Thesis Project Portfolio

HEDGE

Hypersonic ReEntry Deployable Glider Experiment

(Technical Report)

Impacts on U.S.-China Global Relations Due to the Wolf Amendment

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Hong Ji Liu

Spring, 2023

Department of Mechanical and Aerospace Engineering

ADVISORS

MC Forelle, Department of Engineering and Society

Chris Goyne, Department of Mechanical and Aerospace Engineering

Introduction

Back in December 2020, a Chinese space program, known as the Chang'e 5, completed a 23-day mission that resulted in the return of approximately 2 kilograms of lunar rocks. These lunar samples were very valuable for research purposes about lunar resources and have potential as usage for sustainable sources (Handel-Mazzetti, 2021). During a news conference after the landing of the probe, Chinese officials announced that they would share the samples with international partners, including the United Nations. However, the sharing of these lunar samples would be barred with the United States government (U.S.) due to the existence of the Wolf amendment. Wu Yanhua, vice administrator of the China National Space Administration (CNSA), proceeded to call the Wolf amendment adopted by Congress "unfortunate" and indicated that direct cooperation with NASA was not likely (Berger, 2020).

In 2011, U.S. Republican Senator Frank Wolf proposed the Wolf amendment, which functionally banned space cooperation between the U.S. and China. The Wolf amendment bans scientific cooperation with China by NASA and any civilian space entity that requires government funding without approval from the FBI and the U.S. Congress (Whitford, 2019). This bill was passed with the intention of preventing accidental technology transfers with China. Potential theft of technological advancements is seen as a national security threat due to the "dual-use" nature of space technologies for both military and civilian purposes (Whitford, 2019). One example of these "dual-use" space technologies are hypersonic systems. Hypersonic flight occurs at speeds exceeding five times the speed of sound and is an expanding research field in the aerospace industry with military and civil applications (Urzay, 2020). Military applications include hypersonic missiles, both offensive and defensive, and highspeed aircraft. Hypersonic missiles can be split into two categories: hypersonic glide vehicles, which launch from a rocket

and glide from there, or hypersonic cruise missiles, which activate a scramjet after reaching supersonic speeds (Crouse, 2022). Civil applications include access to commercial air travel and space. As one of the most noticeable recent developments, hypersonic systems research in China has made significant breakthroughs that have surpassed the technology of the U.S., putting pressure on the U.S. to put more focus into hypersonic research. It is imperative that we pay attention to hypersonic research advancements of competitive countries because these advancements will impact political relations between the countries and fuel research into major areas of focus such as hypersonic research.

One specific sector that these countries are interested in is the space technology and exploration power held by both countries. Both countries have been working on massive space projects that will expand their possibilities in outer space and show the prowess of their space technology. The U.S. will soon be launching the Artemis I space mission, which is the first in a series of increasingly complex space missions that will enable human exploration to the Moon and Mars. The Artemis II mission is the first scheduled crewed mission of the Orion spacecraft, which will be the first crewed spacecraft to travel beyond low Earth orbit since the Apollo 17 mission in 1972 (Foust, 2021). Finally, the Artemis III mission will land a crew at the Moon's south polar region and is planned to have two astronauts on the surface of the Moon for about one week (Chang, 2019). With the Artemis missions, NASA will land the first woman and the first person of color on the Moon, using innovative technologies to explore the lunar surface like never before (NASA: Artemis, n.d.). NASA is going back to the Moon for scientific benefits, economic benefits, and desire to maintain American leadership in space exploration and establish the first long-term presence on the Moon. Research conducted in outer space promotes scientific inquiry and can result in beneficial spinoff technologies such as advancements in medicine,

technology, and improvements in automobile safety testing. Space research also has strong implications for the U.S. economy, with a study from NASA reporting that their Moon to Mars exploration missions have supported over 93,700 jobs nationwide and generated more than $20.1 billion in total economic output (Dodson, 2022).

