THE EFFECT OF MILITARY INCENTIVES ON CIVIL SPACE DEVELOPMENT

by

JACKSON TILLEY

(Under the Direction of Justin Conrad)

ABSTRACT

Civilian space programs continue to proliferate across the globe at an astonishing rate. This dissertation utilizes a mixed-method approach to analyze states' rationales behind pursuing civil space. Three distinct manuscripts explore how and why states may take advantage of such agencies to benefit their own military apparatus, primarily through the research and development of dual-use technologies. By producing these technologies under civil space, states can politically frame such activities as peaceful and scientific, avoiding audience costs both domestically and internationally. Each manuscript employs a unique research design that includes a large-N analysis, survey experiment, or qualitative case study. Findings reveal that civil space expenditure is significantly correlated with aspects of military power, such as air and ballistic missile forces, in addition to participation in recent militarized conflicts. Domestically, audiences appear far more trusting of civilian over military leaders in outer space. Finally, a case study of the Chinese National Space Administration compounds these results and uncovers specific statements by the government, increasingly framing their actions as harmless and providing benefits for all of humanity. This research spearheads a new approach in the burgeoning literature on the politics of outer space while contributing to existing work on dual-use technologies and the security dilemma.

INDEX WORDS: Politics of Outer Space, Civil Space, Dual-Use Technologies, Political Framing, Large-N Analysis, Survey Experiment, Case Study

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DEDICATION

To my loving family and fiancé

Ad astra per aspera

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.0 Setting the Scene

For decades, the exploration of outer space has captivated numerous generations, and today, the pace of exploration is only increasing. The space race between the United States and the Soviet Union laid the foundation of what states could hope to achieve in space. Since the culmination of that competition, dozens of states have pursued space exploration efforts in various forms. While the pioneers of space activities arose primarily from military entities, many nations now pursue outer space separate from military oversight in the form of civilian space agencies. Civil space agencies most commonly consist of government-funded civilian entities that participate in the exploration of outer space, develop advanced aerospace technologies, and contribute to the scientific understanding of our solar neighborhood (AIA 2023). Yet, space exploration is extremely expensive, with advanced activities such as manned and planetary missions doubly so. In reflection, the tangible exploratory and scientific benefits derived from these missions arguably fail to justify the cost. This begs the question, why pursue civil space agencies? Why not develop a space program through military means with a more immediate return on investment? While these questions could apply to all space-faring states, they become especially relevant in the context of smaller nations creating civil space entities. In recent history, states consistently refrained from forming military space organizations in favor of pursuing civilian organizations, and if a military organization is eventually formed, it is well after the establishment of a civil agency.

Academic literature on the effect of politics in outer space remains in its infancy with few established theories. However, a burgeoning debate exists surrounding the ultimate goals of states in acquiring civil space programs. The most prominent idea described in recent work is that of states developing civil space agencies for economic benefits (Harvey et. al. 2010, Schrogl 2011, Detsis and Detsis 2013, Krolikowski 2011, Clark 2014, Early 2014, Andriaensen 2015, Dawson 2017). As a state advances economically, its revenue grows to a point in which funds can be spent on activities that were once deemed not essential (Detsis and Destsis 2013, Dawson 2017). Following the establishment of a civil space agency, material advantages such as reliable communication, navigation, and weather systems can lead to a more efficient economy (Krolikowski 2011, Clark 2014, Andriaensen 2015). As an alternative motive, some scholars point toward security ambitions as having a strong influence on the creation of space programs, generally (Moltz 2011, Blake 2014, Steer 2017, Early and Gartzke 2018). A "high ground" advantage over adversaries can be achieved through the deployment of intelligence, early warning, and weapons capabilities that bolster a state's security apparatus (Blake 2014, Steer 2017). These assets can transform the way a state participates in conflict and, more importantly, can dissuade adversaries from ever launching a first strike (Early and Gartzke 2018).

Prestige or status-seeking represents a third potential motive for civil space agencies as described by the literature (Ehrenfreund 2009, Schrogl 2011, Sheehan 2013, Lewis 2014, Panagiotarakou 2016, Dawson 2017, Musgrave and Nexon 2018). If a status deficit exists between a state and its rival, the state may attempt to increase its status through large-scale public programs (Barnhart 2016, Renshon 2016, 2017, Ward 2017, Duque 2018). Civil space programs and their ensuing achievements constitute one method in which states may obtain additional symbolic capital (Cho 2016, Musgrave and Nexon 2018, Larson and Shevchenko 2010). An increase in

international status can lead to various positive effects for a state, including international partnerships and aid (Ehrenfreund 2009, Walt 1985, Sheehan 2013). Likewise, national prestige can also appease domestic public opinion which avoids potential audience costs for leaders (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019, Powers and Renshon 2020, Li and Chen 2021). One final motive in play is scientific ambition. Bettering humanity's understanding of the universe certainly begets intellectual advancement, but with the expense and lack of material impact on a state's well-being, many scholars downplay the significance of scientific motivations in civil space development (Early 2014, Adriaensen et al. 2015, Dawson 2017).

This dissertation explores the advent of civil space proliferation through the lens of military benefits, showcasing the dual-use nature of modern space technologies. States can develop such capabilities under the guise of peaceful, innocuous civilian programs but with the ultimate intention of furthering military prowess. While such assets are designed, the international community and domestic populaces have little reason to suspect malicious intentions. This relationship would explain why, in the modern era, some states pursue civilian space programs prior to or in place of military ones and what factors affect this decision-making process. A robust research regiment consisting of three papers with three distinct research designs details these ideas, testing novel theory that improves our understanding of civil space agencies and the politics of outer space.

1.1 Study One

Utilizing previous literature on dual-use technology, the second chapter introduces novel theory proposing how key elements of a state's military power can lead to the development and growth of civilian space programs. Specifically, the chapter notes that air, ballistic missile, and

nuclear forces could benefit the most from dual-use technologies produced by a state's civil space agency, and states with greater numbers of these forces are more likely to prioritize civil space. An additional conjecture of the chapter proposes a causal relationship between the probability of conflict and civil space investment. As a state's probability of conflict increases, it becomes more likely to prioritize a civil space program.

The two hypotheses are put to the test using a large-N approach with data from the Organization for Economic Cooperation and Development, Souva's (2022) Material Military Power (MMP) measures, Correlates of War (COW) Militarized Interstate Dispute (MID), and a handful of other sources. In total, one group of models investigates each respective hypothesis, with the overall period of analysis spanning several decades. Both groups place civil space expenditure as the dependent variable, while MMP and probability of conflict variables constitute the independent variables. Examining the results, the first model group displays a significant statistical and substantive relationship between civil space expenditure and the following two elements of military power: air and ballistic missile forces—but not nuclear forces. Subsequently, the second group of models showcases a statistically significant relationship between civil space expenditure and the probability of conflict, although the substantive impact of the relationship appears negligible. The results largely support the chapter's theory and set the stage for the following two chapters to further study the implications of civilian space agencies.

1.2 Study Two

Underlining the third chapter of the dissertation is a question about how domestic audiences react to differing leadership types in outer space. Will the public react more positively to civilian-led space missions than to military-led ones? Building off the second chapter, this paper magnifies the domestic politics of civil space proliferation through several original survey experiments. A

total of five hypotheses comprises the papers' novel theory, touching on domestic perceptions of a nation's space activities in addition to foreign and private programs. Foundational to all hypotheses is the notion that the public will, generally speaking, prefer space efforts led by civilian entities. Specifically, domestic audiences are likely to support and trust civilian missions at a higher rate than military-led missions holding the mission parameters themselves constant. Furthermore, approval for space activities will rise when the leader of a state indicates they have purely civil intentions, and in contrast, approval will fall when it is revealed that the leader intentionally lied about the military applications of such activities. The paper generalizes the theory to foreign programs by arguing that individuals will also likely prefer foreign space missions when they are under the control of a civilian space program. The final hypothesis holds that when private companies are introduced into the equation, public sentiment will remain in favor of civilian-led entities overseeing space programs.

Testing the conjectures, I field a survey of the American public that described three hypothetical—but realistic—scenarios relating to U.S. space activities. The first depicts a dual-use technology being placed into orbit under the supervision of either NASA or the United States Space Force. Following, participants read a statement made by the President indicating the civil or military use of the technology, and later, further information states whether this information was valid. The second scenario shares the overall mission structure as the first but describes the program as falling under foreign civil or military entity. Finally, the third scenario imagines a manned mission to Mars led by either NASA or an unnamed private space company. After calculating average treatment effects (ATEs) for all three experiments, mixed support for the paper's theory can be observed. Overall support levels for civilian-led missions are not significantly higher than those of military-led ones, but respondents displayed a much stronger

degree of trust in civilian leaders, in addition to decreased hesitancy about the dual-use technology's use when under civilian supervision. Meanwhile, a leader's acknowledgement of civil intentions appears to increase support, yet if the leader misleads the public, support for the mission falls drastically along with trust in the leader. These results, however, do not transfer to the second experiment detailing a foreign mission, as respondents do not appear to prefer civilian over military oversight in this instance. Treatment effects from the final scenario demonstrate a strong desire for a civilian space program to remain in control when faced with a private space company alternative. While mission support levels may not indicate a stark difference in opinion, it is clear individuals trust civil space leaders more, value affirmation and honesty from leaders, and do not perceive private space as a preferential replacement for civil space efforts.

1.3 Study Three

The capstone manuscript of the dissertation delves further into a state's decision-making process involving civil space. In the second chapter, results demonstrated a strong link between aspects of military power and civil space investment, but the bulk of included states in the analysis leaned heavily democratic due to the available data sources. Additionally, while models indicated a significant correlation between the probability of conflict and civil space development, recent involvement in Militarized Interstate Disputes constituted the probability of conflict measure. Cementing and expanding upon those results, this paper inspects the same theory but in the context of autocratic states. Do autocratic states also invest in civil space for military advantages and out of fear of public blowback? If we anticipate domestic audience costs to affect authoritarian leaders less or at least differently than democratic leaders (Weeks 2008, Chen et al. 2016, Chen and Xu 2017, Li and Chen 2021), then little reason should remain for autocratic nations to hide their intentions in outer space. However, the paper provides an explanation for why this may prove

incorrect. Following, the chapter introduces a new theory by postulating that states will attempt to increasingly conceal any militaristic intentions of its civil space program as it progresses technologically. Both hypotheses enhance the concept of states pursuing civil space for dual-use military benefits while attempting to mitigate domestic and international criticism. Doing so, even as an autocratic nation, displays a state's strategic considerations by adhering to international norms and potentially leading to scientific and technological assistance from international partnerships in space.

The analysis portion of the paper takes a different approach than the first study, implementing a case study of a single nation's civil space program to adequately highlight specific examples of the theory in action. In this instance, the history, organization, and actions of the People's Republic of China (PRC) civilian space program, the Chinese National Space Administration (CNSA), are analyzed in-depth. Established relatively recently in 1993, the CNSA boasts a vast portfolio of space activities that are publicized heavily to the international community, providing rich data for analysis. Qualitative sources such as open-source press reporting, think-tank papers, and official government documents help illuminate how China's international threat environment and military makeup affected elements of its civil space progression. Following, PRC policy whitepapers, public statements, and international participation show how the government frames its space efforts over time. Scrutiny of the data reveals specific examples of dual-use technologies developed under the CNSA's purview that have direct military applications. Furthermore, these programs appear to have been designed in response to China's increasingly threatening security environment and to bolster the nation's military forces. Since the release of China's first space policy whitepaper, the use of defense-related terminology fell while rhetoric emphasizing cooperation and peaceful intentions rose dramatically. This development,

increasingly noble statements from leaders, and a perceived importance placed upon participation in international space forums by China all signify a desire by the PRC to frame its intentions in space as more civil over time. In totality, the paper's results provide an in-depth example of the dissertation's theory in practice and establish a precedent for new research on civil space.

1.4 References

Adriaensen, Maarten, Christina Giannopapa, Daniel Sagath, and Anastasia Papastefanou. 2015. "Priorities in National Space Strategies and Governance of the Member States of the European Space Agency." *Acta Astronautica* 117: 356–67. doi:10.1016/j.actaastro.2015.07.033.

Barnhart, Joslyn. 2016. "Status Competition and Territorial Aggression: Evidence from the Scramble for Africa." *Security Studies* 25(3): 385–419. doi:10.1080/09636412.2016.1195620.

Blake, Duncan. 2014. "Military Strategic Use of Outer Space." In *New Technologies and the Law of Armed Conflict*, eds. Hitoshi Nasu and Robert McLaughlin. The Hague: T.M.C. Asser Press, 97–114. doi:10.1007/978-90-6704-933-7_7.

Cho, Il Hyun. 2016. *Global Rogues and Regional Orders: The Multidimensional Challenge of North Korea and Iran*. Oxford University Press.

"Civil Space." 2023. *Aerospace Industries Association*. https://www.aia-aerospace.org/issues-advocacy/space/civil-space/ (September 25, 2023).

Clark, John, Carl Koopmans, Bert Hof, Paula Knee, Rogier Lieshout, Paul Simmonds, and Frank Wokke. 2014. "Assessing the Full Effects of Public Investment in Space." *Space Policy* 30(3, Part A): 121–34. doi:10.1016/j.spacepol.2014.03.001.

Crisman-Cox, Casey, and Michael Gibilisco. 2018. "Audience Costs and the Dynamics of War and Peace." *American Journal of Political Science* 62(3): 566–80.

Dawson, Linda. 2017. "Politics and the Space Race." In *The Politics and Perils of Space Exploration: Who Will Compete, Who Will Dominate?*, Springer Praxis Books, ed. Linda Dawson. Cham: Springer International Publishing, 107–26. doi:10.1007/978-3-319-38813-7_6.

Detsis, Bianca, and Emmanouil Detsis. 2013. "The Benefits Brought by Space—General Public versus Space Agencies Perspectives." *Acta Astronautica* 88: 129–37. doi:10.1016/j.actaastro.2013.03.021.

Duque, Marina G. 2018. "Recognizing International Status: A Relational Approach." *International Studies Quarterly* 62(3): 577–92. doi:10.1093/isq/sqy001.

Early, Bryan R. 2014. "Exploring the Final Frontier: An Empirical Analysis of Global Civil Space Proliferation1." *International Studies Quarterly* 58(1): 55–67. doi:10.1111/isqu.12102.

Early, Bryan R., and Erik Gartzke. 2021. "Spying from Space: Reconnaissance Satellites and Interstate Disputes." *Journal of Conflict Resolution* 65(9): 1551–75. doi:10.1177/0022002721995894.

Ehrenfreund, P., and N. Peter. 2009. “Toward a Paradigm Shift in Managing Future Global Space Exploration Endeavors.” *Space Policy* 25(4): 244–56. doi:10.1016/j.spacepol.2009.09.004.

Fearon, James D. 1994. “Domestic Political Audiences and the Escalation of International Disputes.” *The American Political Science Review* 88(3): 577–92. doi:10.2307/2944796.

Harvey, Brian, Henk H. F. Smid, and Theo Pirard. 2010. *Emerging Space Powers: The New Space Programs of Asia, the Middle East and South-America*. Praxis. doi:10.1007/978-1-4419-0874-2.

Krolikowski, Alanna. 2011. “China’s Civil and Commercial Space Activities and Their Implications.” : 15.

Larson, Deborah Welch, and Alexei Shevchenko. 2010. “Status Seekers : Chinese and Russian Responses to U.S. Primacy.” *International Security* 34(4): 63–95.

Lewis, James Andrew. 2014. *Space Exploration in a Changing International Environment*. Lanham Washington, DC: Rowman & Littlefield.

Li, Xiaojun, and Dingding Chen. 2021. “Public Opinion, International Reputation, and Audience Costs in an Authoritarian Regime.” *Conflict Management and Peace Science* 38(5): 543–60. doi:10.1177/0738894220906374.

Moltz, James Clay. 2011. *Asia’s Space Race: National Motivations, Regional Rivalries, and International Risks*. Columbia University Press.

Musgrave, Paul, and Daniel H. Nexon. 2018. “Defending Hierarchy from the Moon to the Indian Ocean: Symbolic Capital and Political Dominance in Early Modern China and the Cold War.” *International Organization* 72(3): 591–626. doi:10.1017/S0020818318000139.

Nomikos, William G, and Nicholas Sambanis. 2019. “What Is the Mechanism Underlying Audience Costs? Incompetence, Belligerence, and Inconsistency.” *Journal of Peace Research* 56(4): 575–88. doi:10.1177/0022343319839456.

Panagiotarakou, Eleni. 2016. “Agonal Conflict and Space Exploration.” In *The Ethics of Space Exploration*, Space and Society, eds. James S.J. Schwartz and Tony Milligan. Cham: Springer International Publishing, 47–60. doi:10.1007/978-3-319-39827-3_4.

Powers, Ryan, and Jonathan Renshon. 2020. “International Status Concerns and Domestic Support for Political Leaders.” : 31.

Renshon, Jonathan. 2016. “Status Deficits and War.” *International Organization* 70(3): 513–50. doi:10.1017/S0020818316000163.

Renshon, Jonathan. 2017. *Fighting for Status: Hierarchy and Conflict in World Politics*. Princeton University Press. https://www.jstor.org/stable/j.ctt1q1xsw9 (November 11, 2020).

Schrogl, Kai-Uwe. 2011. "The Political Context for Human Space Exploration." In *Humans in Outer Space — Interdisciplinary Perspectives*, Studies in Space Policy, eds. Ulrike Landfester, Nina-Louisa Remuss, Kai-Uwe Schrogl, and Jean-Claude Worms. Vienna: Springer, 3–14. doi:10.1007/978-3-7091-0280-0_1.

Sheehan, Michael. 2013. "'Did You See That, Grandpa Mao?' The Prestige and Propaganda Rationales of the Chinese Space Program." *Space Policy* 29(2): 107–12. doi:10.1016/j.spacepol.2013.03.003.

Steer, Cassandra. 2017. "Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space." *Georgetown Journal of International Affairs* 18: 9.

Tomz, Michael. 2007. "Domestic Audience Costs in International Relations: An Experimental Approach." *International Organization* 61(4): 821–40.

Ward, Steven. 2017. *Status and the Challenge of Rising Powers*. Cambridge: Cambridge University Press. doi:10.1017/9781316856444.

CHAPTER 2

AD ASTRA MILITARIZED:

A LARGE-N ANALYSIS OF CIVIL SPACE AGENCIES AND MILITARY CAPABILITIES[1]

[1] Jackson Tilley. To be submitted to a peer-reviewed journal

Abstract

Space Exploration is a relatively new phenomenon. As access to space becomes cheaper, an increasing number of nations have opted to develop civil space programs in addition to or in place of military space organizations. While on the surface, many of these programs advocate for scientific advancement and exploration, alternative motives likely act as influential factors in their development. This paper analyzes the potential security motive, arguing that states with military technologies that could benefit from civil space research and development (R&D) are more likely to invest in their civil space programs. In addition, states that are increasingly conflict-prone may choose to pursue many of the defense-related advantages provided by civil space-produced technologies. I test these hypotheses using a large-N analysis that incorporates civil space spending, military power, and conflict. The models' results suggest ballistic missile forces, air power, and conflict participation are strong determinants of civil space R&D investment. These conclusions help illuminate motivations behind civil space programs and add to an increasing literature on the effect of politics in outer space.

2.1 Introduction

Civil Space Programs are government-funded entities, normally in the form of agencies, that participate in the exploration of outer space, develop advanced aerospace technologies, and contribute to the scientific understanding of our solar neighborhood—including Earth's climate and atmospheric features (AIA 2023). As of 2023, 76 nations host civil space programs, with more planning to develop their own soon. Civil space agencies share several common characteristics around the world, regardless of cultural or goal-based differences. Namely, civilians make up the employee and leadership base of civil space agencies, and while the government directly funds their budgets, these entities are publicized as having scientific or exploratory goals that may not

directly benefit their host states (Detsis and Detsis 2013). Early (2014) shows that most early civil space programs evolved from existing intercontinental ballistic missile (ICBM) development initiatives put forth by wealthy states to deliver nuclear warheads anywhere on the globe. This notion is supported by the fact that many of the components used in ICBMs are also directly used in civilian rocketry. This paper separates itself from Early's work by looking beyond the creation of civil space agencies, instead focusing on the resources invested in them over time. It incorporates a wider range of defense considerations and motives to explain more recent motives for civil space interest. Today, nations from across the economic spectrum opt to create and invest in civil space programs. States that could never dream of hosting space programs fifty years ago can now build and launch microsatellites for less than $200,000 (Chow 2022). What modern incentives motivate nations to invest in civil space? What caused this shift?

States publicly justify their civil space programs as scientifically driven endeavors that benefit all of humanity. Yet, even within a liberal framework, one can conceive of civil space organizations used as vehicles to develop dual-use aerospace technologies that bolster the capabilities of a state's military forces. In the realm of nuclear politics, "dual-use technologies" refer to devices and equipment that can be used for both the generation of nuclear power as well as nuclear weaponization (Brandt 1994, Fuhrmann 2012, Rath et al. 2014, Lupovici 2018). Here, dual-use refers to space assets or technologies that have to the potential to be utilized for civil or military space missions. Leaders may view civil space technological investment as a means of pursuing its defense objectives, particularly if they lend themselves to space-based missions. While military ambition and strategy likely play a central role in determining the growth of civil space agencies, it is not the only motivation in play at the domestic level. Nor does this explanation describe the case of every single civil space agency currently operating. Economics, status-

seeking, and science almost certainly influence funding and programmatic decisions for these agencies. However, I suggest the desire for the utilization of outer space by the military provides a significant motivator for the phenomena of civil space investment. Connecting civil space investment to specific defense-related elements, I form two central hypotheses. First, states with increased levels of specific military technologies—namely air, ballistic missile, and nuclear forces— are more likely to develop and grow civil space programs, as these defense assets could be bolstered by space-based resources. Second, states facing a higher probability of conflict are more likely to develop and grow civil space programs.

In crafting a research design on any topic related to the politics of outer space, data is relatively sparse to come by. Thanks to several measures from international organizations and previous academic endeavors, I can create a dataset of military technology, conflict proneness, and civil space expenditure variables, compromising forty countries and spanning over forty years. The main variables and appropriate controls are regressed in several Ordinary Least Squares (OLS) regression models. Coefficients from the models suggest that a significant, statistical, and substantive relationship exists between civil space R&D and a state's ballistic missile and air forces—but not nuclear forces. Regarding the second hypothesis, civil space R&D also shows a strong statistical connection to recent militarized conflicts. The results add merit to the idea that civil space investment can come because of defense-oriented motivations, providing new implications for the study of state behavior in outer space.

With this paper touching on many aspects of international relations, scholarly work on the competing motivations influencing civil space and outer space exploration, generally, are covered in the following literature review. Furthermore, an examination of relevant papers related to status-seeking, prestige, and symbolic capital provides context for how leaders view large-scale,

publicized endeavors such as civil space missions. Following, the theory section ties previous work to the paper's novel theories on the types of states who pursue these programs. The research design portion of the paper then introduces two distinct model groups to test the hypotheses, describing the different variables that need to be controlled for and potential data sources to create such variables. Finally, the results and conclusion sections detail key findings from the model—in addition to challenges, potential shortcomings, and overall implications.

2.2 Civil Space Motivations

The politics of outer space remains a fledgling field in international relations but is poised to grow significantly in the coming years. Literature on motivations for funding space initiatives is sparse, and academic studies on civil space programs, specifically, are even harder to find. However, several scholars have recently explored why states may become interested in outer space and, in the process, form a civil space agency. For many, civil space proliferation appears to come as a result of the natural evolution set forth by a state's advancing technological and economic status. Early (2014) finds that states with ICBM programs are much more likely to create civil space agencies. Meanwhile, others pinpoint strong economic performance as a hallmark characteristic that causes states to pursue outer space (Harvey et al. 2010, Schrogl 2011). A strong economy may allow states to indulge in activities that do not necessarily have monetary benefits but can produce new scientific or intellectual discoveries, such as space exploration (Detsis and Detsis 2013, Dawson 2017). In addition to performance, economic ambition can play a role as states look to increase their industrial and technological competitiveness in the future (Krolikowski 2011, Clark 2014, Andriaensen 2015). Satellites and space communication assets benefit numerous economic sectors, such as commercial internet accessibility, government communications, weather forecasts, navigation, and even financial market trades. Based on this

literature, the question becomes not *if* a nation will develop its own space program but rather *when* as determined by its economic progression.

Another area of interest focuses on the potential security benefits that can be derived from national space programs, specifically those provided by dual-use technologies and partnerships. Orbiting satellites provide "high ground" benefits such as global reconnaissance, communications, early warning systems, and even weapons—capabilities that cannot necessarily be replicated using surface-based assets (Steer 2017). Efforts to weaponize space have largely been met with disdain, yet they undeniably possess qualities that have attracted military interest from around the globe (Blake 2014). These potential weapons include devices that could be used in, to, from, or through outer space. The deployment of weapons themselves in outer space is not restricted by any formal international agreement, but the Outer Space Treaty of 1967 bans the placement of nuclear weapons in orbit. Whether the international community continues to uphold this portion of the treaty is up for debate, as Russia reportedly plans to deploy nuclear devices into space to counter mass satellite proliferation by adversary states (Reuters 2024). Even primitive space technologies, such as low-resolution observation or basic communications satellites, can have significant consequences for regional rivalries (Moltz 2011). Early and Gartzke (2018) find that states who possess reconnaissance satellites are much less likely to engage in militarized conflict with one another due to the intelligence and early warning capabilities those systems provide. While reconnaissance satellites themselves are not necessarily deterrents, they can detect an opponent's move prior to a potential act of aggression—giving the defender ample time to deter an attack.

Many space objects, such as rockets and earth imaging systems, can be utilized for peaceful or militaristic purposes. Lubojemski (2019) highlights this dual-use question by exploring the security dilemma presented by satellites—or the idea that a state's uncertainty over their rival

satellites' capabilities and intentions can lead to insecurity and military buildups in space. The dual-use question continues to gain traction in the realm of outer space as space programs evolve, but the issue has long extended to other areas—such as nuclear energy, chemical or biological toxins, drone technology, and more (Rath et al. 2014, Mahfoud 2018). While a state actor may intend to develop a technology for purely civil purposes, the potential dual-use nature of the asset can lead to a socially constructed security dilemma in which an opponent "securitizes" a civilian technology out of fear of its opponent doing the same (Lupovici 2021). Considering one class of dual-use technology, nuclear energy development generally causes numerous information and security issues between states and often contributes to insecure leaders taking drastic steps to level the playing field (Brandt 1994, Jo and Gartzke 2007, Kroenig 2009, Monteiro and Debs 2014). Throughout the late twentieth century, concerns of nuclear proliferation lay heavily on the world as Israel, Pakistan, India, and others pursued what they claimed as "peaceful nuclear energy" (Baghat 2006, 2007, Bell 2015). The host states of these nuclear programs denied all allegations of nuclear weaponization, but in the end, nuclear bombs were produced. Today, Iran faces the same allegations, fueling a regional security crisis (Landua 2013, Sobelman 2018). While perhaps not as destructive as nuclear weapons, a similar dual-use dilemma plays out in orbit as more nations pursue outer space for "peaceful" purposes.

An alternative motive is status-seeking. States are constantly aware of their status on the international stage, specifically if they have a status deficit relative to a rival (Renshon 2016, 2017, Ward 2017, Duque 2018). When in a relative stalemate or in a deficit, states will often look to increase their recognition on the international stage (Barnhart 2016). One popular way of doing this is through building symbolic capital—outsized influence on a political body—among peers and rivals alike (Lake 2010, Cho 2016, Musgrave and Nexon 2018, Larson and Shevchenko 2010).

The accumulation of symbolic capital can provide states with new opportunities, such as international partnerships and aid (Ehrenfreund 2009, Walt 1985, Sheehan 2013). Domestically, prestige-seeking can also serve the purpose of appeasing the public and lowering audience costs that may be associated with large-scale, expensive programs (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019, Powers and Renshon 2020, Li and Chen 2021). Civil space entities, based on their host state's circumstances, are noted by some scholars as being prime examples of status-seeking projects (Sheehan 2013, Lewis 2014, Musgrave and Nexon 2018). Reputable space programs can lead to international advantages for states, including cooperation agreements with other states' space agencies and potentially even economic or security arrangements (Ehrenfreund 2009, Adams 2019). Status-seeking can also explain specific mission choices for civil space agencies—namely, why they choose to launch missions far away from earth where material benefits are few and far between (Schrogl 2011, Panagiotarakou 2016, Dawson 2017). Exploration to the Moon, planets, or other solar bodies constitutes few immediate advantages for a state's security, economics, or even scientific knowledge—as often the same mission has already been completed by a different space-faring nation. The most salient advantage of this class of mission appears to be the national prestige gained from being the 2nd, 3rd, or higher state to cross such a milestone.

This section highlighted various motivations for civil space development and the benefits derived from such programs. One remaining motive not discussed is that of investing in civil space for the stated scientific and educational benefits. While it is true that virtually all civil space entities maintain the goal of scientific advancement, that alone is likely not cause enough for civil space expansion for two primary reasons (Early 2014, Adriaensen et al. 2015, Dawson 2017). First, much of the science conducted by novel agencies appears redundant in the face of major space powers'

previous achievements, and second, missions focused on the solar system or beyond often fail to provide host states with swathes of meaningful knowledge that can provide tangible goods for its citizens. It is important, however, to note that the puzzle of civil space incentives does not have a "one size fits all" solution, with each of the referenced motivations likely exerting some effect on states as they consider investment in space. In fact, civil space creation likely results from the interplay of all three incentive areas— economics, security, and status-seeking. In the theory portion of the paper, I highlight why security motivations, broadly, might play a significant role in this equation and may produce the most tangible benefits.

2.3 Theory

While economic, security, and prestige-based benefits can result from civil space programs, security benefits remain some of the most tangible and attractive. Many states already possess components of their military that focus directly on space. Civil space programs, however, provide plausible deniability for the research and development of aerospace technologies under the assumption they are being used for peaceful, scientific purposes. Dual-use technologies developed by civil space agencies, such as launch vehicles, space planes, imaging systems, launch facilities, re-entry materials, and communications technologies, can all be used for both civil and military missions (Moltz 2011, Blake 2014, Steer 2017, Early and Gartzke 2018, Lubojemski 2019). Militaries can also use civil space capabilities to host their own missions. Military payloads often launch from civil space-controlled launch facilities and use their ground infrastructure to communicate with satellites in orbit. In addition, many commercial partners of civil space programs—or contractors—have agreements for the development of space technologies for both military and civil space. When a space agency signs a contract with aerospace firms, they are supporting resources and expertise vital for military development and ensuring they maintain a

competitive edge. Lockheed Martin, a well-established U.S. defense firm, produces various technologies for both the Department of Defense (DoD) and NASA—including deep space propulsion for the DoD and human landing systems for NASA's return to the moon. These technologies, while contracted for separate agencies and purposes, share much of Lockheed's space development resources (Lockheed Martin 2023).

Concerning international recognition, the door opens for cooperation in space with major state powers, potentially including security arrangements, following the development of a civil space program and subsequent successful missions. Peaceful nuclear assistance provides a strong example of a different dual-use technology, nuclear power, utilized as a tool of economic and political statecraft. Fuhrman (2010) shows that, across the globe, states who received peaceful nuclear assistance from foreign powers were far more likely to develop nuclear weapons. Nuclear assistance from France, Italy, the U.S.S.R, and the U.S. to various nations during the twentieth century led to nuclear energy plants, often followed by enrichment and weaponization programs. In the same vein, the proliferation of space technologies could inevitably lead to militarized space assets. Even rudimentary aid with rocketry or space systems given by a major space power could allow for the further militarization of space by new players. Regardless of the intent of a dual-use technology supplier, states will often grasp any security advantage they can, particularly if they are more prone to conflict (Jervis 1978, Betts 1980, Levit 1987, Van Evra 1998, Biddle 2001, Butcher 2005).

Speaking to one class of dual-use technology, satellites can complement a state's burgeoning military, especially when acting as force magnifiers for military assets (Moltz 2011, Blake 2014, Steer 2017). Examples include global communications for forward deployed forces, orbital reconnaissance of a rival's capabilities, GPS navigation for naval and land units, early

warning for missile defense, and data downlinks for drones. These technologies not only benefit a state's forces but can also act as a deterrent for opponents considering aggression (Lubojemski 2019). Some aspects of a state's military would likely benefit more from the referenced space-based assets than others. Take the size of a nation's air force, for example. The larger a state's air force, the greater the need for satellite-provided GPS for both navigation and targeting systems. Drone technology, specifically data uplinks and downlinks, often rely heavily on satellite communications as well. Outside of air power, ballistic missiles utilize many of the same components as civil space rockets, such as propulsion methods, aero-dynamic surfaces, guidance systems, and re-entry materials. Ballistic missiles, by their definition, embark on a ballistic-sub-orbital trajectory into space. As a state's ballistic missile forces mature, civil space R&D could positively impact their effectiveness. Building on this theme, states that possess nuclear weapons use ballistic missiles to deliver the warheads to their targets. In this case, ICBMs are vastly more complex than standard ballistic missiles and require more advanced propulsion methods and materials. Furthermore, space-based early warning systems are essential for detecting a nuclear first strike in time to initiate a retaliatory one. States with nuclear weapons, therefore, may also benefit from increased investment in civil space.

Hypothesis 1: *States with military assets that can benefit the most from space-based dual-use technologies are more likely to prioritize civil space research and development*

States will often "securitize" their civilian technology after observing alarming moves from their opponents pertaining to their own dual-use civilian technology (Lupovici 2021). The degree of aggression a state has experienced in the past often determines its response to the perceived threats. This spiral security dilemma can impact a multitude of sectors, allowing for cyber, nuclear, bio-tech, and outer space technologies to all be militarized to some extent. A key benefit that dual-

use space assets provide is intelligence on a rival(s)' capabilities and intentions, which may greatly impact the extent to which leaders fear the outbreak of conflict. Through orbital imaging, signal interception, and space situational awareness, satellites provide key details as to an opponent's intentions and true abilities. Furthermore, during the outbreak of conflict, early-warning satellites provide key advantages in defending against an attack. This may prove extremely attractive for insecure states who continually fear for their security.

Reconnaissance satellites, in particular, matter extensively in prepping for and carrying out offensive or defensive military operations (Brown 1971). Intelligence failures on behalf of states can often lead to surprise attacks by their opponents (Betts 1980, Levit 1987). According to offense-defense theory, the easier an offensive is made, the more likely conflict is to erupt (Jervis 1978, Van Evra 1998, Biddle 2001, Butcher 2005). With the appropriate assets in orbit, a state can impose costs on its opponent by revealing important information on their military practices. Zorn (2001) points toward the case of Israel after it launched its first reconnaissance satellite in 1995, claiming the desire for space-based reconnaissance assets arose after the failure to predict the Arab offensive during the Yom Kippur War in 1973. A recent study by Early and Gartzke (2018) shows that the deployment of reconnaissance satellites, broadly, does not necessarily prevent conflict, but it can certainly help a state prepare for it—bolstering its sense of security. Information gathering from outer space can also affect diplomatic negotiations. During the twentieth century, intelligence gathered from reconnaissance satellites impacted the Strategic Arms Limitation Talks (SALT) taking place between the United States and the Soviet Union by providing both nations with information on their counterpart's nuclear arsenal (Brugioni 1996). The intelligence advantages, coupled with military benefits mentioned previously, provided by space assets dictate the need for the development of space technologies by states facing pressure from opponents. To address this

need while maintaining positive domestic and international relationships, leaders may see the value in civil space investment.

Hypothesis 2: *States facing a higher potential for militarized conflict are more likely to prioritize civil space research and development*

The theory described in this section bridges two security-linked subjects—military capabilities and conflict potential—with civil space research and development. Again, while security advantages likely do not describe the sole intentions of leaders when investing in such programs, I argue they do play a significant role in the decision-making process. The next portion of the paper describes a research design that empirically tests the two hypotheses.

2.4 Methodology

Two groups of quantitative models are developed using data from various sources to test the paper's theory. Both models utilize OLS regressions with variables from a custom-built dataset. Public, open-source data for space-related programs can be quite hard to come by, making quantitative research on the politics of outer space hard to conduct. Thankfully, however, select datasets exist from renowned organizations that publish civil space funding data. For both models, the dependent variable is *Civil Space R&D* as a percent of the state's overall R&D expenditure. Conceivably, there may be situations in which some nations' *Civil Space R&D* rises as percent of the total government R&D expenditure but does not rise in monetary value or vice versa; however, the variable can measure the degree to which a state prioritizes civil space over other R&D programs. Data for this variable is available in the OECD R&D dataset and contains country-year observations starting in 1980 to the present day for over 40 nations, including some non-OECD members. States that are not official members of the organization can still adhere to OECD-sponsored data-sharing programs, which allows for further data collection and variation. The time

range of the dataset proves beneficial as it begins at the end of the U.S.-Soviet Space race and prevents potential bias from the massive funding allotted to each of their civil space agencies by the respective superpowers. To create a more balanced distribution of data and to avoid positive skewness, the logs of several control variables are used rather than the realized value. All expenditure variables are adjusted to the 2022 international dollar (PPP).

For the main independent variables in the first group of models, I draw from Souva's (2022) Material Military Power (MMP) measures, which account for a state's share of *Naval Tonnage, Air Power, Armored Forces, Army Personnel, Nuclear Forces,* and *Ballistic Missiles*. The variables list each state's military power measure as a percentage of the total available resources of that category worldwide. To differentiate between large militaries and large militaries with forces that can be augmented by satellites, I include Souva's individual measures as independent variables in the same model. Specifically, I narrow the focus to *Air Power, Ballistic Missiles,* and *Nuclear Forces* to maximize recognition of a potential relationship between those aspects of military power and civil space R&D in the first group of models. As described in the theory section, I suggest space assets can bolster specific military forces more than others. With orbital aid, air power can benefit from GPS-guided munitions, drone uplink and downlinks, global communications, and real-time threat awareness. For example, imagine a drone flying thousands of miles away from its home base thanks to a satellite datalink allowing for external control. Recent passes of a reconnaissance satellite provide a picture of the threat situation facing the drone, including nearby air defense systems and enemy bases. The drone then drops its guided munition from a standoff position, allowing for GPS satellites to lead the ordinance precisely to the target. Virtually every segment of this hypothetical operation relies on space-based technologies for success.

Meanwhile, ballistic missiles share many components with civil space rocket technology, and consequently, certain types of ballistic missiles can service either civil or military payloads. Regarding nuclear weapons, a state that possesses a large nuclear force likely sees value in civil space through three main processes. First, ICBMs carrying nuclear warheads are very similar in nature to civilian launch vehicles. Second, satellites can provide early warning of an opponent's opening strike, allowing for a quick retaliatory response, and third, orbital reconnaissance of an opponent's nuclear forces can affect a state's security posture concerning their own production and deployment of nuclear weapons. A five-year lag is introduced to all of Souva's MMP measures. A lag ensures that a state already possesses the relevant technologies prior to expanding its investment in civil space R&D. Alternate lags are implemented for additional robustness checks in the appendix. If the theory holds, the presence of these technologies would then encourage leaders to invest in space assets—via civil space entities— that can directly bolster their capabilities.

In the model, I control for the following potential confounding variables: *Log GDP, Log Military Spending, Total R&D Spending, Education R&D, Regime Type, International Status,* and *European Space Agency (ESA) membership.* The *Log GDP*, *Total R&D Spending,* and *Education R&D* measures are also taken from the OECD R&D dataset. Controlling for GDP accounts for the economic standing of states and the potential natural increase to civil space investment brought about by economic progress. It is likely that states with high GDPs will invest in space and military programs at a higher rate. Likewise, states raising their overall investment in R&D will almost certainly see rises in civil space and military R&D as well. *Education R&D* controls for potential scientific or educational influences in civil space investment. If a state truly cares about scientific advancement and education benefits from space-based activities, it will likely start at home by

funding education research initiatives. The variable indicates the percent of a government's overall R&D budget on education and society, particularly in higher education and university programs. *Log Military Expenditure* is pulled from the Stockholm International Peace Research Institute's (SIPRI) military expenditure dataset and lists the total dollar value of each country's expenses on their military each year. If the military uses civil space programs for any reason at all, such as launch facilities or space communication networks, it is plausible that greater military spending would be associated with high civil space R&D. *Regime Type* uses a continuous measure of democracy from the Varieties of Democracy (VDEM) dataset. This variable applies a democracy score between 0 and 1 to each country by year. While there are no academic studies directly linking regime type and outer space endeavors, the sheer importance placed on achieving space goals by autocratic nations implies that they may have a greater interest in funding civil space and military initiatives (Moltz 2011, Musgrave and Nexon 2018)

Taking inspiration from Duque's (2018) measure of international status, I use Diplometric's Diplomatic Representation dataset to create an indicator of international status called *Status Rank*. For each country, I count the total number of diplomats received by country per year, then rank each state on the number of diplomats received relative to other states, with 1 being the highest rank. Duque points to diplomatic representation as a key indicator of status in her paper. The more diplomats a nation receives, the larger its diplomatic network and reputation likely is on the international stage. If status does play a role in civil space and military investment, states with a higher status rank may contribute to space missions at a greater rate to maintain an aura of prestige among the international community. As the only dummy variable in the model, the *ESA Membership* control assigns a value of 1 to all members of the ESA and a 0 to nonmembers. Many ESA members also have their own domestic civil space agencies, yet if a state

is already contributing to civil space activities internationally, budgets for their domestic agencies could be negatively affected. Finally, country and year fixed effects allow for variation within units to provide even further variation. These two additions control for specific country and year anomalies not directly covered by the other variables— including possible black swan events, unforeseen economic influences, further prestige motives, and scientific or educational motives.

