members. Originally politically appointed.	A regional scientific organization that fosters cooperation and exchange among scientific institutions, researchers, and experts in the Asia-Pacific region. China's active participation in PNC-PSA has contributed to the development of regional scientific networks and sustainable development in the region. The committee promotes interdisciplinary research, sustainable development, science education, and public awareness through conferences, workshops, and outreach activities, which aligns with China's SD efforts in the Asia-Pacific region (PSA, 2023).
The Chinese Academy of Engineering (CAE)	Nominated by members of CAST, appointed by the central government of China	A scientific institution affiliated with the Chinese Academy of Sciences, focused on advancing engineering research and innovation. It provides expertise and advice to the Chinese government, conducts research and development, and provides training and education for engineers and technicians. The CAE promotes international scientific cooperation and exchange through partnerships with international institutions and initiatives such as the China-Europe High-Level Forum on Engineering Science and Technology. Its academic divisions are organized by engineering specialty, and its members frequently participate in international scientific events (CAE, 2023).
The China International Science and Technology Cooperation Center (CISTCC)	Nominated by the Minister of Science and Technology, appointed by the central Chinese government	Established in 1985 to promote international cooperation in science and technology. It operates under the Ministry of Science and Technology in China and provides a platform for Chinese scientists to collaborate with counterparts from other countries. The CISTCC manages several programs and initiatives to facilitate joint research projects, exchanges of researchers and scientists, and other forms of scientific cooperation between China and

		other countries. Additionally, the center provides training and education to Chinese scientists, conducts studies and research on international science and technology cooperation, and hosts international conferences and workshops. The CISTCC plays a vital role in promoting China's scientific and technological progress and enhancing the country's global influence in the field of science and technology (CISTCC, 2023).

4.4 Chapter Conclusion

This chapter focuses on China's SD system, which differs from the US in its centralized structure. The Chinese Communist Party's agenda takes precedence over all other agencies, providing a cohesive approach to SD. China's rapid economic and technological growth in recent years has led to an emphasis on SD, which is seen as crucial to achieving its national interests and global leadership. In contrast, the US has a longer history of SD, dating back to the post-World War II era, where science and technology were viewed as essential for economic growth and national security. However, US SD is more decentralized, with different agencies promoting their own research agendas.

CHAPTER FIVE

RECENT DEVELOPMENTS IN U.S.-CHINESE SCIENCE DIPLOMACY

5.1 Introduction

China has been consistent in its commitment to its science and technology (S&T) aspirations and science diplomacy (SD) agenda. As part of its expansive approach to SD, China has signed formal Scientific and Technological Cooperation Agreements (STAs) with 51 countries, with another 64 countries having STAs that include science and technology as subjects for cooperation (Wagner & Simon, 2022). While political goodwill remains an important objective, China prioritizes access to the latest S&T know-how in its formal relationships with other countries. However, China's increasing interest in military-related research and industries has raised concerns among other countries, particularly the US (Wagner, Bornmann, & Leydesdorff, 2015).

Over the past few decades, the US has taken different approaches towards China's science and technology advancements. During the Obama era, SD was collaborative, with a shared global agenda on healthcare and climate change. However, during the Trump administration, tensions increased due to disagreements on intellectual property and trade tariffs (Wei, 2019), which led to a new era of scientific de-coupling between the two countries (Schuller & Schuler-Zhou, 2020). The Trump administration's accusatory tone towards China during the COVID-19 pandemic worsened this trend. The US government accused China of mishandling the pandemic and engaging in espionage and intellectual property theft, leading to limited scientific collaboration between the two countries (Wagner, Cao, Jonkers, Seger, & Goenaga, 2021).

This de-coupling is significant because China and the US are two of the largest producers of scientific knowledge and technological innovation in the world (Wagner, Zhang, & Leydesdorff, 2022). Reduction of scientific collaboration between them could hinder global scientific progress. The Biden administration has signaled its intent to return to scientific collaboration but remains wary of intellectual property theft in China. However, this back and forth in US SD towards China has caused a global decrease in knowledge production and concerns on how other countries should behave as the two largest knowledge production systems appear to be drifting apart (Schuller & Schuler-Zhou, 2020). The next section discusses in detail the relationships between Chinese and US sciences under each US administration while reflecting on bilateral tensions as well as the scientific agenda of each.

5.2 Obama-China Science Diplomacy

During President Obama's time in office, there was a renewed focus on using SD to tackle global challenges and promote international cooperation. The administration recognized the importance of science and technology in diplomacy and implemented various measures to enhance SD efforts. One of these measures was the establishment of the President's Council of Advisors on Science and Technology (PCAST, 2023), which provided valuable advice on science and technology issues to the President and other officials.

The Obama administration prioritized climate change as a major focus of their SD efforts and played a leading role in negotiating the Paris Agreement to limit global temperature rise (Kincaid & Roberts, 2013). They also initiated programs such as the Clean Power Plan and the Mission Innovation initiative to reduce greenhouse gas emissions and promote clean energy. The administration recognized the importance of addressing a range of other global issues, such as global health, food security, and disaster response, and invested in research to address these issues (Bollyky & Bollyky, 2012).

During his administration, President Obama expressed concerns about China's human rights record and territorial ambitions, and there were efforts to contain China's rise as a global power. On the issue of human rights, President Obama spoke out against China's treatment of dissidents, ethnic minorities, and human rights activists. In 2014, he met with Chinese President Xi Jinping and called on China to respect human rights and freedoms (Office of the Press Secretary, 2014). He also hosted the Dalai Lama, the exiled Tibetan spiritual leader, at the White House, despite protests from China. In terms of territorial ambitions, the Obama Administration was concerned about China's assertiveness in the South China Sea, where it has territorial disputes with several countries (De Castro, 2013). The US conducted freedom of navigation operations in the region to challenge China's claims and maintain freedom of navigation in international waters. The US also strengthened its alliances with countries in the region, such as Japan and South Korea, and increased its military presence in the Asia-Pacific region (De Castro, 2013).

China reacted strongly to these actions, accusing the US of interfering in its internal affairs and trying to contain its rise as a global power. China criticized the US for supporting separatist movements in Tibet and Taiwan and for conducting military activities near its borders (Godbole, China’s Asia strategy under president Xi Jinping, 2015). China also increased its military presence in the South China Sea and pursued its own alliances and partnerships in the region, such as the Belt and Road Initiative (Godbole, China’s Asia strategy under president Xi Jinping, 2015).

Despite these tensions, both countries continued to engage in SD and cooperate in areas such as climate change and public health (Ruffini, 2017). The administration pursued a policy of engagement with China in science and technology, recognizing that this could enhance cooperation while addressing areas of concern. In particular, the United States and China worked together to address global challenges related to climate change and clean energy (De Castro, 2013). One of the key initiatives launched during this time was the U.S.-China Strategic and Economic Dialogue (Bergsten, 2009). This dialogue provided a forum for officials from both countries to discuss various science and technology-related issues, including cybersecurity, intellectual property rights, and joint research and development projects. The dialogue aimed to build a more constructive and cooperative relationship with China on global issues (Bergsten, 2009).

Another significant initiative was the U.S.-China Clean Energy Research Center (CERC), which was launched in 2009 with a $150 million budget and later extended for another five years. The CERC aimed to accelerate joint research and development on clean energy technologies, including areas such as clean coal, advanced buildings, and clean vehicles (Lewis, 2014). It brought together researchers and industry leaders from both countries to collaborate on cutting-edge research (Lewis, 2014). The Obama administration pursued several other science and technology cooperation agreements with China. One of these agreements was the “U.S.-China Climate Change Working Group”, established in 2014. This agreement aimed to enhance cooperation on climate change mitigation and adaptation, including joint research and development projects on low-carbon technologies and cooperation on greenhouse gas emissions reduction targets (Lewis, 2014).

