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Science Diplomacy

Science and Technology Diplomacy in the Era of U.S.-China Technology Rivalry

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Abstract

What is the role that science and technology diplomacy can play amid the competition between the United States and China for technological hegemony? Can science and technology still serve as a bridge between countries and mitigate conflict? What does it mean to talk about cooperation on new technologies for climate change and pandemics in the midst of the ongoing and unrelenting science and technology competition in reality?

The current competition between the United States and China highlights the need to consider factors other than economic costs in technological innovation, such as security, health, and the environment. And because national security considerations are closely intertwined with technological innovation, science and technology diplomacy is now being approached from a security perspective. As regulations tighten on the free flow of R&D funds and personnel across borders, which has been the driving force behind global technological innovation, innovation is becoming more costly, and discussions are emerging about the possible bifurcation of the global innovation system. International cooperation in emerging technology areas such as climate change, pandemics, and artificial intelligence is also declining. In this article, the author recognizes that competition in science and technology is inevitable, but on the other hand, the call for cooperation in science and technology is as strong as ever, emphasizing the importance of science and technology diplomacy that balances cooperation and competition.

1. Introduction

Over the past decade, science and technology diplomacy has been actively discussed and practiced. In addition, there has been a growing recognition of the importance of science and technology diplomacy, where the rationality and universality inherent in science and technology act as a soft power and science and technology play a catalytic role in improving relations between countries. In fact, the collaboration between the US and Cuba's scientific institutes was an essential foundation for normalizing the countries' relations. Also, the collaborative research on Mount Paektu volcano between British scientists and North Korean researchers has remained a useful channel of cooperation between the West and North Korea.

In the current unstable international political environment, where the war in Ukraine and the US-China rivalry unfolds, competition and exclusion are more prominent than cooperation in the science and technology sector. For example, in protest against Russia's invasion of Ukraine, the EU and the European Space Agency have decided to suspend various science and technology research and education collaborations,

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including the ongoing lunar mission with Russia. Increased public scrutiny by the U.S. government has made it increasingly difficult for researchers at U.S. universities and laboratories to collaborate with their Chinese counterparts. In the case of South Korea, various channels of inter-Korean science and technology cooperation opened in the early 2000s, when inter-Korean relations were good, have been closed. In fact, at a time of increasing uncertainty in relations between countries, science and technology should play a role in reducing conflicts and stabilizing relations. Still, in reality, conflicts in the science and technology sector and competition are intensifying. Currently, humanity is facing unprecedented challenges of climate change and coronavirus. We do not understand precisely how the rapidly developing AI technology and the Fourth Industrial Revolution will change human life and civilization. We need to gather all of humanity's scientific knowledge and wisdom to identify and respond to the threats posed by climate change, pandemics, and new technologies. Still, in reality, competition is outpacing scientific cooperation.

What role can science and technology diplomacy play in the era of US-China technology rivalry? Can science and technology still serve as a bridge between countries and mitigate conflicts? Is it really meaningful to talk about cooperation on new technologies, climate change, and epidemics amid ongoing and relentless technological competition? This article first summarizes the rise and concept of science and technology diplomacy and examines the causes and effects of the intensifying science and technology conflicts, especially in the era of US-China technology rivalry. While competition in science and technology is inevitable, the demand for cooperation in science and technology is stronger than ever. This article will emphasize the importance of science and technology diplomacy in balancing cooperation and competition.

2. Emergence and Concept of Science and Technology Diplomacy

Traditionally, diplomacy is the act of negotiation conducted by the supreme ruler with other countries to maximize the state's interests on matters closely related to the state's survival, such as external aggression and territorial conflicts. However, with the expansion of state activities over the past few decades, diplomacy's scope, subjects, and targets have been transformed. The scope of diplomacy has expanded to include trade, investment, the environment, human rights, science, technology, and culture. Diplomacy practitioners have diversified from politicians and career diplomats to civil servants, entrepreneurs, and civic activists. Additionally, the targets of diplomacy have come to include not only the elites of the other country but also ordinary citizens.