Meanwhile, China has been constructing the Tiangong space station, which means the 'Heavenly Palace' in Mandarin and is a permanent Chinese space station that will widen China's prospects in outer space (Reuters, 2021). The Tiangong is made of three key modules that will combine to form the main structure of the space station. The first module, Tianhe or 'Harmony of the Heavens', was sent into orbit in April 2021 and contained the living quarters for crew members. The second module, Wentian or 'Quest for the Heavens', was launched in July 2022 and is utilized to carry out biological and life science research (Song & Tauschinski, 2022). The third module, Mengtian or 'Dreaming of the Heavens', was launched at the end of 2022 and it provides a pressurized environment for researchers to conduct science experiments in zero gravity. With these three modules combined, the space station will have its own power, propulsion, life support systems, and living quarters to sustain both crew members and research experiments. The station is also designed to provide refueling power to China's new space telescope, called Xuntian, when it flies close to the space 3 station in 2023 (Song & Tauschinski, 2022). The advantages of having a permanent space station include giving China its own platform for conducting research in outer space and strengthening China's "independent innovative capacity" (China Power Team, 2021). By most metrics, which include space mission accomplishments, the U.S. is still the global leader in space exploration, but this could change in coming years due to China rapidly accelerating its space agenda.

Despite promising independent space initiatives in each country bolstering the possibility for scientific knowledge and development to prosper from cooperation between the U.S. and China in outer space endeavors, the Wolf amendment continues to be an obstacle and mirrors the complex and strained political relationship that exists between the two countries. To assert this argument, first, I provide a literature review that looks at how cooperation has been possible between these two countries on other issues such as the trade war. The literature review also covers how the Wolf amendment came into existence and the initial effects of the Wolf amendment on the bilateral cooperation between the U.S. and China. Then, I will analyze opinions and reports from officials and journalists in the space sector on the bilateral cooperation between the two countries. I will use the social construction of technology (SCOT) theory to analyze how these relevant groups perceive the effects of the Wolf amendment. In my analysis, I provide explanations for why the Wolf amendment has persisted in law despite efforts by some groups to have it repealed. Finally, I will end with a discussion of how cooperation with China in space can relieve tensions between these two world superpowers and assist in humanity's future in outer space.

Literature Review

The U.S. and China have one of the world's most complex and important bilateral relationships. Since 1949, the countries have experienced periods of both tension and cooperation over issues including climate change, Taiwan, and trade (CFR.org Editors, 2017). Looking more closely at recent years, the U.S. and China have had political tensions that have been exacerbated by major events such as the trade war. The U.S.-China trade war began in July 2018, when the U.S. imposed a 25 per cent tariff on $34 billion USD of imports from China, including cars, hard disks, and aircraft parts (SCMP Reporters, 2020). China quickly retaliated

with tariffs of their own, impacting agricultural products like soybeans, automobiles, and aquatic products. Both sides continued to impose more and more tariffs, similar to a game of tug of war, until a phase one trade deal was signed in January 2020. As part of the trade deal, China agreed to buy an additional $200 billion USD of U.S. products over the next two years and resulted in the suspension of more planned tariffs on Chinese products (SCMP Reporters, 2020). As of 2022, these countries are currently the world's largest and second largest economies and have mutual political, economic, and security interests such as the non-proliferation of nuclear weapons (Silver, 2022). The resolution of the trade war demonstrates that these two major superpowers have and can cooperate in other sectors so why not space?

The U.S. typically partners with other countries on major projects in outer space because it provides an opportunity for scientists all over the world to conduct research regardless of their own country's space infrastructure (Beginnings, n.d.). In fact, the International Space Station includes contributions from 15 different nations. The major partners of the space station are NASA (U.S.), Roscosmos (Russia), and the European Space Agency (ESA). These three partners contribute most of the funding for the space station and other partners include the Japanese Aerospace Exploration Agency (JAXA) and the Canadian Space Agency (CSA) (Howell, 2022). However, the U.S. cannot partner with China the same way as it can the other countries due to the Wolf amendment.