The Obama administration's SD efforts with China demonstrated a commitment to building a more constructive relationship with China on global issues. While there were continuing tensions between the two countries, these initiatives showed that the United States and China could work together to address shared challenges and promote international cooperation.

5.3 Trump-China Science Diplomacy

The Trump administration had a different approach to SD than the Obama administration. Trump was skeptical of climate change and wanted to cut funding for scientific research, especially in the area of environmental research (Selby, 2019). This meant that science wasn't given as much importance in diplomacy and foreign policy during his administration. This approach was criticized by many scientists (Rutledge, 2020). One major example of Trump's approach was his decision to withdraw from the Paris Agreement on climate change (Tollefson, 2017). This was seen as a setback for global efforts to address climate change. Trump reduced funding for federal agencies involved in SD, like the Environmental Protection Agency and the State Department (Selby, 2019). This made it harder for them to support international environmental agreements and collaborate with international scientists.

During the Trump administration, the US took a confrontational stance towards China in the field of science and technology. One reason for this was concerns about intellectual property theft and national security risks associated with China's growing technological capabilities (Dhue & Tausche, 2018). As a result, the US implemented several measures to address these perceived threats, such as restricting Chinese investment in US technology firms, targeting Chinese telecom company Huawei, and revoking visas for Chinese students and researchers thought to be affiliated with the Chinese military (Farrell & Newman, 2020).

The Trump administration argued that these measures were necessary to protect US national security interests. However, some critics saw the measures as overly broad and potentially damaging to US-China science and technology cooperation (Witze, 2017). For instance, new restrictions on Chinese investment in US technology firms could discourage Chinese scientists and researchers from collaborating with their US counterparts (Wagner, Poland, & Yan, 2021). Likewise, targeting Huawei could negatively affect US-China collaboration on next-generation technologies, such as 5G (Farrell & Newman, 2020). Furthermore, some in the scientific community expressed concern that revoking visas for Chinese students and researchers affiliated with the Chinese military could hinder scientific collaboration and knowledge-sharing between the US and China (Wagner & Simon, 2022). Scientific collaboration and knowledge-sharing are essential for tackling global challenges such as pandemics and climate change, and a more confrontational approach towards China in science and technology could hinder progress on these issues (Whetsell, Dimand, Jonkers, Baas, & Wagner, 2021).

During the COVID-19 pandemic, the Trump administration accused China of not being transparent about the outbreak and mishandling the early response (Rutledge, 2020). This caused tensions between the two countries, including in SD. As the virus began to spread globally, there was an urgent need for countries to share information and collaborate on research to better understand and combat the virus (Lee & Haupt, Scientific collaboration on COVID-19 amidst geopolitical tensions between the US and China, 2021). However, tensions between the US and China escalated due to the Trump administration's accusations that China was not being transparent about the outbreak and mishandling the early response.

This politicization of the pandemic had negative implications for SD, as cooperation on public health issues between the two countries was impacted. The US and China have historically collaborated on research related to infectious diseases, but the confrontational approach taken by the Trump administration hindered this collaboration (Kapucu & Monynihan, 2021). For example, Chinese scientists were initially reluctant to share information about the virus, which led to accusations of a lack of transparency and hindered global efforts to understand and contain the virus (Yamey & Gonsalves, 2020). Furthermore, the Trump administration's criticism of China's handling of the pandemic was seen by some as an attempt to deflect blame from the administration's own handling of the crisis (Kapucu & Monynihan, 2021). This further contributed to a breakdown in communication and cooperation between the two countries on public health issues. As a result, scientific collaboration and data sharing between the US and China were hindered, which ultimately impeded efforts to combat the pandemic (Yamey & Gonsalves, 2020).

Despite some efforts to engage with China on science and technology issues, the Trump administration's confrontational approach overshadowed these efforts. This approach was driven by broader concerns about national security and geopolitical competition, which ultimately took priority over SD. As a result, the relationship between the US and China on science and technology cooperation was strained during the Trump era.

5.4 Biden-China Science Diplomacy

The Biden administration understands the importance of science and technology in tackling global challenges and has made it a top priority in its foreign policy agenda

(Brands, 2021). To support these efforts, the administration has taken several steps such as rejoining the Paris Agreement on climate change and committing to reducing greenhouse gas emissions (South, Vangala, & Hung, 2021). Additionally, the administration has prioritized public health and pandemic response efforts, and has made significant investments in scientific research and development (Tanne, 2021).

To ensure that science and technology policy is coordinated across federal agencies and to promote international scientific collaboration, the administration has established a new cabinet-level position, the White House Office of Science and Technology Policy (OSTP). The administration has also taken steps to promote diversity and inclusion in science and technology by supporting scientific research at historically black colleges and universities and other minority-serving institutions (The White House, 2021).

The Biden administration's proactive approach to SD has been welcomed by many in the scientific community and by foreign leaders (Drew, 2020). The administration's focus on climate change, public health, and scientific research and development is seen as crucial for addressing global challenges and promoting international cooperation. By prioritizing SD, the administration aims to use scientific and technical expertise to find solutions to pressing global issues and build a more sustainable and prosperous future for all (Medina, 2023).

When it comes to collaborating with China, the Trump administration was confrontational while the Biden administration is taking a more strategic approach. The Biden administration recognizes the importance of working with China on global issues such as climate change and pandemics, while still addressing concerns around national security and intellectual property theft (Lewis, 2020). They have established a Science and Technology Partnership Task Force with China, which is co-chaired by the National

Security Advisor and the Science Advisor, showing that they value both security and scientific collaboration (Garamone, 2021; The White House, 2022).

The administration has also engaged with China through multilateral forums such as the UNFCCC and WHO and taken measures to protect U.S. biomedical research from undue foreign influence, particularly from China (Lewis, 2020; Medina, 2023). However, these measures are designed to be targeted and effective, focusing on specific instances of intellectual property theft and other security risks instead of implementing blanket restrictions on collaboration. Overall, it's too early to know if this approach will work, it's a significant shift from the policies of the previous administration, and many in the scientific community have welcomed it.

5.5 Chapter Conclusion

China's approach to SD is more uniform and consistent than that of the US. While the US system changes with each new administration, China's priorities and goals are driven by the CCP's agenda. Over the years, the Obama, Trump, and Biden administrations have had different approaches to Chinese SD, with the Biden administration trying to balance cooperation with competition and address national security concerns. China, on the other hand, has been investing in initiatives like "Made in China 2025" and improving its domestic scientific capabilities. While China wants to collaborate with other countries on global challenges, it also aims to expand its influence in science and technology, such as through the Belt and Road Initiative. China has made significant progress in areas like AI, biotechnology, and quantum computing, but faces challenges like intellectual property theft.

CHAPTER SIX

ANALYSIS OF THE DE-COUPLING OF U.S. AND CHINESE SCIENCES

6.1 Chinese-US Scientific Funding

Chapters III and IV demonstrated the presence of national agencies responsible for funding and maintaining science diplomacy (SD) in China and the US. These agencies collaborate through networks formed around grants or areas of shared interest between American and Chinese scientists. Between 2008 and now, a total of 87 Chinese funding agencies have supported international collaborations, with all of them being connected to the US government. Whereas a total of 178 agencies US funding agencies have supported international collaborations over the same period. Figures 1 and 2 detail the percentage distribution of the most significant funders in each community.