Traditionally, science and technology diplomacy has been aimed primarily at spying on or acquiring advanced scientific knowledge from other countries. For example, the United Kingdom sent Charles Galton Darwin (grandson of Charles Darwin) to the United States between 1942 and 1946, before and during World War II, to establish the Central Scientific Office in Washington and to exchange scientific information and collaborate with American scientists (Royal Society 2010). Joseph Needham is also known to have stayed in China as a British Scientific Mission and wrote "Science and Civilization in China" based on the knowledge he gained during that time. Competing with other countries in science and technology and gathering information about their advanced technologies is still crucial in science and technology diplomacy. For example, the recent conflict between the United States and China over advanced technologies such as semiconductors, artificial intelligence, and quantum computers can be seen as diplomacy over science and technology.

Science and technology diplomacy has traditionally been recognized as a field of competition and espionage between nations. In the 21st century, however, science and technology diplomacy has literally expanded into new areas. As cross-border capital, human resources, and technology exchanges become more frequent, the need for cooperation in science and technology has increased beyond competition between countries. Moreover, there are growing calls for global cooperation to combat climate change, contain the spread of infectious diseases such as SARS, Ebola, and MERS, and address food and energy challenges. As the critical role of science and technology in addressing the challenges facing the

international community is recognized, opportunities for the convergence of science and diplomacy through international organizations are increasing. At the global level, many countries are working together to find solutions to the problems facing humanity, such as frequent extreme weather events and the spread of infectious diseases such as SARS, avian flu, Ebola, and MERS. More recently, as the values of universality and objectivity pursued by science and technology have been recognized as a kind of soft power, efforts are being made to use their scientific and technological capabilities as a basis for public diplomacy, to run various programs directly targeting the people of other countries, and to enhance the external status and image of countries.

The various forms of science and technology diplomacy can be categorized into the following three types (Royal Society 2010; Bae 2015). Type I science and technology diplomacy mainly refers to the intense competition and cooperation over science and technology between countries. This type consists of acquiring advanced technologies, exchanging human resources, and exchanging information while keeping an eye on and competing with other countries to strengthen their own science and technology capabilities. Currently, various joint research and exchange activities conducted by the government and its affiliated organizations, private companies, and universities fall under this category. Here, science and technology is understood from an economic perspective as a source of national economic growth.

Type II science and technology diplomacy refers to activities that take place at the global level, particularly within the framework of multilateral international organizations, to find solutions to problems in various areas such as the environment, energy, telecommunications, and health. A prime example is the Intergovernmental Panel on Climate Change (IPCC), which works to combat climate change. In this area, science and technology are recognized as the specialized knowledge needed to diagnose and solve immediate problems accurately.

Type III science and technology diplomacy is about utilizing science and technology as a breakthrough to resolve diplomatic impasse or expand diplomatic relations. The Obama administration in the

Table 1 **Science and Technology Diplomacy Types**

The Royal Society categorized science diplomacy into three types as follows, based on its 2010 document "New Frontiers in Science Diplomacy," which played a critical role in raising awareness of the importance of science and technology diplomacy and summarized the contents, objectives, nature of science and technology, and cases in each area.

	Diplomacy for Science (Type I Science and Technology Diplomacy)	Science in Diplomacy (Type II Science and Technology Diplomacy)	Science for Diplomacy (Type III Science and Technology Diplomacy)
Contents	International cooperation and competition in science and technology, international collaborative research (bilateral/multilateral, government/ business/university)	International organization activities in science and technology (science and technology specialized organizations, general international organizations, etc.)	Utilizing science and technology to solve diplomatic problems science and technology public diplomacy
Objectives	Economic growth through science and technology capability enhancement (acquisition of advanced technologies, training of science and technology personnel, information exchange, etc.	Providing expertise to solve problems in the environment, energy, health, etc. Participation in shaping the agenda of international organizations	Utilizing science and technology as a breakthrough in resolving diplomatic tensions, deadlocks, and difficulties Strengthening a country's position in the international community
Nature of Science and Technology	Source of national competitiveness and external standing	Expertise needed to diagnose and solve current problems	Non-ideological, rational, and universal, bridging relationships
Cases	Competition in advanced science and technology between countries Bilateral joint research, personnel exchange Multilateral international joint research	Global Warming and IPCC Activities IAEA nuclear facility inspections Activities in other deep-sea and space-related international organizations Scientific and technological advisory to OECD, UN, etc.	Science and technology cooperation with Western countries such as the U.S. and the U.K. and Islamic countries, and science and technology cooperation with South Korea and North Korea science and technology ODA

United States has invested heavily in science and technology personnel exchanges and joint research and development activities with Middle Eastern countries to improve relations and promote mutual understanding since the Cairo Declaration in 2009. In this type, science and technology are understood as representatives of reason and rationality, values that are universally pursued and exchanged beyond differences in regimes and ideologies.