For the second group of models, testing the relationship between civil space and conflict-proneness, the dependent and control variables stay the same. However, the primary independent variable is now a measure labeled *Number of Conflict Years*. While there are many existing measures of conflict-proneness, many are unfit for this study due to data limitations, incomplete sources, or general theory differences that could cripple the model's explanatory power. As a result, I measure a state's probability of conflict by accounting for its recent history of militarized disputes. The Correlates of War (COW) Militarized Interstate Dispute (MID) dataset records every militarized interstate dispute from 1816 to 2014. For the independent variable, I tally the total number of years a state was involved in a MID in the past five years. Like the first model's five-year lag, a five-year time horizon for this variable allows for significant development to occur in a nation's predisposition to conflict, which could affect leaders' attitudes towards investment in civil space R&D. While the total number of disputes within the past five years could be used as an alternative measure, it would risk including certain disputes twice or more as MIDs are recorded on a dyadic scale and can include numerous MIDs for the same conflict if multiple states are involved. For example, any dispute involving a coalition of countries against one state produces multiple MIDs with the same opponent state listed numerous times, even though the dispute itself counts as only one event. In these cases, MIDs are substantially overcounted for select nations and can bias the analysis.

2.5 Results and Discussion

Table 1 unveils the first group of regressions, which test the relationship between specific MMP measures and the dependent variable— *Civil Space R&D as % of R&D Expenditure*. Around 900 country year observations are included in each of the three models. The observations themselves span forty nations from 1980 to 2022, and country and fixed effects are applied for all three models. The implications of variables of interest are analyzed below, with further model variations and robustness checks explored in the appendix.

Table 1.1: Material Military Power Regressions

	Dependent variable:		
	Civil Space R&D as % of R&D Expenditure		
	Designated MMPs	MMPs with Controls (Primary Model)	All MMPs with Controls
Air Power	14.225	32.277***	21.816*
	(11.994)	(10.646)	(11.216)
Ballistic Missiles	42.696***	33.112***	22.158*
	(12.089)	(10.542)	(11.377)
Nuclear Forces	31.358	15.652	-11.242
	(32.634)	(27.782)	(31.151)
Army Personnel			-36.018***
			(13.184)
Navy Tonnage			1.987
			(11.436)
Armored Forces			7.502
			(12.712)
Log Military Spending		-0.642*	-0.453
		(0.361)	(0.366)
Log GDP		0.423	0.357
		(0.690)	(0.700)
Log Total R&D Spending		0.535	0.515
		(0.332)	(0.334)
Education R&D		0.018	0.018
		(0.020)	(0.020)
Regime Type		2.251	2.479
		(2.056)	(2.061)
Status Rank		0.019	0.019
		(0.013)	(0.013)
ESA Member		-7.886**	-3.224
		(3.517)	(4.044)
Country Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Constant	6.069***	-0.376	-1.021
	(0.778)	(7.416)	(7.496)
Observations	972	890	890

R^2	0.844	0.897	0.898
Adjusted R^2	0.830	0.887	0.888
Residual Std. Error	1.936 (df = 892)	1.591 (df = 808)	1.584 (df = 805)
F Statistic	61.006^{***} (df = 79; 892)	86.838^{***} (df = 81; 808)	84.579^{***} (df = 84; 805)
Note:			*p<0.1; **p<0.05; ***p<0.01

The first model (Designated MMPs) includes the designated MMP measures that I theorized would have the strongest association with *Civil Space R&D Spending*. Immediately, several observations can be drawn, even before introducing additional MMPs and controls. *Air Power* and *Nuclear Forces* appear to not possess a relationship of any significance with the dependent variable in this specific model; however, *Ballistic Missile*s demonstrates a positive, statistical, and substantive relationship with *Civil Space R&D Spending*. A one percent increase in a country's share of the world's ballistic missile arsenal is associated with 42.70% increase in *Civil Space R&D Spending* holding all else constant. This demonstrates an extremely strong relationship between the two variables and lends initial support to the ballistic missile aspect of Hypothesis 1. However, the model does not display similar results for *Air Power* or *Nuclear Forces*. Model 2, highlighting the designated MMP measures and full controls, shows a similar—but not quite as substantive—relationship with a one percent increase in ballistic missile share being associated with a 33.11% increase in the DV holding all else constant. This time, however, *Air Power* also shows a strong correlation with *Civil Space R&D.* A one percent increase in a country's share of the world's air arsenal is associated with a 32.28% increase in *Civil Space R&D.*

Model 3 incorporates the full range of MMP measures as well as full controls, and again, similar results are found with *Ballistic Missiles* and *Air Power* showing a meaningful correlation but *Nuclear Forces* and most other MMP measures proving statistically unresponsive to the DV. As additional MMP variables are included, the statistical significance of the *Ballistic Missiles* and *Air Power* falls from the 99% percentile to 90%. A likely explanation for this event is

multicollinearity between the different MMP measures. Specifically in relation to conventional military technologies, states with large ground forces will also likely possess expansive naval, air, and other military assets. Doing so allows for a comprehensive defense posture. In turn, most of Souva's MMP measures are highly correlated with one another. For this reason, Model 2 is the primary model of interest. One very interesting observation from Model 3, however, is that of a one-percent increase in the world's army personnel being associated with a 36.02% decrease in the DV. This relationship suggests that as ground armies grow larger, civil space prioritization decreases. As states become more developed, the size of their military often shrinks. Instead of relying on vast numbers of conventional forces—such as ground troops and artillery, modern states look to technologies that make their defense organizations precise, efficient, and effective (Nordenman 2012). Defense experts note that, particularly in Western nations, armies have shrunk by a large margin since the end of the Cold War (Economist 2020). Developments such as drones, precision munitions, stealth technology, and other modern tools allow nations to defend their territory with smaller armored forces. Many of these tools can interface directly with space-based assets. Overall, while not necessarily telling of a determinant of civil space spending, this statistical finding foreshadows the effect military modernization and downsizing may have on civil space investment.

Why might *Ballistic Missiles* act as a greater indicator of civil space spending than nuclear forces and possibly air power? The model's results do not completely rule out the possibility of states pursuing *Civil Space R&D* for the purpose of bolstering nuclear assets, but it is evident that ballistic missiles are one of the greatest indicators of civil space investment. This aligns with Early's (2014) findings that states already possessing ICBMs are more likely to acquire civil space programs. However, the model's results expand beyond ICBMs to include ballistic missiles of all

types, which have generally proliferated at a far greater rate than ICBMs alone. Furthermore, the purpose of the model is to identify motives for investment post-acquisition rather the creation of the agency itself. The resulting relationship between *Ballistic Missiles* and *Civil Space R&D* should be expected when observing ballistic missile technology and its similarities to civil space development.

Launch vehicles utilized for civil launches share many dual-use components with ballistic missiles. During the boost phase of both rockets and ballistic missiles, similar fuel and oxidizer types are used. Common solid fuels consist of mixtures such as ammonium perchlorate, and liquid fuels are often drawn from liquid oxygen or hydrogen (Sia 2021). Beyond fuel types, the propulsion systems themselves can be considered "dual-use" in nature. Category IV of the United States Munition List (USML) places ballistic missiles and civilian rockets under the same export control restrictions due to their potential uses (DOC 2017). While under fewer restrictions, small components used to build both civil and military space propulsion systems, including specialized engine valves, nozzles, and even power cords, are classified under the Commercial Control List (CCL) and Export Administration Regulations (EAR) 99 limitations. Beyond hardware similarities, ballistic missiles and civil rockets can share software programs, communication networks, and launch sequences. Even with these commonalities, it is important to note that ballistic missiles are primarily intended to bring a payload back to Earth, only using space as a medium to travel through via a sub-orbital velocity. Meanwhile, launch vehicles most often aim to deliver a payload to orbit. Therefore, while sharing many common technologies, ballistic missiles and launch vehicles are two distinct platforms.

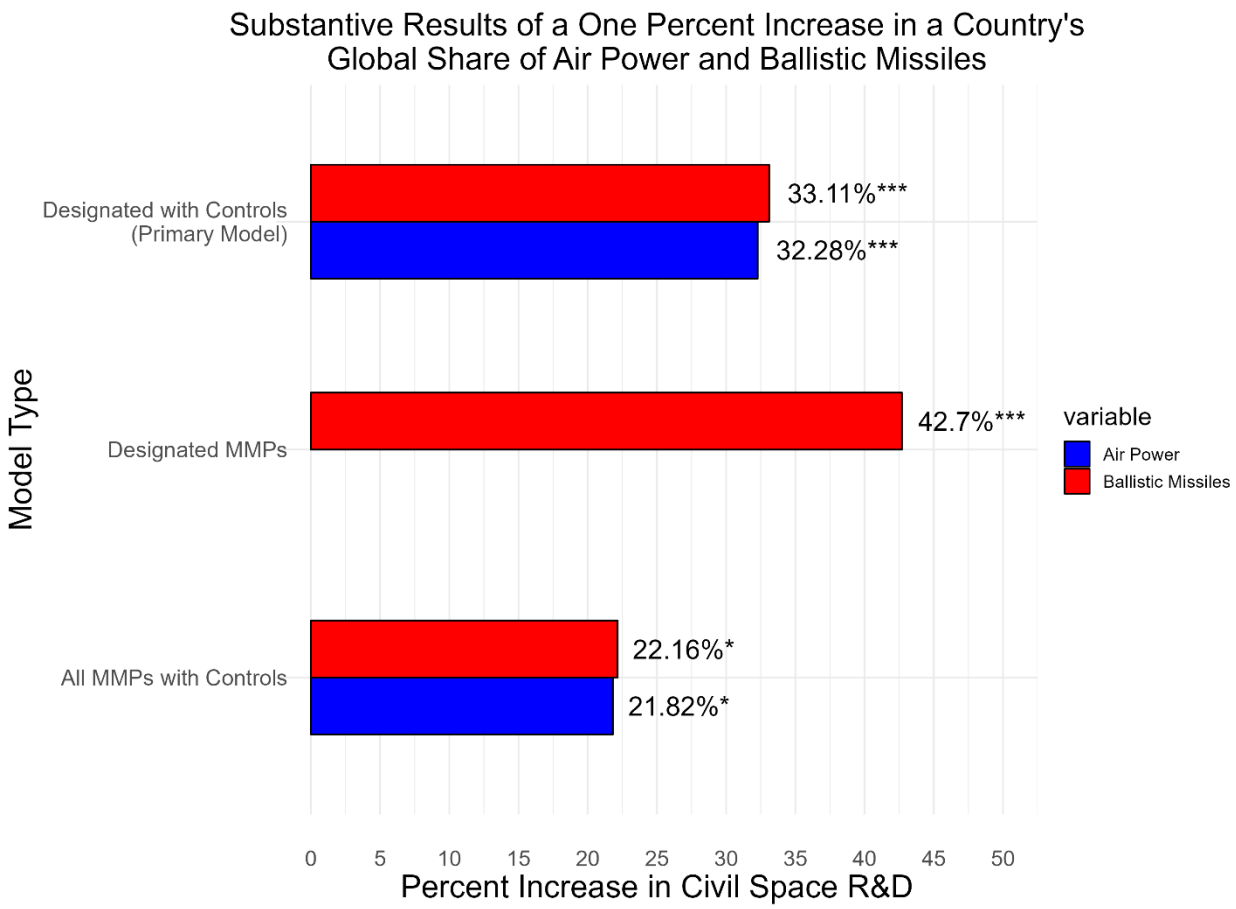

Figure 1.1: Statistically Significant Impacts of Designated MMPs

Note: *p<0.1; **p<0.05; ***p<0.01. "Percent Increase in Civil Space R&D" refers to the percent increase in Civil Space R&D as a percent of the state's overall R&D budget. The *Air Power* measure did not display a statistically significant relationship with *Civil Space R&D* in the Designated MMPs model.

In Models 2 and 3, *Air Power* demonstrates a similar statistical and substantive relationship to the DV as that of *Ballistic Missiles.* A one percent increase in the world's air power is associate with a 32.28% increase in *Civil Space R&D* holding all else constant. This can likely be explained by air wings of modern militaries relying greatly on satellites for GPS navigation, targeting, datalinks, and more advantageous space-based assets. However, many nations continue to utilize older aircraft and aerial mission profiles that do not require the sophisticated communication benefits provided by space assets. Even the U.S., owner of the world's most modern air force, did

not finish upgrading its military jets with GPS until the early 2000s (Baker 2020). It is logical to assume, then, that as the as the world continues to modernize and implement space technologies in their military aircraft, the relationship between *Air Power* and *Civil Space R&D* will only grow. The lack of a significant relationship between *Nuclear Forces* and *Civil Space R&D* is another mystery entirely, particularly since most nuclear nations would have developed ICBMs shortly before or after gaining possession of nuclear weapons. Currently, only nine countries possess nuclear weapons, of which six are present in the paper's dataset. Furthermore, most nuclear-armed nations developed ICBMs as precursors to civilian rockets—accounting for Early 2014's findings. Modern civil space investment differs in that ICBM development is no longer a precursor for vast amounts of R&D allocations. In general, conclusions regarding nuclear weapon politics in IR, especially in country-year analysis, often prove illusive dude to the low number of nations possessing the technology. These facts, combined with the skewness of nuclear forces caused by nations such as the U.S. and Russia, might prevent any major conclusions from being drawn here.

Observing the effects of the control variables, Model 2 shows some statistically significant relationships while Model 3's results are largely insignificant. Broadly speaking, the results from Model 2 both support and negate predictions made in the previous section. *Log Military Spending* is negatively correlated with *Civil Space R&D Spending*—although not a highly significant nor substantive relationship with the statistical significance at the 90^{th} percentile. A one percent increase in *Log Military Spending* is associated with a 0.006% decrease in the DV holding all else constant. The negative association between military spending and civil space is puzzling, but there is a potential answer when considering military modernization and downsizing. As referenced previously, many states have actively downsized their Cold War era militaries in favor of leaner, more efficient defense forces. With a lessening of conventional forces, military expenditure likely

falls as well; meanwhile, reliance on modern technologies, such as space assets, increases. The International Monetary Fund (IMF) shows that military spending as a percent of GDP has collapsed by almost half since the end of the Cold War, with the most substantial decreases seen in Europe (Clements et al. 2021).

ESA Membership is negatively, substantially, and statistically associated with the DV to the 95th percentile. Becoming an ESA member is associated with a 7.89% decrease in *Civil Space R&D* holding all else constant. There could be several reasons why ESA member states contribute to civil space development at a lower rate. However, the most likely answer comes from the notion that these states already fund an external civil space entity and do not feel the need to replicate those efforts domestically. Regardless, the ESA itself cooperates with European military components on various missions, such as providing launch access to space for various European military satellites via the Guiana Space Centre. One key mission area of the ESA is "Safety and Security" applications, which covers a direct partnership with the European Defense Agency and European Defense Fund (ESA 2024). The ESA's position and activities add credit to the idea that civil space can be used—and potentially funded— for security-related purposes, and a further case study of the agency could help expose more of this connection. The remainder of the control variables in the model group present unremarkable results. Their lack of a significant relationship with the DV suggests they do not hold significant influence over civil space R&D.

Shifting focus to the second model group, the independent variable now takes the form of *Number of Conflict Years*— or the number of years a state has been involved in MIDs in the past five years. The same controls as the first model group are applied, and this time, each model consists of almost 900 observations spanning forty countries from 1980 to 2014. Table 2 displays the results.

Table 1.2: Recent Conflict Regressions

	Dependent variable:	
	Civil Space R&D as % of R&D Expenditure	
	Bivariate	With Controls
Number of Conflict Years	0.120**	0.202***
	(0.054)	(0.050)
Log Military Spending		-0.817*
		(0.420)
Log GDP		0.002
		(0.844)
Log Total R&D Spending		0.759**
		(0.314)
Education R&D		0.038*
		(0.020)
Regime Type		4.537
		(2.832)
Status Rank		0.024*
		(0.014)
ESA Member		-0.641
		(1.273)
Country Fixed Effects	YES	YES
Year Fixed Effects	YES	YES
Constant	4.759***	1.763
	(0.721)	(9.244)
Observations	891	871
R^2	0.842	0.874
Adjusted R^2	0.828	0.862
Residual Std. Error	1.989 (df = 816)	1.788 (df = 792)
F Statistic	58.817*** (df = 74; 816)	70.613*** (df = 78; 792)
Note:		*p<0.1; **p<0.05; ***p<0.01

Assessing Table 2's results presents a couple of notable remarks. In the bivariate model, a one-year increase in *Number of Conflict Years* is associated with 0.12% increase in *Civil Space R&D Spending*, holding all else constant, a positive and statistically significant result. While not particularly substantive, this result shows that conflict-prone nations are more likely to invest in

civil space assets. In the second model with all controls included, the increase in the DV from a one year-increase in *Number of Conflict Years* increases to 0.2%. The significance level also grows from the 95th percentile to the 99th percentile, aligning further with the paper's theory. Conflict spurs research and development in security-related areas, and civil space agencies produce technologies that can greatly impact the security posture and awareness of a state. Recent militarized disputes may place pressure on leaders to identify new ways to secure their military advantage in the future and deter new conflicts from arising. In today's world, space assets can provide those desired benefits and more through reconnaissance satellites, early warning systems, global communications networks, and additional dual-use technologies. As of now, Hypothesis 2 shows promise of rejecting the null hypothesis. Further research into this subject, perhaps utilizing different measures of conflict-proneness, could add potential support to the link between the two variables. In the appendix, a different measure of conflict is applied to the variable to show the staying power of the significant relationship.

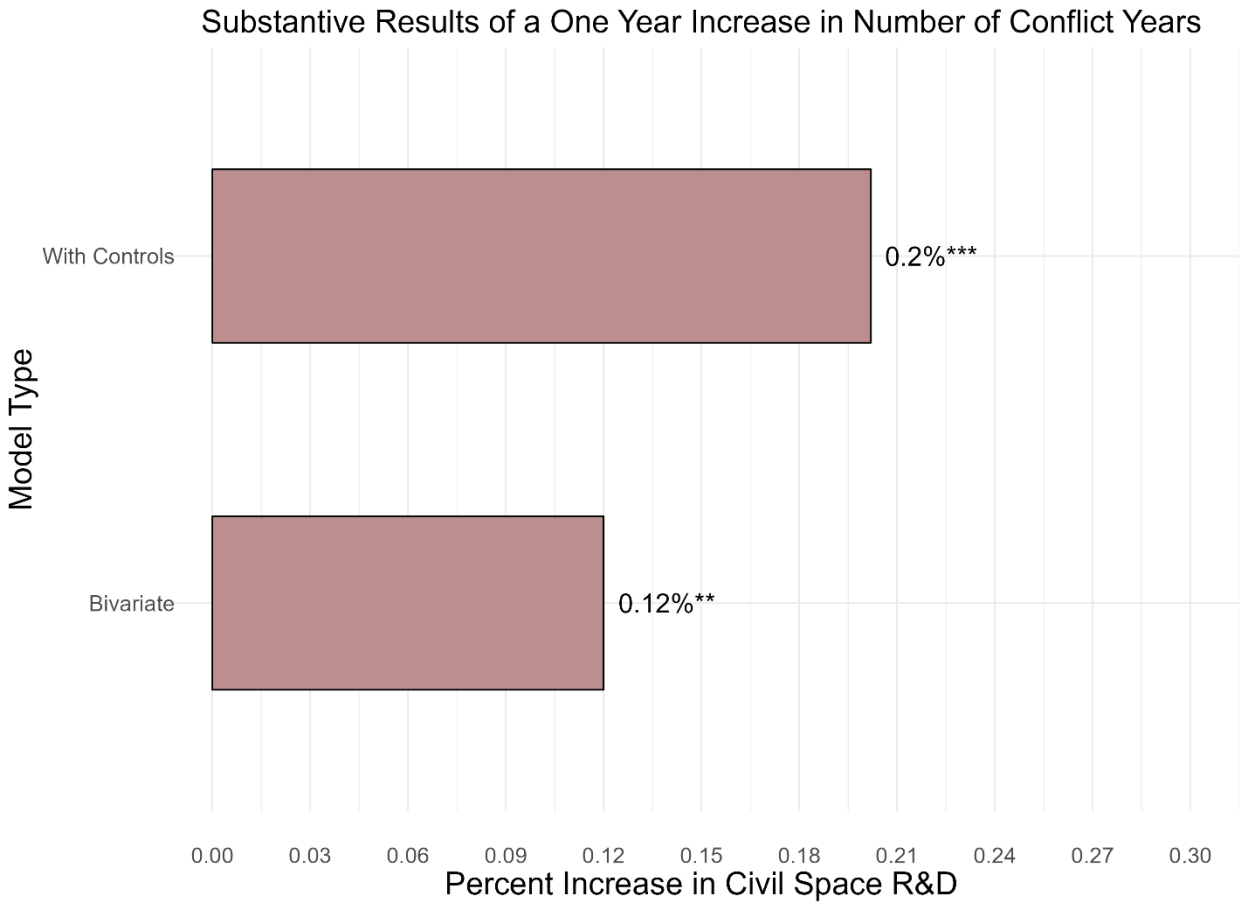

Figure 2.2: Statistically Significant Impact of Number of Conflict Years

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$. "Percent Increase in Civil Space R&D" refers to the percent increase in Civil Space R&D as a percent of the state's overall R&D budget.

Regarding the control variables' effects, the story remains the same with *Log Military Spending*, but new significance is found among the *Log Total R&D Spending, Education R&D,* and *Status Rank* controls. *Education R&D* and *Status Rank* demonstrate a slight statistical correlation with the DV (to the 90th percentile) but are substantively unremarkable. *Civil Space R&D* sees a 0.038% increase following a one percent increase in *Education R&D* and a 0.024% increase resulting from a one rank increase in *Status Rank.* While these findings could confirm predictions made in the methodology section, the lack of a strong statistical or substantive

connection to the DV prevents firm conclusions from being drawn. Meanwhile, a one percent increase in *Log Total R&D Spending* is associated with a 0.76% increase in *Civil Space R&D.* This result is significant to the 95th percentile and can be interpreted as somewhat substantive. Should this relationship hold firm in future work, it would confirm that interest in civil space can increase due to a rise in overall R&D funding by a state. The final difference from the first group of models is *ESA Membership,* as a statistical relationship between it and the DV fails to materialize.

2.6 Robustness Checks and Limitations

Each of the paper's models represents an empirical test of Hypotheses 1 and 2. While the previous portion of the paper provides an overarching interpretation of the models and their implications, the appendix includes further robustness checks and statistical testing to answer lingering questions about the methodology. One key test in the appendix replaces the *Status Rank* variable with the total number of diplomatic visits received by country per year (non-ranked). For both model groups, the results remained almost identical with only slight substantive differences in the independent variables of interest. For the first model group, I introduced different lag measures for each of the MMP measures, including a four- and three-year lag. When changing the lag to four years, *Air Power* and *Ballistic Missiles* retained their significance in the "Designated MMPs" and "MMPs with Controls" models but lost all significance in the "All MMPs with Controls" model. This is expected, though, as the level of significance for those relationships started at the 90th percentile to begin with. Modifying the lag to three years further diminishes the significance of *Ballistic Missiles* and removes all significance between *Air Power* and the *Civil Space R&D.* As the lag decreases, the significance level is expected to also decrease. Theoretically, reducing the lag prevents time between acquisition of loss of military assets and the decision of civil space funding allocation. Budget considerations, particularly for large-scale, expensive

projects, encompass years of consideration—making lags necessary for the models. If states view civil space assets as advantages for defense technologies they already possess, then they will view military standing in recent years prior to the year of deciding the budget. Overall, however, the relationship between *Ballistic Missiles, Air Power, and Civil Space R&D* stands strong, even with smaller lags.

Changing the measure of the dependent variable for both model groups, I test the effect of *Log Civil Space R&*D, which totals the absolute monetary value spent on civil space R&D each year, on both models. The significance of *Ballistic Missiles* remains strong and substantive to the 99th percentile, but *Air Power* loses its statistically significant relationship with the DV. Additionally, several of the control variables now correlate with civil space R&D to a significant degree. While providing the greatest break yet in results from the original model, this robustness test does solidify the relationship between *Ballistic Missiles* and civil space R&D. Using civil space R&D as a percentage of the government's total R&D budget allows the measure to focus a greater deal on prioritization, while also avoiding natural increases that happen over time with most government projects. The final alternative measure introduced in the appendix modifies the measure of recent conflict in Model Group 2. Rather than counting the number of years which a state was involved in a MID over the past five years, I use the total number of MIDs that a state participated in over those five years. While the new measure proves statistically insignificant in the bivariate model, the full model shows a positive and significant relationship with the DV to the 95th percentile. The substantive impact of the relationship results in a 0.06% increase in *Civil Space R&D* for every additional MID tallied per year. Keep in mind, however, that states can be involved in multiple MIDs during the same year—meaning the actual substantive increase could indicate a greater outcome compared to using the number of years where an MID occurred.

Throughout the appendix tests, the initial results and conclusions from the paper consistently stand firm with only a few notable differences present.

Some limitations of the models cannot be addressed due to data availability issues. One main drawback is that the dataset pulls from OECD data, as many OECD nations tend to skew higher in GDP, military power, and status. Consequently, generalizing the paper's theory to developing nations—particularly in the Global South and Middle East— proves difficult. Incorporating those additional states could potentially lead to new implications for the theory, perhaps such as cultural or geographic influences. Another factor to note regarding data is that of recency. Space exploration is novel and extremely so for many countries. Unlike other fields in international relations, space politics extends for mere decades and not centuries. As time passes, more data will become available for study, and further tests will help determine the validity of the theory presented here. Despite data limitations, alternative research avenues, including survey experiments, case studies, and text analysis, could help bridge the gap.

2.7 Conclusion and Future Research

The phenomenon of civil space development remains largely uninvestigated. States spend vast resources on programs that, at face value, produce few benefits. This paper represents one of the first major efforts to uncover the story behind civil space investment. In doing so, I argue that the defense advantages provided by civil-space-produced, dual-use technologies create meaningful incentives for states to bolster their military forces under the guise of peaceful, scientific exploration. Using a large-N dataset and OLS regressions, I test two distinct hypotheses specifying specific elements of these ideas. Namely, states are more likely to invest in civil space research and development if *(1)* they possess military forces that can take direct advantage of civil space technologies and *(2)* are more prone to militarized conflict. In an analysis of the results, ballistic

missile share and air power prove to have a strong, positive relationship with civil space R&D, but other military elements that could also theoretically benefit from civil space, such as nuclear forces, do not. Meanwhile, states with histories of recent conflict demonstrate a higher tendency to invest in civil space than states with a lower propensity for conflict, lending initial support to the second hypothesis.

The paper's results lead to several noteworthy implications for both academia and policymaking. First, it builds on the foundation for the study of civil space development started by Early (2014) and links this category of space development directly to security-related goals. While military ambition and strategy likely do not explain every state's sole rationale behind the pursuit of civil space, it could describe a significant motivator for many states. The findings also provide additional support to dual-use theories and concerns in IR in the context of outer space. Specifically, ballistic missiles—which share many components with civilian rocketry— appear to spur higher civil space investment. Furthermore, the observed relationship between recent conflict and civil space R&D strengthens other aspects of IR, including Offense-Defense Theory and the Security Dilemma, by connecting those theories to entirely a new domain of contention, outer space. In the policy world, shifting priorities to monitor civil space growth at an increasing rate could hint at states' greater security strategies and platforms. Analyzing specific R&D initiatives and technology production conducted by civil space entities, for example, would likely benefit intelligence analysis by previewing plans for future platforms that could bolster present military forces.

While this paper marks one of the first studies attempting to explain civil space activities, it will certainly not be the last. Going forward, additional data will allow scholars to fully realize this paper's theory and others in more effective quantitative models. An increased number of

observations will lead to more generalizable results, but alternative measurements for variables would also provide greater redundancy. For instance, looking at interstate rivalries and their relationship with civil space, as opposed to merely conflict, could help shine a light on both security and status-related motivations. Other methods of research, such as case studies and experiments, would provide additional vehicles in which to explore the military-civil space connection and its impact (or lack thereof) on domestic audiences. Instead of identifying key sections of a state's military that could benefit from civil space, future work could select specific technological devices and components that explicitly show civil space influence. The study of politics in space has barely taken off, but research in the field continues to accelerate. As time passes, the strategic importance of outer space will increase exponentially, and understanding states' behavior in this new domain will prove vital for international cooperation.

2.8 References

Adams, Benjamin. 2019. “Cooperation in Space: An International Comparison for the Benefit of Emerging Space Agencies.” *Acta Astronautica* 162: 409–16. doi:10.1016/j.actaastro.2019.06.011.

Adriaensen, Maarten, Christina Giannopapa, Daniel Sagath, and Anastasia Papastefanou. 2015. “Priorities in National Space Strategies and Governance of the Member States of the European Space Agency.” *Acta Astronautica* 117: 356–67. doi:10.1016/j.actaastro.2015.07.033.

Bahgat, Gawdat. 2006. “Israel and Nuclear Proliferation in the Middle East.” *Middle East Policy* 13(2): 113–33.

———. 2007. “Iran, Israel and the United States The Nuclear Paradox.” *The Journal of Social, Political, and Economic Studies* 32(1): 3–21.

Baker, Berry. 2020. “A Position in History: 25 Years of GPS - Airforce Technology.” https://www.airforce-technology.com/features/a-position-in-history-25-years-of-gps/ (January 30, 2024).

Barnhart, Joslyn. 2016. “Status Competition and Territorial Aggression: Evidence from the Scramble for Africa.” *Security Studies* 25(3): 385–419. doi:10.1080/09636412.2016.1195620.

Bell, Mark S. 2015. “Beyond Emboldenment: How Acquiring Nuclear Weapons Can Change Foreign Policy.” *International Security* 40(1): 87–119. doi:10.1162/ISEC_a_00204.

Betts, Richard K. 1980. “Surprise Despite Warning: Why Sudden Attacks Succeed.” *Political Science Quarterly* 95(4): 551–72. doi:10.2307/2150604.

Biddle, Stephen. 2001. “Rebuilding the Foundations of Offense-Defense Theory.” *The Journal of Politics* 63(3): 741–74. doi:10.1111/0022-3816.00086.

Blake, Duncan. 2014. “Military Strategic Use of Outer Space.” In *New Technologies and the Law of Armed Conflict*, eds. Hitoshi Nasu and Robert McLaughlin. The Hague: T.M.C. Asser Press, 97–114. doi:10.1007/978-90-6704-933-7_7.

Bower, Adam, and Jeffrey S. Lantis. 2023. “Contesting the Heavens: US Antipreneurship and the Regulation of Space Weapons.” *European Journal of International Security*: 1–22. doi:10.1017/eis.2023.2.

Brandt, Linda. 1994. “Defense Conversion and Dual-Use Technology.” *Policy Studies Journal* 22(2): 359–70. doi:10.1111/j.1541-0072.1994.tb01474.x.

Brown, Neville. 1971. “Reconnaissance from Space.” *The World Today* 27(2): 68–76.

Brugioni, Dino A. 1996. “The Art and Science of Photoreconnaissance.” *Scientific American*

274(3): 78–85.

Butcher, Charity. 2006. “Offense-Defense Theory: An Empirical Test.” *International Studies Review* 8(3): 489–91. doi:10.1111/j.1468-2486.2006.00608.x.

Cervino, M, S Corradini, and S Davolio. 2003. “Is the ‘Peaceful Use’ of Outer Space Being Ruled Out?” *Space Policy* 19(4): 231–37. doi:10.1016/j.spacepol.2003.08.012.

Clark, John et al. 2014. “Assessing the Full Effects of Public Investment in Space.” *Space Policy* 30(3, Part A): 121–34. doi:10.1016/j.spacepol.2014.03.001.

Clements, Benedict, Sanjeev Gupta, and Saida Khamidova. 2021. “Military Spending in the Post-Pandemic Era – IMF F&D.” https://www.imf.org/external/pubs/ft/fandd/2021/06/military-spending-in-the-post-pandemic-era-clements-gupta-khamidova.htm (February 26, 2024).

Colaresi, Michael P., Karen Rasler, and William R. Thompson. 2008. *Strategic Rivalries in World Politics: Position, Space and Conflict Escalation*. Cambridge University Press.

Davis, Lorrie A, and Lucien Filip. 2013. “How Long Does It Take to Develop and Launch Government Satellite Systems?” : 13.

Dawson, Linda. 2017. “Politics and the Space Race.” In *The Politics and Perils of Space Exploration: Who Will Compete, Who Will Dominate?*, Springer Praxis Books, ed. Linda Dawson. Cham: Springer International Publishing, 107–26. doi:10.1007/978-3-319-38813-7_6.

Detsis, Bianca, and Emmanouil Detsis. 2013. “The Benefits Brought by Space—General Public versus Space Agencies Perspectives.” *Acta Astronautica* 88: 129–37. doi:10.1016/j.actaastro.2013.03.021.

“Diplometrics | International Studies.” 2023. https://korbel.du.edu/pardee/content/diplometrics (January 29, 2024).

Duque, Marina G. 2018. “Recognizing International Status: A Relational Approach.” *International Studies Quarterly* 62(3): 577–92. doi:10.1093/isq/sqy001.

Early, Bryan R. 2014. “Exploring the Final Frontier: An Empirical Analysis of Global Civil Space Proliferation1.” *International Studies Quarterly* 58(1): 55–67. doi:10.1111/isqu.12102.

Early, Bryan R., and Erik Gartzke. 2021. “Spying from Space: Reconnaissance Satellites and Interstate Disputes.” *Journal of Conflict Resolution* 65(9): 1551–75. doi:10.1177/0022002721995894.

Ehrenfreund, P., and N. Peter. 2009. “Toward a Paradigm Shift in Managing Future Global Space Exploration Endeavors.” *Space Policy* 25(4): 244–56. doi:10.1016/j.spacepol.2009.09.004.

"ESA and Safety & Security Applications." 2024. https://www.esa.int/Space_Safety/Safety_and_security_applications/ESA_and_safety_security_applications (January 31, 2024).

Faulconbridge, Guy, Arshad Mohammed, and Guy Faulconbridge. 2024. "Nukes in Space: What Have Russia and the United States Said?" *Reuters*. https://www.reuters.com/world/nukes-space-what-have-russia-united-states-said-2024-02-21/ (February 22, 2024).

Fearon, James D. 1994. "Domestic Political Audiences and the Escalation of International Disputes." *The American Political Science Review* 88(3): 577–92. doi:10.2307/2944796.

Fuhrmann, Matthew. 2012. *Atomic Assistance: How "Atoms for Peace" Programs Cause Nuclear Insecurity*. Cornell University Press. https://www.jstor.org/stable/10.7591/j.cttn34vg (January 26, 2024).

Harvey, Brian, Henk H. F. Smid, and Theo Pirard. 2010. *Emerging Space Powers: The New Space Programs of Asia, the Middle East and South-America*. Praxis. doi:10.1007/978-1-4419-0874-2.

Hennessy, Paul. 2022. "To Cheaply Go: How Falling Launch Costs Fueled a Thriving Economy in Orbit." *NBC News*. https://www.nbcnews.com/science/space/space-launch-costs-growing-business-industry-rcna23488 (January 31, 2024).

Horowitz, Michael C. 2010. The Diffusion of Military Power *The Diffusion of Military Power: Causes and Consequences for International Politics*. Princeton University Press. doi:10.1515/9781400835102.

———. 2020. "Do Emerging Military Technologies Matter for International Politics?" *Annual Review of Political Science* 23(1): 385–400. doi:10.1146/annurev-polisci-050718-032725.

Jervis, Robert. 1978. "Cooperation under the Security Dilemma." *World Politics* 30(2): 167–214. doi:10.2307/2009958.

Jo, Dong-Joon, and Erik Gartzke. 2007. "Determinants of Nuclear Weapons Proliferation." *The Journal of Conflict Resolution* 51(1): 167–94.

Kaplow, Jeffrey M, and Erik Gartzke. 2021. "The Determinants of Uncertainty in International Relations." *International Studies Quarterly* 65(2): 306–19. doi:10.1093/isq/sqab004.

Kommel. 2020. "Exploring Insights from Emerging Space Agencies." *Aerospace Security*. https://aerospace.csis.org/exploring-insights-from-new-space-agencies/ (September 13, 2023).

Kroenig, Matthew. 2009. "Importing the Bomb: Sensitive Nuclear Assistance and Nuclear Proliferation." *Journal of Conflict Resolution* 53(2): 161–80. doi:10.1177/0022002708330287.

Landau, Emily B. 2013. “Egypt, Israel, and the WMDFZ Conference for the Middle East: Setting the Record Straight.” *Israel Journal of Foreign Affairs* 7(1): 13–16. doi:10.1080/23739770.2013.11446529.

Larson, Deborah Welch, and Alexei Shevchenko. 2010. “Status Seekers : Chinese and Russian Responses to U.S. Primacy.” *International Security* 34(4): 63–95.

Levite, Ariel, and Professor Ariel Levite. 1987. *Intelligence and Strategic Surprises*. Columbia University Press.

Lewis, James Andrew. 2014. *Space Exploration in a Changing International Environment*. Lanham Washington, DC: Rowman & Littlefield.

“Lockheed Martin Selected to Develop Nuclear-Powered Spacecraft.” 2023. *Media - Lockheed Martin*. https://news.lockheedmartin.com/2023-07-26-Lockheed-Martin-Selected-to-Develop-Nuclear-Powered-Spacecraft (January 26, 2024).

Lubojemski, Aleksander M. 2019. “Satellites and the Security Dilemma.” *Astropolitics* 17(2): 127–40. doi:10.1080/14777622.2019.1641689.

Lupovici, Amir. 2021. “The Dual-Use Security Dilemma and the Social Construction of Insecurity.” *Contemporary Security Policy* 42(3): 257–85. doi:10.1080/13523260.2020.1866845.

Mahfoud, Tara, Christine Aicardi, Saheli Datta, and Nikolas Rose. 2018. “The Limits of Dual Use.” *Issues in Science and Technology* 34(4): 73–78.

Moltz, James Clay. 2011. *Asia’s Space Race: National Motivations, Regional Rivalries, and International Risks*. Columbia University Press.

Monteiro, Nuno P., and Alexandre Debs. 2014. “The Strategic Logic of Nuclear Proliferation.” *International Security* 39(2): 7–51. doi:10.1162/ISEC_a_00177.

Musgrave, Paul, and Daniel H. Nexon. 2018. “Defending Hierarchy from the Moon to the Indian Ocean: Symbolic Capital and Political Dominance in Early Modern China and the Cold War.” *International Organization* 72(3): 591–626. doi:10.1017/S0020818318000139.

Nordenman, Magnus. 2012. “The Incredible, Shrinking Modern Military.” *The Atlantic*. https://www.theatlantic.com/international/archive/2012/11/the-incredible-shrinking-modern-military/264989/ (February 25, 2024).

Nordhaus, William, John R. Oneal, and Bruce Russett. 2012. “The Effects of the International Security Environment on National Military Expenditures: A Multicountry Study.” *International Organization* 66(3): 491–513.

“Office of Space Commerce – Helping U.S. Businesses Use the Unique Medium of Space to Benefit Our Economy.” 2024. https://www.space.commerce.gov/ (January 30, 2024).

Panagiotarakou, Eleni. 2016. “Agonal Conflict and Space Exploration.” In *The Ethics of Space Exploration*, Space and Society, eds. James S.J. Schwartz and Tony Milligan. Cham: Springer International Publishing, 47–60. doi:10.1007/978-3-319-39827-3_4.

Pelton, Joseph N., Robert J. Oslund, and Peter Marshall. 2004. *Communications Satellites: Global Change Agents*. Routledge.

Petroni, Giorgio, and Chiara Verbano. 2000. “The Development of a Technology Transfer Strategy in the Aerospace Industry: The Case of the Italian Space Agency.” *Technovation* 20(7): 345–51. doi:10.1016/S0166-4972(99)00149-2.

Powers, Ryan, and Jonathan Renshon. 2020. “International Status Concerns and Domestic Support for Political Leaders.” : 31.

Rath, Johannes, Monique Ischi, and Dana Perkins. 2014. “Evolution of Different Dual-Use Concepts in International and National Law and Its Implications on Research Ethics and Governance.” *Science and Engineering Ethics* 20(3): 769–90. doi:10.1007/s11948-014-9519-y.

Renshon, Jonathan. 2016. “Status Deficits and War.” *International Organization* 70(3): 513–50. doi:10.1017/S0020818316000163.

———. 2017. *Fighting for Status: Hierarchy and Conflict in World Politics*. Princeton University Press. https://www.jstor.org/stable/j.ctt1q1xsw9 (November 11, 2020).

Rosen, Stephen Peter. 1988. “New Ways of War: Understanding Military Innovation.” *International Security* 13(1): 134–68. doi:10.2307/2538898.

Sadeh, Eligar, James P. Lester, and Willy Z. Sadeh. 1996. “Modeling International Cooperation for Space Exploration.” *Space Policy* 12(3): 207–23. doi:10.1016/0265-9646(96)00013-6.

Schrogl, Kai-Uwe. 2011. “The Political Context for Human Space Exploration.” In *Humans in Outer Space — Interdisciplinary Perspectives*, Studies in Space Policy, eds. Ulrike Landfester, Nina-Louisa Remuss, Kai-Uwe Schrogl, and Jean-Claude Worms. Vienna: Springer, 3–14. doi:10.1007/978-3-7091-0280-0_1.

Seftas, Randy. 2001. *The Civil Space Sector*. Commission to Assess United States National Security Space Management and Organization.

Sheehan, Michael. 2013. “‘Did You See That, Grandpa Mao?’ The Prestige and Propaganda Rationales of the Chinese Space Program.” *Space Policy* 29(2): 107–12. doi:10.1016/j.spacepol.2013.03.003.

Sia, Jess. 2021. “Rocket Physics, Extra Credit: Rocket Fuels.” *The Mars Society of Canada*. https://www.marssociety.ca/2021/03/25/rocket-fuel/ (January 30, 2024).

Sobelman, Daniel. 2018. “Restraining an Ally: Israel, the United States, and Iran’s Nuclear

Program, 2011–2012.” : 28.

Souva, Mark. 2022. “Material Military Power: A Country-Year Measure of Military Power, 1865–2019.” *Journal of Peace Research*: 00223433221112970. doi:10.1177/00223433221112970.

“Space Exploration | Lockheed Martin.” 2024. https://www.lockheedmartin.com/en-us/capabilities/space/human-exploration.html (January 26, 2024).

Steer, Cassandra. 2017. “Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space.” *Georgetown Journal of International Affairs* 18: 9.

Taylor, Adam. 2024. “Global Military Spending Hits Record $2.2 Trillion amid Multiple Wars.” *Washington Post*. https://www.washingtonpost.com/world/2024/02/13/nato-spending-russia-ukraine-trump/ (February 26, 2024).