Figure 1 - Contribution of Chinese funding agencies by percentage

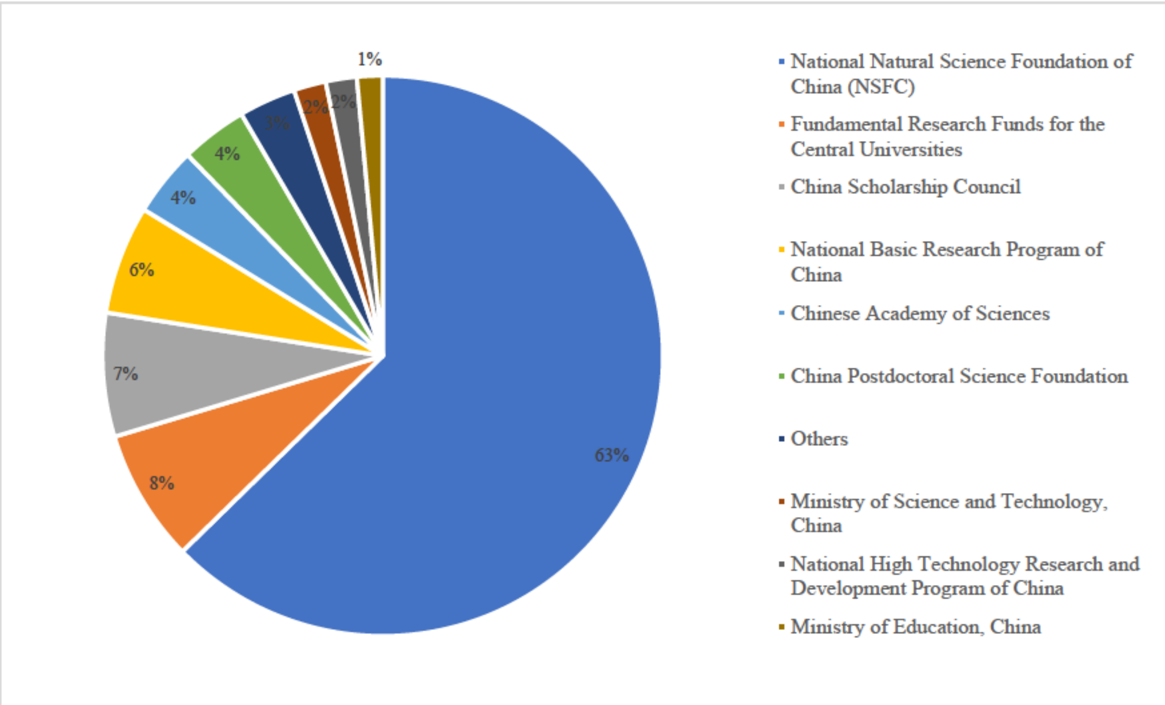
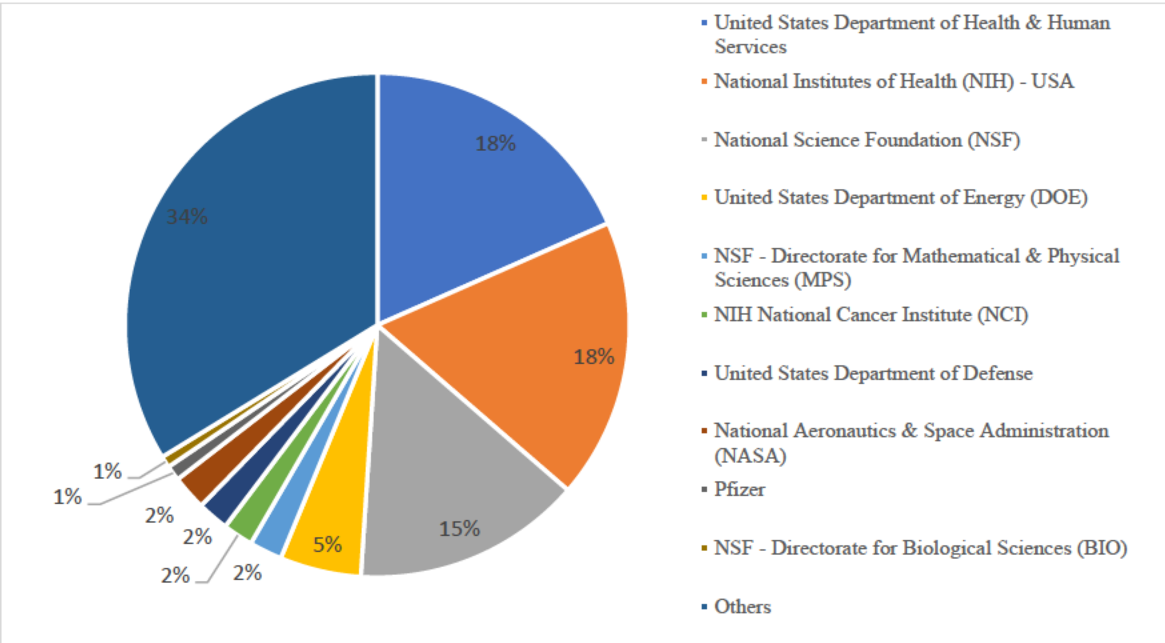


Figure 1 indicates that the majority of funding for international scientific collaborations comes from governmental agencies or programs run by them. For example, the “National Natural Science Foundation of China” (NNSFC), which is managed and controlled by the “Ministry of Science and Technology” in China, is one such organization and maintains an overwhelming leading position in funding accounting for 63% of total funding projects. Furthermore, most of the funding agencies listed under the "others" category were provincial counterparts of the funding agencies mentioned above, such as the “National Natural Science Foundation of Guangdong Province” and Zhejiang Province. Although there were some funding agencies from non-governmental entities such as universities, like Peking University, they are still public institutions and receive funding from the MoE. The findings in Figure 1 are consistent with our earlier discussion in Chapter III on Chinese SD, where we established that the vast majority of scientific funding is derived, managed, or overseen by governmental agencies, namely MOST and MoE.

Figure 2 - Contribution of U.S. funding agencies by percentage



On one hand, Figure 2 illustrates that while the majority of funding agencies for science in the US are government-run or affiliated, certain industries have become competitive players, with Pfizer, Merck & Company, and Bristol-Myers Squibb ranking among the top 15 funding agencies in the country. This demonstrates that US SD has successfully integrated and leveraged funds from industry, which aligns with the country's free market and liberal ideology. However, Figure 2 does not differentiate between US funding agencies involved in international scientific collaboration with or without China. Upon closer examination, we can see that almost all industry funders do not participate in collaborations with China or do not provide funding for Chinese science. Almost all funding towards US-Chinese scientific collaborations comes from government agencies with 68% coming from the NSF, “Department of Health and Human Services”, NIH, and DoE. This aligns with the use of US SD as a bridge when other forms of collaboration are no longer feasible. Given the economic competition between the US and China, it is understandable that US industries would be hesitant to collaborate with or fund Chinese scientists, for fear of jeopardizing their own standing within the industry. Therefore, it is primarily the US government that engages with Chinese scientists, adhering to strict intellectual property laws outlined in Science and Technology Agreements by the Department of State.