The Wolf amendment has deterred outer space cooperation between the U.S. and China. The original intent of the Wolf amendment was to change Chinese attitude towards human rights and slow down their development in the space sector. Wolf had visited China on multiple occasions and felt that the government is oppressive towards its people. He also did not want China to become a rivaling power in space as that would mean competition for the U.S. Wolf

mentions that “in less than 10 years the Chinese have gone from launching their first manned spacecraft to unveiling plans for an advanced space station designed to rival the international space station” (Wolf, 2011). It is worth noting that the Wolf Amendment does not explicitly state that any cooperation between NASA and its Chinese counterpart is banned, but rather that NASA is banned from using government funds to cooperate with China in the absence of direct Congressional approval. This inevitably will lead to the creation of two spheres of influence in the development of space-based infrastructure.

For my research, I used Pinch and Bijker’s social construction of technology (SCOT) theory. The key argument of SCOT is that the study of science and technology should be viewed through the lens of social constructivism (Pinch & Bijker, 1984). SCOT is broken down into mainly two stages with the first stage being interpretative flexibility and the second being closure. In interpretative flexibility, we look at the relevant social groups and how their interpretations of the technology led to its eventual success. Relevant social groups are groups that organize around a shared meaning of a technology. This essentially means that technology and society are co-constructed and that social groups have an influence on how technologies are designed, used, and redeveloped. The second stage of SCOT is closure, which can be achieved in two different forms. One is rhetorical closure, defined as when social groups “see” the problem as being solved and do not require the need for alternative designs or solutions (Pinch & Bijker, 1984). The other is redefinition of the problem, which is when the technology solves another problem that is more pressing, so the previous concerns are overridden. SCOT holds the notion that those who seek to understand the reasons for acceptance or rejection of a technology should look to the social world. According to SCOT, it is not enough to explain why a certain technology succeeded by defining it as “the best” and that we must analyze how the criteria of

being “the best” is defined and what groups and stakeholders participate in defining it (Pinch & Bijker, 1984). The SCOT framework was used in my research by setting NASA, its Chinese counterparts, and the governments of the U.S. and China as the relevant social groups. The framework will analyze how these social groups view the political effects of the Wolf amendment and how these social groups will achieve closure either by cooperating in space exploration and coming to a political understanding or by attempting to cooperate and then failing because it was against both countries’ interests.

Methods

To analyze my research question, I utilized discourse analysis and policy analysis. Discourse analysis is the close reading of texts produced by agents to understand how it functions in a social context (Ho & Limpaecher, 2021). I gathered secondary sources, mainly research articles that focus on the interaction between the U.S. and China in the space sector. These sources included government statements, news reports, scientific journals, and other relevant sources that contributed to the topic. The information collected was divided into two sections, one that supports cooperation between the U.S. and China and one that is against such cooperation. In my review of this literature, I explored these sources to understand the possible benefits of cooperation between the U.S. and China in outer space. Policy analysis is tracing the development, passage, and implementation of a specific policy or set of policies. To support the policy analysis, I focused on research that has been published since the onset of the Wolf amendment in journals for political relationships and the outer space field. The research was split into sections, those that support the Wolf amendment and those that critique the Wolf amendment. In my review of this literature, I examined these articles to see how the Wolf amendment changed the way these two countries interacted, with a focus on the relevant social

groups impacted by the passing of the Wolf amendment. By using these methods, the picture for whether these two countries should cooperate will become clearer and easier to understand.

Analysis

The following analysis considers the primary stakeholder groups: NASA, Chinese space agencies, the governments of the U.S. and China and their officials. Using the SCOT framework, the analysis draws on the background and literature review to explore the various interactions of these stakeholders with each other and their consequential impact on cooperation between the U.S. and China. It further applies the principle of interpretative flexibility when looking at how each of these stakeholders view the Wolf amendment. The various ways that these stakeholders view the impact of the Wolf amendment provides a more complete perspective of the challenges that hinder advancement in outer space.