Tomz, Michael. 2007. “Domestic Audience Costs in International Relations: An Experimental Approach.” *International Organization* 61(4): 821–40. doi:10.1017/S0020818307070282.

Van Evera, Stephen. 1998. “Offense, Defense, and the Causes of War.” *International Security* 22(4): 5–43.

Ward, Steven. 2017. *Status and the Challenge of Rising Powers*. Cambridge: Cambridge University Press. doi:10.1017/9781316856444.

“Western European Armies Have Shrunk Dramatically.” 2020. *The Economist*. https://www.economist.com/graphic-detail/2020/03/02/western-european-armies-have-shrunk-dramatically (February 25, 2024).

Wicht, Anthony, and Zoe Szajnfarber. 2014. “Portfolios of Promise: A Review of R&D Investment Techniques and How They Apply to Technology Development in Space Agencies.” *Space Policy* 30(2): 62–74. doi:10.1016/j.spacepol.2014.03.003.

Williams, Michael C. 2010. “Hierarchy in International Relations. By David A. Lake. Ithaca, NY: Cornell University Press, 2009. 248p. $39.95.” *Perspectives on Politics* 8(2): 712–13. doi:10.1017/S1537592710001040.

Wohlforth, William C. 2009. “Unipolarity, Status Competition, and Great Power War.” *World Politics* 61(1): 28–57.

Zorn, E. L. 2001. *Israel’s Quest for Satellite Intelligence*. Central Intelligence Agency Washington DC Center For The Study Of Intelligence. https://apps.dtic.mil/sti/citations/ADA524044 (March 25, 2022).

CHAPTER 3

PUBLIC REACTIONS TO LEADERSHIP TYPES IN SPACE:

A DOMESTIC SURVEY EXPERIMENT[2]

[2] Jackson Tilley. To be submitted to a peer-reviewed journal

Abstract

Many states advertise space programs as peaceful, scientific endeavors spearheaded by civilian space programs. However, due to the dual-use potential of many space technologies, states often utilize these assets for military-related missions. If these missions fall under the leadership of a civil agency, then leaders may feel better protected from potential domestic pushback to the militarization of space. This paper tests that conjecture. I field a survey of U.S. citizens (N = 3,614) with three embedded experiments in which respondents are faced with a scenario detailing a potential U.S. space mission, with the treatment consisting of either civilian or military control over the mission. Respondents then indicated their level of support for various aspects of the mission. The results suggest that civilian leadership treatment does not affect overall support for the mission, but individuals prefer civilian leaders and are more hesitant about the military utilization of the mission's technologies. Results from a subsequent scenario indicate the public is drastically less likely to support these missions when the President falsely states its objectives. Additional findings from two alternative experiments involving foreign space programs and private space companies are also presented. While civilian leadership mattered for perceptions of one's own country's space program, the public does not appear to condition their support on civilian leadership when considering the foreign space program of a neutral nation. Meanwhile, support for public civilian-led space missions drastically outpaces privately-led missions

3.1 Introduction

Are individuals more accepting of space missions when run by certain authorities over others? I argue the public is more supportive of civilian-run missions, regardless of the nature of the mission, and that this effect likely carries over to individuals' views of foreign and private space missions. When considering how to achieve its goals, leaders take public opinion and

domestic audience costs into account (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019, Powers and Renshon 2020, Li and Chen 2021), and in the case of outer space, states may find it advantageous to utilize civilian-run agencies to advance military-related goals and avoid public pushback. Civil space programs can provide leaders with an alibi for the implementation of dual-use space technology for military purposes, allowing them to point to the scientific, exploratory nature of the civilian agency running the show. However, I also argue that the framing of these missions by political leaders can drastically affect support, particularly if evidence emerges that the mission was never intended to fulfill its stated purpose. This paper takes the case of the United States and its civil space agency, NASA, to examine the potential effect brought about by pursuing space technologies and programs through civil rather than military control.

In Spring 2024, I fielded three survey experiments on a representative sample of the U.S. public to test whether leadership of space missions affects support levels. The first scenario consisted of a hypothetical scenario detailing the use of observation satellites, a common dual-use technology, by either the National Aeronautics and Space Administration (NASA) or the United States Space Force (USSF). While the mission parameters and objectives were fixed in the scenario, the overseeing authority changed at random. Following, the survey presented respondents with a statement from the President confirming either the scientific or military intentions behind the mission. Respondents were then randomly assigned a scenario in which information emerged indicating the President lied about the true intentions behind the use of the observation satellite. At each stage of the experiment, I asked participants to indicate their level of support for the mission, the leaders behind it, and their hesitancy about the use of the technology. To generalize the paper's theory to foreign programs, survey participants also participated in a

second experiment and displayed their support for an Indian-run space mission after being presented with a similar scenario to the first. A third and final experiment detailed a manned mission to Mars, but this time, the treatment assigned either public civil space or private space control over the mission.

Investigating the results, I find mixed support for the paper's central theories. Overall support for the domestic civilian mission is, on average, not higher than support for the military mission, but respondents do respond in a more positive manner to specific characteristics of civilian missions, with the difference proving statistically significant. Specifically, individuals appear to trust civilian leaders at a higher rate than military leaders and display more hesitancy when considering the uses of an observation satellite if controlled by the military. If the President endorses the mission, however, overall support for the civilian mission then proves statistically higher than the alternative. Furthermore, if the individual is notified that the President miscategorized the use of the mission technology, they are far less likely to support the mission and—in the process—lose trust in the President. In attempting to translate these results to foreign space programs, Americans appear to not hold the same attitudes towards a virtually identical mission launched by India. Support for the mission, trust in leaders, and satellite use hesitancy questions in the India experiment all return statistically and substantively insignificant results, suggesting the U.S. public does not fear the space activities of foreign neutral nations. Finally, individuals clearly and loudly demonstrated their preference for public (civil-space) missions over private missions across the board. In particular, the marginal mean trust in hypothetical public leaders is 6.7% percentage points (p-value <0.001) higher than for hypothetical private CEOs. These results illustrate a limited preference for domestic civilian space leadership over military

leadership, the strong effect of a President's words, apathy for foreign space missions, and a strong inclination toward public missions over private ones.

The paper proceeds as follows. First, an overview of established literature covering domestic support for NASA and the military, governmental framing, public reaction to dual-use technologies, and the impact of leaders' statements on public opinion provides the basis for exploration of the paper's primary theory. Following an examination of the hypotheses, I break down the design of the survey experiment and proceed to present the results, elaborating on their potential impact to the papers' arguments. Robustness checks and limitations of the research design are then highlighted before the conclusion identifies avenues for future research.

3.2 Public Support for NASA and the Military

NASA has long enjoyed strong support from both domestic and international audiences (Joyce et al. 2008, Cobb 2011, Steinberg 2011). While individuals broadly support the agency, concerns persist as to its designated priorities. Namely, the allocation of funds to activities that the public thinks of as miscellaneous or non-critical presents obstacles in the way of drastically increasing the agency's budget (Cobb 2011, Pangiotarakou 2020). For civil space programs generally, domestic audiences often cite technology development, scientific research, and exploration as their preferences for the entity's role in the space community; meanwhile, individuals continue to overlook security and the implementation of national space strategies as being relevant to the civil space programs (Detsis and Detsis 2013). Demographically, individuals who are younger, male, more conservative, and have a higher level of education and socioeconomic status are generally more likely to support space activities (Cobb 2011, Burbach 2019). Although, nostalgia for the U.S.-Soviet space race of the twentieth century also plays a role in determining support (Nadeau 2013). In recent years, NASA sought to broaden its appeal by

democratizing its approach to work, primarily by involving the public in its research development and implementing open-innovation methodologies (Kaminski et al. 2016).

Like NASA, scholars find that Americans are favorable to the military as well but for different reasons. Patriotism and a history of service play a role, but many Americans also rely on the military for their own livelihoods due to economic benefits such as jobs provided by the military-industrial complex, foreign economic access, and energy dependence (Russet 1970, Adams 1982, Aldrich et al. 2006, Sparrow 2011, Ledbetter 2011, Caverley 2014, Thorpe 2014). Internationally, audiences view the U.S. military as a formidable tool of U.S. influence, often influencing conflicts negatively; however, individuals in foreign nations are more likely to welcome U.S. military presence if they have direct contact with military members or receive economic benefits from the U.S. (Chase et al. 2017, Allen et al. 2020). While Americans look fondly on both NASA and the U.S. Military, the question remains as to which they prefer to take the lead in select government programs, such as dual-use outer space missions. The next section considers how governments and political leaders tap individuals' preferences and emotions in framing programs with the ultimate motive of altering public opinion on matters such as dual-use technologies.

3.3 Political Framing and Dual-Use Technologies

Previous studies find that U.S. citizens are more likely to respond positively when programs are framed in a manner that emphasizes quality over quantity and appeals to a broad swathe of the American public (Jacoby 2000, Majoor 2011). Most importantly, however, the program needs to seem "legitimate," a characteristic often determined by media coverage (Ninan et al. 2022). Expanding the idea of framing to national security and international relations (IR), scholars point to the various ways in which they manipulate messages to the public to elicit support

for or against a designated objective. For example, during the Cold War, President Nixon framed rapprochement with China as a means of countering the U.S.'s greater adversary, the Soviet Union (Mintz and Redd 2003). Two salient modern occurrences of political framing are climate change and immigration. Gainous and Merry (2022) find that Americans look fondly at climate change initiatives when they are introduced under the guise of protecting aspects of national security, such as energy dependence. Meanwhile, Lahav and Courtemanche (2011) show that individuals are more likely to disapprove of immigration when it is treated as a physical security threat instead of a cultural one. Voss (2018) confirms these results and suggests that framing immigration as a national security issue avoids dealing with social policy issues—should immigration increase. Regardless of the subject, politicians, media outlets, and interest groups alike can utilize national cultural identities to effectively frame national security issues in a manner that suits their agenda (Hotchkiss 2010).

Dual-use technologies are viable candidates for framing due to their potential civilian and military uses. One common example is nuclear technology. Nuclear non-proliferation regimes seek to keep nuclear technology out of the hands of actors who pose a risk of weaponizing it. However, exposed proliferating states can frame their actions in a manner that aligns with civilian energy production rather than military weapons and, thereby, claim they were never out of compliance (Pauly 2022). Meyer (1995) illuminates the actions of American elites in utilizing political movements, both pro- and anti-nuclear, to paint reactors and weapons in a manner that fit their domestic or international agenda. In recent decades, the debate over nuclear technology's dual use potential expanded to outer space, with radioisotope thermoelectric generators (RTGs) coming under intense scrutiny from the public based on their perception of the technology (Schroeer and Elena 2018). Beyond reactors, the U.S. revealed intelligence in early 2024 suggesting Russia

intended to put nuclear weapons in outer space, framing the move as malicious and dangerous for all nations with assets in orbit (Reuters 2024).

Another two sectors of dual-use technologies frequently utilized for political purposes are biological research and drone development. Labeled “Dual-Use Research of Concern” (DURC), biological research developing treatments for illness can also be used to produce biological weapons that purposefully target weak points in a person’s immune system and cause widespread harm (Evan and Hays 2006). Several recent surveys display a significant lack of knowledge and concern among the public, academic journal editors, and life science practitioners when it comes to the malevolent uses of DURC, likely due to the willingness of governments and corporations to frame such research as a positive for humanity (NRC 2009, Oltman 2015, WHO 2021, MacIntyre et al. 2020). Drones, on the other hand, represent a more obvious case of dual-use potential in the minds of the public, but studies show that many drone development firms—alongside government authorities—participate in public legitimacy practices to overcome regulatory barriers to proliferation (Schulzke 2018, Mendoza et al. 2021). In the context of military drone use, the public is likely susceptible to framing techniques from various parties. For example, Walsh and Schulzke (2015) find that Americans are more likely to support drone strikes if the military advertises them as a means of preventing the loss of life on the battlefield. Meanwhile, Kreps and Wallace (2016) demonstrate the value of legal critiques by international organizations (IOs) and non-government organizations (NGOs) in lowering domestic support for drone strikes. To conclude a review of relevant literature, the final section highlights the pivotal role of leaders, such as the U.S. President, in swaying the minds of the public.

3.4 The Impact of Leaders' Statements

As the highest-ranked political official in the country, the U.S. President's words carry weight that few others can match. To get into that position of power, presidents must be proficient at persuasion and framing, particularly in reference to the American public (Feld 1958). One key factor that affects the persuasive viability of presidential statements is popularity, with more popular presidents able to sway public opinion a greater deal than unpopular presidents (Page and Shapiro 1984). Presidents can influence the public in several ways. Speeches, especially those given at a national level, not only help solidify a President's support base but can also nudge his putative opponents into reconsidering their views on certain issues (Tedin et al. 2010). To increase the chance of persuasion, presidents can craft statements that take advantage of human emotions, such as when President Kennedy framed his military buildup as a response to American fear of the Soviet Union (Meagher 2008). This same notion applies to signing statements as Presidents will attach more dramatic statements to bills that they believe have significant impact on policies important to them (Kelly and Marshal 2008)

Acting as a bridge between politics and the public, the media's voice comprises one of the greatest persuasive resources in the world, and should a President choose the right words in a press conference, the media is more likely to release positive coverage of both the President and his message (Eshbaugh-Soha 2013). Yet, some scholars, such as Dewan et al. (2009), argue that the framing and choice of a leader's words matter less than the overall message that their platform and governing party conveys to the public. Of relevance to this paper, Lin-Greenberg (2021) describes how the frame in which information about emerging technologies is presented to the public by the government, including through statements from the President, may directly affect their attitude toward utilizing them, especially if the government's message can be verified. If individuals

discover the government is not fully transparent about a specific program or technology, they are much less likely to lend their support to the cause. This study further expands upon public responses to a specific class of emerging technologies, dual-use outer space missions, and statements concerning proposed oversight of the mission.

3.5 Theory

Existing literature describes the public's general reaction to civil space agencies, dual-use technologies, and governmental framing of large-scale projects, yet few studies actively consider the integration of all three topics, particularly in an experimental framework. Furthermore, the domain of outer space is largely unexplored in the context of political activities and individuals' responses to them (Powers and Tilley 2024). In this section, I will highlight why states and leaders may choose to frame their space programs in a way that exhibits peaceful, respected motivations—even if reality proves the opposite.

As of March 2023, 74% of Americans held a favorable opinion of the National Aeronautics and Space Administration (NASA), and 65% believed the agency should continue to be involved in future space exploration (Pew 2023). In a survey the year prior, Pew Research Center found that only 25% of Americans held "a great deal of confidence" in the U.S. military. In considering how to approach large-scale, expensive initiatives, leaders must consider the optics of these programs in the eyes of the public. Should individuals disapprove of the actions taken by a leader regarding a significant undertaking, support for the leader can fall and lead to consequences for them in the future. This phenomenon illustrates the large body of IR literature concerning domestic audience costs (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019, Powers and Renshon 2020, Li and Chen 2021). In the case of outer space programs, it is plausible that the same theories hold true. If a leader gives military entities complete control over a mission

in outer space, no matter how mundane it is, it could lead to a sentiment among individuals that space is being militarized. Alternatively, if a civil space agency maintains control over the same program, individuals would probably fail to directly connect civil space leadership to military ambitions. With the exact same mission parameters and objectives in place, the only difference in this scenario is which government entity oversees it. Access to and control over a civil space agency allows a state and its leaders to avoid questions as to their intentions and potential blowback from the public.

One important distinction in this argument is that the public does not necessarily support civil over military space entities, generally, but rather the way the military may utilize dual-use technologies as potential weapons of war. Throughout recent decades, American citizens consistently supported U.S. soldiers and missions (Western 2005, Larson 2005 Liberman 2006, Burbach 2018), but the country also possesses a long history of disapproval of the militarization of dual-use technologies (Meyer 1995, Hall et al. 1996, Anthony 2013, MacIntyre et al. 2020). Factors such as the ability to prevent loss of life, propaganda, message verification, and consensus among elites can lead to higher support for the weaponization of and use of dual-use technologies (Berinsky 2007, Walsh and Schulzke 2015, Sagan and Valentino 2017, Lin-Greenberg 2021). However, by and large, Americans prefer the peaceful use of such assets across sectors such as nuclear energy, drone development, and biological research (Meyer 1995, Hall et al. 1996, Anthony 2013, MacIntyre et al. 2020). As result, we can logically extend this argument to outer space technologies with the potential to be utilized for civilian and military purposes. If given the choice between scientific and conflict-driven uses of space assets, individuals will likely choose the former, which are spearheaded by civil space agencies.

Hypothesis 1: *Individuals are more likely to support space activities when they are under the control of civil space agencies, as opposed to direct military entities*

To sell a specific frame for a policy or program in politics, leaders can endorse or legitimize the program through public statements (Meagher 2008, Tedin et al. 2010, Eshbaugh-Soha 2013). In the case of dual-use technologies, their dual-use potential makes statements from leaders regarding their implementation hard to rebuke since they could, in fact, aid civilian or military efforts (Meyer 1995, Pauly 2022). While reception to a leader's words often depends on factors such as partisanship, most Americans support civilian space efforts and have a high opinion of NASA's track record, both current and prior (Joyce et al. 2008, Cobb 2011, Steinberg 2011, Pew 2023). Regardless of the technology or mission parameters involved, the framing of space activities as civilian in nature—combined with the President's endorsement—will likely incite approval from the public.

Hypothesis 2: *Individuals are more likely to support space activities when the President indicates they are purely civil in nature.*

While a leader's statement may lead to higher approval of a program, the validity of that statement also matters. Lin-Greenberg (2021) finds that verified messages from the government concerning emerging technologies lead to higher support for those technologies. In the past, when leaders miscategorized or falsely spoke about specific issues, it led to an increase in negative press coverage and lowered approval ratings (Eshbaugh-Soha 2013). Exact verification of a government program's intentions may prove hard to verify— as is often the case for dual-use technologies, but if definitive information makes its way to the public, the consequences for both the program and the President could be dire (Pauly 2022, Sánchez-Cobaleda 2022, Schroeer and Micro 2018. As a

result, should the President actively deceive the public concerning the oversight and use of a dual-8se space program, support will likely fall.

Hypothesis 3: *Individuals are less likely to support space activities when the President lies about their military applications*

In the same way that civil space control could affect domestic support for outer space missions, the same can likely be said for international audiences. Support for civil space programs, generally, is quite high regardless of region or location (Joyce et al. 2008, Harvey et al. 2010, Detsis and Detsis 2013, Hines 2022). When hearing about foreign space activities, individuals will likely voice a higher opinion of them if they are run by civil space entities. The militarization of space by a foreign actor may even elicit greater feelings of resentment than domestic actions constituting the same outcome. Domestic audiences typically do not want foreign nations gaining an edge in the critical realm of outer space (Moltz 2011, Blake 2014, Goswami 2018, Musgrave and Nexon 2018).

Hypothesis 4: *Individuals are more likely to support foreign space activities when they are under the control of civil space agencies, as opposed to direct military entities*

One increasingly relevant factor to consider in the effect of leadership type on space programs is the private space industry. SpaceX alone accounts for 78% of all rocket launches in the U.S. as of November 2022 (U.S. ITC 2023). With private companies taking on a larger role in the global space arena, there is a noticeable lack of academic attention paid to the public response to the emerging private space companies. Do they prefer public, civil-space-led space missions, or do individuals have the same confidence in private space capabilities and leadership? Research on the public-private debate across all sectors—including healthcare, education, and infrastructure—broadly shows that individuals have mixed perceptions when it comes to the effectiveness of public

and private institutions (Rainey et al. 1976, Mnookin 1982). For example, Hvidman and Andersen (2015) find that individuals often criticize public entities for their low productivity but believe their normative aspects, such as values and policies, are exemplary. Meanwhile, private institutions are praised for their systems-based approach, yet they falter in terms of respecting human capital and lack diversity in problem-solving (Texiera and Amaral 2002, Eskildsen et al. 2004). While the referenced literature does not provide a clear answer on the public-private debate, public policy research often emphasizes the nuance in the type of public or private service being provided and how public approval can differ between sectors (Rainey et al. 1976, Mnookin 1982, Yuan et al. 2012, Hvidman and Andersen 2015, Hodge and Greve 2017).

In the case of outer space and exploration missions, I argue the public is more likely to put their confidence in public civil space agencies rather than private companies. In outer space, actions have consequences, and issues can easily arise. Individuals are likely more willing to trust leaders appointed by those they elected to office, rather than CEOs with largely unknown incentives outside of increasing profit margins. Regarding NASA's goals, they are often dictated by executive mandates from the White House and budget allocations from Congress, members of which are again elected directly by U.S. citizens (Steinberg 2011, Nadeau 2013). NASA also benefits from decades of carefully crafted branding that labels the agency as a peaceful entity dedicated to scientific endeavors (Kaminski et al. 2016). In other words, it is an agency designed to appeal to the largest possible audience. Companies, in contrast, are designed to appeal to their customer base and not necessarily the public. One last noteworthy point is that the U.S., specifically, largely identifies space activities with patriotism following the Cold War-era space race, and consequently, its citizens would probably prefer to see major space activities oriented in a manner that increases U.S. recognition rather than private revenue (Cobb 2011, Nadeau 2013).

Americans' indirect involvement in determining NASA's priorities through elected representatives, combined with the mass-appealing scientific and patriotic branding of NASA developed over recent decades, leads to the conclusion that Americans will likely prefer public rather than private control of space activities.

Hypothesis 5: *Individuals are more likely to support space activities when they are under the control of civil space agencies, as opposed to private entities.*

With these five hypotheses in play, I argue that the public maintains a preference for domestic and foreign civil space programs over militaristic and private ones and—in the case of the U.S.—programs that are endorsed honestly by leaders such as the President. In the next section, I describe an experimental survey that puts these theories to the test.

3.6 Research Design and Data Analysis

In the spring of 2024, I conducted a survey on a sample of the American public using the survey platform Lucid. To ensure a representative sample, Lucid integrates demographic quotas on age, gender, region, and ethnicity in its distribution model. In total, 3,614 individuals participated in the survey, of which 2,753 (76%) passed pre-treatment attention checks. Those who did not pass were prevented from completing the remainder of the survey. To gauge participants' knowledge relevant to the treatment, several pre-treatment questions preceded the experiments themselves. The first series of questions tested the individuals' knowledge of current space activities such as human spaceflight vehicles, the International Space Station (ISS), and which countries possessed launch capabilities. In the second set, questions measured the level of support for NASA, the USSF, India, and the private space industry. All questionnaires in the survey were scaled from 0 to 100. Prior to the treatment scenarios, all participants read the following introduction:

"In the following set of questions, we will ask you about a hypothetical scenario involving activities in outer space. While they are hypothetical, we have tried to describe them in ways that might closely resemble a real future event. Please read each scenario closely and then indicate your support for the measures described in the questions that follow."

From this point on, I randomized the viewing order of three distinct experiments to avoid potential priming effects. The first experiment details a domestic-based mission led by the U.S.'s civil and military entities. Private entities are not included as a treatment for the first experiment due to private space companies remaining relatively irrelevant outside of a handful of countries. Following, a second experiment overviews a similar but foreign-based mission led by India's civil and military space entities. Finally, the last experiment pits the U.S.'s civil space program against a hypothetical private space company in a manned mission to Mars. Together, the three experiments directly test the paper's theory by corresponding to individual hypotheses, as shown in Table 1.

To ensure robustness of the displayed effects for each experiment, I filtered the data used in the OLS models by post-treatment manipulation check accuracy. Following each experiment, more than two-thirds (>67%) of respondents answered the post-treatment manipulation question(s) correctly, on average. All effects found to be statistically significant in the original models remain so when limiting the respondent pool to only those that answered the post-treatment questions correctly. For some models, such as those involving NASA and the USSF, the effects exhibit even greater statistical and substantive significance, specifically in relation to a preference for NASA leadership and increased hesitancy over USSF satellite uses. Meanwhile, the effect of civilian and military leadership on support for foreign space activities continues to express a distinct lack of

significance in any respect. Further materials and plots detailing the survey's mechanisms can be found in the appendix.

Table 3.1: Hypothesis and Experiment Correlations

Hypothesis	Experiment Testing the Theory
Hypothesis 1: Public support for civil over military space activities.	Experiment 1: Domestic Mission (Civil vs. Military Treatment)
Hypothesis 2: Public support for civil space activities following a Presidential statement	Experiment 1: Domestic Mission (Civil vs. Military Treatment Post-Presidential Statement)
Hypothesis 3: Public support for civil space activities following a false Presidential Statement	Experiment 1: Domestic Mission (Civil vs. Military Treatment x Honesty Treatment)
Hypothesis 4: Public support for foreign civil over military space activities	Experiment 2: Foreign Mission (Foreign Civil vs. Military Treatment)
Hypothesis 5: Public support for public over private space activities	Experiment 3: Alternative Domestic Mission (Private vs. Public Treatment)

Following the full collection of response data, I estimate average treatment effects (ATE) and marginal means for each experiment by using OLS regressions. For each of the twelve models, the response to each question—including levels of support, trust in leaders, or hesitancy over uses—acts as a dependent variable regressed on treatment indicators and several pre-treatment controls.

While the overall level of support for a mission indicates initial reactions to the leadership treatment, additional dependent variables, such as trust in individuals running the program and hesitancy over satellite uses, aid in determining which components of the mission alters public perception the most. Support for a program can rely heavily on how much trust individuals have for the program's leader to lead effectively. Civilian scientists and military generals are two different classes of leaders with different motives, and consequently, this difference may affect the public's perception of the overall mission. Due to the dual-use nature of the technology involved in the mission, measuring respondents' hesitancy over the technology's uses is also useful as it can discern whether leadership type affects hesitancy and thereby support for the mission overall. Control variables in the models include the respondent's knowledge of current outer space activities, age, gender, education, political party, and income level. Selection of control variables takes motivation from the indicators for support of U.S. space activities found by Cobb (2011) and Burbach (2019). In the second and third experiments, an additional control variable indicating the respondent's feelings towards India or the private space industry is added to the model. Following each of the previous three experiments, post-treatment manipulation questions garner how well participants understood the scenarios and their treatments. The subsequent sections break down the survey design of each experiment, followed by an analysis of their results.

3.7 Domestic Mission Experiment

Table 3.2: Domestic Experiment Treatment Conditions

Fixed: Mission-Type	Varied: Leadership	Fixed: Statement	Varied: Validity
U.S. Observation Satellite Mission	Led by NASA	**The U.S. President confirms the either civilian or military use of the satellite.**	Information reveals the truth of the President's statement
	Led by the USSF		Information reveals the fallacy of the President's statement

The first experiment involved an announcement detailing the launch of an observation satellite with the power to image small objects on the Earth's surface. While the mission objectives of the scenario remained the same, the treatment allowed for either NASA or USSF oversight over the mission. The scenario had one treatment, except for the follow-on Presidential scenario in which two treatments interact. The treatment changed the wording of the scenario by including the identity of the overseeing authority (NASA or USSF), the type of leaders in charge (civilian scientists or military generals), and whether the program overall was civilian- or military-run. Following treatment, respondents answered questions on the extent to which they supported the mission, trusted its leaders, and were hesitant about the uses of the observation satellite. Immediately after, participants read a statement from the President, not only confirming the leadership behind the program but also providing more context regarding what the satellites would be used for. Based on the treatment assigned to the participant in the previous scenario, the President claimed the satellite would help monitor extreme weather, wildfires, and pollution—in

the case of NASA—or enhance national security by providing intelligence on adversaries' capabilities—in the case of the USSF. The next question asked respondents to indicate whether the President's statement caused them to feel better about the mission. Ending this scenario, one final randomized statement presented itself to the participants, elaborating on if the mission was, in fact, utilized for its intended purpose years after the fact. If not, the statement revealed the satellite's true purpose. The final set of questions asked whether the individual still supported the mission and if the revealed information increased their trust in the President.

Table 3.3: Multivariate Analysis of Support Following Leadership Treatment

	Dependent variable: Response Level (0-100):		
	Support for Mission	Trust in Leaders	Use Hesitancy
	Model 1	Model 2	Model 3
Domestic Civil Treatment	-0.162	3.474***	-2.276*
	(1.131)	(1.186)	(1.214)
Space Knowledge	5.868***	0.327	2.806
	(1.854)	(1.943)	(1.990)
Age	0.053	-0.007	-0.040
	(0.033)	(0.034)	(0.035)
Education	0.00001	0.0002	-0.002
	(0.001)	(0.002)	(0.002)
Income	0.004	0.001	-0.001
	(0.003)	(0.004)	(0.004)
Male	6.269***	3.772***	-2.279*
	(1.166)	(1.222)	(1.251)
Categorical Party ID	YES	YES	YES
Constant	57.672***	58.700***	64.465***
	(2.105)	(2.206)	(2.259)
Observations	2,383	2,383	2,383
R2	0.042	0.036	0.005
Adjusted R2	0.038	0.032	0.001
Residual Std. Error (df = 2373)	27.564	28.884	29.580
F Statistic (df = 9; 2373)	11.444***	9.718***	1.333
Note:	*p<0.1; **p<0.05; ***p<0.01		

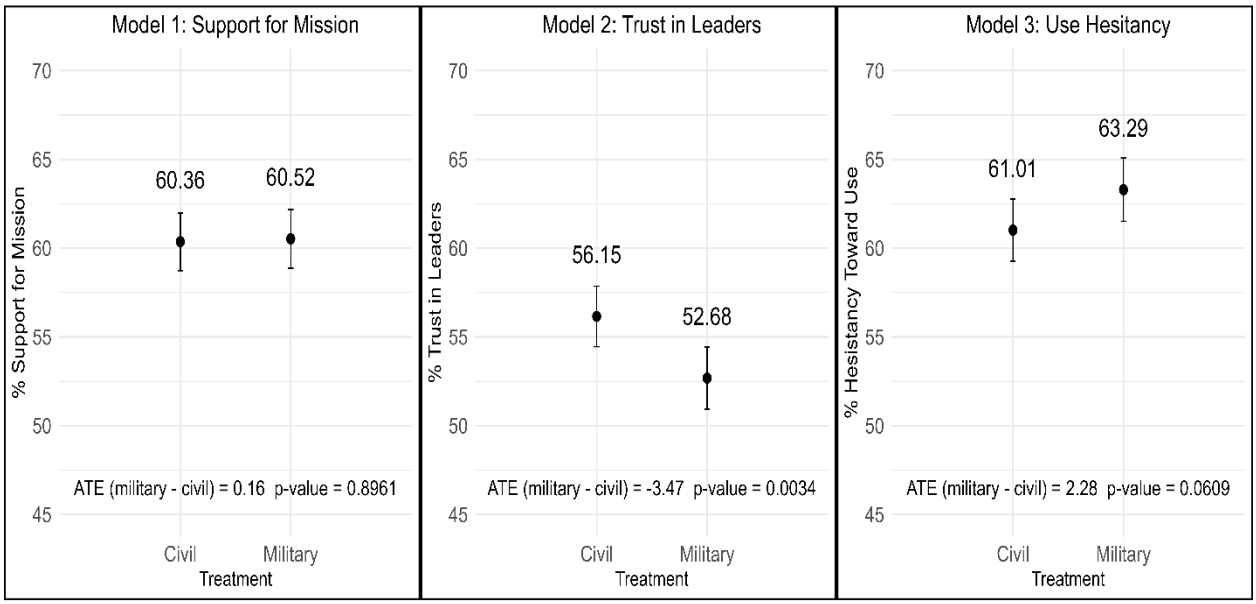

Figure 3.1: Marginal Mean Support for Domestic Civil and Military Missions, Trust in Their Leaders, and Hesitancy Over Satellite Uses

Restricting our attention to the left panel of figure 1 and the ATE of oversight type on support for the domestic-based mission, neither NASA nor USSF leadership support varied across treatments, and substantively, support levels appear almost identical. Nevertheless, as we shift our gaze to the middle panel, individuals appear to trust civilian leaders, namely the civilian NASA scientists listed in the scenario, with a marginal mean of 3.47 percentage points (p-value = 0.0034) greater than military leaders. Individuals also seem increasingly hesitant about the use of observation satellites by the USSF, as the marginal mean level of hesitancy for the civil space mission is 2.28 percentage points lower than for the identical military one. Again, however, while the result of the treatment on use-hesitancy is not substantively large, it is statistically significant above the 90% percentile (p-value = 0.0609). Out of all three ATEs, use-hesitancy was the most expected due to the potential risks of militarizing space that individuals may perceive from a military-led mission. While mission support demonstrates apathy towards the treatment

conditions, trust in leaders and use hesitancy display higher trust among participants for civilian leaders and their utilization of the mission's satellite. Consequently, this outcome represents mixed support for Hypothesis 1.

Table 3.4: Multivariate Analysis of Support Following Presidential Treatments

	Dependent variable: Response Level (0-100):		
	Support for Mission (Post-statement)	Support for Mission (Post-true/false)	Trust in President (Post-true/false)
	Model 4	Model 5	Model 6
Domestic Civil Treatment	2.060*	-4.022**	-7.811***
	(1.185)	(1.642)	(1.753)
True Statement Treatment		4.114**	2.719
		(1.624)	(1.734)
Domestic Civil * True Statement		3.442	5.935**
		(2.298)	(2.456)
Space Knowledge	5.062***	6.474***	2.980
	(1.942)	(1.865)	(1.992)
Age	0.039	0.118***	-0.079**
	(0.034)	(0.033)	(0.035)
Education	-0.001	0.001	-0.001
	(0.002)	(0.001)	(0.002)
Income	-0.002	0.001	0.001
	(0.004)	(0.004)	(0.004)
Male	1.299	4.348***	2.040
	(1.221)	(1.172)	(1.252)
Categorical Party ID	YES	YES	YES
Constant	62.890***	55.647***	67.017***
	(2.201)	(2.298)	(2.454)
Observations	2,369	2,356	2,356
R2	0.091	0.063	0.126
Adjusted R2	0.088	0.059	0.122
Residual Std. Error	28.775 (df = 2359)	27.534 (df = 2344)	29.404 (df = 2344)
F Statistic	26.347*** (df = 9; 2359)	14.375*** (df = 11; 2344)	30.724*** (df = 11; 2344)
Note:		*p<0.1; **p<0.05; ***p<0.01	

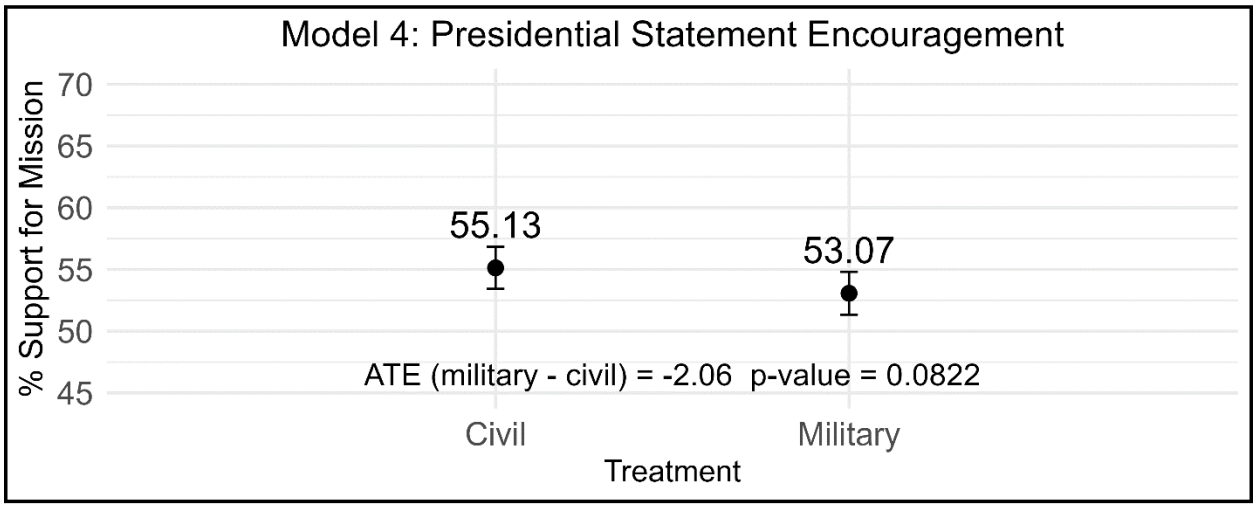

Figure 3.2: Marginal Mean Support for Domestic Civil and Military Missions Following a Presidential Statement Describing its Intended Purpose

Interestingly, while results from the first scenario did not indicate significantly higher levels of support for a civilian mission, Figure 4 shows that a statement from the President describing the purpose behind the mission might be enough to nudge individuals' perceptions over the line. This implies that the decision process for individuals is inherently political, in that their choice can potentially be altered by statements from political leaders. In Figure 2, the civilian-led mission averages a marginal mean support of 2.06 percentage points (p-value = 0.0822) higher than the military. This effect itself is not particularly substantive but does signal that individuals prefer a space mission involving climate science over a program focused on intelligence-gathering. Therefore, the observed effect lends credit to Hypothesis 2, detailing the increased likelihood of individuals to support space activities when the President describes them as purely civil in nature. One key factor that may sway the effects of the model is partisanship, which was controlled for with a categorical *Party ID* variable in the model. Should the participant actively connect the

President making the statement to the current President in office which, in this case is President Biden, it might alter their perception of the statement in a positive or negative manner.

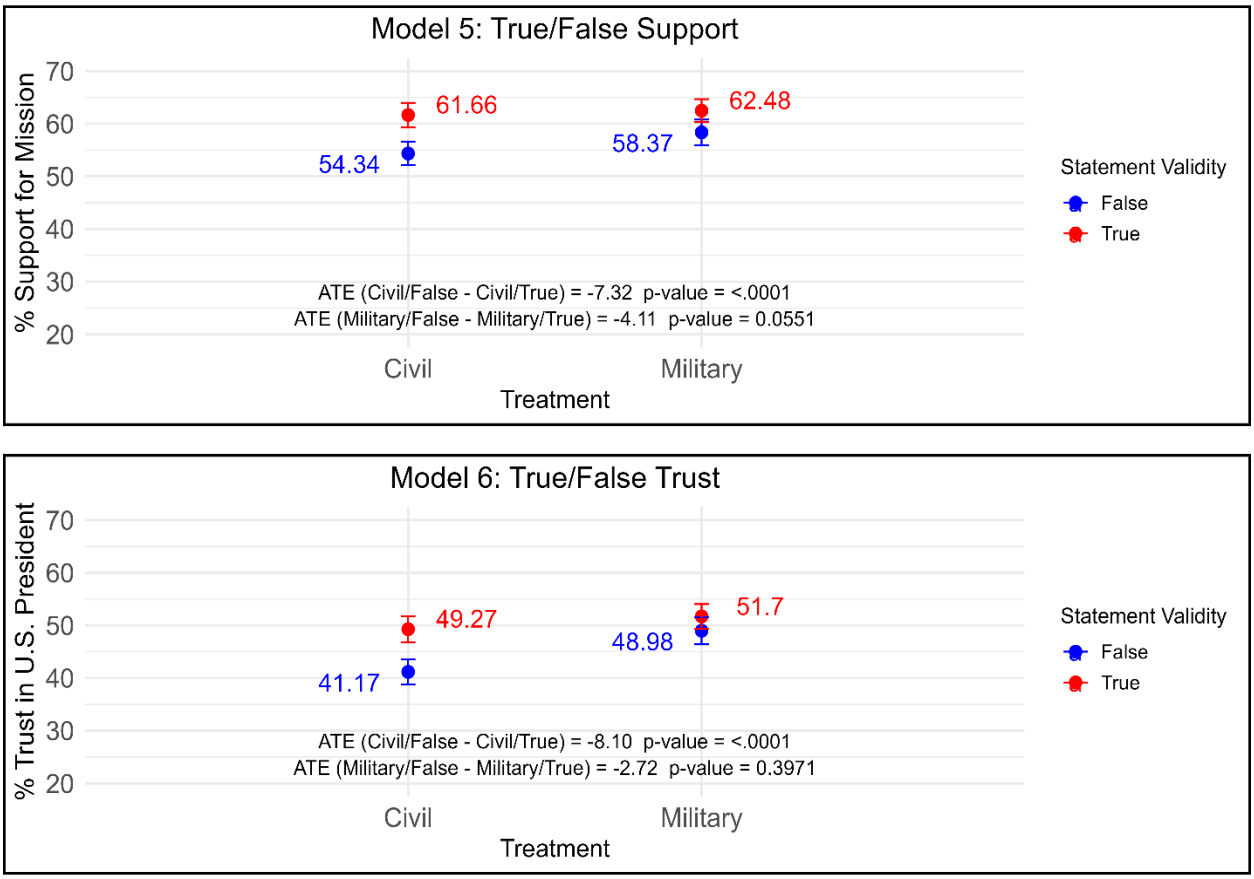

Figure 3.3: Marginal Mean Support for Domestic Civil and Military Missions and Trust in the Presidency After Information Reveals the Validity of the President's Statement.

Figure 3 showcases the effect of the public's support for the mission and trust in the Presidency following a treatment indicator that states whether the President's previous statement is truthful or not. The models sourced for these figures use an interaction term multiplying the leadership treatment by the true/false treatment. Control variables from the first set of models detailing the domestic mission are also utilized here. Across both panels, it is immediately apparent that individuals value truthful statements over false ones. In the top panel, the difference in the

ATE of statement validity on support for civil space missions is 7.32 percentage points (p-value = 0.0001), a highly significant effect. Meanwhile, the difference in the ATE of statement validity on military space missions is slightly lower at -4.11 percentage points (p-value = 0.0551). The reasoning behind the smaller difference between truthful and untruthful statements for military missions remains unclear. Perhaps individuals are less appalled when their leaders lie about military matters compared to civilian ones—especially if the real purpose of the mission was scientific and, therefore, relatively harmless.