6.2 Chinese-US Scientific Collaboration

Having established that the majority of collaborations between China and the US are funded by the government, the state of Chinese and US scientific collaboration is analyzed. Recent political events have cast a wide shadow on the continuity of Chinese and US scientific collaboration. Many prominent scientists in the US who are of Chinese origin have been fired or investigated for undisclosed ties with China (Mervis, 2020; Hao

& Guo, 2021). In addition, Confucius institutes on US university campuses have been closed (NAoS, 2023), and there are stricter limitations on Chinese nationals studying or conducting research in STEM fields. Several Chinese scholars and students have had their visas revoked while already in the US (Hansler & Griffiths, 2020), and the closure of the Chinese consulate in Houston and the US consulate in Chengdu (BBC, 2020) is further evidence of the tumultuous relationship between the scientific communities of these two nations.

The anti-Chinese sentiment during the Trump era has led to a decline in collaboration between the two countries (Tang, Cao, Wang, & Zhou, 2021; Guo, Jiao, & Xu, 2021). This raises concerns about the sustainability and health of the Chinese-US collaboration networks. Chinese students and scholars who migrate to the US for education have played a significant role in benefiting both countries. This influx has resulted in a tremendous increase in the collective share of global scientific production and has helped elevate Chinese sciences to a level of citation parity with those of the US, indicating an overall rise in quality.

If US and Chinese collaborators continue to withdraw from collaborations, the impact would be felt across both countries, and the effects can be quantified through the total share of each country's global scientific production (Tang, Cao, Wang, & Zhou, 2021). To explore this issue further, this study used Clarivate Incites for Web of Science (WoS) data to collect indicators of scholarly outputs for both countries, as shown in Table 3.

Table 3 - Percentage share of Chinese and U.S. international collaborations

Year	World	China		US		Rest of World	
	Total Intl. Collabs	Total Intl. Collabs	% Share	Total Intl. Collabs	% Share	Total Intl. Collabs	% Share
2008	772,681	28,729	3.72%	130,873	16.94%	613,079	79.34%
2009	848,265	34,393	4.05%	142,020	16.74%	671,852	79.20%
2010	916,298	39,603	4.32%	150,534	16.43%	726,161	79.25%
2011	993,624	45,830	4.61%	161,571	16.26%	786,223	79.13%
2012	1,077,546	52,771	4.90%	173,221	16.08%	851,554	79.03%
2013	1,185,301	62,924	5.31%	187,991	15.86%	934,386	78.83%
2014	1,316,953	74,925	5.69%	205,112	15.57%	1,036,916	78.74%
2015	1,438,368	86,192	5.99%	219,512	15.26%	1,132,664	78.75%
2016	1,585,281	99,347	6.27%	237,999	15.01%	1,247,935	78.72%
2017	1,688,743	112,500	6.66%	250,309	14.82%	1,325,934	78.52%
2018	1,807,332	130,068	7.20%	262,530	14.53%	1,414,734	78.28%
2019	2,013,737	154,047	7.65%	282,711	14.04%	1,576,979	78.31%
2020	2,146,902	166,617	7.76%	287,659	13.40%	1,692,626	78.84%
2021	2,300,851	176,243	7.66%	291,830	12.68%	1,832,778	79.66%
2022	2,030,793	161,318	7.94%	245,429	12.09%	1,624,046	79.97%
2023	149,476	15,339	10.26%	16,816	11.25%	117,321	78.49%

Our investigation focused solely on articles and reviews while excluding conferences and pre-prints. We employed full counting methodology to compute the totals for papers with international co-authorship. This approach assigns equal credit to each country involved in a scientific publication, regardless of authorial affiliations. It is worth noting that WoS differentiates China from Hong Kong and Taiwan, such that collaborations between Chinese authors and their counterparts in Hong Kong and Taiwan are considered international collaborations. Our data were procured from WoS in April, encompassing only the first four months of the year 2023, and are not be fully representative of the current outlook.

In comparing the collaborative trends between China and the United States, our analysis revealed that Chinese international collaborations exhibited a steady increase from 3.72% in 2008 to 7.94% in 2022, with a projected share of 10.26% in 2023. In contrast, the US counterpart's share of international collaboration consistently declined from 16.74% in 2008 to 12.09% in 2022 and is projected to further decrease to 11.25% in 2023. In the same period, the share of non-US and Chinese countries, classified as the rest of the world, remained relatively stable, fluctuating between 79.34% and 79.97%, with a projected share of 78.49% in 2023. These findings suggest that the rest of the world's share of international collaborations remained constant, while China's increase came at the expense of the US shares. In other words, as China's share of international collaborations grew, the US percentage share of scientific collaboration shrank to accommodate it, while the rest of the world's share remained stable. This observation underscores the validity of US concerns regarding scientific competition with China, particularly concerning collaborative networks.

To investigate the relationship between the scientific communities of China and the United States, we must examine their interpersonal collaborations. Therefore, we conducted a second query of WoS, analyzing scientific collaborations between China and the US, as well as China and the rest of the world, to track the trend of Chinese scientific collaborations over time. We examined both collaborations to provide a comprehensive picture of the overall trend. It is worth noting that scientific collaboration rarely produces immediate results; in fact, most collaborative networks yield results one to two years after their inception. To account for general research and publishing delays, we projected our data backward by one year. Although this approach may not be entirely accurate, as some papers may take upwards of three years to mature, it is generally an accepted practice in the scientific community.