Until now, various international cooperation activities centered on science and technology have been recognized as science and technology diplomacy. In particular, bilateral and multilateral international joint research activities have been understood as the centerpiece of science and technology diplomacy. In addition to science and technology competition and international cooperation, science and technology diplomacy includes various diplomatic activities that utilize science and technology as a basis for problem recognition and resolution or as soft power. Since science and technology diplomacy refers to a variety of diplomatic activities, including science and technology competition and international cooperation, it is appropriate to understand science and technology diplomacy as a higher concept than science and technology international cooperation.

3. U.S.–China Technology Rivalry and Science and Technology Diplomacy

The hegemonic rivalry between the United States and China is one of the most critical topics of global politics in the 21st century. In the recent prolonged trade conflict between the two countries, advanced technologies such as semiconductors, artificial intelligence, quantum computing and 5G telecommunications equipment have become the center of attention. China's challenge to the U.S. dominance in the high-tech sectors and the U.S. position to restrain it in various ways have been sharply contested in the form of tariffs, foreign investment regulations, trade restrictions, and intellectual property disputes.

The rivalry between great powers over science and technology is not new. During the rise of Japanese automakers and semiconductor companies in the global and U.S. markets in the 1980s, the United States accused Japanese semiconductor companies of stealing U.S. technology and selling militarily sensitive products to the Soviet Union. In 1982, IBM sued Hitachi for stealing its technology, and the U.S. government pressured Toshiba for selling technology to the Soviet Union. The U.S. attacked Japanese semiconductor companies using Section 301, dumping duties, and ex officio investigations. The U.S. struck the 1986 U.S.-Japan Semiconductor Agreement, which imposed 100% tariffs and increased the market share of U.S. companies in Japan.

Technological innovation was increasingly recognized as the basis for economic growth and military power in the modern international political order. Dominance in advanced science and technology was critical for global political and economic hegemony. Britain's success in the Industrial Revolution, coupled with a series of technological innovations such as the spinning wheel and steam-powered railroads, enabled it to build a global empire. The United States, which led the way in electricity, chemicals, and automobile technology, established itself as a global hegemon through the First and Second World Wars. While it is widely recognized that science and technology have played a pivotal role in the foundation of hegemony, technological competition and conflict between hegemonic powers have not previously received as much attention as military or economic conflict. Why, then, has science and technology become a particularly prominent focus of the recent U.S.-China rivalry?

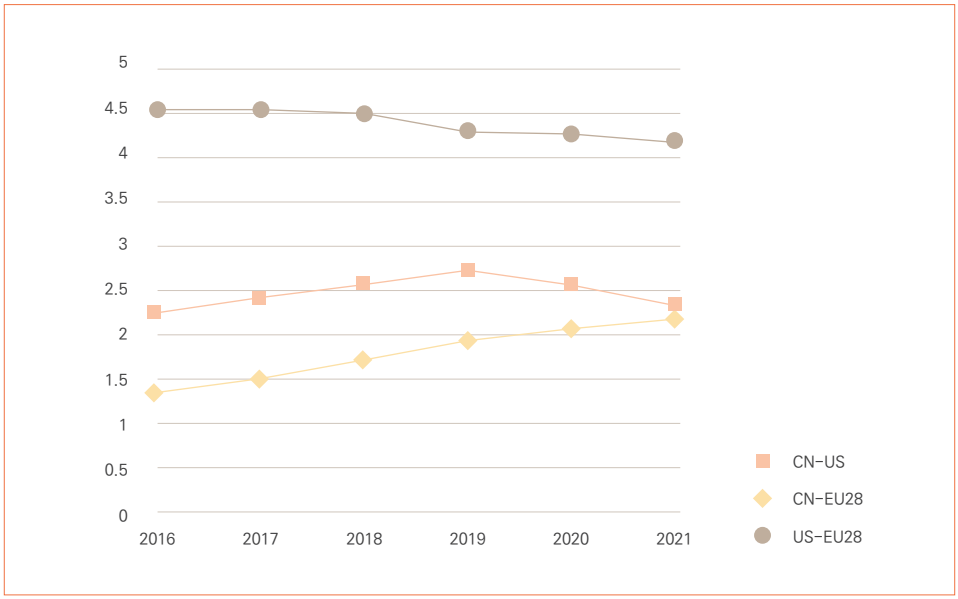
Recent studies on the dynamic relationship between science and technology and global political hegemony emphasize the need to understand technological innovation as an inherent variable in forming global political and economic order. In particular, the studies have centered on the concept of technological externality, which links technology to global politics (Kennedy et al. 2018). Since advanced technologies such as drones and robots have dual-use characteristics in most cases, cutting-edge technological innovations by hegemonic powers create a "security externality," causing hegemonic powers to take notice of them and curb technology transfer and technology acquisition through trade and investment regulations. It is also argued that if a hegemonic power violates the norms