Shifting our attention to the bottom panel, the results largely tell the same story. Individuals are more likely to trust the President at an ATE of 8.10 percentage points (p-value = <.0001) after hearing information that confirms the President's statement on a civilian-led mission. For military-led space missions, truthful statements led to an ATE of -2.72 percentage points (p-value = 0.3971) when moving from truthful to untruthful statements, an insignificant result. Again, respondents appear to actively react worse to false statements in regards to civilian missions. The relationship exhibited here may reflect some level of apathy from individuals in response to the President lying about the purpose of military programs, since a civilian-utilization of the technology provides a net good for the public. Regardless, due to the insignificance of the effect, more research is required before jumping to conclusions on the effect of falsely framing space activities and its consequences for the public's trust in the President. Overall, these results demonstrate moderate support for Hypothesis 3, suggesting that individuals are less likely to trust the President when he lies about the applications of space activities.

3.7 Foreign Mission Experiment

Table 3.5: Foreign Experiment Treatment Conditions

Fixed: Mission-Type	Varied: Leadership
Indian Observation Satellite Mission	Lead by ISRO
	Lead by the DSA

In the second experiment, the same space mission involving the launch of an observation satellite is utilized, but this time in the context of a foreign-controlled mission. The dependent variables remain the same; however, the OLS model now contains a control variable for U.S. public support for India derived from a pre-treatment question in the survey that asked respondents how valuable of a U.S. ally they believed India to be.

Choosing a foreign nation for this scenario proved difficult, as I knew biases in the American public toward friendly and unfriendly states would drastically affect the results. U.S. citizens would likely approve of British space programs at a higher rate than Russian space programs, for example, regardless of whether military or civilian entities oversaw it. Eventually, I settled on India as the nation of choice for two primary reasons. First, India is a rising space power capable of providing domestic launch services and developing its own observation satellites. Second, the country maintains a relatively neutral stance on the world stage. For instance, while India signed on to the U.S.-led Artemis Accords, it also failed to criticize the Russian invasion of Ukraine and continues to import Russian military weapons (State Department 2023, Tellis 2022). When India is implemented into the treatment scenario, the exact mission parameters remain the same, but NASA is substituted for the civilian-led Indian Space Research Organization (ISRO) and the USSF for the Defense Space Agency (DSA). Participants then responded to the same set

of questions on support for the mission, trust in leaders, and hesitancy over the satellite's uses. However, unlike the domestic experiment, the foreign experiment halts here and does not include statements from leaders and differences in their validity.

Table 3.6: Multivariate Analysis of Support Following Foreign Treatment

	Dependent variable: Response Level (0-100)		
	Support for Mission	Trust in Leaders	Use Hesitancy
	Model 7	Model 8	Model 9
Foreign Civil Treatment	0.871	0.630	-1.297
	(1.087)	(1.099)	(1.208)
India Sentiment	0.405***	0.407***	0.073***
	(0.021)	(0.021)	(0.023)
Space Knowledge	-2.085	-5.961***	2.994
	(1.802)	(1.821)	(2.003)
Age	-0.180***	-0.229***	0.128***
	(0.031)	(0.032)	(0.035)
Education	0.001	0.002	-0.001
	(0.001)	(0.001)	(0.002)
Income	-0.002	0.001	0.001
	(0.003)	(0.003)	(0.004)
Male	3.826***	2.829**	-0.831
	(1.120)	(1.132)	(1.245)
Categorical Party ID	YES	YES	YES
Constant	41.686***	40.964***	53.805***
	(2.281)	(2.306)	(2.536)
Observations	2,361	2,361	2,361
R2	0.182	0.187	0.014
Adjusted R2	0.178	0.184	0.010
Residual Std. Error (df = 2350)	26.284	26.562	29.211
F Statistic (df = 10; 2350)	52.123***	54.136***	3.442***
Note:	*p<0.1; **p<0.05; ***p<0.01		

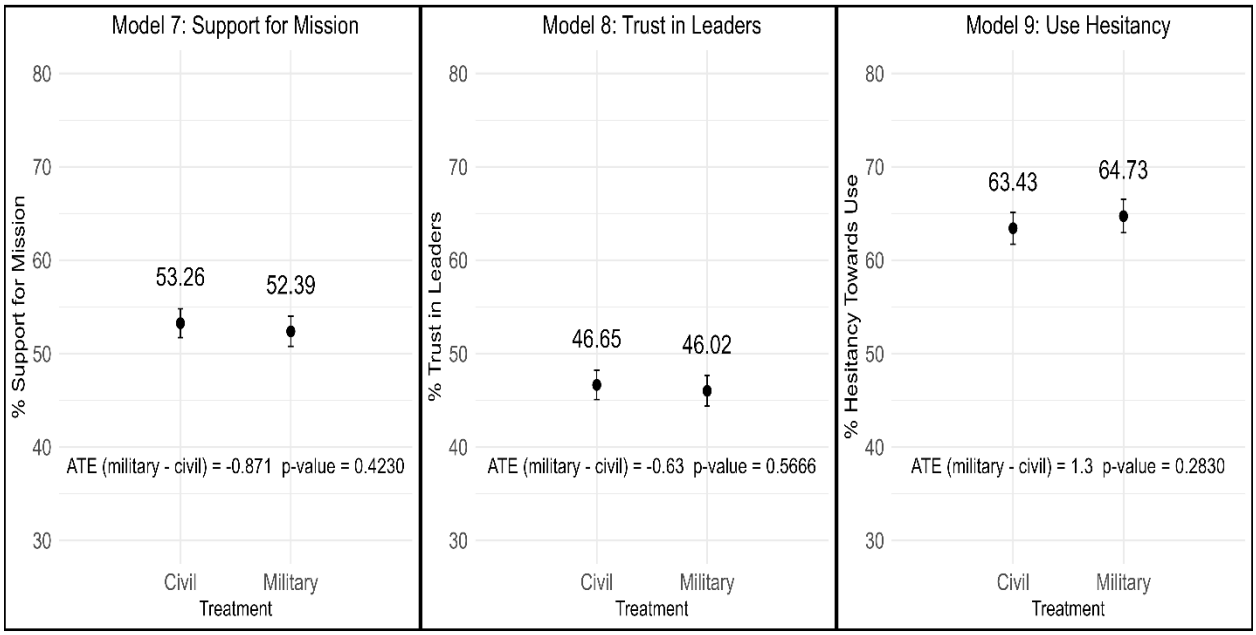

Figure 3.4: Marginal Mean Support for Foreign Civil and Military Missions, Trust in Their Leaders, and Hesitancy Over Satellite Uses

The narrative changes from the first experiment as we analyze results from the foreign-based experiment involving an Indian space mission. If the U.S. public possesses little interest in civilian-led missions, an identical mission led by India fails to capture their attention at all. In the above figure, we can observe that the treatment indicator of civilian vs. military oversight has no bearing on support levels for the overall mission, trust in its leaders, or hesitance over the satellite's uses. Substantively, the difference in support levels in marginal, and statistically, none of the ATEs stand out. Why might the domestic scenario attract a stronger response than a foreign scenario, particularly when foreign progress in space could negatively affect U.S. national security? The answer likely lies in the choice of country in the foreign-based scenario. Scholars previously identified the unwillingness of Americans to tolerate foreign dominance in outer space, but they largely analyze the question in the context of U.S. adversaries and not neutral states (Moltz 2011,

Blake 2014, Goswami 2018, Musgrave and Nexon 2018). India, as a neutral country, does not represent an existential or militaristic threat to the United States, and as a result, likely does not appear as threatening to U.S. citizens compared to nations such as China or Russia. Subsequently, respondents may feel a renewed sense of apathy pertaining to any Indian space activities, regardless of civilian or military intentions. In the future, studies continuing this line of research should consider several states, including those that garner both positive and negative reception from the American public. While these results seemingly indicate a lack of support Hypothesis 4, they also suggest that Americans do not care about the space activities of "neutral" nations, which itself is noteworthy. Should this finding be replicated, it could demonstrate the potential for states to progress their dual-use space programs without fearing blowback from the U.S., if the American public is largely apathetic to them.

3.8 Alternative Domestic Mission Experiment

Table 3.7: Public vs. Private Experiment Treatment Conditions

Fixed: Mission-Type	Varied: Leadership
Manned Mission to Mars	Lead by NASA
	Lead by a Private Space Company

The final experiment pitted NASA against a hypothetical, unnamed private space company in a first-ever mission to Mars. Because private space companies possess different motivations from military space entities, the treatment required a different, more believable scenario. At least half a dozen private space companies expressed interest in developing Mars-bound missions as of 2023 (Nam 2023). While private-public partnerships between private space companies and NASA

are common, several companies, such as SpaceX and Blue Origin, are well on their way to independently carrying out manned space missions (Grind 2024). Consequently, this scenario considers the treatment entity—NASA or the hypothetical private space company—as conducting the mission on its own. In the scenario, a statement announces a manned mission to Mars, who oversees the program itself and its safety standards (NASA or private space company), and the leaders behind it (civilian scientists or a CEO). Furthermore, the scenario states that the assigned authority will likely conduct and oversee future missions to Mars as well. Respondents then indicate to what extent they support the program, trust its leaders, and believe the overseeing organization possesses the capabilities to successfully complete the mission. In the data analysis portion of the experiment, the models' control variables remain largely the same as previous experiments outside of one exception. A private approval variable, taken from a pre-treatment check and measuring expressed support for the private space industry taking on a greater role in space exploration, is now included.

Table 3.8: Multivariate Analysis of Support Following Private Treatment

	Dependent variable: Response Level (0-100)		
	Support for Mission	Trust in Leaders	Confidence in Capabilities
	Model 10	Model 11	Model 12
Private Treatment	-2.603**	-6.744***	-5.799***
	(1.094)	(1.097)	(1.049)
Private Sentiment	0.437***	0.405***	0.377***
	(0.020)	(0.020)	(0.019)
Space Knowledge	2.837	-0.865	0.947
	(1.803)	(1.808)	(1.729)
Age	-0.116***	-0.056*	-0.063**
	(0.031)	(0.031)	(0.030)
Education	0.0005	0.0005	0.0003
	(0.001)	(0.001)	(0.001)
Income	-0.001	0.002	0.003
	(0.003)	(0.003)	(0.003)
Male	6.685***	1.972*	2.785**
	(1.142)	(1.145)	(1.095)
Categorical Party ID	YES	YES	YES
Constant	41.878***	43.042***	50.382***
	(2.233)	(2.239)	(2.141)
Observations	2,369	2,369	2,369
R2	0.217	0.187	0.178
Adjusted R2	0.214	0.183	0.175
Residual Std. Error (df = 2358)	26.545	26.611	25.447
F Statistic (df = 10; 2358)	65.413***	54.062***	51.113***
Note:	*p<0.1; **p<0.05; ***p<0.01		

Figure 3.5: Marginal Mean Support for Private and Public Missions, Trust in Their Leaders, and Confidence in Their Capabilities

In Figure 5, we examine the difference in support for various aspects of a manned mission to Mars, with the treatment indicator representing either a NASA- or private space company-sponsored mission. From all three panels, it is clear the public vastly favors public space ventures over private ones. For the hypothetical manned mission to Mars, marginal mean support for the NASA-sponsored mission reached 61.54%, clearing support for the private-sponsored mission by an ATE of 2.6 percentage points (p-value = 0.00174). Public leaders, in the form of civilian scientists, also appear to attract increased trust from individuals over private CEOs as the ATE between the two treatments is 6.74 percentage points (p-value = <.0001) in favor of trust in public leaders. In the last model, NASA again garnered higher support than the private company as the ATE of introducing the public mission into the scenario increased marginal mean confidence in their capabilities by 5.8 percentage points (p-value = <.0001). All three models present statistically

and substantively significant results, with survey participants responding especially negatively to private CEOs. In total, the effects observed here provide strong backing for Hypothesis 5 and the theory behind individuals preferring public missions over private ones.

Narrowing our attention to the dislike of private space company leaders, participants in this survey likely visualized the hypothetical private company in the scenario as a currently successful private space company— such as SpaceX or Blue Origin. If this is the case, individuals' views of the companies' CEOs may bias a participant's response. For example, in 2023 and early 2024, Elon Musk repeatedly used his social media platform *X* to push right-wing talking points, and in July, Musk officially endorsed Donald Trump for president (Conger 2024). Consequently, his actions likely alienated much of the left-leaning U.S. public and possibly lowered public approval of his companies, such as SpaceX. In the case of Blue Origin, a recent poll showed that 65% of registered voters in the U.S. maintained an unfavorable view of CEO Jeff Bezos, which could again potentially diminish his company's perception in the eyes of the public (Shapero 2024). Should these assumptions hold true, it would indicate that the U.S. public's view of private space companies remains heavily dependent on who leads them. This implies that the results showcased in this survey might not stay relevant in the future as rising private space companies with new CEOs jump into the private space arena.

3.9 Conclusion and Future Research

As humanity's aspirations in outer space grow, more nations will want to participate in their own space activities so as not to miss out on the numerous benefits provided by space-based assets. When considering how to approach space programs, most governments are faced with two choices. The first option involves developing a space program founded on military principles and technology and under the jurisdiction of the military. In contrast, the second option allows a state

to grow a domestic civilian-led space program, focused—at least from an outside perspective—on peaceful, scientific values. This paper argues why the latter option is more attractive for leaders by providing experimental evidence for why the public is more likely to support civilian efforts in space, even if their activities appear identical to hypothetical military-sponsored ones.

After conducting a survey of 3,614 members of the U.S. public in the Spring of 2024, I used OLS regressions to produce marginal means and average treatment effects for the effects of domestic civilian and military leadership on a hypothetical observation satellite mission. The first experiment included a second portion measuring individuals' support for the mission following hypothetical information from the President regarding the mission's purpose and responses if that information was outed as untruthful. In a second experiment, I analyzed the same civilian versus military effects involving a foreign-space mission, and in the third, I tested the public's preference for public space mission over private ones. The results indicate that while individuals do not blatantly support civilian over military leadership in the context of the same space mission, they do actively trust civilian leaders at a higher rate and are more likely to feel hesitant about how the military would use the technology involved in the mission. Regardless of the mission's leadership, individuals are far less likely to support the mission if the President lies about its true purpose, and simultaneously, the individual's trust in the President falls in the process. In the foreign-based experiment, the U.S. public appears apathetic to either foreign civilian or military leadership over an observation satellite mission; however, the choice of India as the foreign nation in the scenario likely explains the lack of significance found in the effects. Finally, results from the private company experiment showcase the strongest observed treatment effects as individuals are much more supportive of a civilian-led mission to Mars than one led by a private space company. Notably, survey participants responded adamantly in favor of NASA scientists at the helm of the

mission instead of a private company CEO, and they also voiced a much greater confidence in NASA's capabilities to complete the mission over private efforts. As a caveat, biases for or against current CEOs of current, popular private space companies may bias support levels for the hypothetical private space company.

There are several avenues for future research to pursue. In the spirit of variety, future surveys could describe space missions based on different types of dual-use technologies, possibly including nuclear energy, debris removal, or communications systems. Focusing on foreign space programs, further examination of a diverse set of nations is required. In a follow-up survey, scholars could detail space missions run by the civilian or military entities of nations both friendly and unfriendly to the U.S. This would allow for an understanding of whether the country of choice does, in fact, bias responses or whether the U.S. public feels largely unconcerned with foreign space programs broadly. Expanding the scope beyond the U.S., similar surveys of foreign respondents living in nations with both civilian and military space efforts could illuminate whether the results found in this analysis are generalizable to foreign audiences. Another topic not covered in this study is public-private relationships. Would the public support private space activities to a greater degree if they were done in coordination with a public space program? How might individuals react if the President endorsed a privately-led space mission? These ideas represent the tip of the iceberg in the context of academic research on civil space programs and the politics behind them. As outer space becomes increasingly vital for national development, leaders must consider the benefits and consequences of framing their space programs as civilian or military enterprises.

3.10 References

Allen, Michael A., Michael E. Flynn, Carla Martinez Machain, and Andrew Stravers. 2020. "Outside the Wire: U.S. Military Deployments and Public Opinion in Host States." *American Political Science Review* 114(2): 326–41. doi:10.1017/S0003055419000868.

Anthony, Ian. 2013. "The Evolution of Dual-Use Technology Controls : A Historical Perspective." In *Technology Transfers and Non-Proliferation*, Routledge, 25–44. doi:10.4324/9780203798973-4.

Atske, Sara. 2023. "Americans' Views of Space: U.S. Role, NASA Priorities and Impact of Private Companies." *Pew Research Center Science & Society*. https://www.pewresearch.org/science/2023/07/20/americans-views-of-space-u-s-role-nasa-priorities-and-impact-of-private-companies/ (October 2, 2023).

Bower, Adam, and Jeffrey S. Lantis. 2023. "Contesting the Heavens: US Antipreneurship and the Regulation of Space Weapons." *European Journal of International Security*: 1–22. doi:10.1017/eis.2023.2.

Burbach, David T. 2019. "Partisan Rationales for Space: Motivations for Public Support of Space Exploration Funding, 1973–2016." *Space Policy* 50: 101331. doi:10.1016/j.spacepol.2019.08.001.

Caverley, Jonathan D. 2014. *Democratic Militarism: Voting, Wealth, and War*. Cambridge: Cambridge University Press. doi:10.1017/CBO9781107551008.

Chase, Michael S., Cristina L. Garafola, and Nathan Beauchamp-Mustafaga. 2018. "Chinese Perceptions of and Responses to US Conventional Military Power." *Asian Security* 14(2): 136–54. doi:10.1080/14799855.2017.1301931.

Crisman-Cox, Casey, and Michael Gibilisco. 2018. "Audience Costs and the Dynamics of War and Peace." *American Journal of Political Science* 62(3): 566–80.

Detsis, Bianca, and Emmanouil Detsis. 2013. "The Benefits Brought by Space—General Public versus Space Agencies Perspectives." *Acta Astronautica* 88: 129–37. doi:10.1016/j.actaastro.2013.03.021.

Dewan, Torun, Macartan Humphreys, and Daniel Rubenson. 2009. "The Impact of Leaders and the Messages They Convey: Evidence From a Field Experiment in British Columbia."

Emerging Technologies and Dual-Use Concerns: A Horizon Scan for Global Public Health. 2021. World Health Organization.

Evan, William M., and Bret B. Hays. 2006. "Dual-Use Technology In the Context of the Non-Proliferation Regime." *History and Technology* 22(1): 105–13. doi:10.1080/07341510500517850.

Faulconbridge, Guy, Arshad Mohammed, and Guy Faulconbridge. 2024. "Nukes in Space: What

Have Russia and the United States Said?" *Reuters*. https://www.reuters.com/world/nukes-space-what-have-russia-united-states-said-2024-02-21/ (February 22, 2024).

Fearon, James D. 1994. "Domestic Political Audiences and the Escalation of International Disputes." *The American Political Science Review* 88(3): 577–92. doi:10.2307/2944796.

Feld, M.D. 1958. "Political Policy and Persuasion: The Role of Communications from Political Leaders." *Journal of Conflict Resolution* 2(1): 78–89. doi:10.1177/002200275800200109.

Gainous, Jason, and Melissa K. Merry. 2022. "Climate Change as a National Security Issue: Examining Framing Effects Across Party." *American Politics Research* 50(2): 199–212. doi:10.1177/1532673X211053213.

Gomez, Miguel Alberto, and Gregory H Winger. 2024. "Third-Party Countries in Cyber Conflict: Public Opinion and Conflict Spillover in Cyberspace." *Journal of Peace Research*: 00223433241235852. doi:10.1177/00223433241235852.

Goswami, Namrata. 2018. "China in Space: Ambitions and Possible Conflict." *Strategic Studies Quarterly* 12(1): 74–97.

Grind, Kirsten. 2024. "Elon Musk's Plan to Put a Million Earthlings on Mars in 20 Years." *The New York Times*. https://www.nytimes.com/2024/07/11/technology/elon-musk-spacex-mars.html (August 17, 2024).

Harvey, Brian, Henk H. F. Smid, and Theo Pirard. 2010. *Emerging Space Powers: The New Space Programs of Asia, the Middle East and South-America*. Praxis. doi:10.1007/978-1-4419-0874-2.

Hastedt, Glenn P. 2007. *White House Studies Compendium*. Nova Publishers.

Hodge, Graeme A., and Carsten Greve. 2017. "On Public–Private Partnership Performance: A Contemporary Review." *Public Works Management & Policy* 22(1): 55–78. doi:10.1177/1087724X16657830.

Hotchkiss, Nikole. 2010. "Globalizing Security? Media Framing of National Security in France and the United States from the Cold War through 11 September." *International Journal of Comparative Sociology* 51(5): 366–86. doi:10.1177/0020715210376867.

Hvidman, Ulrik, and Simon Calmar Andersen. 2016. "Perceptions of Public and Private Performance: Evidence from a Survey Experiment." *Public Administration Review* 76(1): 111–20. doi:10.1111/puar.12441.

Jacoby, William G. 2000. "Issue Framing and Public Opinion on Government Spending." *American Journal of Political Science* 44(4): 750–67. doi:10.2307/2669279.

Joyce, S., C. S. Tomkins, and P. Weinstein. 2008. "Mars Sample Return: Do Australians Trust NASA?" *Advances in Space Research* 42(6): 1096–1102. doi:10.1016/j.asr.2007.02.009.

Kaminski, Amy, Lynn Buquo, Monsi C. Roman, Beth Beck, and Michelle Thaller. 2016. "NASA's Public Participation Universe: Why and How the U.S. Space Agency Is Democratizing Its Approaches to Innovation." In *AIAA SPACE 2016*, American Institute of Aeronautics and Astronautics. doi:10.2514/6.2016-5466.

Kelley, Christopher S., and Bryan W. Marshall. 2008. "The Last Word: Presidential Power and the Role of Signing Statements." *Presidential Studies Quarterly* 38(2): 248–67. doi:10.1111/j.1741-5705.2008.02638.x.

Kreps, Sarah E, and Geoffrey PR Wallace. 2016. "International Law, Military Effectiveness, and Public Support for Drone Strikes." *Journal of Peace Research* 53(6): 830–44. doi:10.1177/0022343316657405.

Lahav, Gallya, and Marie Courtemanche. 2012. "The Ideological Effects of Framing Threat on Immigration and Civil Liberties." *Political Behavior* 34(3): 477–505. doi:10.1007/s11109-011-9171-z.

Lin-Greenberg, Erik, and Theo Milonopoulos. 2021. "Private Eyes in the Sky: Emerging Technology and the Political Consequences of Eroding Government Secrecy." *Journal of Conflict Resolution* 65(6): 1067–97. doi:10.1177/0022002720987285.

MacIntyre, Chandini Raina, Dillon Charles Adam, Robin Turner, Abrar Ahmad Chughtai, and Thomas Engells. 2020. "Public Awareness, Acceptability and Risk Perception about Infectious Diseases Dual-Use Research of Concern: A Cross-Sectional Survey." *BMJ Open* 10(1): e029134. doi:10.1136/bmjopen-2019-029134.

Majoor, Stan. 2011. "Framing Large-Scale Projects: Barcelona Forum and the Challenge of Balancing Local and Global Needs." *Journal of Planning Education and Research* 31(2): 143–56. doi:10.1177/0739456X11402694.

Mendoza, Mario A., Mauricio Rodriguez Alfonso, and Stephane Lhuillery. 2021. "A Battle of Drones: Utilizing Legitimacy Strategies for the Transfer and Diffusion of Dual-Use Technologies." *Technological Forecasting and Social Change* 166: 120539. doi:10.1016/j.techfore.2020.120539.

Meyer, David S. 1995. "Framing National Security: Elite Public Discourse on Nuclear Weapons during the Cold War." *Political Communication* 12(2): 173–92. doi:10.1080/10584609.1995.9963064.

Mintz, Alex, and Steven B. Redd. 2003. "Framing Effects in International Relations." *Synthese* 135(2): 193–213. doi:10.1023/A:1023460923628.

Mnookin, Robert H. 1982. "The Public/Private Dichotomy: Political Disagreement and Academic Repudiation." *University of Pennsylvania Law Review* 130(6): 1429–40. doi:10.2307/3311977.

Moltz, James Clay. 2011. *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks*. Columbia University Press.

Nadeau, François. 2013. “Explaining Public Support for Space Exploration Funding in America: A Multivariate Analysis.” *Acta Astronautica* 86: 158–66. doi:10.1016/j.actaastro.2013.01.004.

Nam, Yuree. 2023. “One-Way Ticket to Mars: The Privatization of the Space Industry and Its Environmental Impact on Earth and Beyond.” *Northwestern Journal of Law & Social Policy* 19(1): 150.

Ninan, Johan, Ashwin Mahalingam, and Stewart Clegg. 2022. “Power in News Media: Framing Strategies and Effects in Infrastructure Projects.” *International Journal of Project Management* 40(1): 28–39. doi:10.1016/j.ijproman.2021.09.003.

Nomikos, William G, and Nicholas Sambanis. 2019. “What Is the Mechanism Underlying Audience Costs? Incompetence, Belligerence, and Inconsistency.” *Journal of Peace Research* 56(4): 575–88. doi:10.1177/0022343319839456.

Oltmann, Shannon. 2015. “Dual Use Research: Investigation Across Multiple Science Disciplines.” *Science and Engineering Ethics* 21(2): 327–41. doi:10.1007/s11948-014-9535-y.

Page, Benjamin I., and Robert Y. Shapiro. 1984. “Presidents as Opinion Leaders: Some New Evidence.” *Policy Studies Journal* 12(4): 649–61. doi:10.1111/j.1541-0072.1984.tb00480.x.

Pauly, Reid B C. 2022. “Deniability in the Nuclear Nonproliferation Regime: The Upside of the Dual-Use Dilemma.” *International Studies Quarterly* 66(1): sqab036. doi:10.1093/isq/sqab036.

Powers, Ryan, and Jonathan Renshon. 2020. “International Status Concerns and Domestic Support for Political Leaders.” : 31.

Rainey, Hal G., Robert W. Backoff, and Charles H. Levine. 1976. “Comparing Public and Private Organizations.” *Public Administration Review* 36(2): 233–44. doi:10.2307/975145.

Roehrich, Jens K., Michael A. Lewis, and Gerard George. 2014. “Are Public–Private Partnerships a Healthy Option? A Systematic Literature Review.” *Social Science & Medicine* 113: 110–19. doi:10.1016/j.socscimed.2014.03.037.

Sánchez-Cobaleda, Ana. 2022. “Defining ‘Dual-Use Items’: Legal Approximations to an Ever-Relevant Notion.” *The Nonproliferation Review* 29(1–3): 77–95. doi:10.1080/10736700.2023.2202966.

Schroeer, Dietrich, and Micro Elena. 2018. *Technology Transfer*. Routledge.

Schulzke, Marcus. 2019. “Drone Proliferation and the Challenge of Regulating Dual-Use Technologies.” *International Studies Review* 21(3): 497–517. doi:10.1093/isr/viy047.

Science, American Association for the Advancement of, National Research Council, Division on Earth and Life Studies, Board on Life Sciences, Policy and Global Affairs, Development Cooperation Security, and, and Committee on Assessing Fundamental Attitudes of Life Scientists as a Basis for Biosecurity Education. 2009. *A Survey of Attitudes and Actions on Dual Use Research in the Life Sciences: A Collaborative Effort of the National Research Council and the American Association for the Advancement of Science*. National Academies Press.

Semanik, Mitch, and Patrick Crotty. 2023. "U.S. Private Space Launch Industry Is Out of This World."

Shapero, Julia. 2024. "Majority of US Voters Hold Unfavorable Views of Bezos, Zuckerberg: Poll." *The Hill*. https://thehill.com/policy/technology/4583555-majority-of-us-voters-hold-unfavorable-views-of-bezos-zuckerberg-poll/ (August 18, 2024).

Steinberg, Alan. 2011. "Space Policy Responsiveness: The Relationship between Public Opinion and NASA Funding." *Space Policy* 27(4): 240–46. doi:10.1016/j.spacepol.2011.07.003.

Tedin, Kent, Brandon Rottinghaus, and Harrell Rodgers. 2011. "When the President Goes Public: The Consequences of Communication Mode for Opinion Change across Issue Types and Groups." *Political Research Quarterly* 64(3): 506–19. doi:10.1177/1065912910370685.

Tellis, Ashley. 2022. "'What Is in Our Interest': India and the Ukraine War." https://carnegieendowment.orgundefined?lang=en (August 17, 2024).

Thorpe, Rebecca U. 2014. *The American Warfare State: The Domestic Politics of Military Spending*. Chicago, IL: University of Chicago Press. https://press.uchicago.edu/ucp/books/book/chicago/A/bo17607479.html (October 5, 2023).

Tomz, Michael. 2007. "Domestic Audience Costs in International Relations: An Experimental Approach." *International Organization* 61(4): 821–40. doi:10.1017/S0020818307070282.

Tyson, Brian Kennedy and Alec. 2023. "Americans' Views of Space: U.S. Role, NASA Priorities and Impact of Private Companies." *Pew Research Center*. https://www.pewresearch.org/science/2023/07/20/americans-views-of-space-u-s-role-nasa-priorities-and-impact-of-private-companies/ (August 19, 2024).

"United Nations Register of Objects Launched into Outer Space." 2024. https://www.unoosa.org/oosa/en/spaceobjectregister/index.html (August 19, 2024).

"United States-India Relations." 2023. *United States Department of State*. https://www.state.gov/united-states-india-relations/ (August 17, 2024).

Voss, Loren. 2018. "Choosing Words with Purpose: Framing Immigration and Refugee Issues as National Security Threats to Avoid Issues of Social Policy." *Yale Journal of*

International Affairs 13: 39.

Walsh, James I., and Marcus Schulzke. 2015. *The Ethics of Drone Strikes: Does Reducing the Cost of Conflict Encourage War?* ARMY WAR COLLEGE CARLISLE BARRACKS PA STRATEGIC STUDIES INSTITUTE. https://apps.dtic.mil/sti/citations/ADA621793 (February 18, 2022).

White, Richard H, James P Bell, J Scott Hauger, Michael S Nash, Merle Roberson, An-Jen Tai, and Caroline F Ziemke. 1996. "A SURVEY OF DUAL-USE ISSUES."

Whitman Cobb, Wendy N. 2011. "Who's Supporting Space Activities? An 'Issue Public' for US Space Policy." *Space Policy* 27(4): 234–39. doi:10.1016/j.spacepol.2011.09.007.

Yuan, Jingfeng, Chao Wang, Mirosław J. Skibniewski, and Qiming Li. 2012. "Developing Key Performance Indicators for Public-Private Partnership Projects: Questionnaire Survey and Analysis." *Journal of Management in Engineering* 28(3): 252–64. doi:10.1061/(ASCE)ME.1943-5479.0000113.

CHAPTER 3

THE TRUE NATURE OF CIVIL SPACE DEVELOPMENT:

A CASE STUDY OF THE CHINESE NATIONAL SPACE ADMINISTRATION[3]

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Abstract

In recent decades, civilian space programs launched into action at an accelerating rate. Access to space is now more affordable than ever. The precise reasoning behind investing in civil space programs remains under debate, but one promising idea is that of developing civilian space programs for the purpose of acquiring dual-use technologies to benefit a state's security apparatus. Previous studies show that states, which face increasing involvement in international conflicts and possess military assets that could greatly benefit from space assets, are more likely to consider civil space development a worthy investment. However, most states considered in prior works are democratic. This study builds on established mechanisms by demonstrating how autocratic states display similar behavior due to international strategic considerations influencing their public messaging. In addition, this study suggests states will be more likely to conceal the civil-military connection as they become a more capable space power. This paper tests those conjectures by analyzing the autocratic government of the People's Republic of China and its civil space program, the Chinese National Space Administration (CNSA). Utilizing open-source data for analysis, the case study exposes precise details and examples of China using civil space for present and future military gain. The analysis describes explicit cases of dual-use mission profiles with transfer potential to benefit existing military assets and combat rising international threats. Further sources detailing international cooperation efforts, organizational features, and official policies of the agency indicate a distinct effort by the PRC to characterize their civilian space efforts as entirely peaceful.

4.1 Introduction

Around the world, a new space race emerges. Unlike the competition of the 1960s between the United States and the Soviet Union, this new race involves numerous participants with wildly

varying characteristics. Access to space is now more affordable than ever, and thanks to advancements in computing hardware, states can construct effective satellites at a fraction of the cost and size of previous eras. One phenomenon that requires further examination, however, is the advent of civil space programs, which AIA (2023) describes as government-funded civilian entities that participate in the exploration of outer space, develop advanced aerospace technologies, and contribute to the scientific understanding of our solar neighborhood. Why are states choosing to produce civilian space agencies rather than leave space activities under the jurisdiction of the military?

Scholars recommend different explanations, including economic, scientific, prestige, and security ambitions (Ehrenfreund 2009, Harvey et al. 2010, Moltz 2011, Schrogl 2011, Sheehan 2013, Blake 2014, Early 2014, Adriaensen et al. 2015, Dawson 2017, Steer 2017). In the second chapter of this dissertation, evidence from quantitative research found support for ties between civil space development and aspects of a state's military, such as air and ballistic missile power, in addition to interstate conflict and civil space development. Yet, most states included in the chapter's data skewed heavily toward democratic governance, illuminating a significant drawback of the analysis. Meanwhile, the third chapter demonstrated how civilians are more trusting of civilian dual-use space missions domestically, particularly when political leaders reaffirm their civilian nature. Complementing those findings, this study expands the scope of research by focusing on authoritarian states, enlarging the conception of and mechanisms underpinning "dual-use" space technologies, considering international threats instead of conflict, and analyzing government framing of space programs over time. This paper argues that autocratic states can also invest in civil space largely for its dual-use incentives and international cooperation potential. Technologies such as observation satellites, launch vehicles, and communication networks

developed by a civil space agency can also be utilized for military purposes. These dual-use benefits are more attractive if they bolster military technologies already possessed by the state and if that state faces increasing international threats. Furthermore, presenting this relationship in the context of an autocratic state demonstrates the strategic motivations behind civil space development, as states often adhere to international norms to receive political and technological assistance from foreign actors. Beyond mere motivations for developing such programs, this study also scrutinizes the official framing of civil space agencies and how states attempt to conceal connections between their civil and military space entities. The paper's theory proposes that as a program develops and becomes more capable, its host country will publicize potential military connections at a lesser rate to avoid primarily international backlash.

Testing these conjectures, the paper employs a research design consisting of a case study of the People's Republic of China and its civil space agency, the Chinese National Space Administration. China represents an advanced space power that has quickly progressed its space capabilities over the past three decades. Today, the CNSA oversees a large space portfolio consisting of various observation, telecommunications, navigation, and exploratory missions. One interesting benefit of using China as the subject of analysis is its increasingly autocratic nature. As President Xi and the Chinese Communist Party (CCP) continue to consolidate power, they should have little reason to hide any militaristic intentions behind civilian programs. Public opinion in authoritarian states, generally, matters less and is not as effective at changing public policy relative to democratic states (Chen et al. 2016, Li and Chen 2021). Yet, as the analysis shows, China may continue its framing efforts to appease the international community—rather than domestic public opinion— to garner strategic benefits. This notion, in effect, builds on the theory from Chapter 2 and biases the case study against the paper's second hypothesis concerning the governmental

framing of civil space programs, since the autocratic nature of the Chinese government should cause its leaders to see little incentive in framing dual-use programs as purely civilian.

Official policy documents, public statements, polls, and press reporting from open-source databases provide a basis for qualitative analysis, which is useful as it allows a narrow but deep dive into the processes of civil space evolution and how states may use civil space agencies for military gain. Results from the case study indicate broad support for the paper's theory. Chinese space power demonstrates a strong correlation with the nation's increasingly hostile security environment, and as China's armed forces continue to modernize, dual-use space assets are developed by the CNSA with the potential to complement those forces. Regarding the publicization of this connection, China's official civil space policy adheres to the paper's public messaging hypothesis, showing a decrease in militaristic rhetoric and an increase in cooperative and altruistic rhetoric over time. Meanwhile, statements from Chinese leaders, in addition to international space outreach programs, display a growing desire by the PRC for their space program to be perceived as peaceful by the international community.

The paper proceeds as follows. First, relevant literature on rationales behind civil space development and political framing of dual-use technologies is explored and gaps are identified. The subsequent sections then lay out the paper's theory and methodology. With theoretical foundations established, an overview of threats facing the PRC is described along with Chinese military capabilities. Following, open-source data provides a basis for breaking down the CNSA regarding the hypotheses. The final section summarizes the conclusions, identifies limitations of the study, and points toward new research opportunities.

4.2 Civil Space Development and Dual-Use Technologies

While literature pertaining to the politics of outer space is still in its infancy, scholars have provided several explanations for why states develop their own civilian space programs. The most popular proposal put forth is that of civil space progression aligning with economic and technological development (Harvey et. al. 2010, Schrogl 2011, Detsis and Detsis 2013, Krolikowski 2011, Clark 2014, Early 2014, Andriaensen 2015, Dawson 2017). As a state advances economically, it gains the necessary extraneous funds and industrial base needed to launch space missions (Detsis and Destsis 2013, Dawson 2017). These missions, in turn, can aid in furthering economic goals through assets such as reliable communication, navigation, and weather systems (Krolikowski 2011, Clark 2014, Andriaensen 2015). Parallel to the economic motive, some scholars point toward security ambitions as a strong motivator for creating space programs (Moltz 2011, Blake 2014, Steer 2017, Early and Gartzke 2018). A presence in outer space provides a state with a "high ground" advantage consisting of intelligence, early warning, and weapons capabilities that often surpass ground-based systems (Blake 2014, Steer 2017). These assets can dramatically increase the effectiveness of a state's armed forces and deter opponents from initiating conflict (Early and Gartzke 2018).

The third potential motive represented in the literature is prestige or status-seeking (Ehrenfreund 2009, Schrogl 2011, Sheehan 2013, Lewis 2014, Panagiotarakou 2016, Dawson 2017, Musgrave and Nexon 2018). States aware of a status deficit relative to a rival will seek to increase their international status through various large-scale, public programs (Barnhart 2016, Renshon 2016, 2017, Ward 2017, Duque 2018). Using programs such as civil space, states can accumulate additional symbolic capital (Lake 2010, Cho 2016, Musgrave and Nexon 2018, Larson and Shevchenko 2010). With increased status, states can enjoy benefits such as international

partnerships and aid (Ehrenfreund 2009, Walt 1985, Sheehan 2013), and at home, national prestige often appeases the domestic population and mitigates potential audience costs for leaders' actions (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019, Powers and Renshon 2020, Li and Chen 2021). Finally, while some scholars consider scientific motivations to play a role in civil space development, they argue against science acting as the sole incentive due to the lack of tangible benefits brought about by purely scientific missions (Early 2014, Adriaensen et al. 2015, Dawson 2017).

Regardless of the rationale behind investing in civil space, the technological and material benefits are obvious. Assets such as GPS navigation, global communications, observation satellites, and launch vehicles are just a few examples of the technologies that civilian space agencies historically oversaw the development of. Identifying the advantages of these systems is simple, but their intended uses can open more questions due to their dual-use potential. Lubojemski (2019) and Lupovici (2021) discuss the potential civilian and military applications of space technologies and uncertainty around their true objectives. Even if a state intends to utilize a technology for peaceful purposes, its rival may perceive it as a threat and begin to "securitize" its own technologies. The most relevant example of this phenomenon is nuclear energy (Brandt 1994, Jo and Gartzke 2007, Kroenig 2009, Monteiro and Debs 2014). Due to the fear of weaponization, states often express angst when their opponents build nuclear reactors for energy production, even if their intentions are peaceful. Meanwhile, states seeking to weaponize can use "energy production" as a cover to quietly advance nuclear weaponization efforts (Baghat 2006, 2007, Fuhrmann 2012, Landau 2013, Bell 2015, Sobelman 2018). Other areas often scrutinized for their dual-use potentials are drones and biological or chemical agent development (Rath et al. 2014,

Mahfoud 2018). As technology advances and becomes more accessible to states and individuals, the dual-use dilemma will continue to evolve.

The way a state frames its dual use programs greatly affects its perception domestically and internationally. Politicians emphasizing the civilian utilization of a dual-use technology can avoid blowback and potential obstacles to the technology's development. Nuclear energy, for example, remains the target of political framing by elites to achieve both pro and anti-nuclear agendas (Meyer 1995, Schroeer and Elena 2018, Pauly 2022). Recent studies show that "Dual-Use Research of Concern" (DURC)—also known as biological research—is another popular candidate for framing as government officials and pharmaceutical companies often highlight the benefits of research for humanity without revealing its harmful potential if weaponized (NRC 2009, Oltman 2015, WHO 2021, MacIntyre et al. 2020). Lastly, the proliferation of drone technology in both the civilian and military worlds creates a new level of uncertainty concerning their use and leading to the creation of new regulatory barriers. In response, many drone manufacturers and practitioners engage in public legitimacy efforts to surpass regulations and gain the trust of the public (Schulzke 2018, Mendoza et al. 2021).

Should state leaders effectively frame their actions, they can potentially avoid domestic audience costs, which are often incurred from poor public reception to leaders' decisions (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019). However, a discrepancy exists between audience costs in democratic and autocratic societies. While much of the previous literature on audience costs appears in the context of international conflict, it can also apply to other government actions. Fearon (1994) argues democracies are more prone to truthfully signaling their intentions due to the potential of high-audience costs from a democratic system of governance that can replace its leaders with haste. In contrast, autocratic leaders do not face the

same costs from their domestic audiences and, therefore, should not need to mislead their populace. Yet, more recent work highlights that autocracies may still face audience costs if their leaders are unable to effectively limit elite coordination during outbreaks of protest (Weeks 2008). Should the state control and repress public discourse in a timely manner, however, audience costs become a far lesser threat.

One distinct reason regimes may choose to hide their intentions is to avoid international confrontation, which can also affect domestic perception of their states' status and ensuing opinions (Powers and Renshon 2020). When autocratic states listen to public opinion, it is often selective and with the goal of achieving accessible short-term benefits, such as infrastructure and environmental improvements (Tang et. al 2018). Scholars suggest that authoritarian governments allow public discourse and the formation of popular public opinion for four primary reasons. First, it allows them to identify selective but critical areas of policy that need to be addressed (Jin 2019). Second, by controlling the channels of discourse, state leaders can bias opinion in their favor (Rogov 2017, Wang et al. 2024). Moreover, political conversations can foster heterogeneity among groups, further dividing any opposition that may exists and safeguarding the dominance of the ruling party (Chen and Wu 2017). A final argument proposes that authoritarian governments may utilize anti-foreign protests to signal strength in resolve to foreign powers, as allowing such disorder to transpire is potentially costly for regimes (Weiss 2013). With the appropriate guardrails, public opinion in autocratic states often works to the benefit of its leaders and maintains less influence over their decisions than in democratic nations.