Figure 3 - Trend of scientific collaboration in China

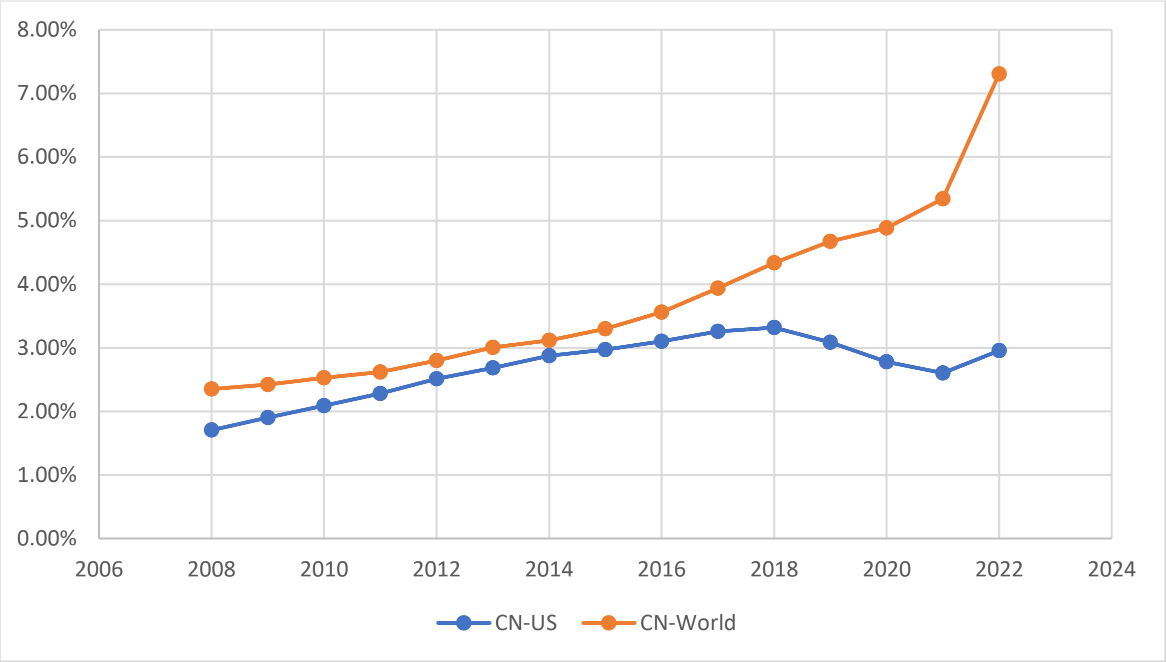
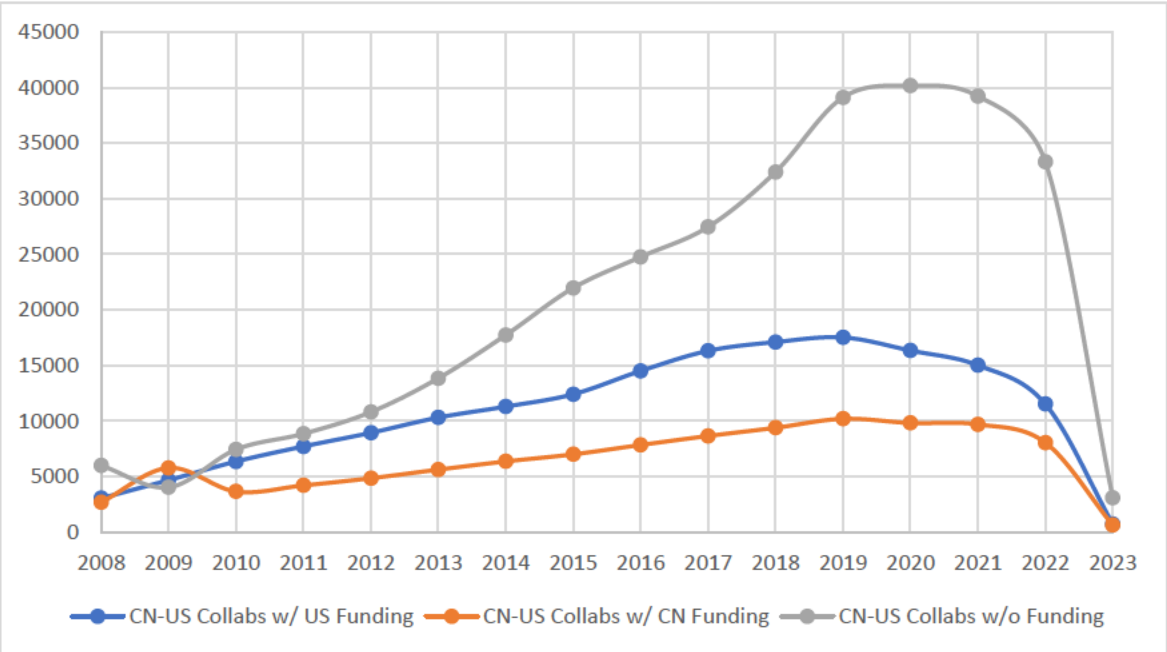


Figure 3 illustrates a divergence in the trend of scientific collaboration between China and the United States, which is contrary to the general trend of China's collaboration with other countries. This indicates a significant change from the previously increasing collaborative relationship between the two countries, as scientific collaboration between China and the United States has been declining since 2018. It is worth noting that the rate of decline in Chinese-US scientific collaboration is substantial, with a decrease of nearly 22% between 2018 and 2021. In contrast, scientific collaboration between China and the rest of the world increased by 23% during the same period.

This decline in scientific collaboration between China and the United States is exceptional, as it is not in line with China's worldwide collaborative behavior in science. It is possible that this decrease is unique to US and Chinese sciences. Additionally, the comparable fluctuations in scientific collaboration between China and the United States and China and the rest of the world suggest that the United States may have become more scientifically exclusionary during the Trump era (2018-2021). China has taken advantage of the withdrawal of US collaboration shares in international scholarly production, claiming a more significant percentage share, as demonstrated in Table 3.

On the other hand, Figure 3 only offers a surface-level analysis of the scientific collaboration between the United States and China, failing to capture the intersection between political rhetoric and its potentially varying impact. It is crucial to consider multiple types of scholarly endeavors to gain a more nuanced understanding of the situation. This includes: (i) scientific research funded by US governmental agencies, as outlined in Chapter III; (ii) scientific research funded by Chinese governmental agencies, as outlined in Chapter IV; and (iii) scientific research that is either not funded or funded by non-governmental agencies[2]. Figure 4 shows the trend of scholarly collaboration across the three categories.

Figure 4 - Trend of three categories of scholarly collaboration between China and U.S.



[2] The distinction between those who received non-governmental funding and those who did not receive any funding was not made due to limited controls of the databases. Additionally, non-governmental agencies that fund academically publishable research are often international organizations like the UN and World Bank, which collect funds from member countries, making it hard to attribute the efforts of a single state.

Figure 4 depicts the collaborative trend between China and the US in the three categories. It is observed that collaborations funded by the US showed a consistent increase from 2008 to 2015, with a linear trend until the latter year. The surge in 2015 can be attributed to the clean energy initiative launched by the US during the Obama administration, which continued until 2018, and is supported by the substantial share of funding provided by the US "Department of Energy"[3] (DoE). However, in 2019, the number of US-funded collaborations declined at a much faster rate than their previous increase. In fact, as of 2022, the number of Chinese and US collaborations funded by the US has dropped back to the levels seen in 2014. Although we are only four months into 2023 at the time of writing, it is worth noting that if the current monthly publication rate is projected to a full year, it would indicate a decrease in publications to around the levels seen in 2011. It should be kept in mind that publications take time to appear, so those in 2023 may also represent progress made several years ago. Thus, it is reasonable to assume that the decline in publications could still be aftershocks of previous years.

The decline in publications of collaborations funded by China is not as sharp as that of US-funded collaborations. Chinese-funded collaborations followed a linear trend until 2019, plateaued, and showed little change until dropping to 2017 levels in 2022. The percentage change between 2019 and 2022 for Chinese-funded collaborations was a 21% decrease, while US-funded collaborations had a 35% decrease. This translates to a drop of 2,000 publications for Chinese-funded collaborations and 6,000 publications for US-funded collaborations, resulting in a net loss of approximately 8,000 funded publications for the scientific community over four years.

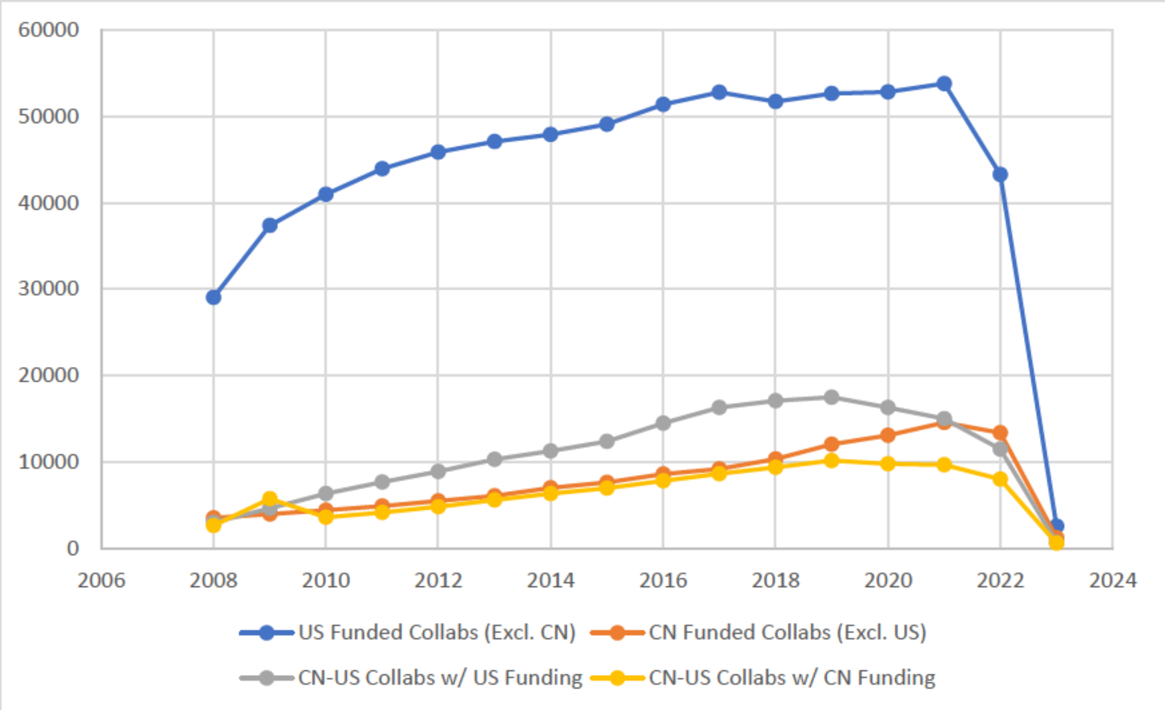
[3] The DoE was not included in Chapter III on US SD apparatuses, as they traditionally do not have a role in it. However, during President Obama's term, a special agreement was made China for the development of clean energy (OPS, 2014). Despite the diplomatic agreement being managed and negotiated by the DoS, it is the DoE that funded and oversaw scientific collaboration.