and rules institutionalized by the existing hegemonic powers in the process of transferring or acquiring advanced technologies, such as the TRIPs intellectual property rights agreement or internet freedom, an 'order externality' is generated, leading to bilateral conflicts as the hegemonic power mobilizes coercive means to maintain the existing order. Unlike the hegemonic rivalry between Western countries in the past, the hegemonic rivalry between the United States and China, which have heterogeneous cultural backgrounds, is characterized by the military implications of advanced science and technology and the externalities of challenging the existing world order, which can be interpreted as making science and technology a key area of conflict.

In addition, the current U.S.-China technology competition is mainly focused on semiconductors, 5G, quantum computing, and artificial intelligence because these sectors are general-purpose technologies that serve as the cornerstone of a new economic paradigm called the so-called Fourth Industrial Revolution, and new industries and economic paradigms will emerge based on these technologies, playing an essential role in the future reorganization of the global political and The commercial peace theory of international politics predicts that conflicts between states are less likely to reach catastrophic states and result in war when there is economic interdependence, which has been the basis for optimism about U.S.-China relations. Recent examples of U.S.-China trade and technology conflicts suggest that interdependence within the global economy and the construction of global value chains, which have accelerated since the 1980s, maybe a variable rather than an unchanging constant. Recently, there have been signs that the United States and China are reducing their technological and economic interdependence, forming separate economic and technological blocs, each at significant cost and side effects and increasing uncertainty.

Under such uncertainties, at first, the securitization and cost of technological innovation is expected to increase. There is an increasing need to consider various factors such as security, health, and environment other than economic costs in technological innovation. Also, as national security considerations and technological innovation are closely linked, science and technology diplomacy is being approached from a security perspective. Tightening regulations on the free movement of R&D funds and R&D personnel across borders, which have been the backdrop for promoting global technological innovation, have increased the cost of innovation, and the possibility of bifurcating the global innovation system is also being discussed. In fact, as shown in Figure 1, the share of

Figure 1 US China EU joint publication trends



Source: Wagner et al (2022)

joint research and publications between the United States and China has been declining since 2019. Joint publications between the U.S. and the EU are also falling, and joint publications between the EU and China are growing at a slower rate.

Secondly, international cooperation in emerging technologies such as climate change, epidemics, and artificial intelligence is declining. A significant problem with the development of artificial intelligence and biotechnology in the context of the U.S.-China rivalry is that there is a growing risk that the direction of technological progress will be set in a way that helps to defeat the other side while recognizing and seeking responses to the civilizational challenges posed by these technologies takes a back seat. In addition, the space for cooperation in science and technology diplomacy to address common challenges facing humanity is shrinking and worrisome. Lack of cooperation between the U.S. and China in this area could have serious consequences, and the ultimate winner of the U.S.-China technology race is likely to be the technology that pushes humans out of the way, not the U.S. or China. International cooperation and norms are essential in identifying and adjusting to the problems caused by killer robots in charge of national security, AI robots in production, various types of human-machine hybridization in terms of civilizational challenges. U.S.-China cooperation is needed on these issues, which are as crucial as who becomes the global political hegemon.