The Wolf amendment has remained in policy for so long because the U.S. does not want to help China develop its capabilities in outer space. The Chinese space program has accomplished everything that they said they would. China stated that they would put up a space station, bring back lunar samples, and land on Mars, all of which they have completed in a short period of time. For these reasons, Bill Nelson, a former senator of Florida and now NASA's 14th administrator, believes that we are already in a space race with China for the position of outer space leadership (David, 2021). Frank Wolf, the originator of the Wolf amendment, is worried about the U.S. losing its spot as the dominant country in space due to the Chinese space program quickly advancing its agenda. If the American space program were to be surpassed by the Chinese space program, potential business partners would flock to China instead of the U.S. for advancing scientific research or building a commercial space industry. Wolf is troubled by the potential aggressiveness that a commercial Chinese space industry could exhibit towards the

American space industry. A study conducted by independent consultant Rob Ronci found that the influence of the Wolf amendment has caused the U.S.-China relationship to remain mainly competitive in space exploration activities (Ronci, 2019). This competitiveness has caused China to accelerate its space program and find other commercial partners in space, knowing that the U.S. will not cooperate with them.

Despite the Wolf amendment meaning to slow Chinese efforts in space, it has instead been often seen to be detrimental to NASA and the U.S. The U.S. Space Shuttle program ended in the same year that the Wolf amendment was passed. After the Space Shuttle was retired from service, the only remaining option for astronauts to reach the International Space Station (ISS) were the Russian Soyuz vehicles (Ronci, 2018). This means that the Russian government had leverage over the U.S. if any tense political situations were to occur until an alternative was found. These fears came to life when Russia annexed Crimea in 2014, straining the political relationship between the U.S. and Russia. Dmitry Rogozin, the deputy prime minister of Russia at the time, made a comment about how NASA should send its astronauts to the ISS "using a trampoline" after reviewing sanctions against the Russian space industry (Kramer, 2014). After this, the U.S. turned to China as a possible alternative human launch supplier since they had proven that they could send humans to space during the Shenzhou 5, a human spaceflight mission in 2003. However, the Wolf amendment eliminated this possibility of cooperating with China as a substitute source of transport. Another concern is that the ISS is set to retire within the next 10 years, meaning that something else will have to replace its role. The first option would be the Tiangong, China's own space station, and China has already begun agreements throughout the United Nations (UN) to make this station an international project. The ESA and Russian space programs have expressed significant interest in joining the project, with European

astronauts learning Mandarin and conducting sea survival training with Chinese astronauts off the coast of China (ESA, 2017). With all these partners that China has secured, it seems that they do not need the U.S. to help develop their space program. Todd Harrison, the director of the Aerospace Security Project at the Center for Strategic and International Studies, said that "our policy of excluding China from human spaceflight and exploration missions to the Moon and beyond has not slowed its rise as a space power" (Foust, 2019). Instead of slowing China down, the Wolf amendment has created an incentive for China to build an alternative partnership for space exploration that could threaten American leadership in the space sector.

Another reason for why the Wolf amendment has remained in policy is to prevent the Chinese government from stealing from the U.S., whether it is intellectual information or military technology. There are also U.S. concerns about how China has clear intentions on the militarization of space through Nelson's statement that the Chinese civilian space program is the same as their military space program (David, 2021). In 2019, the situation was further inflamed when the U.S. established the Space Force as a new military branch, with the stated goal of "protecting the U.S. and allied interests in space and to provide space capabilities to the joint force" (Hawn, 2021). With the formal establishment of the Space Force, it indicates a major shift in the U.S. mindset of space as a civilian-led exploration to a mindset of gradual militarization. China has shown multiple times that they are capable of weaponizing space such as in 2007, when they launched a missile from earth to destroy a Chinese satellite, or in 2021, when they tested a nuclear-capable hypersonic missile (Hung, 2022). These incidents challenged the American military supremacy in space technology, especially when considering possible consequences such as the proliferation of these weapons to hostile countries like Iran and North Korea. Advancements in space technologies and exploration could cause major countries that are