Despite some claims that interpersonal collaborations between Chinese and US scholars without funding could have compensated for the net loss of funded publications, our findings contradict such assertions. We observed that the number of publications that received no governmental or any funding at all followed the same trend as their funded counterparts. Although the rate of increase and the slope of the graphs were much higher than those of funded collaborations from 2008 to 2019, a similar plateau observed in Chinese funded collaborations was also observed in those without funding between 2019 and 2021, with a significant drop in 2022 back to 2018 levels. The drop rate between 2021 and 2022 was 15% lower than the drop of both types of funded publications. However, considering the significant difference in quantities, that 15% difference resulted in a loss of approximately 7,000 publications in just one year.

The decline in scholarly collaborations between China and the US has resulted in a loss of around 20,000 publications in just four years, from 2019 to 2022. This drop suggests that there may have been external factors affecting the collaborative network. This trend is not limited to the Chinese-US relationship; table 1 shows that global scholarly collaborations have decreased by about 11% over the last four years. This decrease highlights the vital contributions made by both the US and Chinese scientific communities to the global scientific community. It is evident that the decline in collaboration between these two scientific powerhouses has had a significant impact on scientific production worldwide.

Furthermore, we can attribute the international publication deficit to US-Chinese collaboration by examining the funding patterns of the two scientific communities. Figure 5 illustrates the number of funded collaborations by the US and China, with cross-funded collaborations shown in Figure 4.

Figure 5 - Scholarly funding patterns of China and U.S.



We have observed that US-funded collaborations with China declined between 2019 and 2021. However, during the same time period, US-funded collaborations with other countries showed an increase. Similarly, when comparing Chinese-funded collaborations globally, excluding those with the US, there was growth during the same period. Even in 2022, which saw a decrease in funded collaborations globally across all categories, we noted that the percentage change in global collaborations and Chinese-US collaborations was not similar. Chinese-funded collaborations globally dropped by 8%, while China-US collaborations dropped by 21%. Similarly, US-funded collaborations globally decreased by 19%, while Chinese-US collaborations declined by 35%. Therefore, even though the global trend in funding collaborations is declining, the decline in Chinese-US collaborations, which make up the majority of international collaborations, is significantly higher. This further indicates that external factors are affecting their collaboration behavior and networks, despite the global trend.

6.3 Political Rhetoric

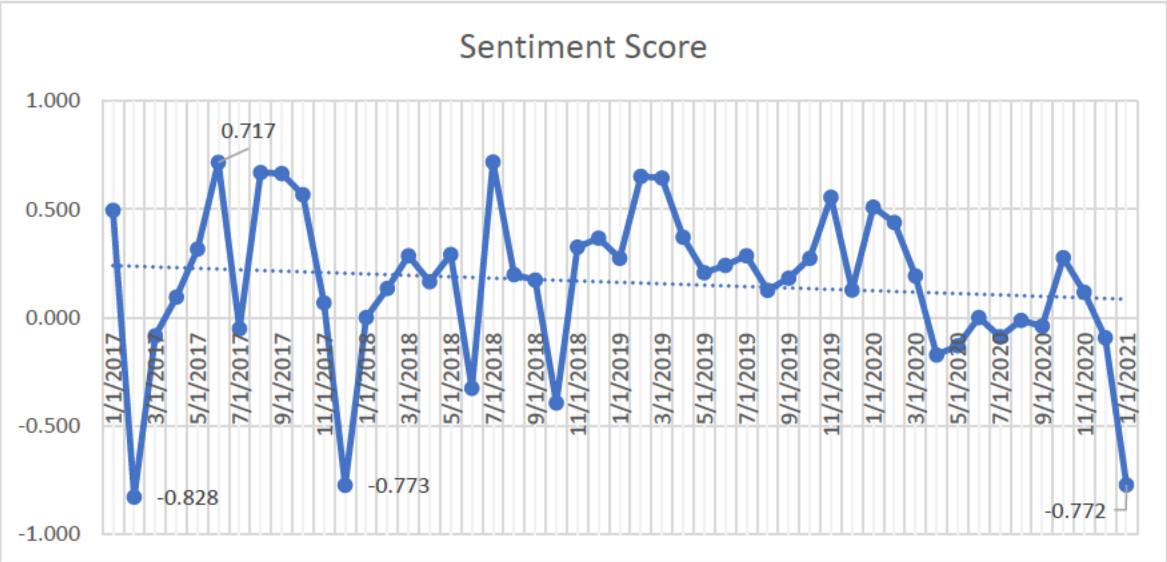
Chapter V provides an analysis of the foreign policy approaches and tools utilized by the three US administrations from 2008 to 2022 in dealing with China. The analysis reveals that the Trump administration's policies were the most divisive compared to those of either Obama or Biden administrations. The trade war and COVID-19 pandemic during the Trump era are significant events that affected the diplomatic relations between the US and China, leading to a potential reduction in scholarly collaboration between the two countries. To establish a correlation between political rhetoric and scholarly collaboration, it is necessary to quantify the sentiment behind political speeches. Several methodologies have been developed for this purpose, of which Critical Discourse Analysis is often the most employed due to its ability to capture the political and social backdrop of the speech. However, given that the previous chapters have already established SD and Chinese-US relations as the primary backdrop sentiment analysis becomes the most viable methodology to be employed.

After conducting a sentiment analysis of President Obama's speeches, it is evident that both Peace and Security were among the most frequently used words, with 93% of his speeches referencing peace and 72% referring to security. This indicates that throughout his tenure, President Obama prioritized peace and security in the international arena. When discussing China, President Obama's speeches focused heavily on peace, collaboration, and responsibility, with these three terms appearing as the most frequently used words. A sentiment analysis of the 2015 joint press conference between President Obama and President Xi of China revealed that President Obama's speech had a 0.25 favorable sentiment towards China, with "friendship" and "competition" being the two standout words of the speech. President Xi's speech echoed this sentiment, with a 0.48

favorable sentiment towards the United States. President Obama's sentiment towards China maintained an average of 0.12 throughout his tenure, indicating a relatively cooperative relationship between the two nations. This is further evidenced by the steadily increasing pattern of collaboration between the United States and China, as well as the energy collaboration agreement that was produced as a result of the 2015 joint conference.