Existing literature provides several explanations for why states develop civil space programs, but an in-depth analysis of individual space programs in the context of dual-use technologies and their effect on a state's security apparatus has not yet been attempted out of this

dissertation. While the focus likely supports the security motivation described earlier, the referenced studies do not explicitly state which security characteristics determine civil space investment. Furthermore, while research describes the effect of political framing on dual-use technologies such as nuclear energy and DURC, scholars have barely scratched the surface of expanding this concept to outer space. If political framing does play a role in describing space technologies, which factors determine how states characterize these missions, and how does authoritarianism fit into the equation? The following section offers tailored theory to fill the recognized gaps in the literature.

4.3 Theory

How and why states prepare for conflict is a commonly debated topic among scholars. The 'Steps to War' theory posits that the type of threat facing a state determines the degree to which a nation preps its defenses (Valerino and Marin 2010, Sample 2016, Owsiak 2017, Atkinson et al. 2023). Of these issues, territorial disputes present the most dangerous implications, as they can lead to rivalries, defensive alliances, arms races, and eventually war. Moreover, the longer lasting a dispute over territory, the more likely a state will exhibit behavior better reflecting a conflict-ready posture (Senese and Vasquez 2005). Throughout this process, defense preparations are also affected by changes in the political makeup of its government, in addition to regional instability caused by the breakup of once sovereign states (Palmer 1990, Alesina and Spalaore 2006). Regime type itself does not necessarily mandate how a state coordinates its defense, but it can weigh on a leader's decision to enter an armed conflict (Gartzke 2002). Democracies, unlike autocracies, are often more selective in the wars they enter, choosing to limit engagements to avoid blowback from their domestic audiences which can vote elected officials out of office (Tangeras 2008, Sirin and Koch 2015). Authoritarian regimes, in principle, are not beholden to the success of their policies

or actions—including participation in war—so long as their elite supporters are satisfied by private goods, and they have organized their military in a manner that adequately represses internal dissent, also known as "coup-proofing" (Bueno de Mesquita et al. 1999, Weeks 2012, Talmadge 2015). Put into practice, these postulates give greater freedom to authoritarian regimes in pursuit of their agendas, especially those that seek to further their regional influence, and as a state's territorial ambitions grow, the likelihood of conflict also increases—leading to a military buildup.

In pursuit of defensive advantages, states may look upon the security or military advantages of outer space technologies as some of the most promising assets to acquire, especially when certain situational elements are present. Facing the increased threat of international conflict, state actors attempt to improve their security situations by seeking out key advantages in the form of new technological capabilities (Jervis 1978, Betts 1980, Levit 1987, Van Evra 1998, Biddle 2001, Butcher 2005). As a result, states can "securitize" civilian technology to aid in deterrence (Lupovici 2021). With a developed civilian space industry, states can build capabilities such as launch vehicles, reconnaissance satellites, orbital weapons, and enhanced communications networks to be deployed (Moltz 2011, Blake 2014, Steer 2017). While these assets make offensive maneuvers more effective, they also lead to a bolstered deterrent posture through improved intelligence-gathering capabilities provided by reconnaissance satellites (Brown 1971, Zorn 2001). Early and Gartzke (2018) demonstrate that this specific class of satellite heightens a state's sense of security even if it does not explicitly prevent conflict. If intelligence failures are prevented and the enemy's advantages blunted, the overall threat to a state on the defensive diminishes (Jervis 1978, Betts 1980, Levit 1987, Van Evra 1998, Biddle 2001, Butcher 2005). Outer space technologies assist in accomplishing both of those objectives.

In addressing international threats, outer space dual-use technologies and research can bolster military technologies that a state already possesses (Moltz 2011, Blake 2014, Steer 2017, Lubojemski 2019). Engines, fuel mixtures, heat-resistant materials, and ground equipment produced for civilian launch vehicles can likewise be utilized for ballistic missiles, rockets, and other long-range military projectiles. Once in orbit, a civilian environmental observation satellite can also serve the purpose of collecting intelligence on enemy naval and ground formations, thereby alerting friendly forces on the surface of potential threats. GPS satellites tasked with providing navigation for a state's populace can just as easily lead a GPS-guided bomb to its target, should the host nation employ a modern air force. Meanwhile, a state may use an orbital communications satellite constellation to provide internet and cell service to remote regions, but that same network may also deliver orders to forward-deployed forces or provide downlinks for military drones to be controlled remotely.

One advantage of investing in civil space projects beyond the obvious dual-use applications of agency-owned missions themselves is the funding of private contractors who also work for the state's military. Lockheed Martin, a well-known U.S. defense contractor, currently develops space technologies for both the Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA) using the same personnel, machinery, and other resources (Lockheed Martin 2023). This pattern of dual development dates to the early days of the Cold War when the company tested experimental civilian launch vehicles for the predecessor to NASA and intercontinental ballistic missiles (ICBMs) for the military concurrently. By growing and diversifying a contractor's expertise and tools through civil space contracts, a nation can simultaneously develop that firm's capacity to support military missions with similar technology. This relationship remains ever more prominent in authoritarian nations where private industry is

under strict oversight from government entities. ‘Authoritarian Capitalism’ entails the government owning large shares in private companies and assuring that they invest solely in leadership and programs friendly to state interests (Lin et al. 2020, Sallai 2020, Huang and Tsai 2022, Zhang et al. 2022). With state-owned investments in a private space company, an autocratic state can effectively dictate which technologies the company produces. Through this process, the government may dictate the contracting and development of specific technologies intended for its civil space agency that also have implications for military utilization as well. A strong domestic space industry developed through civilian efforts grants a nation a strong military advantage.

Hypothesis 1: *An authoritarian state facing increasing international threats, and who possesses military technologies that could benefit from dual-use space technologies, is more likely to prioritize and invest in their civil space programs for military benefits*

Questions may arise as to why a civilian program is necessary if a state’s true ambitions lie in advancing military prowess. Why not create a dedicated military space organization? Why conceal those intentions? This paper proposes that states, especially those with international adversaries, may invest in civilian space organizations to avoid international and domestic backlash from the “militarization” of outer space. Since the signing of the Outer Space Treaty of 1967, the concept of militarizing outer space has remained immensely unpopular among international forums (UN 2023). The treaty does not explicitly ban weapons in outer space outside of nuclear weapons, a clause that recent developments suggest Russia is intent on ignoring (Reuters 2024). However, during publicized international meetings in various venues, leaders are quick to highlight the scientific, peaceful accomplishments of their space programs while downplaying questions concerning military involvement in the domain (Moltz 2011, Adriaensen et al. 2015). These leaders, especially those from nations with advanced space programs, often call for some

form of arms control unilaterally and multilaterally in United Nations committees; although, the form those proposals take differs drastically between state powers (Britt 2024).

States can appear—on the surface—to possess altruistic goals by downplaying or altogether concealing a military agenda in space. This innocent appearance could potentially lead to positive relations with more powerful states and tangible benefits for a state in the form of international agreements and assistance. For example, in the mid-twentieth century, countries such as Israel, Pakistan, and India received assistance from other nations for what they described as peaceful nuclear energy production (Baghat 2006, 2007, Bell 2015). However, in the span of a few decades, those three states developed their own nuclear weapons. Fuhrmann (2012) explains that states who are aided by greater powers in their nuclear development journey become far more likely to weaponize the technology. Applying this concept to outer space, if a state partners with an established space power to develop new space technologies, the newly acquired expertise and technical assistance could directly translate to the state's military space programs. Consequently, international agreements can accelerate a nation's military prowess and equip it with technologies and expertise that it could not develop on its own.

Domestically, studies show that individuals historically disapproved of the militarization of dual-use technologies such as nuclear energy, drone proliferation, and biological or chemical research (Meyer 1995, Hall et al. 1996, Anthony 2013, MacIntyre et al. 2020). Leaders can frame the weaponization of dual-use programs in ways that decrease public backlash (Berinsky 2007, Walsh and Schulzke 2015, Sagan and Valentino 2017, Lin-Greenberg 2021), but maintaining the peaceful, scientifically driven façade of such programs may stand as the more attractive alternative. Doing so may offset domestic audience costs, which can plague the public approval of leaders (Fearon 1994, Tomz 2007, Crisman-Cox and Gibilisco 2018, Nomikos and Sambanis 2019).

Although, the effects of public opinion can differ between democracies and autocracies, we should expect autocracies to pay less attention to their citizens' concerns, albeit in select circumstances when they perceive short term benefits from acting (Chen and Xu 2017, Li and Chen 2021). Authoritarian governments often rely on institutions to bias public opinion and, therefore, limit the vocalization of issues by public interest groups (Rogov 2017). As a result, few incentives remain for autocratic states to deceive their domestic audiences as to their intentions in outer space. Certainly, authoritarian leaders value higher public opinion, but I argue their international concerns weigh more heavily on their framing decisions. The strategic partnerships mentioned in the previous paragraph require goodwill from foreign nations to initiate and, once established, can make a substantial difference in advancing a military space agenda. Another positive side effect of civilian space missions is that—based on the international recognition they acquire— they may increase a state's status and, in the process, raise domestic support for the state's leaders (Powers and Renshon 2020). In other words, even if a government positions its programs to appease the international community, secondary effects can also appease the domestic populace.

The benefits of concealing military motivations are clear, but do these restrictions apply to space programs at varying developmental stages? This paper argues states with more capable programs are less likely to pronounce the military benefits of their civilian programs due to threat perception. If a state lacks advanced space technologies, such as launch vehicles and a fleet of satellites, adversaries will be less likely to view their space capabilities as a meaningful threat to their own security. Singer (1958) and He (2012) present findings that indicate countries are predisposed to balancing their own security relative to major regional or global powers and do not consider "minor" powers a threat. Although state characteristics, including the socio-economic status of a country, geographic proximity, and the presence of democracy, can determine whether

that state is considered a threat by others (Myers 1991, Buchan 2010). Statements alluding to the nation's military ambitions from a minor space program in its infancy will likely not bear the same weight as a state with proven space technologies that could be militarized and threaten the regional or global interests of others. As states develop, the international community begins to expect them to adhere to certain norms that were made precedent by others (Cohen 1978, Simmons 2000, Miller et al. 2015). If the state wants to maintain its growth and reputation, it will fall in line (Foot and Waller 2013, Kahler 2013). The same could apply to national space power. Should a state desire positive recognition and assistance from the international community, it will join ranks with established space powers in discussions on how to limit the militarization of space.

Hypothesis 2: *A state is more likely to hide the connections between its civil space and military objectives as it acquires more sophisticated space technologies*

The following section presents and justifies the paper's qualitative research design.

4.4 Methodology

Testing these hypotheses, I examine the unique attributes of an individual civil space agency, the Chinese National Space Administration. China represents a developed space power that hosts an established civilian space entity that is, on paper, entirely separated from its military space endeavors. With a history spanning more than three decades, the CNSA provides a lengthy history in which to examine the PRC's changing framing of the agency and its mission. Due to the increasingly authoritarian nature of the nation's leaders, China acts as a perfect example to apply the paper's theory to an autocratic government which, in theory, should be less likely to frame government initiatives due to the mitigated effect of audience costs on authoritarian states relative to democracies (Chen and Xu 2017, Rogov 2017, Li and Chen 2021). As a country becomes less holden to domestic audience costs, we should expect funding for civil space entities to decline

while spending on purely military space programs increases. This alternative hypothesis is derived from traditional assumptions and sets a higher threshold for the paper's theory to surpass. Additionally, the PRC releases vast amounts of open-source data for its missions and policy approaches, likely as a means of attracting international attention. The bulk of qualitative sources used in the paper come from official government press releases and databanks, media reporting, public surveys, think tank analyses, and archival documents.

In the first part of the analysis, I examine the degree to which China invests in and prioritizes its civil space agencies with the goal of identifying what fuels these actions. Specifically, I look at the state's current military capabilities and international security apparatus. By assessing the sources and progression of threats circling China in recent history, it is possible to surmise how the state intends to use in-development space technologies to its military advantage. I examine China's interstate disputes and incidents from 1993 to 2014 using data from the Correlates of War Militarized Interstate Dispute (MID) dataset and derive their implications for civil space developments occurring simultaneously. To supplement the MID dataset, I incorporate a range of qualitative sources to better understand the PRC's changing international stance from a tumultuous period in the late 1990s, to a relatively calm decade in the 2000s, and finally ending with the rise of President Xi and the PRC's territorial ambitions. Due to the limitations of the MID dataset, I analyze threats to Chinese interests from the period of 2014 to 2024 through the lens of thinktank reporting, public PRC documents, and other qualitative sources. A civil space entity developing technologies that could improve the effectiveness of the state's current military assets would likely launch civilian missions with nonexplicit dual-use profiles that can be found in government sources. Examples of these instances are identified in public press releases and other reporting from inside China ranging from inception of the CNSA to the present

day. Cases of technology transfer to a state's military may also be gleaned through publicized, direct government partnerships or indirect contracts with associated aerospace firms or other third parties. Both considerations are ever more prominent when a state faces increasing international threats to its interests.

The second portion of the case study scrutinizes China's public acknowledgement of any civil-military space connection and, more importantly, deciphers when and how this acknowledgment has changed over time. Investigating the organizational makeup of the CNSA and comparing policy documents from the early days of the program to more recent policy papers expose the nature of this relationship. This includes a text analysis of both militaristic, cooperative, and altruistic rhetoric in five official CNSA policy whitepapers published by Chinese government sources from 2000 to 2021. Public statements are also inspected for political framing, in addition to an analysis of how the Chinese public reacts to the publicized view of the CNSA. Finally, an overview of space international cooperation agreements and arms control proposals give an idea of how the CNSA utilizes international engagement to further the PRC's military space agenda while maintaining an aura of deniability on the global stage.

4.5 The Chinese National Space Administration

China belongs to the first generation of national space programs born in the 1950s and 60s. Aided by the Soviet Union's rocket technology, China's homegrown space initiative launched its first satellite in 1970. From the start, Chinese scientists expressed interest in the "civil and military use" applications of space technologies (Zhang 2021). Under Mao and subsequent leaders, the Chinese space program blended security and scientific elements together, and it was not until 1993 that the Chinese National Space Administration (CNSA)—the civilian agency overseeing civil space administration and international space cooperation—was founded (Krolikowski 2011). At

its founding, Chinese leaders described the new agency as a supervisory body that would lead the country's international obligations, domestic and international scientific exchanges, and enforce the national space agenda. Differing from NASA and other civil space agencies, the CNSA dictates policy for numerous subordinate civil government agencies that directly develop and produce space-related technologies, while the CNSA itself acts as an oversight body. Partner agencies to the CNSA, such as the Chinese Aerospace and Technology Corporation (CASC), maintain working relationships with both the civil space agency and the PLA in developing various space technologies. In 2003, China launched its first astronauts into space on a domestically produced rocket. This event coincided with China's declaration of its "peaceful development" slogan, intended to dissuade fear of its military and economic rise across all sectors (Dellios 2012).

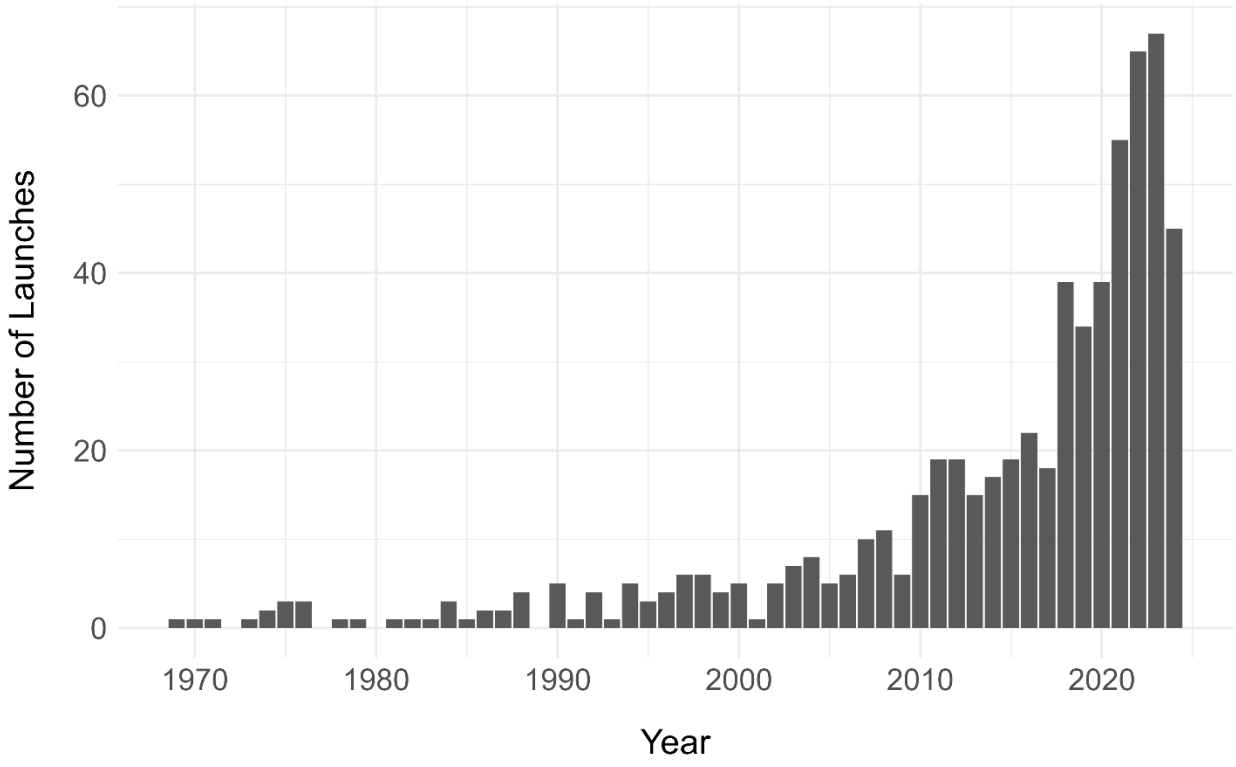

Figure 4.1: Timeline of Chinese Launches to Orbit (1968-2024)

As its space technologies became increasingly sophisticated, suspicions arose from foreign nations as to China's military intentions in orbit following several key milestones such as the first PRC anti-satellite missile test, spacewalk, and lunar exploration missions in 2007 and 2008. (Handberg and Li 2006, Macdonald 2008, Tellis 2008). With President Xi's rise to power in 2013, the CNSA's goals became more ambitious—to include future, manned, and autonomous missions outside of Earth's orbit to the Moon, Mars, and beyond (Goswami 2018, Drozhashchikh 2018, Harvey 2019). Under the stated policy of the CNSA, China will adhere to international law and seek out solely peaceful opportunities in outer space. This message is further illustrated through the design of its logo. The logo, seen in Figure 1, consists of a Chinese character that describes how humanity is the focus of all space exploration, an ellipse resembling escape velocity to display that China is primarily interested in exploration beyond Earth, and olive branches likely emphasizing the peaceful motivations of the country's space efforts (CASC 2009). Currently, China's publicized military space directives are designated to the recently established People's Liberation Army Aerospace Force (PLAASF). At face value, China's civil and military space programs remain entirely separated, and today, the nation ranks second globally in space launches per year. The PRC does not publicize the annual budget of its civil space agency, but rising funding for the agency is evidenced by its growing mission portfolio, much of which is discussed in the following sections. The CNSA's possession of sophisticated space technologies and influence over a rising domestic space industry cement the agency as a prime example of what burgeoning civil space entities may become one day.

Figure 4.2: The Official Logo of the Chinese National Space Administration

4.6 International Threats

Over the last three decades, China's regional security environment has become increasingly hostile, in part due to the growing ambitions of its leadership in the region and abroad. In 1992, the PRC passed an act known as the Law on the Territorial Sea, which allowed the nation to claim large swathes of the South China Sea as its own territorial waters. While China could not officially enforce this law at the time, the move implied that its leadership sought to expand Chinese influence in the region at the expense of relations with states that also made claims in the South China Sea (CFR 2024). One such nation, the Philippines, engaged in brief combat with the Chinese navy in 1996 over a disputed reef in the Spratly Islands. The next ten years saw continued incidents in the South China Sea and the greater region but to a lesser extent than in the previous decade due to a change in Chinese posture toward the international community. In 2001, China joined the World Trade Organization (WTO) to better integrate its economy internationally. This time frame also saw the signing of several cooperation agreements between China and its neighbors, including Japan and the ASEAN bloc of countries.

Another potential reason for the lack of disputes during the early 2000s is the 9/11 terror attacks and the U.S.'s ensuing shift in focus to the Middle East (Van Vu 2023). Without fierce American diplomatic resistance, the PRC could more easily assert its claims and expand its presence in the region. However, this period came to an end with the Obama Administration's "Pivot to Asia" in 2011 (Lieberthal 2011). During the following years, several incidents occurred between the Chinese Navy and the Philippines, Vietnam, and Japan over disputed waters. As tensions rose, China grew its navy and introduced its first aircraft carrier in 2012, allowing the nation to project air power far away from the mainland. In response, Manila and Tokyo began a military build-up as well, and observers noted a growing number of U.S. forces and military exercises across the region (CFR 2024). A turning point occurred following President Xi Jinping's rise to power in 2013 as the newly appointed leader vowed to reset the status quo and push out U.S. influence in the region (Lokman 2022).

Between 2013 and 2015, China developed 3,000 new acres of artificial islands in the South China Sea near the Spratly Islands, upsetting regional neighbors and causing renewed tensions of disputes lasting decade (USCC 2016). While a relatively small geographic area, this effort demonstrated the PRC's continued willingness to push the boundaries of claimed territory in the South China Sea. Notably, the PRC officially denies the militarization of these islands, instead stating that they will act as a public good for the Chinese people (Ingram and Mines 2024). Yet, open-source satellite imagery and aerial photography indicate the addition of runways and military facilities to several of the recently constructed islands, implying their future use by the PLA as military bases. Expansion in the South China Sea represents another move by the PRC to portray military advancement as a civilian activity and remains priority of President Xi as he works to strengthen China internationally. With the removal of the constitutional limit on Chinese

Presidential terms in 2018, Xi extended his presidential tenure potentially for life, making the already authoritarian structure of the PRC even more centralized.

Figure 2 displays militarized interstate disputes (MIDs) and incidents (MIIs) involving China from 1993 to 2014. Data for the plot is taken from the Correlates of War (COW) dataset published by Palmer et. al in 2020, a project that compiles information on interstate disputes and conflict from the early nineteenth century to 2014. For each year in the given time frame, militarized interstate incidents are stacked on top of militarized interstate disputes. In this case, MIDs refer to "historical cases of conflict in which the threat, display or use of military force short of war by one member state is explicitly directed towards the government, official representatives, official forces, property, or territory of another state." Meanwhile, MIIs consist of individual incidents, such as threats of use of force or limited combat short of war, that occurred as part of a MID. As discussed in the previous paragraph, the number of incidents increased drastically beginning in 2010 likely due to revamped U.S. policy and military buildups. In contrast, the number of disputes remains relatively low and constant, indicating that the disputes themselves become increasingly threatening and produce a greater number of incidents.

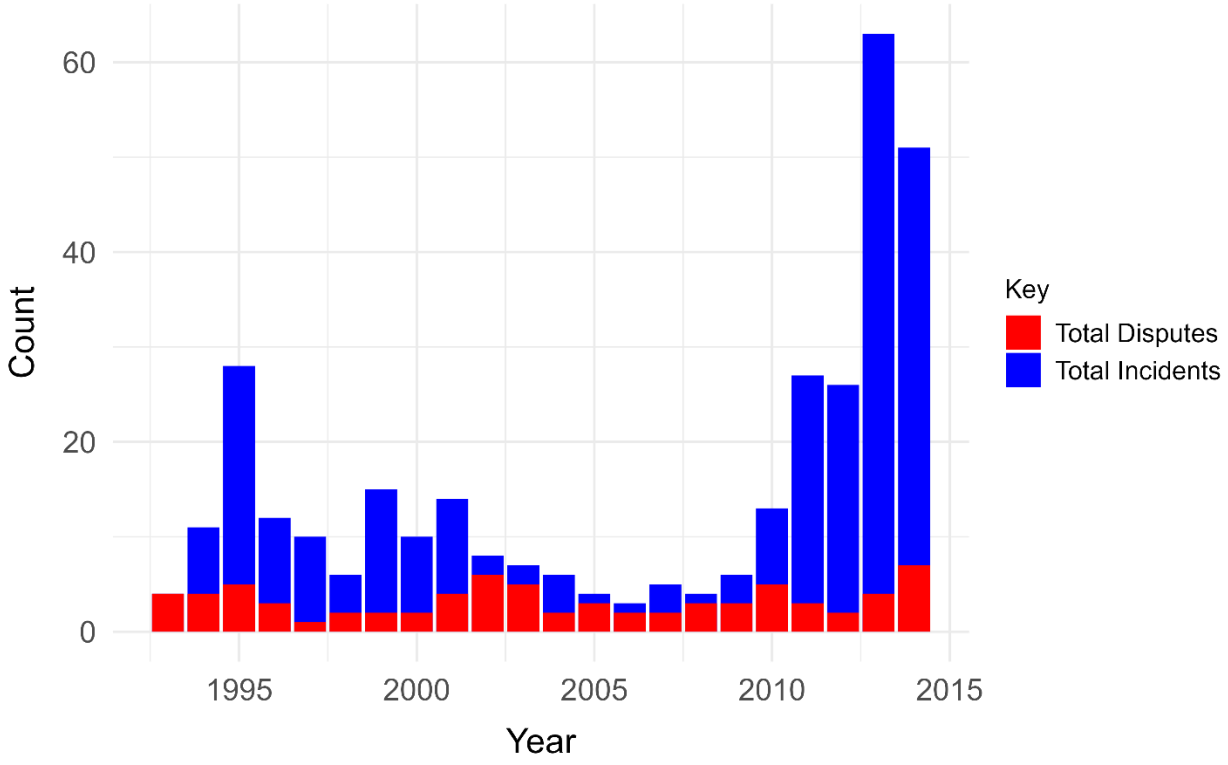

Figure 4.3: Militarized Interstate Disputes and Incidents Involving China (1993-2014)

Within the last decade, the strategic atmosphere in East Asia has only grown more tense. The People's Republic of China (PRC), guided by President Xi's ambitions, appears determined to establish dominance in the South China Sea and the greater region (Rudd 2022). A clear and pronounced objective of the current regime is to reunify with the Republic of China (ROC), which houses the remnants of the nationalist party that fled from the mainland to Taiwan following the Chinese Revolution of 1949. While the PRC vastly outguns the ROC, the United States provides immense material and financial support to the ROC, and should a conflict break out, the possibility remains of the U.S. directly involving itself in the defense of Taiwan (Lee and Chang 2014). According to a 2024 report by the Council on Foreign Relations, the U.S. has sold over $50 billion dollars of military arms to Taiwan since 1950. Aid increased dramatically in 2007 and 2008 under

President Bush and again in 2010 and 2011 under President Obama. Adjusted for inflation, however, the largest aid packages occurred in 2023 and 2024 following the Russian invasion of Ukraine and an assessment by the U.S. government that China will be ready to invade the island nation by 2027 (Masters and Merrow 2024, DoD 2024).

Beyond the issue of Taiwan, China perceives the U.S. as a direct challenge to their power due to U.S. bases in Japan, South Korea, Guam, the Philippines, and other strategically located positions (Beckley 2017). The U.S. also maintains signed treaty alliances with several states in the region, including Australia, Japan, the Republic of Korea (ROK), and Thailand. Such alliances help bolster regional actors' defenses against China while allowing the U.S. to sow its influence through the area. In countries that are not official U.S. allies, increasing American diplomatic and military working relationships within recent years actively attempt to undermine the PRC's agenda of becoming a regional hegemon. Indonesia, Malaysia, Singapore, and Vietnam are all recent targets of American diplomacy as the U.S. works to establish economic and military partnerships throughout the region (Tow and Lamaye 2017). While not an official coalition, these nations represent a bloc of states with growing disapproval of PRC expansion in the region.

The United States may represent the largest danger to China's ambitions but is far from the only threat. In the South, low-intensity conflict between the PRC and India on the Sino-Indian border continues as the two nations appear unable to back away from their territorial claims. While experts debate the significance of the region, the prospect of escalation is clear (Donthi 2024). Between 2020 and 2021, dozens of Chinese and Indian soldiers died during physical clashes in the disputed Kashmir region. Prior decades saw additional clashes between the two nations, but this round proved the most significant and deadly. Should a small skirmish transform into a wider shooting war, China faces a nuclear-armed nation that hosts an expansive military with modern

tools at their disposal, including space-based assets. Chinese leaders will likely become increasingly concerned as India progresses economically and militarily. Neither nation views the other as an existential threat, perhaps, but uncertainty clouds the future. In the South, China faces a singular but increasingly dangerous power, and in the East, a coalition of U.S.-aligned partners threatens Chinese expansion. For now, China rests in a regional cage that it perceives as shrinking ever smaller.

Globally, the PRC seeks to expand its influence through various programs such as the $44 billion dollar Belt and Road Initiative (BRI), which consists of China loaning out funds and workers to developing nations. In exchange, the beneficiary state grants the PRC an opportunity to create new markets for Chinese companies while establishing bilateral diplomatic ties that further the nation's interests in the region. Newly formed bilateral ties from the BRI can also result in the construction of forward-deployed People's Liberation Army (PLA) bases on partner country territory allowing China to advance its military footprint through diplomatic means (Mobley 2019). Again, this program acts as another example of the PRC framing a political move as peaceful and constructive when, in reality, the PLA benefits significantly from new deals made with foreign actors due to the possibility of expanding its presence to a new territory among other military benefits. The BRI and other Chinese efforts to expand its influence help further party goals but also expose potential vulnerabilities by stretching Chinese resources across the globe. To counter the growth of Chinese influence, the U.S. and aligned parties seek to grow their own presence in these developing nations, leading to further political clashes with the PRC. President Xi, however, likely expects and even welcomes these challenges as it provides China with the opportunity to prove its strength regionally and around the world (Rudd 2022). As the PRC

continues down the path of physical and political expansion, it will continue to encounter an increasing number of threats to its interests.

4.7 The People's Liberation Army

Defending against increasing threats to its territorial sovereignty, regional interests, and international status places pressure on the PRC to maintain the political and military power necessary to deter adversaries. In recent years, China transformed its standing military, the People's Liberation Army (PLA), into a highly capable, modern fighting force. This includes a navy comprising more than 370 ships, including three operational three aircraft carriers. China's Navy constitutes the largest naval contingent in the world, which the PRC sees as essential for enforcing its territorial claims in the South China Sea and projecting power across the globe (Palmer et al. 2024). At sea, Chinese naval vessels rely heavily on space-based telecommunications and navigation networks to carry out missions. On the ground, the PLA continues to replace cold-war era technology with modern tanks, armored vehicles, and artillery, but one major revolution is the implementation of drone technology into their battle strategies. Two years into the Russian invasion of Ukraine, military leaders have learned several lessons from the conflict, one of which is the importance of drone technology in modern warfare. Beijing is no exception, having seen the effect of weaponized Ukrainian drones on Russian armored and infantry formations (Meideiros et al. 2024). Chinese leaders foresee swarms of small, inexpensive drones sweeping the battlefield in both reconnaissance and strike roles, and larger, more advanced autonomous vehicles conducting long-range missions with the capacity for better intelligence collection, guided strikes, and electronic warfare (Bajak 2024). Based on the distance from the user, military drones often require a satellite downlink for communication and navigation.

In addition to drones, the PLA Air Force is upgrading its manned aerial fleet. While the exact number of aircraft is unknown, China acquired at least 200 5th-generation Cheng-du J-20 fighter jets by 2024 and is prototyping the 5th generation Shenyang FC-31 fighter. These modern fighter programs introduce a range of capabilities including an advanced sensor and data array, stealth profile, and new guided munitions that can precisely strike GPS coordinates. Meanwhile, the PLA Army Rocket Force houses the nation's missile arsenal, including cruise, ballistic, intercontinental ballistic, hypersonic, and air defense missiles—in addition to their conventional and nuclear warheads. Recent reporting suggests the PRC increased the number of available nuclear warheads in its inventory to 500 at the start of 2024, with potential plans for additional warheads by the end of the decade (Pietsch 2024). China's nuclear strategy relies on a suite of other technologies to ensure its effectiveness. Intercontinental ballistic missiles project the nation's nuclear umbrella worldwide, while short and medium-range ballistic missiles ensure coverage of the local theater. Advanced nuclear-capable hypersonic cruise missiles also pose a meaningful threat to land and naval targets but rely on capable engines and heat-resistant materials to function. During a potential nuclear exchange, the PRC would utilize the Rocket Force's air defense regiment to detect and engage incoming warheads. To do so effectively requires a constellation of early warning satellites, as the coverage of ground-based radars is limited.

In early 2024, President Xi ordered the reorganization of the PLA Strategic Support Force into three separate entities, one of which is the PLA Aerospace Force (PLAAF). The PLAAF embodies all aspects of China's space-based military capabilities. This includes military orbital command, control, communications, and computer (C4) systems which provide the vital networks that the PLA uses to receive information and distribute orders to deployed forces. Reconnaissance satellites, both optical observation and signal interception, also fall under the PLAAF's

jurisdiction; although, the exact number, type, and function of these assets are not disclosed by the Chinese government. Additional military-sponsored satellites controlled by the organization include those with navigation, space situational awareness (SSA), and early warning functions. On the ground, the PLAAF oversees several national launch sites and research centers. Beyond a general overview of the functions of the PLAAF, the PLA maintains a tight lid on information surrounding its military space forces. However, further details can be derived from a detailed analysis of several dual-use technologies developed and administered by its civilian space program.

4.8 Dual-Use Technologies

Today, the CNSA oversees numerous outer space exploration programs with targets ranging from low earth orbit (LEO) to the outer solar system. While participating in international competitions such as the race back to the Moon helps attract international acclaim, satellite programs closer to Earth provide clearer material and military benefits for the nation. One such program is the China High-Resolution Earth Observation System (CHEOS). Started in 2006, CHEOS represents one of the greatest efforts by the CNSA to produce, launch, and maintain a constellation of high-resolution observation satellites. The initial proposal described the CHEOS initiative as building a highly capable space-based observation system that could "provide all-weather, all-time, and global earth observation capability" (CNSA 2023). In total, 7 "Gaofen" satellites have launched since 2010 as part of the CHEOS program, with more planned in the coming years (Chen et al. 2022).

From 2010 to 2014, militarized interstate incidents involving China increased by over 200% representing heightened tensions in the region, and through this period, the Chinese government pronounced all Gaofen satellites as fulfilling work in "a variety of fields, including

land surveys, urban planning, road network design, crop yield estimation, and disaster relief." However, the CNSA stopped publicizing mission information for new CHEOS satellites beginning with Gaofen-8 in 2015, indicating the likelihood of dual-use to acquire geospatial intelligence (Smid 2022). Notably, the year China halted public messaging for its Gaofen systems coincided with the first U.S. Navy patrol near China's artificial islands in the South China Sea, an act the PRC considered incredibly provocative (CFR 2024). Currently, three Gaofen satellites rest in Geosynchronous Orbit (GEO) while the remainder fill alternative orbits closer to the surface such as Sun-Synchronous Orbit (SSO) and Near-Earth Orbit (NEO) orbit. If used to gather intelligence, the CHEOS constellation could collect high-resolution images of U.S. naval groups and airbases around the world, and Gaofen satellites in GEO could provide constant 24/7 coverage of the same geographical area due to their orbit matching the speed of the Earth's rotation. Satellites in GEO often conduct observations of naval movements, troop buildups, and can also be used as early-warning systems that monitor nuclear launch sites.

Under the supervision of the CNSA, the China Aerospace Science and Technology Corporation contracts out projects to civilian firms, including remote sensing (observation) satellites. For example, China Siwei developed the SuperView observation satellite constellation that provides 30cm optical resolution to customers, primarily the Chinese government, with the eventual goal of deploying 28 satellites (Siwei 2022). The company states its plans were heavily influenced by CHEOS but brings new capabilities to the table as well, including Synthetic Aperture Radar (SAR), which can see through obstructions such as clouds, rain, and fog. Together, optical and SAR sensing satellites in NEO can enable the PLA to image groupings of adversaries' forces or infrastructure in high resolution and in any weather, a critical capability for detecting the movements of military assets. Other Chinese companies involved in producing remote sensing

satellites for CASC are GalaxySpace, Beijing Space View Tech Company, and Zhongxing Zhilian. Projects from these firms support both public and private interests by pioneering Chinese SAR and electro-optical sensing in orbits that official Chinese government satellites with the same capabilities have not yet reached (Chen 2023). Investments in these firms likely indicate a desire by the PRC for private innovation to aid the progression of government systems.

Chinese government claims of the civilian uses of satellite programs are often believable for many CNSA and privately-led missions. At times, however, they attempt to masquerade commonly known spy satellites as civilian in nature. One prime example is the Yaogan Program, which consists of several dozen spy satellites launched into various orbits. Yaogan-41 launched in 2023, and soon after, a Chinese spokesperson described its mission as "intended for crop yield estimation, environmental management, weather forecasting, and disaster prevention" (Swope 2023). Strangely, however, the official designation of the mission falls under the PLA in the public record, and soon after its launch, Western analysts identified that it would reach an orbit in GEO that maintains 24/7 overwatch of the Indo-Pacific region, including Taiwan and the South China Sea, two areas of high contention for both the PRC and its adversaries. Another telling example is the Ludi-Tance 4 01A, the first SAR-capable satellite launched to GEO by China. Officially, the Ludi-Tance satellites are civilian assets developed under the China's National Civil Space Infrastructure Development Plan for 2015 to 2025 (Graham 2022), and CNSA officials described Ludi-Tance 4 01A as providing major benefits to disaster monitoring, forestry observations, and land resource mapping. As the only Chinese GEO satellite with 30m SAR resolution, the PLA would likely see it as too valuable to use purely for civilian use, and as a result, Western observers monitor it as a potential spy satellite (Swope 2023). Both Yaogin-41 and Ludi-Tance 4 01A launched during a year in which the U.S. expanded its military partnership with the Philippines

and facilitated a summit with Japan and South Korea that resulted in a joint statement condemning Chinese aggression in the region (CFR 2024).

The CNSA's purview over satellite programs extends far outside of the area of remote sensing. In 1993, the U.S. jammed the GPS capabilities aboard a Chinese vessel named the *Yinhe*, assessing that it might house chemical weapons destined to Iran (Tiwari 2024). Without GPS navigation, the vessel was stranded for weeks before international inspectors reached the ship. This event alerted the PRC to the dangers of Positioning, Navigation, and Timing (PNT) denial and the need for a domestically-produced GPS system to reduce reliance on foreign systems. Consequently, the Chinese government tasked the newly established CNSA with developing BeiDou in 1994. Two years later, the PRC blamed U.S. GPS jamming for losing control of two missiles fired as a show of force during the Third Taiwan Strait Crisis, again demonstrating the urgent need for China to obtain its own GPS-equivalent (RNTF 2023). With its first launch in 2000, the BeiDou navigation and positioning program sought to rival the U.S. Global Positioning System (GPS) by building a constellation of precise navigational, positioning, and timing satellites made exclusively in-house by the CNSA and associated government agencies (CNSA 2024). By 2012, the second generation of BeiDou officially came online, and in 2020, the CNSA completed the deployment of the third-generation network (Baar 2024).

A mature space navigational array like BeiDou grants Chinese naval, land, and air units greater awareness of their surroundings as well as more precisions for their rocket units. Unlike many of their remote sensing projects, Chinese officials candidly spoke about the utilization of BeiDou for both military and economic and social purposes from the very beginning of the program. The rationale behind exposing the system's dual-use nature likely rests in China's international agenda for BeiDou. Throughout the BeiDou network, there are two distinct levels of

positioning services—open and restricted. China utilizes the open network for its citizens to use, while the restricted service requires military credentials to access. In the past several years, China advertised both its restricted and civilian services to foreign nations. Several countries, including Thailand, Laos, Brunei, Cambodia, and Sri Lanka, signed contracts to utilize BeiDou's civilian functions (Baar 2024). Meanwhile, as of 2024, Pakistan, Saudi Arabia, and Iran officially operate on BeiDou's military network, and in 2022, Russia reached a deal with China to combine its network, GLONASS, with BeiDou. Through cooperative agreements and the building of ground stations around the world, the dual-use characteristics of CNSA's global positioning service act as a key tool of Chinese soft power.

One military capability not openly discussed by the Chinese government is that of illicit collection of positional intelligence. Most GPS systems act as a type of satellite beacon that allows a user to know where they are—but does not send the user's location back to the satellite (Xie 2020). This is a one-way process that grants the user privacy. In contrast, Beidou-compatible systems possess the capability to deliver signals back to Beidou satellites, telling the network exactly where the user is located. Not only is navigational data transmitted but also data packets, including messages. A 2017 study by the U.S.-China Economic and Security Review Commission found that, if desired, the Chinese government could use this capability to deliver malware to users' devices without alerting them. As a result, nations, including the U.S. and Taiwan, banned the service from operating within their borders out of fear of intelligence breaches (Sioco 2024). As Beidou proliferates to new users around the globe, China gains an invaluable military asset that allows for positioning intelligence collection, in addition to a potential pathway for cyberattacks against targets utilizing the network.

An additional dual-use program currently facilitated by CNSA is the Dong Fang Hong telecommunications network. Dong Fang Hong 1 (DFH-1) launched in 1970 and served as the PRC's first domestically launched satellite. As it orbited the globe, DFH-1 played "The East is Red," the PRC's national anthem during the cultural revolution, on a loop for all to hear (Harvey 2019). Over the coming decades, DFH development grew exponentially as Chinese aerospace expertise advanced. In 1993, ownership of the program transferred to the CNSA following the agency's creation. Since then, civilian scientists developed fourth- and fifth-generation Dong Fang Hong satellites that currently enable high-speed satellite internet, phone, and radio services for both civilian users and military branches. Dong Fang Hong (DFH-4), which saw its first deployment in 2006, proved a major milestone for the civilian agency as the satellite bus, the primary structural component of the satellite, standardized bus design for future Chinese satellite projects (Harvey 2019). Through the development of the DFH-4, the CNSA produced an otherwise harmless piece of technology that possessed significant military implications due to its ability to influence and serve future Chinese military satellite development. Improving on the previous design, the maiden launch of DFH-5 took place in 2017, and by this point, the satellite bus had proliferated to all sectors of China's space program.