involved in outer space to compete for national pride and gain the upper hand over the other countries. Political relations can be strained when facing strenuous circumstances such as defense weapons advancement or sending the first human to Mars due to the implications of technological advancement correlating with national strength, so to speak.

The Wolf amendment itself does not explicitly mention the type of projects that are particularly prohibited between the two countries, but it became clear that the intent for the amendment was to prevent cooperation on human spaceflight. When Congressman Wolf found out that the ISS partner agency administrators held a meeting to discuss the potential of incorporating China into the ISS project, he responded with a letter that stated, "I believe that any effort to involve the Chinese in the program would be misguided, and not in the national interest" (Ronci, 2018). Wolf's comments are mainly rooted in concerns that there would be technological leaks to China that would advance their military technology if they were to join the ISS. Although concerns about China stealing vital space technologies are valid due to their past record of stealing technology in other sectors, China has access to the newest technology through their active space cooperation with U.S. space partners like the European Space Agency (Whitford, 2019). Charles Bolden, a former NASA administrator, stated that the U.S. already had safeguards in place to prevent China from getting its technology such as limiting the access of students from China and working with intelligence communities (Bolden, 2021). This means that the amendment does not effectively do its job of preventing technology transfers with China and instead encourages distrust with no real benefit to the U.S. Bolden also stated that NASA "encouraged the international partners to work with China because they weren't restricted" (Bolden, 2021). NASA's stance is clearly not to slow down the development of China's space program as they would push for other countries to cooperate with the rising Chinese space

power. The Wolf amendment only drags the U.S. behind in the space sector, as the dominant force in space cannot even freely work with China's developing space industry. Harrison believes that the U.S. should actively engage with China in civil space programs when the goals are shared and try to improve its deterrence stance in national space security (Foust, 2019).

The Wolf amendment supports the U.S.'s interest in punishing China for its human rights violations. One of the motivations driving Congressman Wolf to pass the amendment was his intention of trying to isolate the Chinese government into more closely abiding with the U.S.'s norms in human rights. His grievances were largely based on reports of wide-ranging espionage and data theft by the Chinese government. Wolf's department had undergone a cyber-attack in 2006, when his personal staff's computers were hacked, and he reported to Congress that the Chinese government had accessed his case files on Chinese political dissidents (Ronci, 2018). Additionally, Wolf also sustained a perception that the Chinese government was oppressive to its people and a malevolent force internationally. Bolden stated that "Congressman Wolf and his bipartisan group were passionate civil liberties advocates and human rights advocates" (Bolden, 2021). This leads to an understanding of why Congressman Wolf backed the amendment so strongly. However, the Wolf amendment has not changed China's attitude towards human rights and the Chinese government is still committing human rights violations to this day such as religious freedom abuses, the Xinjiang internment camps, and the assault on Hong Kong's autonomy (China's Disregard, n.d.).

Conclusion

Twelve years have passed since the Wolf amendment has taken control of the political relationship between the U.S. and China in outer space. China's space program has taken off, their military technology is getting better with each coming day, and there are still issues of

human rights that China refuses to acknowledge despite the Wolf amendment intending to be a deterrent to their oppressive ways. The Wolf amendment has not accomplished any of the goals that it set out to but instead it mainly undermines international cooperation and advancement by sowing distrust and creating barriers between the major superpowers, creating the reverse effect of hindering U.S. space initiatives (Handel-Mazzetti, 2021). This leads to an increased potential for misunderstandings between the U.S. and China, along with tensions given the reduced levels of continued communication and cooperation on space related issues. Cooperation with China would assist in alleviating tensions through diplomacy and transparency, establishing a better and more peaceful development of humanity's vision in outer space.