An analysis of President Trump's speeches indicated a less stable relationship with his Chinese counterpart. However, relying solely on his speeches fails to provide a complete depiction of his political rhetoric during his tenure. Scholars have posited that his tweets, which have wielded significant influence in the past, may be more representative. Examining the sentiment of his tweets, as illustrated in Figure 6, demonstrates the fluctuations observed.

Figure 6 - Sentiment scores of President Donald Trump tweets



The preceding data represent monthly average scores, with the last month with tweets being in 2021, when Trump was banned from Twitter (Twitter, 2021). It's worth noting that the lowest sentiment scores were recorded in February 2017 (-0.828), December 2017 (−0.773), and January 2021 (−0.772). Interestingly, the highest positive sentiment was observed in June 2017 (0.717), meaning that the highest sentiment recorded in Trump's tweets was still negative. Despite the negativity, the trendline remained above 0, but declined over time, following the equation $y = -0.0032x + 0.2436$. The negative slope further indicates deteriorating and increasingly negative sentiment towards China during Trump's presidency.

Regarding the sentiment analysis during the Biden administration, it appears that President Biden shares a positive outlook towards Chinese-US relations, following in the footsteps of President Obama. His most recent speech on bilateral relations with China received a sentiment score of 0.34. Furthermore, Chapter V highlights President Biden's intention to engage in conversation with China, with the aim of reversing the policies implemented during the Trump era.

After conducting sentiment analyses on all three US administrations, we proceeded to examine the correlation between political sentiment and Chinese-US scientific collaborations from 2008 to 2022. Our findings indicate a significant correlation of 0.86 between political rhetoric and trends in scientific collaboration, with a p-value of 0.056. This suggests a high probability of political rhetoric affecting scientific collaboration, and the p-value indicates a 5.6% chance of this relationship occurring by chance. While statisticians generally aim for a 0.05 (or 5%) chance, it's important to note that our analysis relied solely on empirical data from social sciences and human behavior[4]; certain extraneous factors like COVID-19 and its impact on collaborative networks were not fully considered. Nonetheless, the significant correlation and p-value provide valuable insight into the potential cause-and-effect relationship being studied.

[4] This research falls under social sciences and relies on both scientometrics and statistics as well as human-to-human interactions, which are influenced by a range of currently unobserved factors. By social science standards, we can state that the correlation identified is statistically significant.

6.4 Science Diplomacy During the COVID-19 Pandemic

Before the COVID-19 pandemic, the United States had implemented policies aimed at limiting scientific engagement with China. These policies included denying visas to Chinese citizens, banning Chinese funding sources, and monitoring Chinese students and scholars (Mervis, 2020; Hao & Guo, 2021). The US was concerned about Chinese nationals collecting non-traditional information for China's military and strategic goals. Despite opposition from the US scientific community, which argued that international collaboration was essential in driving innovation and discoveries, these policies remained in place (Witze, 2017).

The outbreak of COVID-19 and the subsequent pandemic further intensified tensions between the US and China. Both nations disputed the virus's source and the extent of information sharing. Some US leaders referred to COVID-19 as the "Chinese Virus" or "Wuhan Virus," while a Chinese Foreign Ministry spokesman pushed forward a conspiracy theory that the US Army brought the virus to Wuhan (Reuters, 2020). These actions and statements further fueled the already tense relationship between the two countries.

Nevertheless, publications during and on the COVID-19 pandemic were prolific, with many scientific researchers and experts around the world collaborating to share findings and data. China and the US emerged as the two communities with the largest number of publications and collaborations on the topic. Almost 25% of all published works on COVID-19 during the pandemic period were collaborations between China and the US, making their collaboration the most prolific among all others.

Despite the significant amount of collaboration, many consider the sharing of COVID-19 data and study findings may have been hindered by political interference. For example, in the US, there was an order for hospitals to bypass the CDC and submit all COVID-19 data to the federal government (Segers, 2020). Additionally, there was the defunding of a major NIH-funded study on how the coronavirus moves from bats to humans (Aizenman, 2020). These highly political steps taken by both governments have raised concerns among international scientists about the future of international collaboration and data sharing.

The concerns about international collaboration and data sharing were more recently realized due to the significant scholarly drop in collaborations between China and the US after COVID-19. Some experts argue that political interference has caused irreparable harm to international collaboration, which is essential in addressing pandemics such as COVID-19. Given the trends discussed above, it would appear that scientific diplomacy was successfully deployed to combat COVID-19, but the political interference may have caused irreparable harm to international collaboration in the long run.

6.5 Rise of Anti-Chinese Sentiment in US Legislation

This study has two main objectives. Firstly, it seeks to identify a strong relationship between political rhetoric and scholarly collaboration. Secondly, it aims to establish a causal link between the two variables, rather than just a correlation. To achieve this, the study looks for concrete evidence of a direct relationship between political rhetoric and scientific collaboration, while controlling for any confounding variables. As legislation and diplomacy are closely intertwined, the study explores how political rhetoric may have influenced laws and policies that restrict scientific collaboration with China.

Recent trends in US legislative activity indicate a growing concern over Chinese innovation, as evidenced by bills introduced and passed into law. For example, the "Foreign Investment Risk Review Modernization Act" (FIRRMA) was enacted in 2018 to enhance the review process for foreign investments in critical US technologies. This law extended the authority of the "Committee on Foreign Investment in the United States" (CFIUS) to scrutinize and block foreign investments that may pose a threat to national security. The "Export Control Reform Act" (ECRA) of 2018 further strengthened the US export control regime by including emerging and foundational technologies in the "Commerce Control List" (CCL), while granting the "Department of Commerce" greater power to impose export controls on these technologies and impose stiffer penalties for violations. The "National Defense Authorization Act" (NDAA) for Fiscal Year 2019 also included provisions prohibiting federal agencies from procuring products or services from Chinese telecommunications companies like Huawei and ZTE, citing national security concerns. Additionally, in 2019, the US government placed Huawei and other Chinese firms on an entity list, limiting their access to US technology and products due to concerns about their possible ties to the Chinese government and alleged involvement in intellectual property theft.

The bills and legislation passed by the US government primarily aimed to curb alleged Chinese espionage and intellectual property theft. Even scientists who were arrested or deported were accused of committing intellectual property theft. However, with the introduction of the “Endless Frontier Act”, the US made it clear that it was not only seeking to separate US and Chinese technological production, but also to target US and Chinese scientific production. The bill, which aimed to increase US investment in science and technology research, proposed allocating $100 billion over five years to fund research in emerging technologies like artificial intelligence, quantum computing, and biotechnology. The bill later evolved into the “United States Innovation and Competition Act of 2021” (USICA), which aimed to strengthen US innovation and competitiveness in the face of global competition, especially from China. It proposed allocating $250 billion over five years to fund research and development in key areas like artificial intelligence, quantum computing, semiconductors, biotechnology, and advanced manufacturing. The bill also aimed to establish a new Directorate for Technology and Innovation within the NSF to oversee these efforts, and included provisions to strengthen supply chain security, protect intellectual property, and restrict the transfer of sensitive technologies to countries like China.

After passing through the House and Senate, a conference was held to reconcile the differences between the proposed House and Senate bills, resulting in the bipartisan CHIPS and Science Act. Although the CHIPS act had its roots in the Trump administration, it was signed into law by President Biden on August 9, 2022, which further solidified barriers to collaboration between the US and China.