4. Competition and Cooperation in Science and Technology Diplomacy

With the current weakening of the free trade order and the spread of populist moods in major industrialized countries, the uncertainty of the global political and economic order is increasing. As science and technology take center stage in diplomacy and science and technology diplomacy is approached from a security perspective, it is unrealistic to emphasize cooperation alone. First and foremost, countries should strive to stabilize high-tech supply chains and strengthen their own innovation capabilities for their own economic security, which can only be done through a combination of diplomatic and security considerations and technological innovation capabilities.

Governments are examining the backward and forward value chains of key strategic industries, selecting a list of critical components or materials that are highly dependent on foreign countries or have weak supply stability, and supporting R&D activities to localize them. With the current global supply chain that crosses borders, it is clear that a country cannot localize all key materials and components, and supply chain and science and technology cooperation should be coordinated with friendly countries. Countries should identify products and components that can be strategically utilized in their relations with other countries with which they have vital diplomatic ties and strive to become unique and reliable suppliers through continuous R&D investment and technological innovation. In the long run, when countries are closely interdependent, supplying each other's key components, it is challenging to use critical components or materials as a means of economic coercion, and it is easier to prepare countermeasures in an emergency.

Science and technology is currently perceived as a subject of competition between nations due to the ongoing U.S.-China rivalry for technological supremacy. In reality, however, the development of science and technology has been and will continue to be driven by cross-border exchanges and cooperation. For example, South Korea's remarkable technological development over the past half-century has been achieved within an open global innovation system, where R&D investments, people, and markets freely cross borders to acquire and incorporate advanced technologies. Not only Korea but also China, Japan, the United States, Europe, and many other developing countries have benefited from an open global innovation system. In recent years, the spread of a view of science and technology as a resource for interstate competition, as well as the U.S. restrictions on Chinese investment in science and technology and the influx of research personnel, have shaken the foundations of the open global innovation system. The damage caused by this is not limited to China but poses a significant challenge to the U.S. science and technology is a hard power, the foundation of military and economic power, and a soft power, representing universality and rationality. Diplomatic conflicts can

be mitigated and resolved through the continuous exchange of scientists and engineers, the core content of so-called science and technology public diplomacy. To sustain the flow of an open global innovation system, scientists in the field should activate various forms of public diplomacy, and cooperation should be strengthened along with science and technology competition between countries. The science and technology community should also plan and implement a bold science and technology public diplomacy program that can contribute to continuing science and technology development based on universality and rationality across borders in open science and technology international cooperation based on mutual understanding and trust.

In 1956, at the height of the Cold War, the United States, the Soviet Union, and the rest of the world were struggling with a surge in polio cases. Through a series of twists and turns, Sabin in the US was able to get his oral polio vaccine into the hands of Chumakov in the USSR, where it proved to be effective and contributed to the subsequent eradication of the disease. Despite the fact that Sabin had to try the vaccine in the Soviet Union rather than the United States, it was a very successful example of so-called vaccine diplomacy during the Cold War, where scientists from adversarial countries visited each other, with the tacit support of Eisenhower and Khrushchev, and under the watchful eye of the secret police of both countries. After the Soviet Union launched its first satellite, Sputnik, the U.S. became increasingly wary of Soviet science and technology and the U.S.-Soviet scientific and technological competition intensified. Behind the scenes, however, U.S.-Soviet scientific and technological cooperation continued in various forms, and it can be said that it contributed to a certain extent to preventing the two countries from reaching the extremes of conflict and confrontation.

While the U.S.-China relationship is currently characterized by conflict, there are still areas where cooperation continues to flourish amidst significant interdependent economic ties. In times of great power competition, a degree of decoupling are inevitable in high-tech and security-critical areas. Still, it is crucial for both countries to maintain communication channels to ensure that this does not diminish cooperation. In areas such as climate change and infectious diseases, bilateral science and technology cooperation can not only contribute to problem-solving but can also serve as a safety valve to prevent the relationship from developing into an extreme confrontation and serve as an ongoing communication channel. The coexistence of competition and cooperation in the overall U.S.-China relationship has been expressed in various concepts such as "Managed Competition," "Cooperative Rivalry," and "Frenemies" (Nye 2022). In the field of science and technology diplomacy, the cooperative aspect should be expanded to develop into a balanced science and technology diplomacy between competition and cooperation.

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