Policy makers and public officials that are invested in this topic might read this thesis and gain new insight on why the Wolf amendment is detrimental to reaching a bilateral cooperation between the U.S. and China. This can change the way they view the amendment and hopefully motivate them to take actions that will eventually lead to repealing the Wolf amendment. Future researchers could build off this project by looking into the implications of repealing the Wolf amendment and how they could sustain cooperation between the U.S. and China in the aftermath that follows. Other solutions such new policies, a tighter security around sensitive information, or diplomatic space programs are alternatives that could better approach the problems that the Wolf amendment originally intended to solve. One major space project that future research should investigate is NASA's newest lunar Gateway that will serve as a stage point for sustained lunar surface exploration and destinations beyond (Habitation, n.d.). This Gateway will be part of the Artemis program and the U.S. should consider the possibility of including China in the Artemis Accords, which is a non-binding multilateral arrangement between the U.S. government and other world governments participating in the Artemis program.

All in all, cooperation between the U.S. and China could speed up humanity's progress in space exploration and could eventually lead to ways that we can efficiently obtain lunar resources or be able to send the first human to Mars. These are just some of the many things that could become possible once these two major superpowers on Earth are able to cooperate in outer space.

References

Beginnings of the International Space Station · A Space for Diplomacy: The Clinton Administration's Relationship with NASA · Clinton Digital Library. (n.d.). Retrieved from https://clinton.presidentiallibraries.us/exhibits/show/space4diplomacy/space4diplomacy-space-station

Berger, E. (2020, December 17). China collects Moon samples, may not share with NASA due to Wolf Amendment. *Ars Technica*. https://arstechnica.com/science/2020/12/china-completes-lunar-sampling-mission-eyes-n ext-steps-on-the-moon/

Bolden, C. (2021, December 9). *10 Years of the Wolf Amendment: Assessing Effects and Outcomes* [Webinar]. Secure World Foundation. https://swfound.org/media/207289/10-years-of-the-wolf-amendment_-assessing-effects-and-outcomes_transcript-1.pdf

CFR.org Editors. (2017, April 27). *U.S.-China Relations*. Council on Foreign Relations. https://www.cfr.org/timeline/us-china-relations

Chang, K. (2019, May 13). For Artemis Mission to Moon, NASA Seeks to Add Billions to Budget. *The New York Times*. https://www.nytimes.com/2019/05/13/science/trump-nasamoon-mars.html

China Power Team. (2021, April 21). *What's Driving China's Race to Build a Space Station?*. China Power. https://chinapower.csis.org/chinese-space-station/

China's Disregard for Human Rights. (n.d.) U.S. Department of State. Retrieved from https://2017-2021.state.gov/chinas-disregard-for-human-rights/index.html

Crouse, M. (2022, May 31). U.S. miliary moving forward on hypersonics. *Military+Aerospace Electronics*. https://www.militaryaerospace.com/sensors/article/14277297/us-militarymoving-forward-on-hypersonics

David, L. (2021, August 2). Can the U.S. and China Cooperate in Space? *Scientific American*. https://www.scientificamerican.com/article/can-the-u-s-and-china-cooperate-in-space/

Dodson, G. (2022, October 27). *NASA's Economic Benefit Reaches All 50 States*. NASA. https://www.nasa.gov/press-release/nasa-s-economic-benefit-reaches-all-50-states

ESA and Chinese astronauts train together. (2017, August 24). Retrieved from https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Astronauts/ESA_and_Chinese_astronauts_train_together

Foust, J. (2019, June 3). Defanging the Wolf Amendment. *The Space Review*. https://www.thespacereview.com/article/3725/1