The US government's efforts to curtail Chinese espionage and intellectual property theft continue to this day, as evidenced by recent legislation such as the American Science First bill introduced by Congressman Rick W. Allen in January 2023. The proposed law aims to “close loopholes in federal research funding that could potentially be exploited by the CCP to finance their own research” (Fox, 2023). Specifically, it seeks to prevent the NSF from authorizing grant funds to any individual or entity that is affiliated or has a relationship with a Chinese military company (Fox, 2023).

These legislative restrictions and barriers to collaboration may lead to a further decline in Chinese-US scholarly collaborations. Despite the Biden administration's willingness to collaborate, the introduction of bills by the House and Senate that aim to prevent or hinder scientific collaboration suggests that the relationship is likely to continue to deteriorate.

The Trump administration's political rhetoric aimed at curtailing Chinese-US collaboration, particularly in relation to intellectual property theft, translated into legislative and agreement-based efforts. This highlights a direct correlation between political rhetoric and legislative actions. The resulting agreements placed restrictions and barriers on funding with China, targeted Chinese scholars in the US, and denied Chinese visas. These actions imply that political rhetoric not only significantly correlates with scholarly collaboration but is also the direct cause of legislation designed to prevent such collaborations. The timeline of these legislative efforts, proposed and enacted from 2018 to 2023, coincides with a record low in US-Chinese collaborations.

6.6 Chapter Conclusion

This chapter explores the impact of political discourse and laws on funding and scientific collaboration between China and the US. Chinese science is entirely dependent on government funding, while the US relies on both government funding and corporate support. However, collaborations between the two nations are largely driven by government funding. The Trump administration's rhetoric led to a decline in scholarly collaboration, and recent legislation aimed to compete with China in the fields of science and technology. Despite the potential for science diplomacy to mitigate tensions such as during COVID-19, sentiment analysis suggests a hardening of tone towards China by both democrats and republicans.

CHAPTER SEVEN

CONCLUSION

7.1 Concluding Remarks

The aim of this work is to contribute to the growing body of literature on Science Diplomacy (SD) within foreign relations and International Relations (IR). Given the multifaceted interplay between science, diplomacy, and foreign policy, this study focuses on the relationship between political rhetoric and scientific collaboration. Specifically, it examines *how high-level political rhetoric has affected scholarly collaborations between the US and China from 2008 to 2022*. By doing so, this work is potentially positioned as a data-driven starting point for further explorations of different facets of SD.

The work was carried out across six chapters that endeavored to frame SD and examine the current state of scientific collaboration between China and US. Chapter II discussed the patchwork framing of SD by mainstream IR theories, including liberal-institutionalism, realism, and Marxism. Despite its state-based paradigm, SD offers a soft power approach to diplomacy that can be leveraged for influence. By examining the agencies and offices responsible for using SD as a soft power, we can better analyze its potential within the realm of international relations without preconceived assumptions of the international system or the motives of states.

Agencies and offices of SD were the subject of examination across Chapters III and IV. In Chapter III, the US SD system was described as a decentralized network of government agencies, research institutions, scientific organizations, and individual scientists that collaborate to advance US interests abroad. This complexity has made it difficult to establish a comprehensive S&T policy, but efforts like the OSTC aim to coordinate agency activities. However, the success of SD in the US is heavily influenced by the political agenda of the administration in power, which creates challenges for building trust and sustaining partnerships. In contrast, Chapter IV explored the more centralized SD system of China, where the Chinese Communist Party's agenda takes precedence over all other agencies. Both the US and China recognize the importance of SD in advancing their national interests and global leadership, but their systems have evolved differently over time due to their respective political and economic contexts. The US has a longer history of SD, while China has developed more rapidly in recent years as a global economic and technological power.

To further examine the impact of political agenda on SD between the US and China, an analysis of the past three administrations within the chosen time frame was conducted in Chapter V. During the Obama administration, SD was a priority, and partnerships with China were established. However, the Trump administration shifted its focus to national security concerns and reduced emphasis on SD, at times leveraging SD as a reason for anti-Chinese rhetoric and policies. The Biden administration, in contrast, is attempting to strike a balance between cooperation and competition while addressing national security issues. China, on the other hand, has been investing heavily in initiatives like "Made in China 2025" to improve its domestic scientific capabilities. While China aims to collaborate with other nations on global challenges, it also seeks to expand its influence in science and technology through initiatives such as the Belt and Road Initiative. China has made significant progress in fields such as AI and biotechnology., and quantum computing, but it faces challenges like intellectual property theft.

Chapter VI focused on current trends in scientific funding and collaboration, as well as the political sentiment between the US and China. In China, academic collaborations are entirely government-funded, making Chinese science vulnerable to political influence. In contrast, in the US, while government funding dominates scientific research, some large corporations, such as Pfizer, are among the top funders, indicating the potential for decentralized funding for researchers in the absence of government funding that may come with conditions. However, collaborations between Chinese and US entities are entirely dominated by government funding, with no involvement of non-governmental entities.

Regarding the state of scholarly collaboration, the initial period of scientific collaboration between China and the US during the Obama administration was a successful example of science diplomacy, resulting in several fiscal and scientific obligations between the two nations. However, it deteriorated during the Trump administration, with funding for collaborators from both US and Chinese agencies decreasing. Chinese scientists were targeted, and new laws were introduced to make collaboration with China illegal. The political rhetoric became increasingly exclusionary against China, and bipartisan trends showed a harsher and tougher approach against China. Consequently, several legislations opposing Chinese sciences were introduced, and even under the Biden administration, we continue to see increasingly stringent legislation that builds on the Trump era's political rhetoric.

Despite the challenges in scholarly collaboration between the US and China, the COVID-19 pandemic demonstrated that the two scientific communities can still collaborate effectively and proactively to combat global crises. Science diplomacy was able to maintain its diplomacy for science aspect and resist political agendas, particularly during the pandemic, when Trump administration's denial of the science behind the pandemic's spread created significant challenges (Gavin & Gonsalves, 2020).

This study aimed to shed light on how high-level political rhetoric affects scholarly collaboration. It was found that negative political rhetoric sentiments have a significant impact on reducing scientific collaborations between countries. Moreover, the transformation of political rhetoric and anti-Chinese sentiment into legislation has created significant obstacles to scientific collaboration, with the intent to compete and restrict Chinese-US sciences. Given that funding for scholarly collaborations between China and the US is primarily sourced from the government, political agendas continue to have a significant influence on funding collaborations. While science diplomacy played a central role during the COVID-19 pandemic, this study highlights that during this period SD operated in accordance to the realist perspective in that SD was a tool for advancing national interest and not merely for the sake of scientific advancement or global cooperation. Therefore, SD continues to operate in accordance with the foreign policy and political rhetoric of those in power, allowing for the encroachment of politics on sciences.

7.2 Potential Future Works

The proposed answer to the thesis question provides a foundation for further investigation into other aspects of science diplomacy. By exploring relationships between global powers such as the US, EU, Russia, and China, there could be a deeper understanding of SD within international relations frameworks, particularly those based on institutionalism and realism. The study of internal science diplomacy within the EU would also provide valuable insight, as it represents a unique system of scientific communities collaborating with increased cross-mobility and ease. Additionally, a comparison of the effects of a shared European identity on scientific collaboration with those of the Arab world, the US, or even Chinese provinces could offer further knowledge. This study highlights that science diplomacy remains an underexplored field of human and state interaction that has significant potential to expand the global production and management of scientific knowledge.

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