The rocket that carried DFH-1 to orbit is known as the Long March 1. Like other nations with domestic launch capabilities, China based the design of the Long March 1 on ballistic missiles, specifically the Dong Feng 4. From 1965 to the present day, twelve series of Long March rockets have been produced or designed. In the future, China plans to adopt partial and full reusability for its rockets, starting with the introduction of Long March 9 (PRC 2023). Each series of rockets in the Long March family helped launch both civilian and military space assets, with the ground systems and launch sites both designed and controlled by the CNSA. As China seeks

to expand its satellite constellations to match U.S. space power, launch access and effectiveness will only become more critical for the PLA and, therefore, also the CNSA (Kube and Luce 2023).

Table 4.1: CNSA Dual-Use Technologies and Military Capabilities

Dual-Use Space Technology	Services Provided	Military Capability Affected
Chinese High-Resolution Earth Observation System (CHEOS)	High Resolution Electro-Optical Remote Sensing in NEO, SSO, and GEO	Geospatial Intelligence Nuclear Early-Warning
Yaogan Satellites	Remote Sensing (Electro-Optical, SAR, and Signals) in LEO, SSO, and GEO	Geospatial Intelligence Signals Intelligence Nuclear Early-Warning
Ludi-Tance Satellites	Remote Sensing (SAR) in GEO	Geospatial Intelligence Nuclear Early-Warning
Beidou Satellite Constellation	Positioning, Navigation, and Timing (PNT)	Deployed Forces Positioning Maritime Navigation Precision-Guided Munitions Drone Technology Positioning Intelligence Cyberwarfare
Dong Fang Hong (DFH) Satellites	Telecommunications	C4 Communications Drone Technology Military Satellite Design
Long March Launch Vehicles	Access to Orbit	Military Satellites Orbital Spy Planes

4.9 Organizational Makeup and Administration Policy

Over the past three decades, the organizational makeup of the CNSA evolved little, but its supervisory governmental entity changed entirely in 2008. Following a revamp of Chinese bureaucracy, the State Administration of Science, Technology, and Industry for National Defense (SASTIND) took political control over the CNSA as well as the PLA and their subsidiaries. Officials in SASTIND describe its purpose as coordinating and promoting the development of defense technology, space activities, and international affairs in these domains (PRC 2018). Subservient to the CNSA is its primary government partner, the China Aerospace Science and Technology Corporation (CASC), a government contracting agency that produces technologies, including spacecraft, launch vehicles, missile systems, and ground systems (Krolikowski 2011). CASC itself was divided into ten different subsidiaries in 1998 specializing in unique aspects of aerospace such as rocket propulsion, spaceflight technology, and more.

Participating in contracts for both the PLA and CNSA under the supervision of SASTIND entails that CASC's companies utilize their knowledge base and production lines for both civilian and military use. Without exploring the intricate setup of the Chinese aerospace industrial base, however, it would likely be difficult for individuals to recognize how government components partnering with civilian agencies can also utilize the same resources for the PLA. One telltale sign, though, is the distinction of the China Manned Space Agency (CMSA), China's astronaut or "Taikonaut" corps. Surprisingly, the CMSA reports to the Equipment Development Department of the Central Military Commission and not the CNSA. When organizing manned missions to outer space, China's civil space agency must work directly with the PLA to recruit, train, and deploy taikonauts into orbit. The highlighted connections between the two government entities are

public for all to see, yet the PRC increasingly downplays the CNSA's role in national defense while emphasizing supposed peaceful, cooperative intentions.

Every five years, the State Council Information Office of the People's Republic of China releases a policy whitepaper for the CNSA. The first such paper was published in 2000 and outlines the aims, space applications, and development targets for the agency over the next several years. In that iteration, the authors emphasize the agency's goal of meeting "the growing demands of economic construction, national security, science and technology development, and social progress" (PRC 2000). The paper then discusses the applications of China's remote sensing and telecommunications satellites stating they have been utilized "in all aspects of economy, science and technology, culture, and national defense." The paper concludes with several development targets for the agency to reach over the coming years. These targets include economic construction, state security, science development, social progress, and national strength, which are seen as advantages afforded by the exploration of outer space. In total, the 2000 whitepaper included three unique mentions of "National Security" and two mentions of "National Defense," directly linking the CNSA to militaristic goals.

Over the next two decades, subsequent policy papers in 2006, 2011, 2016, and 2021 would continue to describe the goals of China's civilian space program. Similar in length at around 7,000 words, the papers often convey many of the same topics such as economic development and scientific progression. For each of the five whitepapers, I identified individual occurrences of three keywords that represent or relate to military power, including "National Security," "National Defense," and "National Strength." The term "National Security" can relate to both domestic and international security, but the usage of the word implies some involvement by state security entities, the most influential and powerful one being the military. In contrast, "National Defense"

speaks directly to defense from foreign powers and almost always describes the primary function of a state's armed forces. Finally, "National Strength" can encompass physical, economic, or even social strength. This term is included in the analysis to ensure that physical strength, including the ability of a state to withstand and deliver blows during conflict, is covered in full. In Figure 5, the occurrences of each term are counted for all five policy whitepapers. Terms are not included in the count if they are not a unique occurrence, meaning that they represent the name of an organization or are listed in the table of contents.

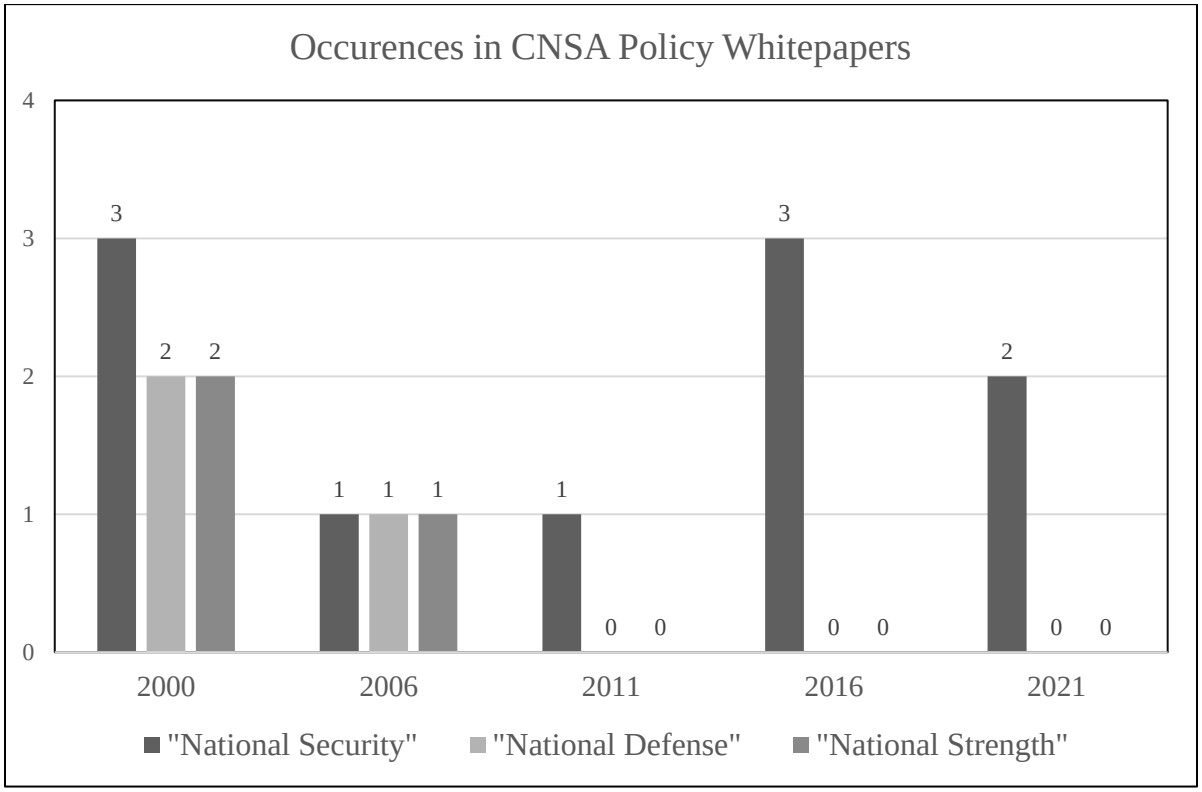

Figure 4.4: CNSA Whitepaper Militaristic Language

Immediately, two noteworthy observations present themselves. "National Security" remains relatively constant, with one to three occurrences for all five papers. Yet, the story changes as we shift our focus to the other terms. The 2000 paper includes "National Defense" and "National

Strength" twice, and the 2006 paper include each term once. However, in all future whitepapers, they are nowhere to be found. The Chinese government's sudden cessation of utilizing those terms to describe the CNSA's policy is both fascinating and potentially telling. Prior to 2003, China did not possess a manned space program and was commonly thought of as a developing space power by the international community (Harvey 2019). Following the first taikonaut mission to orbit, China quickly pressed ahead with its program by launching the first Chinese lunar exploration mission in 2007 and conducting the first Chinese spacewalk in 2008. Simultaneously, the CNSA developed the origins of what would become the BeiDou navigation satellite constellation, with the first prototype satellite launch in 2007, and in 2010 during an uptick in regional dispute incidents, China approved the CHEOS constellation program and immediately began production of the Gaofen series of observation satellites. While China's space program grew, it did so in two directions. The first, consisting of manned and lunar missions, garnered international prestige and implied peaceful intentions. The second involving the creation of the BeiDou and CHEOS programs, would appear more questionable due to their dual-use nature, however. As a result, it would seem logical for China to remove mentions of "National Defense" and "National Strength" to avoid tying military motives to their civil space agency's official policies. "National Security" remains perhaps due to the possibility of officials utilizing this terminology to point to domestic security issues rather than foreign conflicts.

In addition to decreasing militaristic language, the PRC would likely want to amplify cooperative language in their policy descriptions as to attract foreign interest. Figure 6 displays results from a text analysis like the one presented in Figure 3, but this time, it focuses on cooperative language. The occurrences of two terms, including "Cooperation" and "Exchanges," are counted for all five policy papers. The appearance of "Cooperation" implies that a nation is

intent on participating in or at least highlighting its involvement in partnerships with external parties. Lastly, “Exchanges,” particularly in the context of the whitepapers themselves, most often refers to a meeting or exchange of knowledge and scientists with a foreign power. Domestic exchanges are not referenced once in any of the papers. Like the first analysis, terms are not counted if they are not considered a unique occurrence.

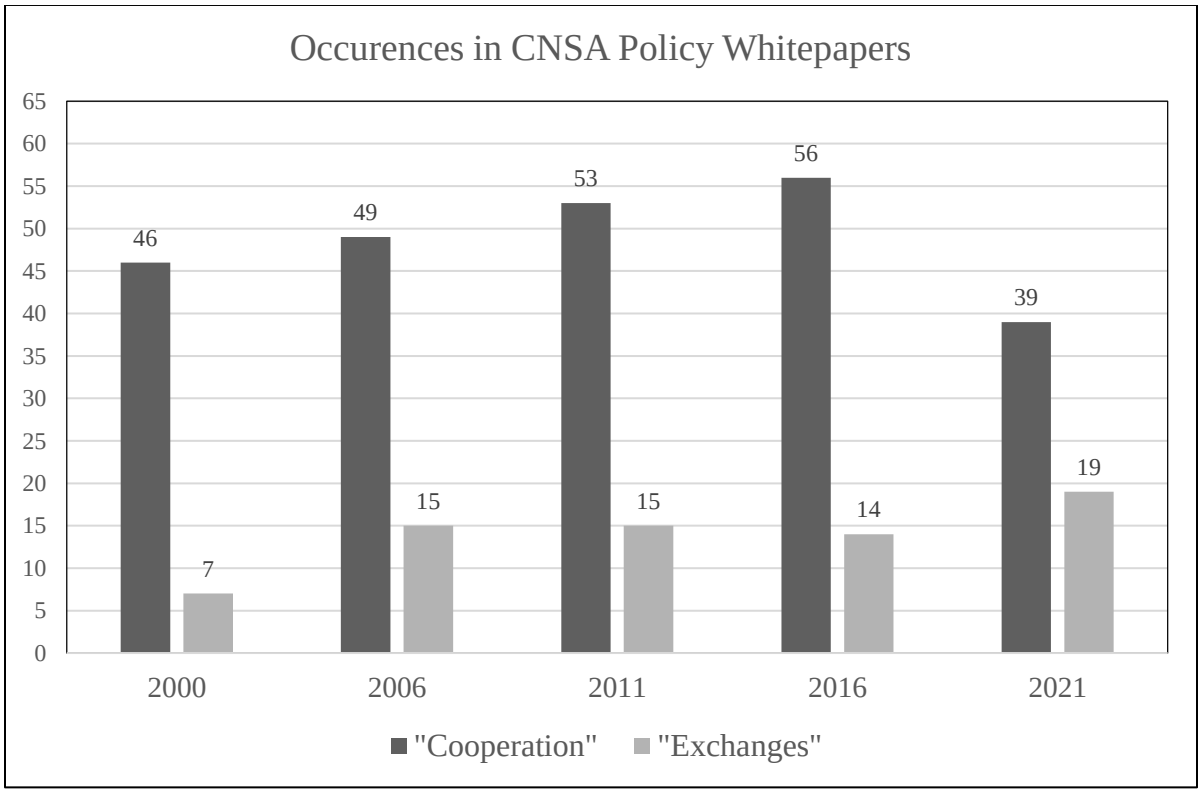

Figure 4.5: CNSA Whitepaper Cooperative Language

Analyzing the results, a trend can be identified for both terms. Occurrences of “Cooperation” increase by three or four every paper until the 2021 paper, which sees a sharp drop of seventeen instances. The exact reasoning behind the 2021 drop is unknown but could potentially be explained by translation differences, internal policy changes, or a drop in the lack of cooperation agreements or memoranda signed in the years prior. Meanwhile, the 2000 paper contains seven

mentions of “Exchanges.” By 2021, that number rises to nineteen, representing a greater than 150% increase. While the drop in “Cooperation” could indicate a lesser number of new agreements, the prominence of “Exchanges” demonstrates the continued desire by the PRC to engage in international meetings and forums. These two trends largely follow Chinese space development as described in the previous analysis, with increases seen for both terms over time.

The final text analysis, presented in Figure 7, identifies instances of altruistic language in which the white paper refers to the CNSA’s activities such that they are benign and potentially even beneficial for the rest of the world. Instances of “Mankind or Humanity” are counted together as they translate to the same term in Mandarin, “Rénlèi.” Utilizing this language appeals to foreign actors as it signifies how China’s space efforts create opportunities to progress all of humanity’s technology and knowledge. “Peaceful” is often used in diplomatic messaging to designate an action as nonconfrontational or aggressive and, as such, is included as the second analyzed term. Finally, “Sustainable” can serve numerous purposes in referring to sustainable practices across China’s space purview, such as launch practices, space debris, human spaceflight, and more. Regardless of how the term is used, labeling an action as “Sustainable” advertises the careful thought and planning put into the activity—while also implying that adverse effects of such practices will not harm other nations’ programs or assets in outer space.

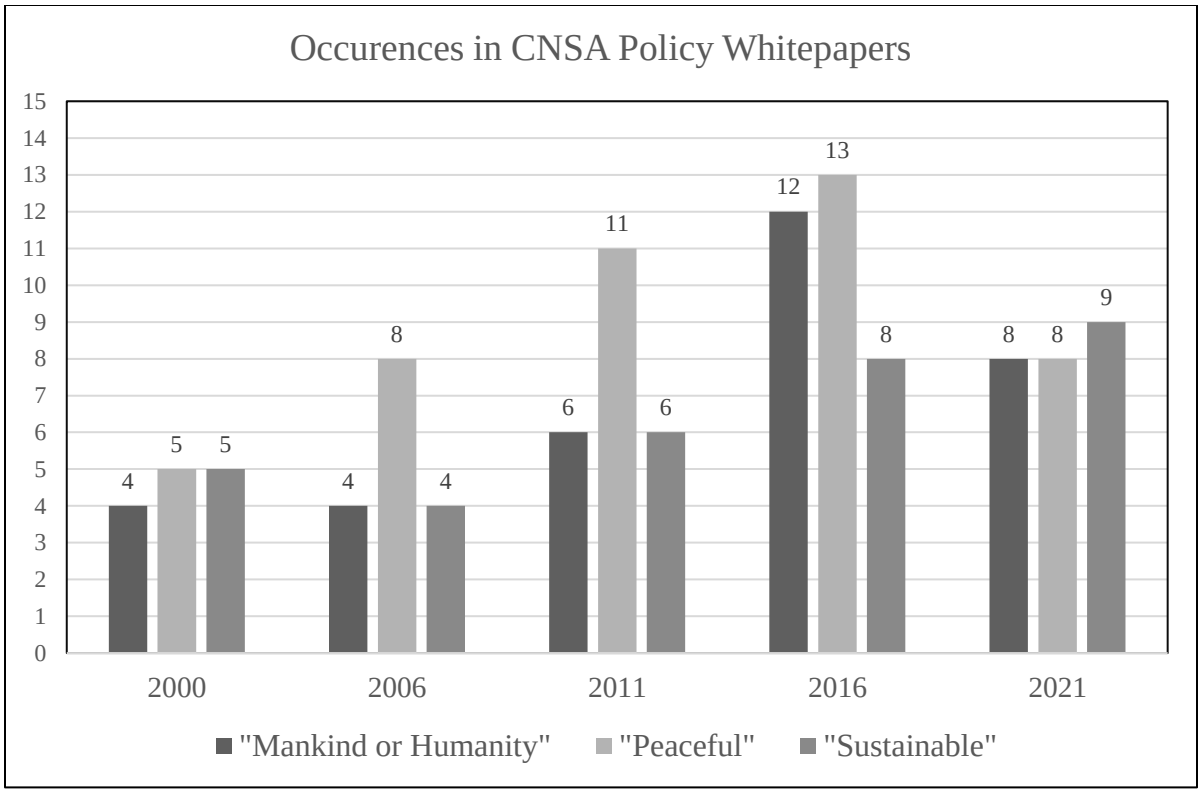

Figure 4.6: CNSA Whitepaper Altruistic Language

Results from the analysis show that instances of "Mankind or Humanity" increase from four in 2000 to eight in 2021, with a high point set at 2016 with twelve instances. An overall increase of 100% from 2000 to 2021 aligns with the idea of appealing to common international goals. The second term, "Peaceful," appears five times in the 2000 whitepaper, and throughout the next three papers, the number of occurrences more than doubles, with the 2016 paper seeing "Peaceful" used thirteen times. As the CNSA's achievements grew, so too did their apparent desire to paint their programs as innocuous. This effect is particularly relevant from 2000 to 2011 when the PRC acquired a manned space program and set off to explore the Moon and Mars. Yet, the trend continues into the 2010s as China became increasingly involved in international disputes—showcasing the desire to be perceived as peaceful and cooperative even when facing great pressure

from foreign actors. Meanwhile, "Sustainable" sees five occurrences in the 2000 whitepaper before almost doubling to nine occurrences by the 2021 edition, again, displaying a desire to promote the CNSA's activities as safe and efficient.

One interesting wrinkle throughout the cooperative and altruistic text analyses is the results from the 2021 paper. In this iteration, occurrences of "Cooperation," "Mankind or Humanity," and "Peaceful" fall relative to the 2016 whitepaper. This decrease could be caused by a change in verbiage or potentially geopolitical events. Since taking power in 2013, President Xi Jinping has concentrated executive power and worked to present China as a formidable world power, especially in the context of its rivalry with the United States (Rudd 2022). These developments could incentivize policy descriptions of China's space program to become less peaceful; although, references to exchanges and sustainability are still high, with both seeing a continued increase over the 2016 paper. China may wish to maintain a cooperative posture with the international community while also not over-emphasizing the peaceful nature of their program. Another possible answer lies in tying language to the rate of technological progress rather than overall progress. Take, for example, the period between 2000 and 2011. During this time, China developed human spaceflight, lunar exploration, advanced earth observation, and global positioning and navigation programs. Such rapid advancement may have compelled the PRC to increase cooperative and altruistic language while decreasing militaristic language to assuage international fears of China's rising power. In other words, when the nation's space program experiences rapid advancement, the need for a positive international image might be greater. However, once time passes and China has solidified its new position in space development, leaders potentially see less need to continue those patterns as the initial shock has diminished.

Delving into the specifics of the most recent whitepaper published in 2021 informs us how the Chinese government currently views its civil space agency and what they consider its priorities. Strengthening space traffic control, improving debris monitoring, producing a near-earth object defense system, increasing the survivability of space assets, and building a space-ground climate monitoring system are described as the CNSA's primary goals in the short term. None of the referenced objects are explicitly beneficial to the military but could certainly possess dual-use potential. The final third of the policy paper highlights the agency's engagement with the international space community and its desire to increase cooperation in several domains. As an example of recent international cooperation, the paper lists various partnerships with the European Space Agency (ESA) on manned spaceflight rehearsals and deep space exploration, in addition to the sharing of space technologies such as the BeiDou navigation satellite constellation with various countries. The number one international achievement listed by the paper is participation in the global governance of outer space. China regularly joins U.N. forums on space sustainability, space resources, and the prevention of an arms race in outer space (PAROS), a 1981 U.N. resolution that initiated annual meetings on the militarization and weaponization of outer space. As a developed space power, the PRC seeks to not only engage with the international space community but also lead it. Doing so lends credit to claims in the CNSA whitepapers that China's program has purely peaceful intentions. This is also evidenced by the inclusion of two never-before-seen terms, "Global Consensus" and "Human Progress," which more explicitly state that the PRC is abiding by international space norms and are producing benefits for all of humanity.

4.10 Public Statements and Approval

Publicly, Chinese officials rarely comment on the CNSA and its objectives. When the subject arises, politicians will often highlight areas of international cooperation. In 2023, China's

Foreign Ministry Spokesperson Mao Ning commented on several of the CNSA's recent achievements (PRC 2023). Ning emphasized that China shared several of their lunar samples from the Chang'e-5 mission with foreign nations such as Russia and France and that the CNSA hopes to continue cooperation on lunar exploration through their planned moon base known as the International Lunar Research Station (ILRS). A year prior, the chairman of CASC, Wu Yansheng made several remarks during a broadcast lecture that identified future space plans and challenges the nation would face (Jones 2022). By 2030, Yansheng hopes China will become a major space power by being the 2nd nation to land humans on the moon, and by 2045, the chairman foresees China as a "comprehensive" space power after transitioning its focus to Mars. Of note, however, Yansheng blames the U.S. for "restarting great power competition" by excluding China from its space programs and working to control strategic orbits and radio frequencies. Regardless, while China would continue to develop its capabilities independently, the chairman's statements underline the importance of China's international involvement in outer space.

President Xi Jinping gives an address to the national party congress at the start of every five-year term. During his speeches, Xi speaks to the Chinese Communist Party's (CCP) history, recent Chinese achievements, and long-term goals for the country. These speeches also serve as a means of signaling intent to the international community on various issues, as they are heavily publicized by official PRC channels in several languages. China's space program is occasionally referenced in Chinese presidents' opening remarks but only as one item on a long list of successes. In 2022, however, President Xi highlighted the nation's space efforts at an unprecedented rate during the opening of the 20th National Party Congress. Unlike other officials, Xi focused on space technology development as a symbol of the CCP's legitimacy on the international stage (Goswami 2023). The speech described programs such as manned spaceflight, exploration of the Moon and

Mars, and increasingly advanced space infrastructure as evidence of China's rise to prominence globally. Due to the venue, President Xi almost certainly framed space efforts to maximize the image of the CCP for both domestic and international audiences. Such a move by the Chinese President at the 20th National Party Congress demonstrates the progress made by the PRC in outer space and the degree to which they consider space power a part of their national strength. It is also worth noting that since the last congress, several events transpired that induced an increasingly threatening international environment for China (CFR 2024). A spiraling trade war initiated by President Trump damaged China's economic outlook. Meanwhile, the Philippines faced off against the Chinese Navy near the Spratly islands as Philippine President Duterte promised a hardline approach to the nation's territorial claims, and from 2020 to 2021, PLA troops engaged Indian troops in skirmishes over disputed territories. By advocating for the progression of Chinese space infrastructure on the national stage, President Xi is placing greater emphasis on producing technologies that can help address recent incidents and project Chinese power to a new domain.

Outside of national party congresses, Xi largely only speaks to China's space endeavors when commemorating the launch of an important mission. These statements are usually short, generic, and hopeful, yet again, they are publicized with both domestic and international audiences in mind. In early 2024, after congratulating CNSA scientists on the return of lunar samples to Earth, the President noted that this mission furthered peaceful cooperation and mutual benefit for all of humanity (Lei 2024). Xi made similar remarks emphasizing "the peaceful use of space and the building of a community with a shared future for humanity" in similar visits to CNSA facilities on an almost annual basis since 2013 (Xinhua 2022, Zhuo 2021, Shaohui 2017). Xi's predecessor, President Hu Jintao, also made similar visits to Chinese space centers to congratulate CNSA scientists and PLA astronauts during his tenure. The number of statements made by President

Jintao pale in comparison to President Xi, yet the few statements Jintao did make came following notable events. In January 2007, China demonstrated its anti-satellite capability by successfully downing one of its satellites in orbit, a move that sparked fears of a space arms race between the U.S. and China (NBC 2007). Several months later, the PRC launched Change-1 to the Moon on the nation's first lunar mission, and shortly following its success, President Jintao reaffirmed China's commitment to the peaceful use of outer space in a public speech likely meant to assuage international concerns over China's growing space power. Overall, statements concerning China's civil space program are relatively few and broad in scope, yet when given the chance, political leaders, company chairmen, and government spokespersons alike consistently attempt to augment the perception of China's space efforts as sincerely peaceful and cooperative. Most importantly, their words imply that China success in outer space bodes well for the entire world.

Surveys of the Chinese public are rare, and surveys on public attitudes concerning space policy are even less common. The first and only such study published in 2022 after Dr. Lincoln Hines conducted an online survey that asked Chinese citizens their opinions on several topics related to the Chinese civil space program and U.S.-China relations. In the paper, the results of the 2020 survey indicated that public approval for missions to the Moon and Mars was exceedingly high, and most respondents (68%) believed China's manned space program to be a good investment. Interestingly, while results show most individuals consider the U.S. space program a threat, they also believe China should work with the country on space exploration. This juxtaposition of views demonstrates the will of the Chinese people to support international cooperation even with their staunchest rival, a notion that is likely encouraged by public statements repeatedly pressing the importance of international engagement. Further questions asked respondents whether they supported China's abiding by international law governing the peaceful

use of outer space and even an agreement that would ban all weapons in outer space. Responses overwhelmingly supported both notions, again reflecting official statements and policy outlooks released by the Chinese government. Such sentiments are also represented by Chinese participation in U.N. space arms control forums, where China has taken an increasingly large role in recent meetings (Qisong 2024, ACA 2024, Bitt 2024). Based on this study alone, the Chinese populace appears to largely accept official stances on space policy, which lends credit to the notion that the PRC's peaceful framing of the PRC successfully appeases its domestic population, even if international audiences are the primary target of such messages.

4.11 International Cooperation and Arms Control

As China's space program further develops, its desire to participate in international ventures grows too. Along with technological and social prowess comes an international expectation to adhere to norms (Cohen 1978, Simmons 2000, Miller et al. 2015). In outer space, this constitutes accepting international law and arms control in space, but it can also entail engaging other states on mutual exploratory and scientific missions. In reference to the paper's theory, China can further develop its outer space technologies by forming technology-sharing agreements between established civilian space agencies and its own, which allow for potential military benefits via dual-use technologies. Meanwhile, by participating in international arms control forums and keeping cooperation civilian in nature, China avoids the international stigma of militarizing space, thereby creating the potential for more agreements in the future.

In June 2021, China and Russia signed an agreement outlining a joint effort to build the International Lunar Research Stations (ILRS) on the surface of the Moon. On paper, Roscosmos and the CNSA share ownership of the program; however, a common understanding exists that China will lead the mission due to its advanced space capabilities and lunar infrastructure already

in place (Wu 2023). Currently, in the design phase, the ILRS will serve as a scientific base that allows numerous nations to send their astronauts to the Moon and conduct lunar research. Thirteen countries, including Venezuela, Pakistan, Egypt, Thailand, South Africa, and more, signed agreements with Roscosmos and the CNSA for utilization of the base. In exchange, the PRC receives international recognition as a leader in lunar exploration and gains access to critical ground sites needed to relay signals to space vehicles in orbit. This trend follows previous efforts by the PRC to expand its ground station footprint across the globe while promising to help develop the host nation's space capabilities in the process.

In South America, China operates a dozen ground stations on leased land in countries such as Brazil, Chile, Argentina, Paraguay, and Venezuela—on the condition that they use the satellite relays for "civilian activity" only (Funaiole et al. 2022). Recently, however, the U.S. and European nations expressed concern that these stations helped operate PRC military and intelligence missions, even after Beijing repeatedly denied such claims (Cadell and Carpio 2023). With ILRS framed as a purely scientific endeavor, it may allow China to approach nations with the promise of lunar prestige so long as they allow the Chinese government to maintain "civilian" satellite ground centers. One notable example is Venezuela, a long-time cooperator with the CNSA. President Maduro recently pledged to allow the PRC to expand its space system infrastructure in the country for the purpose of supporting ILRS missions (Jones 2023). This counts as the first instance under the ILRS program in which a foreign nation's participation in the initiative led to the expansion of Chinese space assets in the country. As a new space race heats up between the U.S. and China, countries will likely feel compelled to choose between joining the Artemis Accords, the U.S.-led program to return to the Moon, and the ILRS to not let a historic opportunity—and its ensuing prestige benefits—go to waste.

Outside of the ILRS program, the PRC continues to engage individual countries in search of key bilateral agreements on cooperation in space. In 2023, in addition to signing on to the ILRS program, Egypt received several low-resolution observation satellites from China to bolster their presence in space. The PRC likely views such procurements as essential to building political and economic inroads with developing economies on the African continent and particularly those who are members of BRICS— a geopolitical bloc of states that works to cooperate on national policies for mutual benefit (Jones 2023). One of the group's most recent developments is the establishment of the BRICS Remote Sensing Satellite Constellation, a satellite network comprised of primarily Chinese-produced satellites that allow BRICS members to share remote sensing data to better facilitate "environmental protection, disaster prevention and mitigation, and tackling climate change" (CNSA 2022). This constellation, while novel and comprised of relatively few satellites, represents a large step taken by the PRC to not only participate in but also lead international cooperation in outer space. Remote sensing is a key dual-use technology utilized by the PRC, and while the BRICS constellation focuses on likely civilian uses, it is not difficult to imagine such partnerships emerging as a step before the sharing of data for military or intelligence purposes. As an aspiring BRICS member, Thailand signed a memorandum of understanding with China in 2018 that committed the two countries to building a joint remote sensing satellite ground station on the Lancang-Mekong River. This agreement preceded Thailand's 2024 announcement of a pact with Beijing that dictated their cooperation on the "peaceful use of outer space" and Thailand's formal entry into the ILRS program. Through numerous outreach programs, China continues to successfully promote its place within the international community while reaping political, diplomatic, and military benefits.

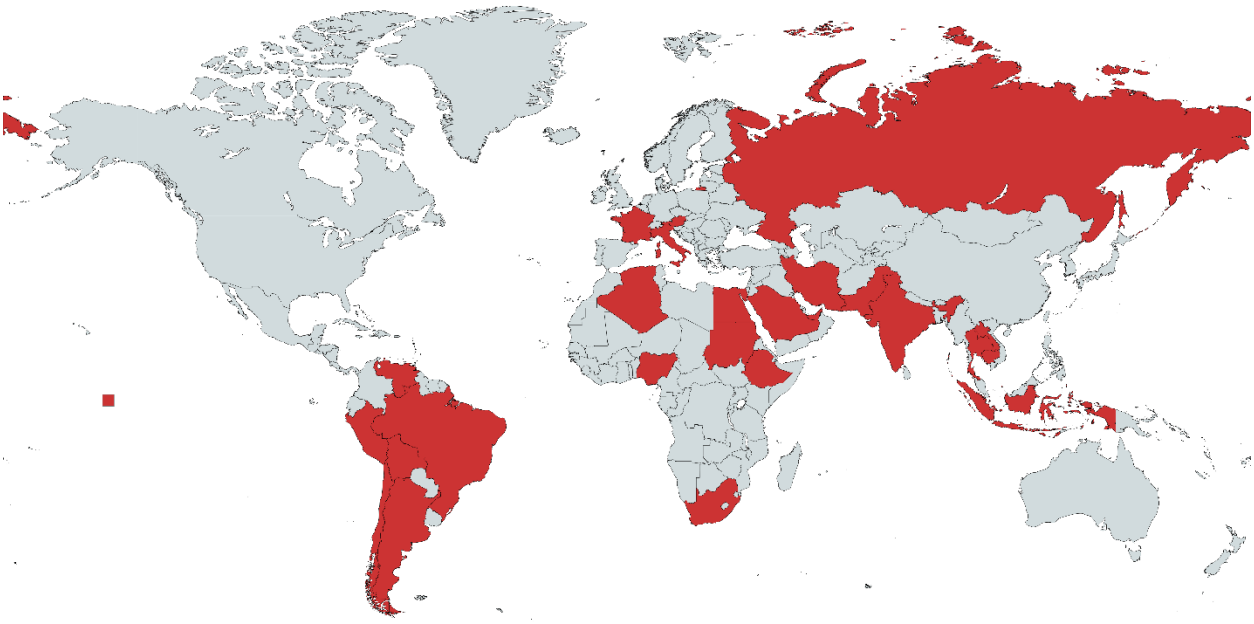

Figure 4.7: States with a Civil Space Cooperation Agreement with China (2024)

Note: This map highlights space cooperation agreements or memorandums of understanding between China and individual countries, not international space organizations. China maintains cooperative agreements with the European Space Agency**.**

In 2011, the United States Congress passed a law known as the Wolf Amendment. The amendment, inserted into appropriations bill annually, prevents NASA from spending funds to cooperate directly with the CNSA. In other words, NASA and the CNSA cannot share research, technology, or manpower. The amendment originated from U.S. Representative Frank Wolf, who feared that collaboration between the two nations in outer space could give the PRC an edge in technology development as well as present a heightened intelligence threat to U.S. space systems (David 2021). Without the U.S., the CNSA relies primarily on domestic industry and scientific expertise to build its space systems, yet one state openly and continually offers its assistance, even as its own space program diminishes. That state is Russia. A 2023 report from the Center for Naval

Analyses (CNA) identifies several ways in which the two states are cooperating in space. On the surface, China and Russia claim to work together for economic, scientific, and diplomatic benefits such as those provided by ILRS. However, the deals made by the two countries concerning strategic and military affairs are less publicized. In 2019, Russia agreed to share sensitive ballistic missile technology with the PRC, granting the nation the opportunity to increase the effectiveness of its ballistic missile inventory. In return, China would help Russia produce an updated early warning system for ballistic missiles to be used by both states. Five years earlier, Roscosmos and the CNSA signed an agreement to integrate their satellite fleets' operability and construct ground stations in each other's territory. As Russia moves further away from the West politically, it faces no choice but to rely on Chinese aid to maintain an image of strength in domains such as outer space (Korolev 2019).

Beyond material cooperation, China and Russia consistently appear diplomatically united at U.N. meetings on arms control in outer space. In 2008, shortly following the first Chinese spacewalk and lunar exploration missions—in addition to its first antisatellite (ASAT) weapons test, the two nations proposed the Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT). This treaty, and its 2014 revision, continue to make up the foundation of both China's and Russia's approach to arms control in space. Yet, scholars note that the proposed document contains various discrepancies regarding the verification of what qualifies as a "weapon" and how weapon tests could be verified (Zhao 2022, Britt 2024). With a flimsy verification regime in place, China could theoretically pursue the weaponization of space without consequences, especially if the technology involved in weaponization is considered dual-use. At the same time, the PRC would appear as if they are actively adhering to international norms.

One additional perspective to consider is that of the United States. In 2022, the Biden Administration announced a unilateral ban on ASAT testing with the hope that other countries would soon follow in their footsteps. Unlike the PPWT, the U.S.'s efforts do not prevent the placement of weapons in outer space and instead focus on testing. China maintains an effective ASAT program, and as proven by their 2007 shootdown of a satellite, testing is essential for development progress (Blatt 2020). Therefore, joining the U.S.-led initiative poses a direct threat to their military space development. The PPWT, in comparison, positions the PRC as a responsible international actor while allowing the country's space program leeway in its development. If the proposed treaty garners more support, it could also tie the U.S.'s hands in weapons development as the nation feels increased pressure to agree to its terms—and do so honestly. China's arms control strategy represents a calculated effort to outwardly engage with the international space arms control community while also attempting to maintain an aura of deniability in its own agenda to militarize outer space.

4.12 Conclusion

The argument at the core of this paper posits that the civil space sector presents an attractive offer to state leaders, including authoritarian leaders. Invest funds into the creation of a civilian space agency, ensure it receives the resources necessary to advance technologically, and frame its mission portfolio as beneficial for all of humanity. In the process, the host nation receives dual-use technologies that improve the effectiveness of its armed forces, a greater intelligence apparatus that illuminates security threats, and new technological cooperation agreements with foreign nations—all while appearing to contribute to the common good of all nations. While Chapter 2 originally proposed the theory, this study examined the idea in the context of authoritarian states, which should place less value on public opinion than democratic states. An analysis of the Chinese

National Space Administration and its evolution over the years demonstrated remarkable adherence by the PRC to the paper's theory even as an authoritarian state. While the CNSA first arrived on the scene in 1993, the PRC grew its investment in the agency over time as its national security interests came under increasing threat—in large part due to the rising ambitions of its leaders and the U.S.'s rebalancing to Asia. The 2000s saw great leaps for China's growing civil space program, yet the following decade proved even more vital as Chinese launches to orbit skyrocketed and numerous CNSA programs came online, all while President Xi consolidated power and disputes with regional neighbors worsened. Specific dual-use applications of these programs continue to allow China to bolster its armed forces in a variety of ways. Meanwhile, between 2000 and the present day, official CNSA policy documents, statements, and outreach programs demonstrated a heightened desire by the PRC for the international community to view its space activities as peaceful and advantageous for all. A strong and positive international reputation in outer space grants China the opportunity to sign space cooperation agreements with foreign nations and progress its own technologies and military power in the process.

These findings indicate support for the paper's central theory and have greater implications for the field of space politics. Illuminating the core motivations behind civil space development and framing helps illustrate why states, regardless of their political system, may pursue civilian over military space programs—and which states may pursue this path in the future. Furthermore, highlighting explicit cases of dual-use space missions could alter public perceptions of space technologies and even influence international discourse on space cooperation agreements. Yet, several drawbacks of the paper's research design limit its generalizability. China's civilian space program is a well-documented, successful endeavor, but how might the paper's ideas hold up in the context of smaller, more novel space programs? In the future, additional case studies are needed

to garner additional support concerning militaristic civil space motivations, especially from countries with smaller militaries, economies, and less obvious security concerns. Multilateral space organizations, such as the European Space Agency and African Space Agency, also introduce new questions as states contributing to these entities do not necessarily receive the same benefits as from their own unilateral programs. This study and these questions act as important pillars for further exploration of a relatively understudied academic field. Civilian space agencies can evolve into marvels of human ingenuity that impart great value to society, but as is often the case, leaders may have ulterior motives in mind.

4.13 References

Adriaensen, Maarten, Christina Giannopapa, Daniel Sagath, and Anastasia Papastefanou. 2015. "Priorities in National Space Strategies and Governance of the Member States of the European Space Agency." *Acta Astronautica* 117: 356–67. doi:10.1016/j.actaastro.2015.07.033.

Aizhu, Chen. 2024. "China, Thailand Sign Pacts on Outer Space, Lunar Outposts." *Reuters*. https://www.reuters.com/technology/space/china-thailand-sign-pacts-outer-space-lunar-outposts-2024-04-05/ (October 14, 2024).

Alesina, Alberto, and Enrico Spolaore. 2006. "Conflict, Defense Spending, and the Number of Nations." *European Economic Review* 50(1): 91–120. doi:10.1016/j.euroecorev.2004.06.003.

Amonson, MAJ Kyle. "The Ambitious Dragon: Beijing's Calculus for Invading Taiwan by 2030."

Atkinson, Douglas B., Andrew P. Owsiak, Joshua Jackson, and Rebecca Buechler. 2024. "Sequencing the Steps to War." *International Interactions* 50(5): 780–808. doi:10.1080/03050629.2024.2378779.

Baar, Jemima. 2024. "BeiDou And Strategic Advancements in PRC Space Navigation." *Jamestown*. https://jamestown.org/program/beidou-and-strategic-advancements-in-prc-space-navigation/ (April 8, 2024).

Bajak, Frank. 2024. "US-China Competition to Field Military Drone Swarms Could Fuel Global Arms Race." *AP News*. https://apnews.com/article/us-china-drone-swarm-development-arms-race-e5808a715415d709f466da00cdeab10f (October 23, 2024).

Ballus, Spencer. "Why Do Less Capable States Go Nuclear?" University of Chicago. doi:10.6082/uchicago.7168.

Bausch, Andrew W. 2015. "Democracy, War Effort, and the Systemic Democratic Peace." *Journal of Peace Research* 52(4): 435–47. doi:10.1177/0022343314552808.

Beckley, Michael. 2017. "The Emerging Military Balance in East Asia: How China's Neighbors Can Check Chinese Naval Expansion." *International Security* 42(2): 78–119. doi:10.1162/ISEC_a_00294.

Bennett, D. Scott. 2006. "Toward a Continuous Specification of the Democracy–Autocracy Connection." *International Studies Quarterly* 50(2): 313–38. doi:10.1111/j.1468-2478.2006.00404.x.