Foust, J. (2021, November 9). NASA delays human lunar landing to at least 2025. *SpaceNews*. https://spacenews.com/nasa-delays-human-lunar-landing-to-at-least-2025/

Habitation and Logistics Outpost (HALO). (n.d.). Northop Grumman. Retrieved from https://www.northropgrumman.com/wp-content/uploads/DS-72-HALO.pdf

Handel-Mazzetti, L. (2021, October 21). *Two Alpha's Howling at the Moon: the history, meaning and implications of the 2011 Wolf Amendment on US-Sino space cooperation*. JASON Institute for Peace and Security Studies. https://jasoninstitute.com/two-alphas-howling-at-the-moon-the-history-meaning-and-implications-of-the-2011-wolf-amendment-on-us-sino-space-cooperation/

Hawn, J. (2021, June 21). Can the US start cooperating with China — in space? *Responsible Statecraft*. https://responsiblestatecraft.org/2021/06/21/the-us-needs-to-start-cooperating-with-china-in-space/

Ho, L., & Limpaecher, A. (2021, July 9). *What is Discourse Analysis?*. Delve. https://delvetool.com/blog/discourseanalysis

Howell, E. (2022, August 24). International Space Station: Facts about the orbital laboratory. *Space.com*. https://www.space.com/16748-international-space-station.html

Hung, A. (2022). Did exclusion ignite China's drive to compete in space station technology? An analysis of the techno-legal implications of the Wolf amendment (2011). https://illinoisjltp.com/journal/wp-content/uploads/2022/04/Hung-FinalS2022.pdf

Kramer, M. (2014, May 1). Russia's Deputy Prime Minister on Twitter: US Can Use Trampolines to Reach Space. *Space.com*. https://www.space.com/25718-russian-official-us-trampolines-space.html

NASA: Artemis. (n.d.). NASA. Retrieved from https://www.nasa.gov/specials/artemis/

Pinch, T. J., & Bijker, W. E. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit 12 each other. *Social Studies of Science, 14*(3), 399–441. https://doi.org/10.1177/030631284014003004

Reuters. (2021, June 17). Major milestones in Chinese space exploration. *Reuters*. https://www.reuters.com/world/china/major-milestones-chinese-space-explor ation-2021-06-17/

Ronci, R. (2018). Dividing heaven – investigating the influence of the U.S. ban on cooperation with China on the development of global outer space governance. https://nmbu.brage.unit.no/nmbu-xmlui/bitstream/handle/11250/2567759/RRonci%202018.pdf?sequence=1&isAllowed=y

Ronci, R. (2019). Dividing heaven - effects of the Wolf amendment on the developing system of global space governance. https://swfound.org/media/206870/ronci_1_iac2019_paper.pdf

SCMP Reporters. (2020, April 13). What is the US-China trade war? *South China Morning Post*.

https://www.scmp.com/economy/china-economy/article/3078745/what-us-china-trade-war-how-it-started-and-what-inside-phase

Silver, C. (2022, September 1). *Countries by GDP: The Top 25 Economies in the World*. Investopedia. https://www.investopedia.com/insights/worlds-top-economies/

Song, W., & Tauschinski, J. (2022, July 26). China space station What is the Tiangong?. *BBC*. https://www.bbc.com/news/world-asia-china-61511546

Urzay, J. (2020, July). *The Physical Characteristics of Hypersonic Flows*. Stanford University. https://web.stanford.edu/~jurzay/hypersonicsCh2_Urzay.pdf

Whitford, G. (2019, October 27). *Trouble in the Stars: The Importance of US-China Bilateral Cooperation in Space*. Harvard International Review. https://hir.harvard.edu/trouble-in-the-stars-the-importance-of-us-china-bilateral-cooperati on-in-space/

Wolf, F. (2011, June 2). Why the U.S. Shouldn't Help China in Space. *SpaceNews*. https://spacenews.com/why-us-shouldnt-help-china-space/