Bergin, Chris. 2009. "Chinese Launch Again with YaoGan Weixing-6 Remote Sensing Satellite." *NASASpaceFlight.com*. https://www.nasaspaceflight.com/2009/04/chinese-launch-again-with-yaogan-weixing-6-remote-sensing-satellite/ (April 8, 2024).

Blake, Duncan. 2014. “Military Strategic Use of Outer Space.” In *New Technologies and the Law of Armed Conflict*, eds. Hitoshi Nasu and Robert McLaughlin. The Hague: T.M.C. Asser Press, 97–114. doi:10.1007/978-90-6704-933-7_7.

Blatt, Talia. 2020. *Anti-Satellite Weapons and the Emerging Space Arms Race*. Harvard International Review. https://hir.harvard.edu/anti-satellite-weapons-and-the-emerging-space-arms-race/ (October 15, 2024).

Brands, Hal. 2018a. “Democracy vs Authoritarianism: How Ideology Shapes Great-Power Conflict.” *Survival* 60(5): 61–114. doi:10.1080/00396338.2018.1518371.

Brands, Hal. 2018b. “Democracy vs Authoritarianism: How Ideology Shapes Great-Power Conflict.” *Survival* 60(5): 61–114. doi:10.1080/00396338.2018.1518371.

Brennan, David. 2024. “Strategic Space Cooperation between Russia and China Raises Alarm.” *Newsweek*. https://www.newsweek.com/russia-china-space-cooperation-raises-alarm-moon-1876342 (March 20, 2024).

Britt, Brian. 2024. “The PPWT and Ongoing Challenges to Arms Control in Space.” *Joint Force Quarterly* 113(1). https://digitalcommons.ndu.edu/joint-force-quarterly/vol113/iss1/13.

Buchan, Russell. 2010. “Explaining Liberal Aggression: The International Community and Threat Perception.” doi:10.1163/187197310X530997.

Cadell, Cate, and Marcelo Perez del Carpio. 2023. “A Growing Global Footprint for China’s Space Program Worries Pentagon.” *Washington Post*. https://www.washingtonpost.com/world/interactive/2023/china-space-program-south-america-defense/ (October 14, 2024).

Chen, Jidong, Jennifer Pan, and Yiqing Xu. 2016. “Sources of Authoritarian Responsiveness: A Field Experiment in China.” *American Journal of Political Science* 60(2): 383–400. doi:10.1111/ajps.12207.

Chen, Jidong, and Yiqing Xu. 2017. “Why Do Authoritarian Regimes Allow Citizens to Voice Opinions Publicly?” *The Journal of Politics* 79(3): 792–803. doi:10.1086/690303.

Chen, Liangfu, Husi Letu, Meng Fan, Huazhe Shang, Jinhua Tao, Laixiong Wu, Ying Zhang, et al. 2022. “An Introduction to the Chinese High-Resolution Earth Observation System: Gaofen-1~7 Civilian Satellites.” *Journal of Remote Sensing* 2022. doi:10.34133/2022/9769536.

Chen, Na. 2023. “Chinese Satellite Constellation Captures High-Precision Terrain Images---- Chinese Academy of Sciences.” *Chinese Academy of Sciences*. https://english.cas.cn/newsroom/cas_media/202310/t20231019_383970.shtml (October 2, 2024).

Cheung, Tai Ming, William Lucyshyn, and John Rigilano. 2019. *The Role of Technology Transfers in China Defense Technological and Industrial Development and the*

Implications for the United States. Acquisition Research Program. Technical Report. https://dair.nps.edu/handle/123456789/2756 (April 8, 2024).

"China 101 Toolkit." 2024. *Air University (AU)*. https://www.airuniversity.af.edu/CASI/Toolkit/ (October 1, 2024).

China's Island Building in the South China Sea: Damage to the Marine Environment, Implications, and International Law | U.S.- CHINA | ECONOMIC and SECURITY REVIEW COMMISSION. 2016. U.S.-China Economic and Security Review Commission. https://www.uscc.gov/research/chinas-island-building-south-china-sea-damage-marine-environment-implications-and (November 12, 2024).

China's Space Activities in 2006. 2006. The State Council Information Office of the People's Republic of China. https://china.usc.edu/chinas-space-activities-2006-white-paper (October 16, 2024).

China's Space Activities in 2011. 2011. The State Council Information Office of the People's Republic of China. https://english.www.gov.cn/archive/white_paper/2014/08/23/content_281474983043142.htm (October 16, 2024).

China's Space Activities in 2016. 2016. The State Council Information Office of the People's Republic of China. https://www.cnsa.gov.cn/english/n6465645/n6465648/c6768527/content.html (October 16, 2024).

China's Space Program: A 2021 Perspective. 2021. The State Council Information Office of the People's Republic of China. https://english.www.gov.cn/archive/whitepaper/202201/28/content_WS61f35b3dc6d09c94e48a467a.html (October 16, 2024).

"China's Xi Allowed to Remain 'president for Life' as Term Limits Removed." 2018. *BBC*. https://www.bbc.com/news/world-asia-china-43361276 (October 22, 2024).

"Chinese Leader Celebrates Space Success." 2007. *NBC News*. https://www.nbcnews.com/id/wbna22219374 (October 21, 2024).

"Chinese President Pledges Peaceful Use of Outer Space." *Embassy of the People's Republic of China*. http://lr.china-embassy.gov.cn/eng/majorevents/200712/t20071213_6248589.htm (October 21, 2024).

Cimbala, Stephen J. 2015. "Chinese Military Modernization: Implications for Strategic Nuclear Arms Control." *Strategic Studies Quarterly* 9(2): 11–18.

CNSA. 2022. "BRICS Countries Launch Joint Committee on Space Cooperation." https://www.cnsa.gov.cn/english/n6465668/n6465670/c6840322/content.html (October 14, 2024).

CNSA. “Beidou System Overview.” http://en.beidou.gov.cn/SYSTEMS/System/ (April 8, 2024).

Cohen, Raymond. 1978. “Threat Perception in International Crisis.” *Political Science Quarterly* 93(1): 93–107. doi:10.2307/2149052.

Cortell, Andrew P., and James W. Davis Jr. 1996. “How Do International Institutions Matter? The Domestic Impact of International Rules and Norms.” *International Studies Quarterly* 40(4): 451–78. doi:10.2307/2600887.

Costello, John, and Joe McReynolds. 2018. “China’s Strategic Support Force: A Force for a New Era.” *Institute for National Strategic Studies* 13.

Crisman-Cox, Casey, and Michael Gibilisco. 2018. “Audience Costs and the Dynamics of War and Peace.” *American Journal of Political Science* 62(3): 566–80.

David, Leonard. 2021. “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/ (October 14, 2024).

Debs, Alexandre, and Jessica Chen Weiss. 2016. “Circumstances, Domestic Audiences, and Reputational Incentives in International Crisis Bargaining.” *Journal of Conflict Resolution* 60(3): 403–33. doi:10.1177/0022002714542874.

Deep Space Exploration Laboratory of CNSA. 2023. “INTERNATIONAL LUNAR RESEARCH STATION (ILRS).” https://www.unoosa.org/documents/pdf/copuos/2023/TPs/ILRS_presentation20230529_.pdf.

Dellios, Rosita. 2012. “China and Outer Space.” In *The Ashgate Research Companion to Chinese Foreign Policy,* Routledge.

Donthi, Praveen. 2024. “India’s Perilous Border Standoff With China.” *Foreign Affairs*. https://www.foreignaffairs.com/india/modi-perilous-border-standoff-china (September 30, 2024).

Drozhashchikh, Evgeniia. 2018. “China’s National Space Program and the ‘China Dream.’” *Astropolitics* 16(3): 175–86. doi:10.1080/14777622.2018.1535207.

Early, Bryan R. 2014. “Exploring the Final Frontier: An Empirical Analysis of Global Civil Space Proliferation1.” *International Studies Quarterly* 58(1): 55–67. doi:10.1111/isqu.12102.

Erickson, Andrew S. 2014. “China′s Space Development History: A Comparison of the Rocket and Satellite Sectors.” *Acta Astronautica* 103: 142–67. doi:10.1016/j.actaastro.2014.06.023.

External Security Risks for China in 2023. 2023. Tsinghua University’s Center for International Security and Strategy. https://www.chinausfocus.com/peace-security/external-security-

risks-for-china-in-2023 (March 20, 2024).

Fearon, James D. 1994. “Domestic Political Audiences and the Escalation of International Disputes.” *The American Political Science Review* 88(3): 577–92. doi:10.2307/2944796.

Foot, Rosemary, and Andrew Walter. 2013. “Global Norms and Major State Behaviour: The Cases of China and the United States.” *European Journal of International Relations* 19(2): 329–52. doi:10.1177/1354066111425261.

“Foreign Ministry Spokesperson Mao Ning’s Regular Press Conference on April 24, 2023.” *Ministry of Foreign Affairs*. https://www.mfa.gov.cn/eng/xwfw_665399/s2510_665401/202304/t20230424_11064804.html (March 21, 2024).

Fuhrmann, Matthew. 2012. *Atomic Assistance: How “Atoms for Peace” Programs Cause Nuclear Insecurity*. Cornell University Press. https://www.jstor.org/stable/10.7591/j.cttn34vg (January 26, 2024).

Funaiole, Matthew, Dana Kim, Brian Hart, and Joseph Bermudez Jr. 2022. “Eyes on the Skies: China’s Growing Space Footprint in South America.” https://features.csis.org/hiddenreach/china-ground-stations-space (October 14, 2024).

Garamone, Jim. 2023. “DOD Report Details Chinese Efforts to Build Military Power.” *U.S. Department of Defense*. https://www.defense.gov/News/News-Stories/Article/Article/3562442/dod-report-details-chinese-efforts-to-build-military-power/https%3A%2F%2Fwww.defense.gov%2FNews%2FNews-Stories%2FArticle%2FArticle%2F3562442%2Fdod-report-details-chinese-efforts-to-build-military-power%2F (October 1, 2024).

Gartzke, Erik. 2001. “Democracy and the Preparation for War: Does Regime Type Affect States’ Anticipation of Casualties?” *International Studies Quarterly* 45(3): 467–84. doi:10.1111/0020-8833.00210.

Goswami, Namrata. 2018. “China in Space: Ambitions and Possible Conflict.” *Strategic Studies Quarterly* 12(1): 74–97.

Goswami, Namrata. 2023. “China’s Space Program in 2023: Taking Stock.” *The Diplomat*. https://thediplomat.com/2023/12/chinas-space-program-in-2023-taking-stock/ (March 21, 2024).

“GPS & China’s ‘Unforgettable Humiliation’ - Defense Strategies Institute Remarks.” 2023. *Resilient Navigation and Timing Foundation*. https://rntfnd.org/2023/05/09/gps-chinas-unforgettable-humiliation-defense-strategies-institute-remarks/ (November 14, 2024).

Graham, William. 2022. “China’s Long March 4C Launches Ludi Tance Radar Imaging Satellite.” *NASASpaceFlight.com*. https://www.nasaspaceflight.com/2022/02/long-march-4c-ludi-tance/ (October 2, 2024).

Handberg, Roger, and Zhen Li. 2006. *Chinese Space Policy: A Study in Domestic and International Politics*. Routledge.

Harvey, Brian. 2004. *China's Space Program - From Conception to Manned Spaceflight*. https://link.springer.com/book/9781852335663 (September 19, 2023).

Harvey, Brian. 2019. *China in Space: The Great Leap Forward*. Springer Nature.

Harvey, Brian, Henk H. F. Smid, and Theo Pirard. 2010. *Emerging Space Powers: The New Space Programs of Asia, the Middle East and South-America*. Praxis. doi:10.1007/978-1-4419-0874-2.

Hassid, Jonathan. 2015. "China's Responsiveness to Internet Opinion: A Double-Edged Sword." *Journal of Current Chinese Affairs* 44(2): 39–68. doi:10.1177/186810261504400203.

He, Kai. 2012. "Undermining Adversaries: Unipolarity, Threat Perception, and Negative Balancing Strategies after the Cold War." *Security Studies* 21(2): 154–91. doi:10.1080/09636412.2012.679201.

Hines, R. Lincoln. 2022. "Heavenly Mandate: Public Opinion and China's Space Activities." *Space Policy* 60: 101460. doi:10.1016/j.spacepol.2021.101460.

Hu, Wen-Rui. 1997. "Space Science in China — Progress and Prospects." In *Space Science in China*, Routledge.

Huang, Jingyang, and Kellee S. Tsai. 2022. "Securing Authoritarian Capitalism in the Digital Age: The Political Economy of Surveillance in China." *The China Journal* 88: 2–28. doi:10.1086/720144.

Huaxia. 2023a. "China Focus: China Helps Egypt Send New Satellite into Orbit-Xinhua." *Xinhua*. https://english.news.cn/20231204/6302450a01004b268235a109c7a0afb7/c.html (March 20, 2024).

Huaxia. 2023b. "China Launches New Satellite for Earth Observation -Xinhua." *Xinhua*. https://english.news.cn/20230821/6233c6396fcd4b9a9440557b8162ee82/c.html (April 8, 2024).

"Indo-Pacific Strategy of the United States | Regional Development Mission for Asia." 2022. *U.S. Agency for International Development*. https://www.usaid.gov/asia-regional/indo-pacific-strategy-united-states (March 20, 2024).

Ingram, Haroro, and Andrew Mines. 2024. *Boiling the Frog: China's Incrementalist Maritime Expansion*. United States Institute of Peace. https://www.usip.org/publications/2024/06/boiling-frog-chinas-incrementalist-maritime-expansion (November 12, 2024).

Jia, Lianrui. 2019. "What Public and Whose Opinion? A Study of Chinese Online Public

Opinion Analysis." *Communication and the Public* 4(1): 21–34. doi:10.1177/2057047319829584.

Jin, Shuai. "Does Authoritarian Propaganda Ever Respond to Public Opinion?"

Jones, Andrew. 2022. "China Sets out Clear and Independent Long-Term Vision for Space." *SpaceNews*. https://spacenews.com/china-sets-out-clear-and-independent-long-term-vision-for-space/ (March 21, 2024).

Jones, Andrew. 2023a. "China Looks to Build New Space Partnerships with Egypt Satellite Project." *SpaceNews*. https://spacenews.com/china-looks-to-build-new-space-partnerships-with-egypt-satellite-project/ (March 20, 2024).

Jones, Andrew. 2023b. "Egypt Joins China's ILRS Moon Base Initiative." *SpaceNews*. https://spacenews.com/egypt-joins-chinas-ilrs-moon-base-initiative/ (March 20, 2024).

KAHLER, MILES. 2013. "Rising Powers and Global Governance: Negotiating Change in a Resilient Status Quo." *International Affairs* 89(3): 711–29. doi:10.1111/1468-2346.12041.

Kania, Elsa. "The PLA's Unmanned Aerial Systems."

Klinger, Julie Michelle. 2018. "A Brief History of Outer Space Cooperation Between Latin America and China." *Journal of Latin American Geography* 17(2): 46–83.

Korolev, Alexander. 2019. "On the Verge of an Alliance: Contemporary China-Russia Military Cooperation." *Asian Security* 15(3): 233–52. doi:10.1080/14799855.2018.1463991.

Krolikowski, Alanna. 2011. "China's Civil and Commercial Space Activities and Their Implications." : 15.

Kube, Courtney, and Dan De Luce. 2023. "How China Is Challenging the U.S. Military's Dominance in Space." *NBC News*. https://www.nbcnews.com/politics/national-security/china-challenging-us-militarys-dominance-space-rcna128993 (November 14, 2024).

Larson, Deborah Welch, and Alexei Shevchenko. 2010. "Status Seekers : Chinese and Russian Responses to U.S. Primacy." *International Security* 34(4): 63–95.

Lee, Wei-chen, and I.-min Chang. 2014. "US Aid and Taiwan." doi:10.12773/arwh.2014.2.1.047.

Lei, Zhou. 2024. "Xi Hails Nation's Landmark Space Efforts - People's Daily Online." *People's Daily Online*. http://en.people.cn/n3/2024/0924/c90000-20222255.html (October 8, 2024).

Li, Xiaojun, and Dingding Chen. 2021. "Public Opinion, International Reputation, and Audience Costs in an Authoritarian Regime." *Conflict Management and Peace Science* 38(5): 543–

60. doi:10.1177/0738894220906374.

Liang, Xiaodon. 2024. *China Takes Over P5 Process, Repeats No-First-Use Call with African States | Arms Control Association*. Arms Control Association. https://www.armscontrol.org/blog/2024-09/nuclear-disarmament-monitor (October 8, 2024).

Lieberthal, Kenneth. 2011. *The American Pivot to Asia*. Brookings. https://www.brookings.edu/articles/the-american-pivot-to-asia/ (October 22, 2024).

Lin, Karen Jingrong, Xiaoyan Lu, Junsheng Zhang, and Ying Zheng. 2020. "State-Owned Enterprises in China: A Review of 40 years of Research and Practice." *China Journal of Accounting Research* 13(1): 31–55. doi:10.1016/j.cjar.2019.12.001.

Lokman, Karadag. 2022. "The PRC'S Military Strategies on the Security Architecture of East and South China Sea under President Xi Jinping." *Intellectual Discourse* 30(2). doi:10.31436/id.v30i2.1895.

MacDonald, Bruce W. 2008. *China, Space Weapons, and U.S. Security*. Council on Foreign Relations.

Maizland. 2020. *China's Modernizing Military | Council on Foreign Relations*. Council on Foreign Relations. https://www.cfr.org/backgrounder/chinas-modernizing-military (October 1, 2024).

Mansfield, Simon. 2024. "Xi Emphasizes China's Drive to Lead in Space Exploration." *Space Daily*. https://www.spacedaily.com/reports/Xi_emphasizes_Chinas_drive_to_lead_in_space_exploration_999.html (October 8, 2024).

Masters, Jonathan, and Will Merrow. 2024. *U.S. Military Support for Taiwan in Five Charts | Council on Foreign Relations*. Council on Foreign Relations. https://www.cfr.org/article/us-military-support-taiwan-five-charts (November 12, 2024).

Mesquita, Bruce Bueno de, James D. Morrow, Randolph M. Siverson, and Alastair Smith. 1999. "An Institutional Explanation of the Democratic Peace." *American Political Science Review* 93(4): 791–807. doi:10.2307/2586113.

Miller, Jennifer L., Jacob Cramer, Thomas J. Volgy, Paul Bezerra, Megan Hauser, and Christina Sciabarra. 2015. "Norms, Behavioral Compliance, and Status Attribution in International Politics." *International Interactions* 41(5): 779–804. doi:10.1080/03050629.2015.1037709.

Mobley, Terry. 2019. "The Belt and Road Initiative: Insights from China's Backyard." *Strategic Studies Quarterly* 13(3): 52–72.

Moltz, James Clay. 2011. *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks*. Columbia University Press.

Musgrave, Paul, and Daniel H. Nexon. 2018. “Defending Hierarchy from the Moon to the Indian Ocean: Symbolic Capital and Political Dominance in Early Modern China and the Cold War.” *International Organization* 72(3): 591–626. doi:10.1017/S0020818318000139.

Myers, David J. 1991. “Threat Perception and Strategic Response of the Regional Hegemons: A Conceptual Overview.” In *Regional Hegemons,* Routledge.

Nathan, Andrew. 2013. “What Are the Biggest Threats to China’s Security?” Presented at the Carnegie Council. https://www.carnegiecouncil.org/explore-engage/classroom-resources/lesson-plan-ideas-film-reviews-syllabi-and-more/index-3/chinasecurity (March 20, 2024).

Nie, Mingyan. 2020. “Space Privatization in China’s National Strategy of Military-Civilian Integration: An Appraisal of Critical Legal Challenges.” *Space Policy* 52: 101372. doi:10.1016/j.spacepol.2020.101372.

Nomikos, William G, and Nicholas Sambanis. 2019. “What Is the Mechanism Underlying Audience Costs? Incompetence, Belligerence, and Inconsistency.” *Journal of Peace Research* 56(4): 575–88. doi:10.1177/0022343319839456.

Nouwens, Mia. 2022. *China’s Military Modernisation | IISS Strategic Survey 2022*. International Institute for Strategic Studies. https://www.iiss.org/online-analysis/online-analysis/2022/12/strategic-survey-2022-chinas-military-modernisation/ (October 1, 2024).

Nouwens, Mia. 2024. *China’s New Information Support Force*. International Institute for Strategic Studies. https://www.iiss.org/online-analysis/online-analysis/2024/05/chinas-new-information-support-force/ (October 1, 2024).

“Outer Space Becoming Contested Domain for Supremacy with Space-Based Communications, Intelligence Assets, Anti-Satellite Weapons, First Committee Hears | Meetings Coverage and Press Releases.” 2023. https://press.un.org/en/2023/gadis3722.doc.htm (September 26, 2024).

Owsiak, Andrew P. 2017. “The Steps to War: Theory and Evidence.” In *Oxford Research Encyclopedia of Politics,* doi:10.1093/acrefore/9780190228637.013.275.

Palmer, Alexander, Henry H. Carroll, and Nicholas Velazquez. 2024. “Unpacking China’s Naval Buildup.” https://www.csis.org/analysis/unpacking-chinas-naval-buildup (October 23, 2024).

Palmer, Glenn. 1990. “Alliance Politics and Issue Areas: Determinants of Defense Spending.” *American Journal of Political Science* 34(1): 190–211. doi:10.2307/2111515.

Pietsch, Bryan. 2024. “China Pursuing ‘Significant’ Expansion of Nuclear Arsenal, Report Says.” *Washington Post*. https://www.washingtonpost.com/world/2024/06/16/china-nuclear-arsenal-weapons/ (October 1, 2024).

Pollpeter, Kevin. 2023. *China-Russia Space Cooperation*. Center for Naval Analysis. https://www.cna.org/reports/2023/06/china-russia-space-cooperation-may-2023 (March 20, 2024).

"Powering the Space Race." 2018. *Lockheed Martin*. https://www.lockheedmartin.com/en-us/news/features/history/space-race.html (September 26, 2024).

Powers, Ryan, and Jonathan Renshon. 2020. "International Status Concerns and Domestic Support for Political Leaders." : 31.

PRC. 2008. "China's National Defense in 2008." https://web.archive.org/web/20121109190402/http://english.gov.cn/official/2009-01/20/content_1210227_13.htm (March 20, 2024).

"Project to Strengthen Development of the Defense Technology Industry at the Grassroots Level: Guidelines for Basic Research and Cutting-Edge Technology Projects (2018)." *Center for Security and Emerging Technology*. https://cset.georgetown.edu/publication/project-to-strengthen-development-of-the-defense-technology-industry-at-the-grassroots-level-guidelines-for-basic-research-and-cutting-edge-technology-projects-2018/ (October 6, 2024).

Qisong, He. 2023. "Space Arms Control or Space Behavior Control? The Competition between American and Chinese Ideas of an International Space Order." *Pacific Focus* 38(1): 26–51. doi:10.1111/pafo.12221.

Rogov, Kirill. 2017. 18 *Public Opinion in Putin's Russia. The Public Sphere, Opinion Climate and 'Authoritarian Bias.'* Norsk Utenrikspolitisk Institutt. Working paper. https://nupi.brage.unit.no/nupi-xmlui/handle/11250/2452184 (November 13, 2024).

Rudd, Kevin. 2022. "The World According to Xi Jinping: What China's Ideologue in Chief Really Believes." *Foreign Affairs* 101: 8.

Sallai, Dorottya, and Gerhard Schnyder. 2021. "What Is 'Authoritarian' About Authoritarian Capitalism? The Dual Erosion of the Private–Public Divide in State-Dominated Business Systems." *Business & Society* 60(6): 1312–48. doi:10.1177/0007650319898475.

Sample, Susan G. 2018. "Anticipating War? War Preparations and the Steps-to-War Thesis." *British Journal of Political Science* 48(2): 489–511. doi:10.1017/S000712341500068X.

Schrogl, Kai-Uwe. 2011. "The Political Context for Human Space Exploration." In *Humans in Outer Space — Interdisciplinary Perspectives*, Studies in Space Policy, eds. Ulrike Landfester, Nina-Louisa Remuss, Kai-Uwe Schrogl, and Jean-Claude Worms. Vienna: Springer, 3–14. doi:10.1007/978-3-7091-0280-0_1.

Senese, Paul D., and John A. Vasquez. 2005. "Assessing the Steps to War." *British Journal of Political Science* 35(4): 607–33.

Shaohui, Tian. 2017. "Backgrounder: Xi Jinping's Vision for China's Space Development -

Xinhua | English.News.Cn." *Xinhua*. http://www.xinhuanet.com/english/2017-04/24/c_136232642.htm (March 21, 2024).

Sharpe, Jack. 2023. "What Does the People's Republic of China's Space Program Mean for Great Britain and the West?" *The Space Review*. https://www.thespacereview.com/article/4612/1 (October 8, 2024).

Sheehan, Michael. 2013. "'Did You See That, Grandpa Mao?' The Prestige and Propaganda Rationales of the Chinese Space Program." *Space Policy* 29(2): 107–12. doi:10.1016/j.spacepol.2013.03.003.

Simmons, Beth A. 2000. "International Law and State Behavior: Commitment and Compliance in International Monetary Affairs." *American Political Science Review* 94(4): 819–35. doi:10.2307/2586210.

Singer, J. David. 1958. "Threat-Perception and the Armament-Tension Dilemma." *Journal of Conflict Resolution* 2(1): 90–105. doi:10.1177/002200275800200110.

Sioco Mary. 2024. "Use of China's Beidou Navigation Satellite System and terminal equipment is illegal: NCC - Rti." *RTI Radio Taiwan International*. https://en.rti.org.tw/news/view/id/2010689 (October 8, 2024).

Sirin, Cigdem V., and Michael T. Koch. 2015. "Dictators and Death: Casualty Sensitivity of Autocracies in Militarized Interstate Disputes*." *International Studies Quarterly* 59(4): 802–14. doi:10.1111/isqu.12207.

Siwei, China. 2022. "China Siwei Releases 30 Cm Imagery from SuperView Neo." *SpaceNews*. https://spacenews.com/china-siwei-releases-30-cm-imagery-from-superview-neo/ (April 8, 2024).

Smid, Henk. 2022. "The Space Review: An Analysis of Chinese Remote Sensing Satellites." *The Space Review*. https://www.thespacereview.com/article/4453/1 (October 2, 2024).

SpaceRef. 2000. *China's Space Activities, a White Paper*. The State Council Information Office of the People's Republic of China. https://spaceref.com/status-report/chinas-space-activities-a-white-paper/ (October 16, 2024).

Steer, Cassandra. 2017. "Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space." *Georgetown Journal of International Affairs* 18: 9.

Strickland, Samuel. 2022. "How China's Military Plugs into the Global Space Sector." *The Strategist*. https://www.aspistrategist.org.au/how-chinas-military-plugs-into-the-global-space-sector/ (April 8, 2024).

"Structural Details of Long March 9 Revealed." 2023. *China Daily*. https://english.www.gov.cn/news/topnews/202301/19/content_WS63c8b4ccc6d0a757729e5d88.html (October 3, 2024).

Suzuki, Kazuto. 2013. “The Contest for Leadership in East Asia: Japanese and Chinese Approaches to Outer Space.” *Space Policy* 29(2): 99–106. doi:10.1016/j.spacepol.2013.03.006.

Swope, Clayton. 2024. “No Place to Hide: A Look into China’s Geosynchronous Surveillance Capabilities.” https://www.csis.org/analysis/no-place-hide-look-chinas-geosynchronous-surveillance-capabilities (April 8, 2024).

Tachibana, Koji, Shoichi Tachibana, and Natsuhiko Inoue. 2017. “From Outer Space to Earth—The Social Significance of Isolated and Confined Environment Research in Human Space Exploration.” *Acta Astronautica* 140: 273–83. doi:10.1016/j.actaastro.2017.08.015.

Talmadge, Caitlin. 2015. *The Dictator’s Army*. Cornell University Press. https://www.cornellpress.cornell.edu/book/9781501700293/the-dictators-army/ (December 9, 2024).

Tang, Xiao, Weiwei Chen, and Tian Wu. 2018. “Do Authoritarian Governments Respond to Public Opinion on the Environment? Evidence from China.” *International Journal of Environmental Research and Public Health* 15(2): 266. doi:10.3390/ijerph15020266.

Tangerås, Thomas P. 2009. “Democracy, Autocracy and the Likelihood of International Conflict.” *Economics of Governance* 10(2): 99–117. doi:10.1007/s10101-008-0055-6.

Tellis, Ashley J. 2008. “China’s Military Space Strategy.” In *Survival 49.3*, Routledge.

Thompson, Bradley Bowman, Jared. 2024. “Russia and China Seek to Tie America’s Hands in Space.” *Foreign Policy*. https://foreignpolicy.com/2021/03/31/russia-china-space-war-treaty-demilitarization-satellites/ (March 20, 2024).

Timeline: China’s Maritime Disputes. 2024a. Council on Foreign Relations. https://www.cfr.org/timeline/chinas-maritime-disputes (October 22, 2024).

Timeline: U.S.-China Relations. 2024b. Council on Foreign Relations. https://www.cfr.org/timeline/us-china-relations (November 14, 2024).

Tiwari, Sakshi. 2024. “‘Breathing Fire’ After Yinhe Embarrassment, China’s Pledge To Counter U.S. GPS Reaches Key Milestone.” *EURASIAN TIMES*. https://www.eurasiantimes.com/gps-an-embarrassment-like-the-yinhe-incident/ (November 14, 2024).

Tomz, Michael. 2007. “Domestic Audience Costs in International Relations: An Experimental Approach.” *International Organization* 61(4): 821–40.

Tow, William T., and Satu Limaye. 2016. “What’s China Got to Do With It? U.S. Alliances, Partnerships in the Asia-Pacific.” *Asian Politics & Policy* 8(1): 7–26. doi:10.1111/aspp.12228.

Valeriano, Brandon, and Victor Marin. 2010. “Pathways to Interstate War: A Qualitative

Comparative Analysis of the Steps-to-War Theory." *Josef Korbel Journal of Advanced International Studies*. https://digitalcommons.du.edu/advancedintlstudies/15.

Van Vu, Anh. 2023. "China-Us Militarized Interstate Disputes (2001-2022): The Escalation Of The Great Power Rivalry." *International Journal of Arts, Humanities & Social Science* 04(03): 48–53. doi:10.56734/ijahss.v4n3a6.

Vaynman, Jane, and Tristan A. Volpe. 2023. "Dual Use Deception: How Technology Shapes Cooperation in International Relations." *International Organization* 77(3): 599–632. doi:10.1017/S0020818323000140.

Wang, Chengli, Jiangnan Zhu, and Dong Zhang. 2024. "The Paradox of Information Control Under Authoritarianism: Explaining Trust in Competing Messages in China." *Political Studies* 72(4): 1431–52. doi:10.1177/00323217231191399.

Wayman, Frank Whelon, and Paul Francis Diehl. 1994. *Reconstructing Realpolitik*. University of Michigan Press.

Webster, Evan Medeiros, Brian Hart, Elizabeth Wishnick, Joseph. 2024. *Chinese Assessments of the War in Ukraine, 2 Years On*. CSIS. https://interpret.csis.org/chinese-assessments-of-the-war-in-ukraine-2-years-on/ (October 23, 2024).

Weeks, Jessica L. 2008. "Autocratic Audience Costs: Regime Type and Signaling Resolve." *International Organization* 62(1): 35–64. doi:10.1017/S0020818308080028.

Weeks, Jessica L. 2012. "Strongmen and Straw Men: Authoritarian Regimes and the Initiation of International Conflict." *American Political Science Review* 106(2): 326–47. doi:10.1017/S0003055412000111.

Weinstein, Emily S. 2021. *Testimony before the U.S.-China Economic and Security Review Commission on "U.S. Investment in China's Capital Markets and Military-Industrial Complex."* Georgetown University: Center for Security and Emerging Technology.

Weiss, Jessica Chen. 2013. "Authoritarian Signaling, Mass Audiences, and Nationalist Protest in China." *International Organization* 67(1): 1–35.

Wilson, Jordan. 2017. "China's Alternative to GPS and Its Implications for the United States."

"WMO OSCAR | Satellite: Ludi-Tance 4 01A." *Observing Systems Capability Analysis and Review Tool*. https://space.oscar.wmo.int/satellites/view/ludi_tance_4_01a (April 8, 2024).

Wu, Xiaodan. 2023. "The International Lunar Research Station: China's New Era of Space Cooperation and Its New Role in the Space Legal Order." *Space Policy* 65: 101537. doi:10.1016/j.spacepol.2022.101537.

Xie, John. 2020. "China's Rival to GPS Navigation Carries Big Risks." *Voice of America*. https://www.voanews.com/a/east-asia-pacific_voa-news-china_chinas-rival-gps-

navigation-carries-big-risks/6192460.html (October 8, 2024).

Xin, Ling. 2023. “Latest China Satellite to Survey One-Third of Earth in High-Orbit Breakthrough.” *South China Morning Post*. https://www.scmp.com/news/china/science/article/3231313/latest-china-satellite-survey-3rd-earth-high-orbit-breakthrough (April 8, 2024).

“Xiplomacy: Xi Promotes Exploration of Outer Space, Advances Global Cooperation.” 2022. *Xinhua*. https://english.news.cn/20220504/22e3c04236a742fdb9eddf66c05038a2/c.html (October 8, 2024).

Zhang, Hui. 2005. *Action/Reaction: U.S. Space Weaponization and China*. Arms Control Association. https://www.armscontrol.org/act/2005-12/features/actionreaction-us-space-weaponization-china (March 20, 2024).

Zhang, Tao, Lishi Gu, and Jenny Jing Wang. 2023. “State-Owned Capital and Corporate Social Responsibility of Private-Holding Companies: Evidence from China.” *Accounting & Finance* 63(S1): 1101–20. doi:10.1111/acfi.12931.

Zhang, Zhihui. 2021. “Space Science in China: A Historical Perspective on Chinese Policy 1957–2020 and Policy Implication.” *Space Policy* 58: 101449. doi:10.1016/j.spacepol.2021.101449.

Zhao, Tong. 2022. *China’s Approach to Arms Control Verification*. Sandia National Laboratories.

Zhong, Yang. 1996. “Legitimacy Crisis and Legitimation in China.” *Journal of Contemporary Asia* 26(2): 201–20. doi:10.1080/00472339680000131.

Zhuo, Chen. 2021. “Xi’s Remarks on Boosting Int’l Cooperation in Space Exploration - Ministry of National Defense.” *Xinhua*. http://eng.mod.gov.cn/xb/News_213114/TopStories/4883036.html (October 8, 2024).

CHAPTER 5

CONCLUSION

5.1 Conclusion

Humanity sees outer space as the next great frontier. We, for the first time in our history, can set out from our home planet to explore, reap, and settle. Inevitably, however, as civilization's focus on space attracts our curiosity and imagination, it also brings new opportunities for states to further their own interests. States seeking to establish their presence in outer space face two major dilemmas: why and how? Motivations behind the development of a national space entity can include economics, national defense, prestige, or science. While leaders could make a rational argument for any of these motives, a focus on national defense likely produces some of the most important and tangible incentives derived from space endeavors. Research and development of dual-use space technologies can radically improve the effectiveness of a state's military through reconnaissance, communication, early warning, and navigation platforms in orbit. Such assets are ever more crucial in hostile threat environments in which a state faces the potential outbreak of conflict.

If we establish that a state may choose to pursue outer space— in part at least—for military benefits, the next question pertains to the best method in which a state can establish a domestic space organization. A simple solution entails the installation of a new military entity focused on developing outer space technologies. However, one clear alternative presents an attractive solution for leaders. Instead of creating a military space entity, leaders may opt to produce a civilian space agency. Space organizations managed by civilians and possessing goals solely pertaining to scientific and exploratory values offer several distinct advantages. Noble objectives such as

furthering humanity's scientific expertise and exploring the universe avoid condemnation from domestic and international audiences accusing a state of militarizing outer space. This allows a civil space agency to research dual-use space technologies and develop domestic space expertise unimpeded, and when the time comes, such technology and expertise can be utilized by the state's military forces without popular recognition. At the domestic level, civilian space agencies potentially aid leaders in avoiding audience costs from public opposition to militarizing space, and internationally, they can lead to new international partnerships in space, allowing for technology and knowledge-sharing that can further benefit a state's military apparatus. The three studies comprising this dissertation approached this phenomenon from different angles but all with this same general premise in mind.

Chapter 2 tested the relationship between civil space investment and the following two variables of interest: pre-existing military power and conflict proneness. The chapter proposed that as certain aspects of military power, such as air, nuclear, and ballistic missile forces increase, civil space expenditure would also rise. Meanwhile, a second hypothesis postulated that as a nation becomes more likely to participate in militarized conflicts, it would also become more likely to invest increased funds into civil space. In the analysis, I ran multiple OLS regression models utilizing a large-N dataset comprised of numerous sources. The results display broad support for the chapter's claims. Model coefficients demonstrated a strong, significant, and substantive relationship between civil space expenditure and air power and ballistic missile forces but not nuclear forces. Additional analysis showed that civil space funds appear significantly correlated with a state's recent involvement in international conflict, lending credit to the second hypothesis. Together, these results represent one of the first major quantitative studies on civil space investment and have broad implications for both academia and the policy world by linking

established theories on dual-use technologies and the security dilemma to the new frontier of outer space. Future research can expand upon this research, including additional states and enlarging the temporal length of the dataset. Additionally, an increased focus on state rivalries could potentially aid in explaining the evolution of civil space programs. State rivals could theoretically contribute additional resources to their civil space programs due to geopolitical competition rather than direct conflict participation.

While Chapter 2 examined various international civil space agencies, the third chapter narrowed the scope of research to the U.S. and its domestic audience to answer several pivotal questions related to public opinion. Chapter 3's theory proposed that individuals will prefer civilian leadership over military leadership in outer space. The theory further predicts that this notion is amplified when a state leader confirms—with honesty— the civil intentions behind the mission. Expanding the idea to international civil space agencies, Chapter Three predicted that individuals would also prefer civil over military leadership in space in foreign countries. Finally, one last hypothesis stated that civil oversight of outer space activities would garner increased support compared to private companies overseeing the same activities.

Chapter 3's research design consisted of three distinct survey experiments involving thousands of U.S. citizens. Different scenarios of realistic but hypothetical space missions comprised the three experiments, with the treatment involving a change in leadership type for each scenario. Estimating the average treatment effect for each experiment exposed overall mixed support for the chapter's theories. Respondents' levels of support for civilian leadership were not significantly higher than for military leadership. Yet, individuals displayed increased trust in civilian leaders and felt less hesitancy as to the mission's intentions. When the state leader in the scenario confirmed the mission's civilian intentions, respondents expressed increased support,

thereby showing the process is inherently political. However, if the leader lied, the respondents; trust in them and the mission fell drastically. The initial preference for civilian leadership did not transfer to the scenario involving a foreign mission, but it appeared stronger than ever when competing with private oversight. In the future, additional survey experiments, including those focused on a range of foreign countries and even foreign respondents, could help divulge critical information pertaining to how individuals perceive space programs globally.

Chapter 4 magnified the dissertation's premise by asking whether the theory from Chapter 2 applies to states with differing governing characteristics, while also offering additional theory on how states behave as their space capabilities advance. Chapter 2 found support for the notion that civil space prioritization will increase if a state's military possesses military assets that could benefit from space-based dual-use technologies and if the nation's potential for involvement in international conflict grows. The first hypothesis in Chapter 4 asked if this same theory holds for autocratic states, since authoritarian leaders should have little incentive to falsely frame their actions if they do not face the same audience costs experienced by democratic leaders. Hypothesis 2 then predicted that as state's capabilities in space progress, they will increasingly characterize their space program as innocuous and civilian in nature to avoid criticism from the international community, as well as invite new international partnerships that could further boost their expertise.

The analysis portion of the chapter delved into a case study of the People's Republic of China and its civil space agency, the Chinese National Space Administration (CNSA). Throughout the study, specific evidence of the CNSA producing dual-use technology for military gain was exposed, and connections between China's threat environment, military capacity, and civil space goals are assessed in full. An ensuing inspection of publicized PRC whitepapers, statements, and international participation showed how the nation increasingly categorized its space efforts as

harmless and beneficial for all of humanity over the past two decades as its space program progessed. The case study's results indicate strong support for the chapter's arguments, showing that autocracies will also pursue civil space and frame their language concerning space efforts due to international strategic considerations. While covering only one state and its program, the chapter opens the door for further case studies of civil space agencies evolving under different circumstances around the world.

Altogether, the three studies included in this dissertation establish a foundation in the literature for research on civil space development. Each individual research design highlights key indicators behind state decision-making in their civilian space programs, focusing primarily on a desire for military advantages and positive audience reception. Most of the dissertation's novel theory received support from the results, suggesting a significant link between civil space investment and militaristic goals. While we can learn much from these studies, confirmation and expansion of the findings requires further research. Specifically, more data is needed. Space exploration remains an emerging phenomenon among the international community, and as both time and technology progress, scholars will be able to make better determinations about state actions in the new domain. Future research questions could consider the impact of the private space industry on civil space, the development of space agencies in middle to low-income nations, geographic considerations, and the effect of leaders' personalities on space initiatives. Much remains uncertain in the realm of politics in outer space, but one trend we can remain certain of is the increasing relevance of the new domain. States' involvement in outer space will only grow as it provides too many benefits to ignore. Not a single nation has so far established a space program only to permanently cease its activities sometime later. As participation in space activities rises, states will inevitably bring the best and worst of their behaviors to bear. Outer space simply

provides a new palette for the classic issues of IR to manifest on, and comprehending this transition will require rigorous academic scrutiny.

CHAPTER SIX

APPENDIX FOR "AD ASTRA MILITARIZED: A LARGE-N ANALYSIS OF CIVIL SPACE AGENCIES AND MILITARY CAPABILITIES"

6.1 Dataset Statistics

Table 6.1: Countries and Years Included in the Dataset

Country	Start	End
Australia	1995	2021
Austria	1981	2022
Belgium	1981	2022
Canada	1987	2016
Chile	2011	2021
Colombia	2000	2020
Czech Republic	2000	2022
Denmark	1981	2022
Estonia	2002	2021
Finland	1988	2022
France	1981	2022
Germany	1981	2022
Greece	1981	2022
Hungary	2005	2022
Iceland	1983	2022
Ireland	1981	2022
Israel	1993	2021
Italy	1981	2022
Japan	1988	2022
Korea	1999	2021
Latvia	2005	2022
Lithuania	2007	2022
Luxembourg	2000	2022
Mexico	1990	2022
Netherlands	1981	2022
New Zealand	1989	2017
Norway	1981	2022
Poland	2004	2022
Portugal	1986	2022
Slovak Republic	1998	2022
Slovenia	1996	2022
Spain	1981	2022
Sweden	1981	2022
Switzerland	1981	2022
Turkey	2008	2022
United Kingdom	1981	2021
United States	1981	2022
Argentina	1996	2012

Country	Start	End
Romania	1994	2022
Russian Federation	1994	2009
Chinese Taipei	2000	2022

Table 6.2: Variable Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Civil Space R&D %	1,178	3.996	4.611	0.000	25.932
Air Power	972	0.019	0.036	0.000	0.219
Ballistic Missiles	972	0.014	0.032	0.000	0.148
Nuclear Forces	972	0.020	0.052	0.000	0.214
Army Personnel	945	0.008	0.025	0.000	0.179
Navy Tonnage	972	0.025	0.082	0.000	0.464
Armored Forces	972	0.013	0.027	0.000	0.206
Number of Conflict Years	1,178	1.578	2.024	0	5
Log Military Spending	1,166	8.715	1.604	4.751	13.684
Log GDP	1,178	12.979	1.418	8.181	17.053
Log Total R&D Spending	1,178	7.728	1.638	2.508	12.043
Education R&D %	1,154	5.064	4.839	0.119	62.315
Regime Type	1,178	0.832	0.104	0.276	0.924
Status Rank	1,112	38.248	36.000	1	162
ESA Member	1,178	0.643	0.479	0	1

6.2 Status Rank Alternative

The Status Rank variable ranked each state by the number of diplomatic visits received per year. As an alternative measure, I use simply the total number of diplomatic visits received per year rather than a ranking. For the first model group, the overall conclusions remain the same with slight substantive, but not statistical, differences for the IVs. *Total Diplomatic Visits* is now

statistically correlated with the DV, but substantively, the result is negligible showing a <0.035% decrease in *Civil Space R&D* for a one visit increase in *Total Diplomatic Visits.*

Table 6.3: Status Rank Alternative MMP Regressions

	Dependent variable:		
	Civil Space R&D as % of R&D Expenditure		
	Designated MMPs	MMPs with Controls	All MMPs with Controls
Air Power	14.225	28.510***	19.772*
	(11.994)	(10.626)	(11.173)
Ballistic Missiles	42.696***	31.327***	21.413*
	(12.089)	(10.474)	(11.310)
Nuclear Forces	31.358	11.997	-15.969
	(32.634)	(27.695)	(31.082)
Army Personnel			-35.012***
			(13.160)
Navy Tonnage			4.917
			(11.471)
Armored Forces			4.856
			(12.680)
Log Military Spending		-0.718**	-0.535
		(0.361)	(0.367)
Log GDP		0.018	0.005
		(0.668)	(0.677)
Log Total R&D Spending		0.556*	0.529
		(0.331)	(0.334)
Education R&D		0.019	0.019
		(0.020)	(0.020)
Regime Type		2.335	2.477
		(2.048)	(2.054)
Total Diplomatic Visits		-0.034***	-0.030**
		(0.012)	(0.012)
ESA Member		-4.413	-0.134
		(3.727)	(4.217)
Country Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Constant	6.069***	7.430	6.081
	(0.778)	(7.144)	(7.211)

Observations	972	890	890
R^2	0.844	0.898	0.899
Adjusted R^2	0.830	0.887	0.888
Residual Std. Error	1.936 (df = 892)	1.585 (df = 808)	1.580 (df = 805)
F Statistic	61.006^{***} (df = 79; 892)	87.514^{***} (df = 81; 808)	85.050^{***} (df = 84; 805)
Note:			*p<0.1; **p<0.05; ***p<0.01

For the second model group, the results also remain mostly identical with the IV's coefficients provide the same conclusions as the alternative model. *Status Rank* loses its slight statistical significance, but the correlation was small enough to begin with so that further analysis is not warranted.

Table 6.4: Status Rank Alternative Conflict Regressions

	Dependent variable:	
	Civil Space R&D as % of R&D Expenditure	
	(1)	(2)
Number of Conflict Years	0.120^{**}	0.200^{***}
	(0.054)	(0.050)
Log Military Spending		-0.850^{**}
		(0.425)
Log GDP		-0.380
		(0.822)
Log Total R&D Spending		0.751^{**}
		(0.316)
Education R&D		0.038^{*}
		(0.020)
Regime Type		4.667
		(2.849)
Total Diplomatic Visits		-0.006
		(0.013)
ESA Member		-0.255
		(1.810)
Country Fixed Effects	YES	YES
Year Fixed Effects	YES	YES
Constant	4.759^{***}	7.618
	(0.721)	(9.064)

Observations	891	871
R^2	0.842	0.874
Adjusted R^2	0.828	0.861
Residual Std. Error	1.989 (df = 816)	1.791 (df = 792)
F Statistic	58.817^{***} (df = 74; 816)	70.314^{***} (df = 78; 792)
Note:		*p<0.1; **p<0.05; ***p<0.01

6.3 Multicollinearity Concerns

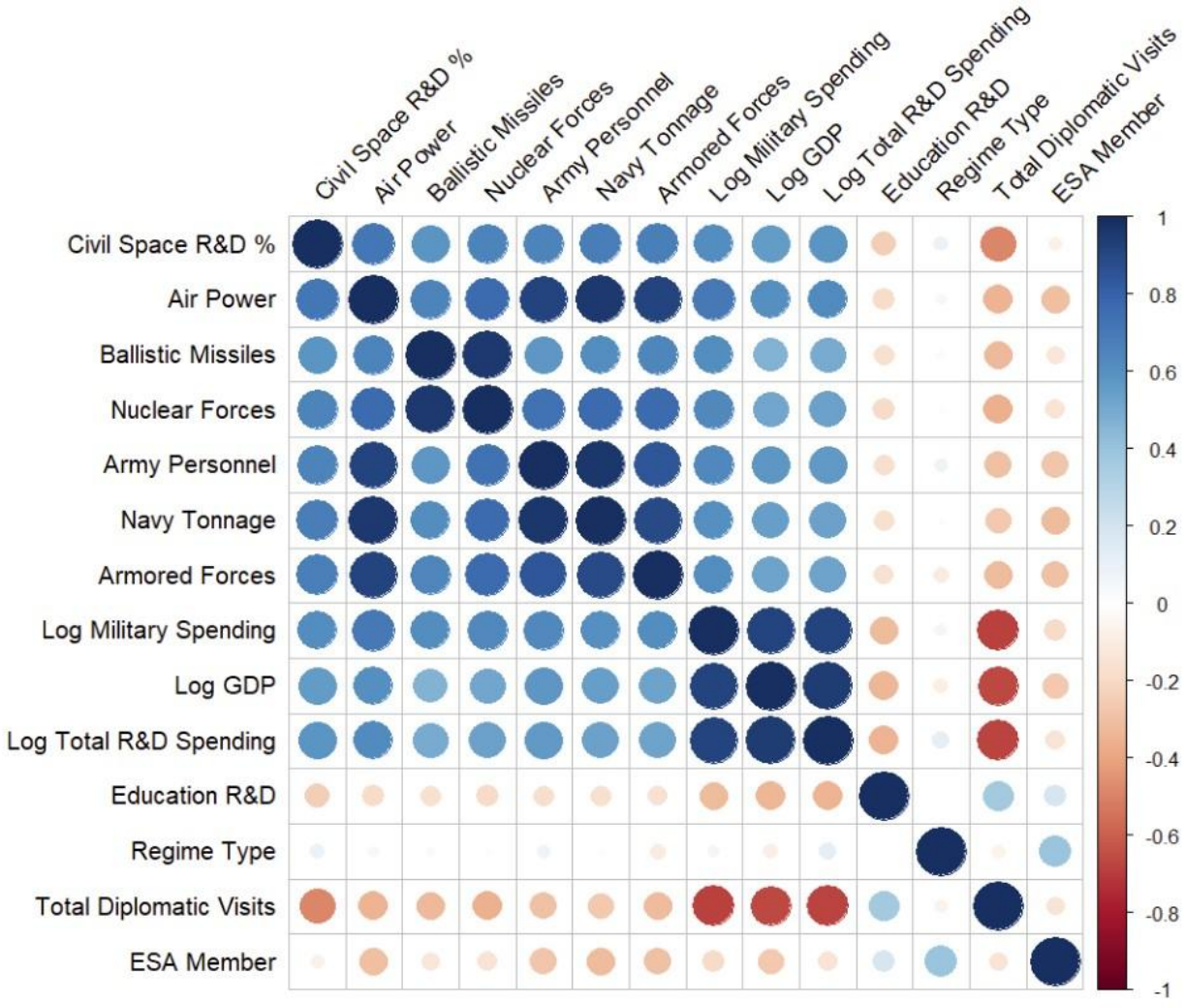

Figure 6.1: Model Group 1 Multicollinearity Concerns

Above is a correlation plot of the variables included in Model Group 1. As referenced in the paper, MMP measures tend to have a high correlation with one another and can potentially cause multicollinearity within the models. If a state possesses a large military, it will likely possess large quantities of air, naval, and land assets—meaning that its MMP values will all be high. For this reason, the primary model of interest is the "Designated MMPs with Controls" model as it does not include all MMP measures and instead focuses on the variables of theoretical interest. Other highly correlated relationships, such as between *Log GDP, Log Military Spending,* and *Log Total R&D Spending* are expected but still necessary to include as controls.

6.4 Different Lag Measures for MMP Variables

Testing the robustness of the first model group, the table below showcases the original models with a 4-year lag instead of a 5-year lag. For the most part, the conclusions hold firm, albeit, with a loss of significance for the Designated MMPs in the "All MMPs with Controls" model. This is to be expected as the level of significance for those relationships was only at the 90% threshold to begin with. Theoretically, reducing the lag prevents time between acquisition of loss of military assets and civil space funding allocations. Budget considerations, particularly for large-scale, expensive projects, encompass years of consideration—making lags necessary for the models. If states view civil space assets as advantages for defense technologies, then they will view military standing in recent years prior to the year of deciding the budget. Overall, however, the relationship between *Ballistic Missiles, Air Power, and Civil Space R&D* remain the same.

Table 6.5: MMP Measures with a 4 Year Lag Regressions

	Dependent variable:		
	Civil Space R&D as % of R&D Expenditure		
	Designated MMPs	MMPs with Controls	All MMPs with Controls
Air Power	14.417	24.466**	14.131
	(11.824)	(10.644)	(11.277)
Ballistic Missiles	36.331***	28.796***	16.010
	(12.077)	(10.633)	(11.487)
Nuclear Forces	29.304	15.140	-25.379
	(32.774)	(28.257)	(31.514)
Army Personnel			-44.821***
			(13.098)
Navy Tonnage			8.706
			(10.654)
Armored Forces			0.666
			(12.200)
Log Military Spending		-0.958***	-0.742**
		(0.353)	(0.357)
Log GDP		0.763	0.755
		(0.677)	(0.686)
Log Total R&D Spending		0.507	0.499
		(0.324)	(0.326)
Education R&D		0.022	0.022
		(0.020)	(0.020)
Regime Type		1.836	1.867
		(1.958)	(1.956)
Status Rank		0.026**	0.025**
		(0.012)	(0.012)
ESA Member		-5.998*	0.379
		(3.530)	(4.058)
Country Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Constant	5.267***	-2.974	-4.377
	(0.772)	(7.295)	(7.370)
Observations	1,012	929	929
R^2	0.837	0.890	0.892
Adjusted R^2	0.823	0.879	0.881

Residual Std. Error	1.963 (df = 931)	1.635 (df = 846)	1.626 (df = 843)
F Statistic	59.912*** (df = 80; 931)	83.394*** (df = 82; 846)	81.493*** (df = 85; 843)
Note:			*p<0.1; **p<0.05; ***p<0.01

Taking a step further, I run a 3-year lag of the MMP measures. The significance of *Ballistic Missiles* lessens even further, while the significance level of *Air Power* completely disappears. Again, this is expected due to theoretical considerations. What this version of the lagged MMPs demonstrate is the staying power of the influence of ballistic missiles on civil space funding movement.

Table 6.6: MMP Measures with a 3 Year Lag Regressions

	Dependent variable:		
	Civil Space R&D as % of R&D Expenditure		
	Designated MMPs	MMPs with Controls	All MMPs with Controls
Air Power	15.973	12.124	5.938
	(11.649)	(10.476)	(11.416)
Ballistic Missiles	27.925**	19.547*	8.339
	(12.059)	(10.603)	(11.588)
Nuclear Forces	21.244	2.024	-45.563
	(32.896)	(28.510)	(31.817)
Army Personnel			-48.343***
			(13.046)
Navy Tonnage			14.750
			(9.760)
Armored Forces			6.353
			(12.278)
Log Military Spending		-0.979***	-1.008***
		(0.344)	(0.362)
Log GDP		0.635	0.735
		(0.662)	(0.716)
Log Total R&D Spending		0.810***	0.843***
		(0.310)	(0.326)
Education R&D		0.025	0.033*
		(0.019)	(0.019)

Regime Type		2.715	3.608*
		(1.876)	(2.017)
Status Rank		0.024**	0.020
		(0.012)	(0.012)
ESA Member		-3.475	3.793
		(3.523)	(4.105)
Country Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Constant	4.606***	-4.257	-6.172
	(0.767)	(7.132)	(7.647)
Observations	1,051	967	934
R^2	0.831	0.885	0.889
Adjusted R^2	0.817	0.874	0.878
Residual Std. Error	1.987 (df = 969)	1.661 (df = 883)	1.644 (df = 848)
F Statistic	58.869*** (df = 81; 969)	81.518*** (df = 83; 883)	79.630*** (df = 85; 848)
Note:			*p<0.1; **p<0.05; ***p<0.01

6.5 Alternative Measure of Civil Space R&D

In the following tables, *Log Civil Space R&D* is used as opposed to Civil Space R&D as a percent of total government R&D. This variable contains the same number of observations as the previous measure but lists the total 2022 International Dollar (PPP) value spent on civil space R&D by country per year. *Ballistic Missile* results stay largely the same, but the significance of the relationship between *Air Power* and the DV is lost. In addition, many of the control variable's coefficients now show a strong association with Civil Space R&D, while *Army Personnel* loses its significance. The reason for not using this measure of civil space as the primary measure in the paper is twofold. First, civil space funding can rise on a year-to-year basis due to natural funding increases, which is not necessarily representative of a prioritization of those capabilities. Increasing the allocation of R&D funds to civil space over other initiatives shows increased interest in developing space assets, regardless of the state's financial situation that year. Second, several of the coefficients of interest from the tables below prove almost impossible to meaningfully

interpret due to extremely large coefficients —which are exponentiated by the DV being logged and the IVs non-logged.

Table 6.7: Alternative Measure of Civil Space R&D MMP Regressions

	Dependent variable:		
	Log Civil Space R&D		
	Designated MMPs	MMPs with Controls (Primary Model)	All MMPs with Controls
Air Power	-2.737	-1.331	1.511
	(3.731)	(3.621)	(3.824)
Ballistic Missiles	25.349***	14.855***	17.908***
	(3.760)	(3.585)	(3.879)
Nuclear Forces	-11.125	-18.349*	-16.886
	(10.150)	(9.449)	(10.622)
Army Personnel			4.741
			(4.495)
Navy Tonnage			5.194
			(3.899)
Armored Forces			-1.030
			(4.335)
Log Military Spending		0.429***	0.381***
		(0.123)	(0.125)
Log GDP		-0.315	-0.239
		(0.235)	(0.239)
Log Total R&D Spending		0.797***	0.781***
		(0.113)	(0.114)
Education R&D		0.034***	0.035***
		(0.007)	(0.007)
Regime Type		-4.095***	-4.146***
		(0.699)	(0.703)
Status Rank		0.004	0.004
		(0.004)	(0.004)
ESA Member		0.029	-0.662
		(1.196)	(1.379)
Country Fixed Effects	YES	YES	YES
Year Fixed Effects	YES	YES	YES
Constant	3.283***	2.180	1.710

	(0.242)	(2.522)	(2.556)
Observations	972	890	890
R^2	0.951	0.961	0.961
Adjusted R^2	0.947	0.957	0.957
Residual Std. Error	0.602 (df = 892)	0.541 (df = 808)	0.540 (df = 805)
F Statistic	220.454^{***} (df = 79; 892)	247.209^{***} (df = 81; 808)	239.298^{***} (df = 84; 805)
Note:			*p<0.1; **p<0.05; ***p<0.01

Utilizing this alternative measure for the second model group, *Number of Conflict Years* again appears strongly and significantly correlated with the DV. Like the table above, several of the controls' coefficients appear stronger than when utilizing the alternative measure of civil space R&D, but the results primary conclusions remain the same.

Table 6.8: Alternative Measure of Civil Space R&D Conflict Regressions

	Dependent variable:	
	Log Civil Space R&D	
	Bivariate	With Controls
Number of Conflict Years	0.073^{***}	0.050^{***}
	(0.018)	(0.017)
Log Military Spending		0.181
		(0.146)
Log GDP		0.225
		(0.294)
Log Total R&D Spending		0.596^{***}
		(0.109)
Education R&D		0.053^{***}
		(0.007)
Regime Type		-3.061^{***}
		(0.986)
Status Rank		-0.001
		(0.005)
ESA Member		-0.689
		(0.443)
Country Fixed Effects	YES	YES

Year Fixed Effects	YES	YES
Constant	2.913***	-2.318
	(0.242)	(3.218)
Observations	891	871
R^2	0.944	0.951
Adjusted R^2	0.938	0.946
Residual Std. Error	0.667 (df = 816)	0.622 (df = 792)
F Statistic	184.384*** (df = 74; 816)	197.789*** (df = 78; 792)
Note:		*p<0.1; **p<0.05; ***p<0.01

6.6 Alternative Measure of Conflict

In the following table, the recent conflict regressions are run again. This time, however, the total number of MIDs in which has participated in over the past five years is used, rather than the number of years which a state was involved in a MID over the past five years. As explained in the paper, the reason for not using this measure involves the overcounting of MIDs on a state-level basis and the incorporation of small disputes that involved few military personnel. Regardless, observing the results below, *Total MIDs* does not display a statistically significant relationship with *Civil Space R&D* in the bivariate model. However, the significance returns at the 99% percentile in the full model. While the relationship between the two variables mirrors that of the model in the paper, it possesses only a quarter of the substantive impact. Despite less impact, the results confirm the robustness of the original model and measure, providing support for the paper's theory. Future work integrating different measures of recent conflict will further test the assumption that conflict plays a role in determining civil space spending.

Table 6.9: Alternative Measure of Conflict Regressions

	Dependent variable:	
	Civil Space R&D as % of R&D Expenditure	
	Bivariate	With Controls
Total MIDs Past 5 Years	0.006	0.055***
	(0.016)	(0.015)
Log Military Spending		-0.882**
		(0.420)
Log GDP		0.009
		(0.846)
Log Total R&D Spending		0.843***
		(0.313)
Education R&D		0.040**
		(0.020)
Regime Type		5.423*
		(2.863)
Status Rank		0.024*
		(0.014)
ESA Member		-0.573
		(1.275)
Country Fixed Effects	YES	YES
Year Fixed Effects	YES	YES
Constant	4.582***	0.881
	(0.721)	(9.260)
Observations	891	871
R^2	0.841	0.874
Adjusted R^2	0.827	0.861
Residual Std. Error	1.995 (df = 816)	1.792 (df = 792)
F Statistic	58.411*** (df = 74; 816)	70.261*** (df = 78; 792)
Note:		*p<0.1; **p<0.05; ***p<0.01

CHAPTER SEVEN

APPENDIX FOR "PUBLIC REACTIONS TO LEADERSHIP TYPES IN SPACE: A DOMESTIC SURVEY EXPERIMENT"

7.1 Example Survey Vignette and Language

In the following set of questions, we will ask you about a hypothetical scenario involving U.S. activities in outer space.

While they are hypothetical, we have tried to describe them in ways that might closely resemble a real future event.

Please read each scenario closely and then indicate your support for the measures described in the questions that follow.

Figure 7.1: Experiment Introduction Seen by all Respondents

civil.vs.mil.nasa

U.S. CIVILIAN SPACE AGENCY SET TO LAUNCH NEW SATELLITES

The United States recently announced a brand-new, **civilian-run** program designed to produce advanced observation satellites.

- Overseen by the **National Aeronautics and Space Administration (NASA), the U.S.'s civilian space agency that "explores the secrets of the universe for the benefit of all",** the satellites will launch on a NASA-contracted rocket from Cape Canaveral, FL and remain in orbit for several years.
- **Civilian scientists at NASA** overseeing the project intend for the devices to monitor features on the Earth's surface constantly.
- With a high level of magnification, the satellites will possess the capability to image very small objects all around the Earth.
- According to **NASA**, the exact targets of observation are yet to be determined.

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U.S. MILITARY SET TO LAUNCH NEW SATELLITES

The United States recently announced a brand-new, **military-run** program designed to produce advanced observation satellites.

- Overseen by the **United States Space Force (USSF), the U.S.'s military space branch that "secures the nation's interests in outer space"**, the satellites will launch on a USSF-contracted rocket from Cape Canaveral, FL and remain in orbit for several years.
- **Military generals in the USSF** overseeing the project intend for the devices to constantly monitor features on the Earth's surface.
- With a high-level of magnification, the satellites will possess the capability to image very small objects all around the Earth.
- According to **USSF**, the exact targets of observation are yet to be determined.

Figure 7.2: Domestic Experiment Scenarios

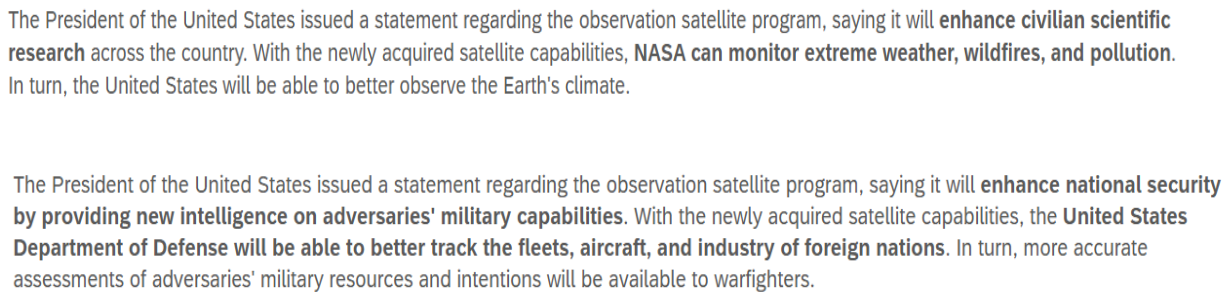

Figure 7.3: Domestic Scenario President Confirmations

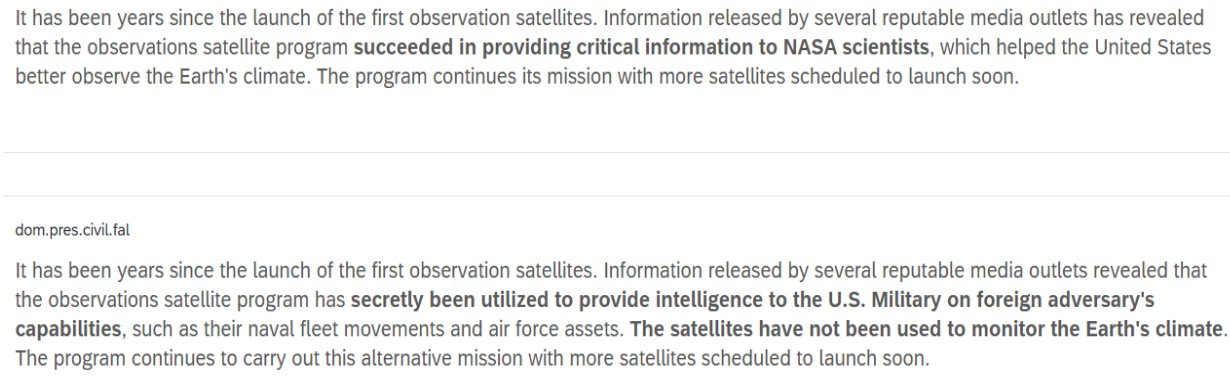

Figure 7.4: Domestic Civil Scenario True and False Information

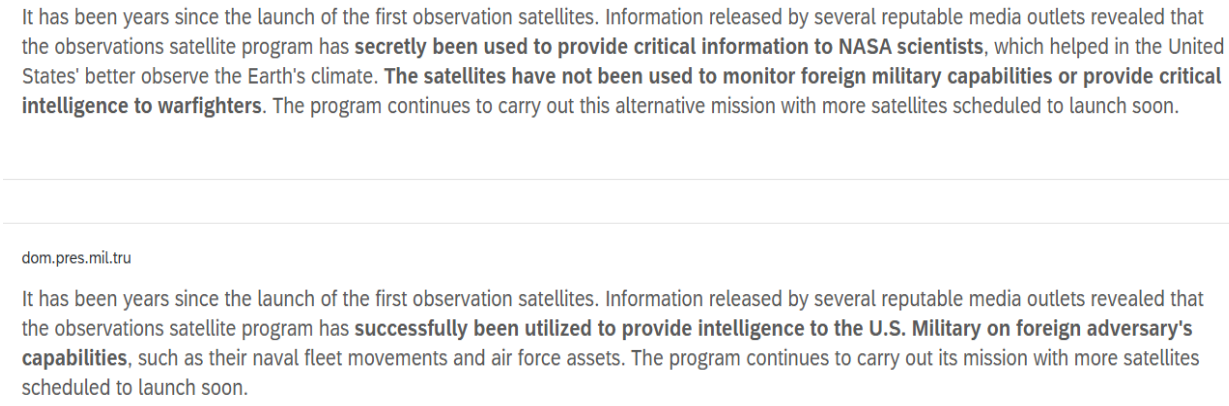

Figure 7.5: Domestic Military Scenario True and False Information

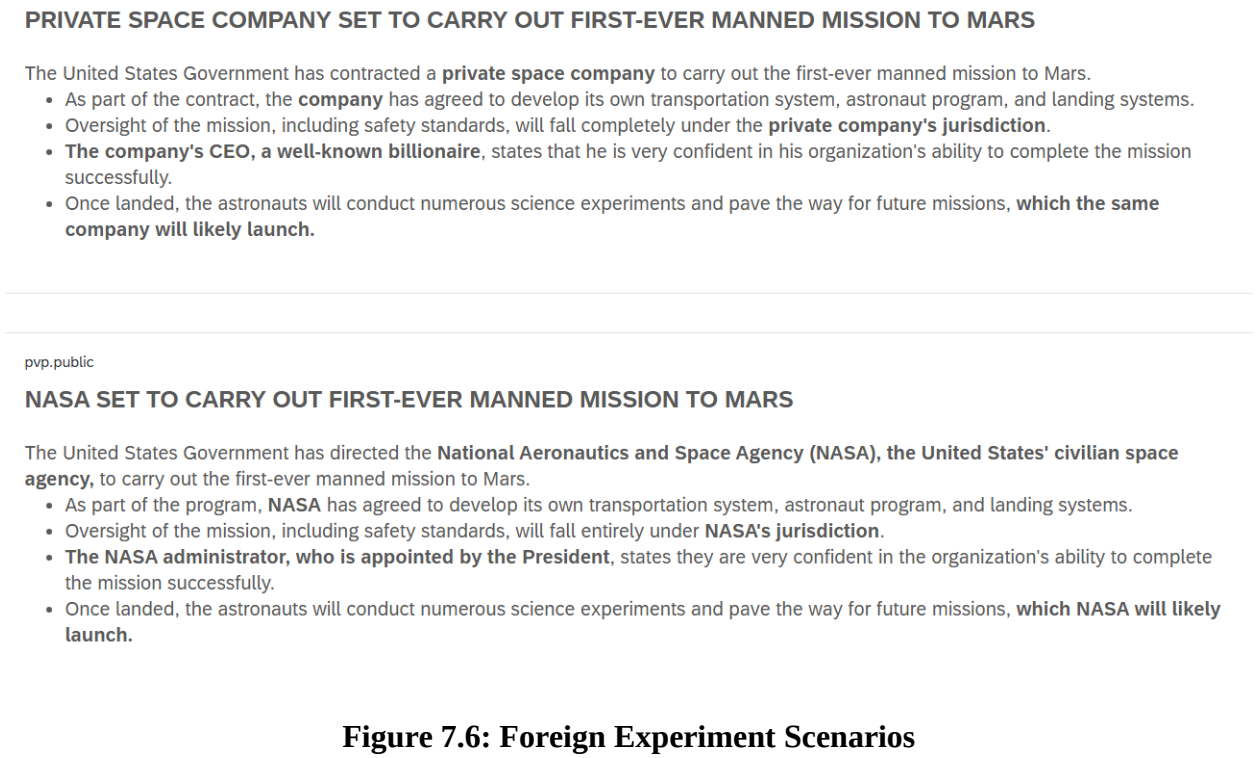

Figure 7.6: Foreign Experiment Scenarios

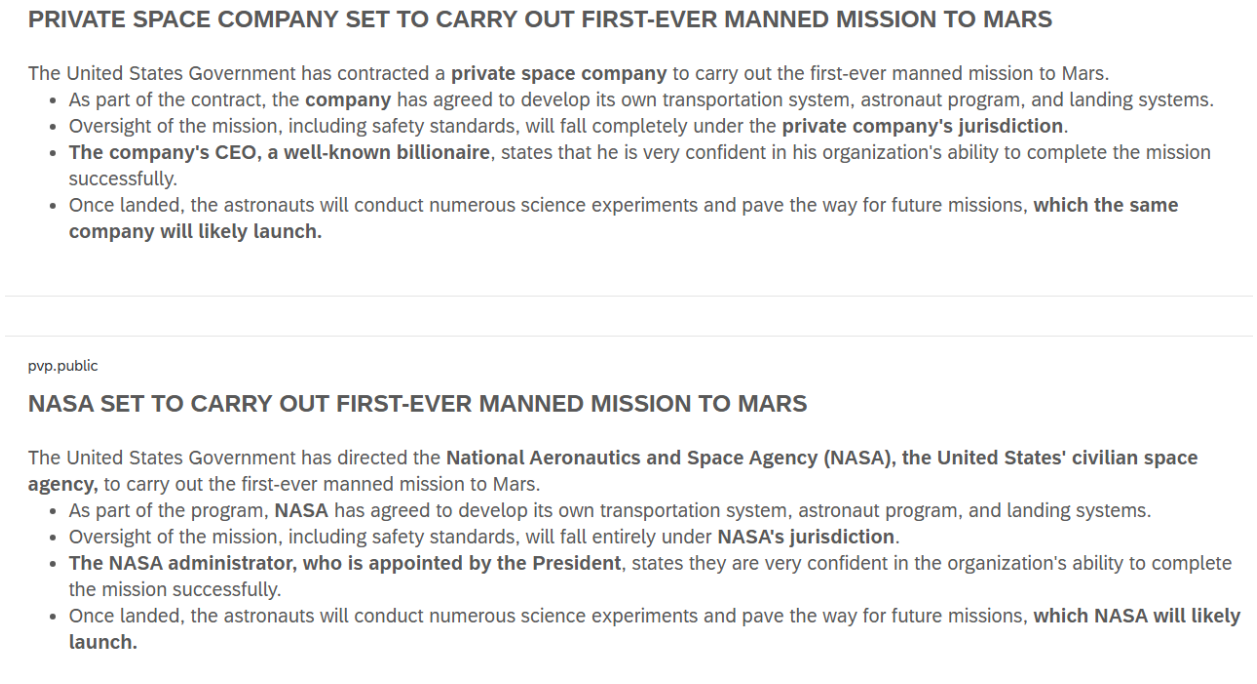

Figure 7.7: Domestic Private vs. Public Scenarios

In response to the scenario you read, please select how strongly you agree with the following statements from 0 (Strongly Disagree) to 100 (Strongly Agree).

Figure 7.8: Example Response Input Options

7.2 Demographics

Table 7.1 Survey Demographics

	Lucid Sample (N= 2,753)
Gender	
Male	1,251 (46.5%)
Female	1,502 (54.5%)
Income	
Less than $30,000	891 (32.4%)
Between $30,000 and $59,999	757 (27.5%)
Between $60,000 and $149,999	867 (31.5%)
$150,000 or more	139 (5 %)
Prefer not to say	63 (2.3%)
Age	
18-29	548 (19.9%)
30-39	514 (18.7%)
40-49	406 (14.7%)
50-59	461 (16.7%)
60-69	489 (17.8%)
70+	335 (12.2%)
Region	
Northeast	561 (20.4%)
Midwest	490 (17.8%)
South	1,002 (36.4%)
West	700 (25.4%)
Party ID	
Democrat	822 (29.9%)
Republican	736 (26.7%)

	Lucid Sample (N= 2,753)
Independent	871 (31.6%)
Other	324 (11.8%)
Education	
Some high school or less	125 (4.5%)
High school graduate	656 (23.8%)
Some college	695 (25.2%)
2-year degree	307 (11.2%)
4-year degree	589 (21.4%)
Post-grad	341 (12.4%)
Ethnicity	
White	1,964 (71.3%)
Hispanic	122 (4.4%)
Black	347 (12.6%)
Indigenous	48 (1.7%)
Asian	137 (5%)
Other	113 (4.1%)
Prefer not to say	22 (0.8%)

7.4 Measuring Knowledge of Space

To maximize model efficiency, I control for several pre-treatment variables that are likely to be associated with American support for space programs (Cobb 2011, Burbach 2019). These variables include age, gender, education, ethnicity, political party, and income. Each scenario deals with a specific outer space technology, in this case an observation satellite. A lack of knowledge about space technologies could potentially bias the results. As a result, the survey asked the three questions displayed below, which measure the average attentiveness paid to modern space

activities by the respondent. Data from the three questions then provided the basis for the "Space Knowledge" control variable.

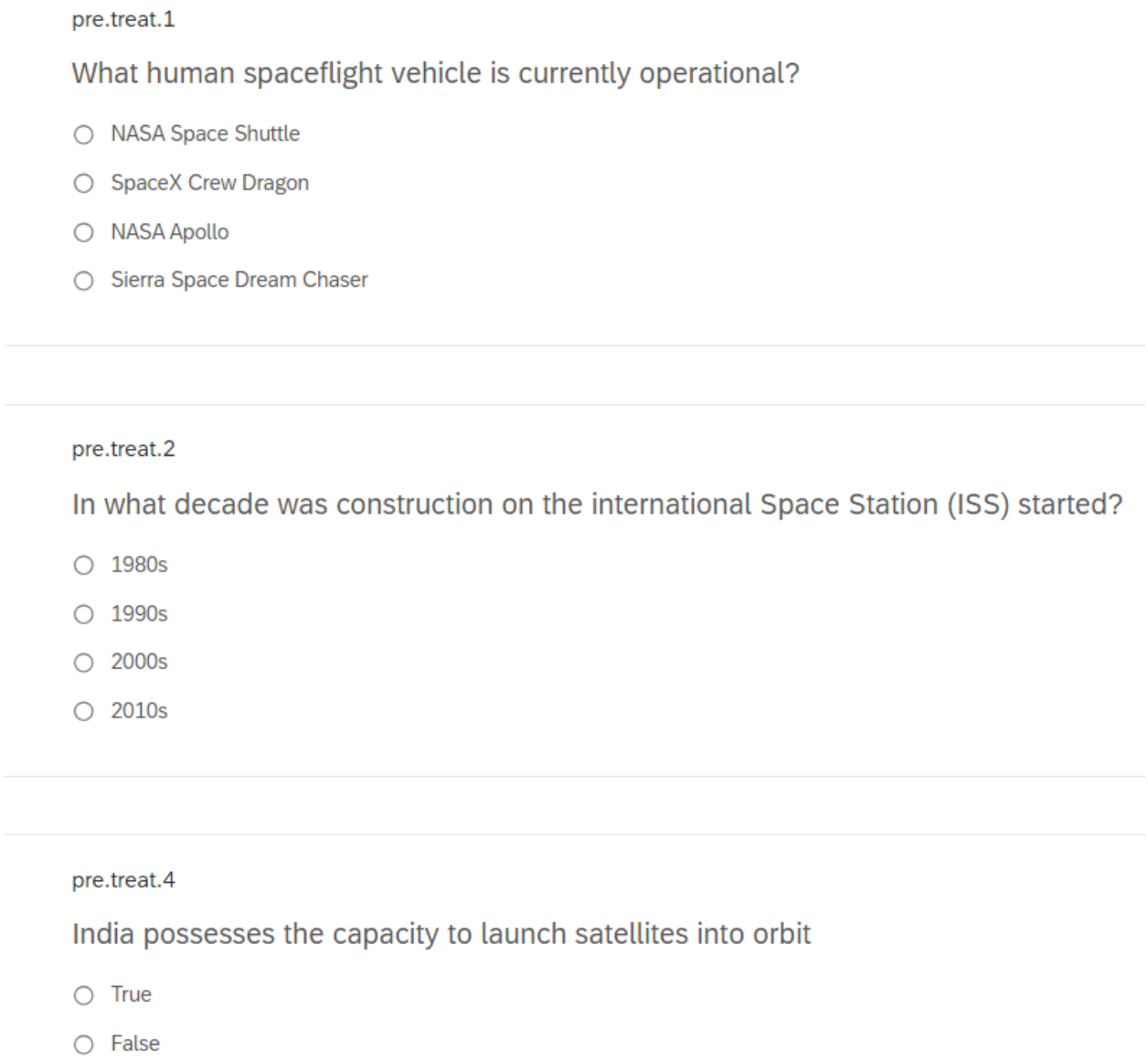

Figure 7.9: Questions Measuring Respondents' Knowledge of Space

7.4 Measuring Sentiment Toward India and the Private Space Industry

In addition to the space knowledge control variable, models for the second (foreign) and third (private vs. public) experiments implemented new controls. The foreign-based experiment focused

on India, a state that may illicit differing emotions and responses from U.S. citizens based on their personal view of the country. To adjust for individual sentiment towards India, the survey presented respondents with the following pre-treatment statement and asked how strongly they support it.

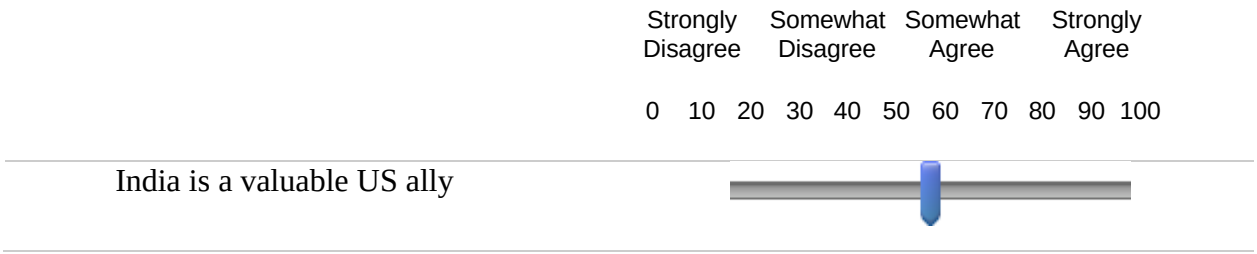

Figure 7.10: Indicator Measuring Sentiment Toward India

Meanwhile, the third experiment highlighted the private versus public space divide. Again, based on personal views of the private space industry, individuals may harbor differing opinions on the role of the private industry on matters as grand and important as space exploration. To gauge general attitudes toward the private space industry, the survey presented the following pre-treatment statement to respondents and asked how strongly they support it.

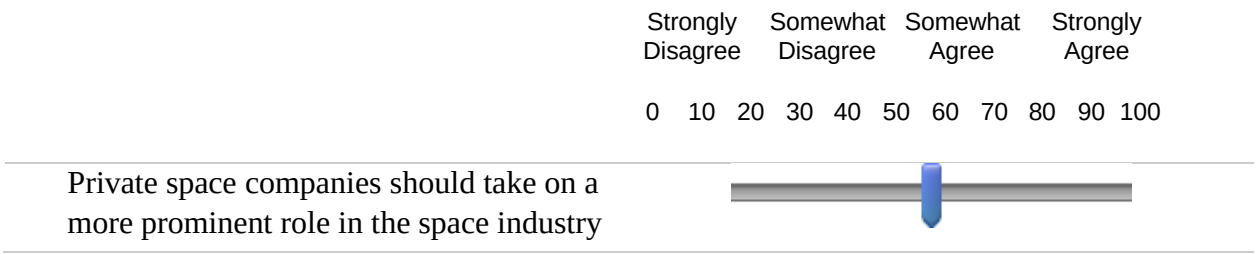

Figure 7.11: Measuring Sentiment Toward the Private Space Industry

7.5 Attention Checks

I contracted with Lucid/Cint to recruit the sample and field the survey. Recent studies show mixed attentiveness in Lucid surveys since 2019 but also that the results of survey experiments using Lucid data can often be replicated (Ternovski and Orr 2022, Peyton et al. 2022). At the beginning of the survey, I included the following attention check to ensure that the data used for analysis included attentive respondents.

“Everyone has a favorite color. Blue, green, red, yellow, purple, and orange are all great choices. To show that you are paying attention, however, please select the "red" answer below.”

- ○ Blue (1)
- ○ Green (2)
- ○ Yellow (3)
- ○ Red (4)
- ○ Orange (5)
- ○ Purple (6)

Figure 7.12: Example Attention Check 1

Those who did not choose “Red” were immediately removed from the survey and directed back to the provider’s website. In total, 2,753 (76%) of respondents passed the attention check and

proceeded with the survey. Taking inspiration from Berinsky, Margolis, and Sances (2014), I included an additional pre-treatment attention check seen below.

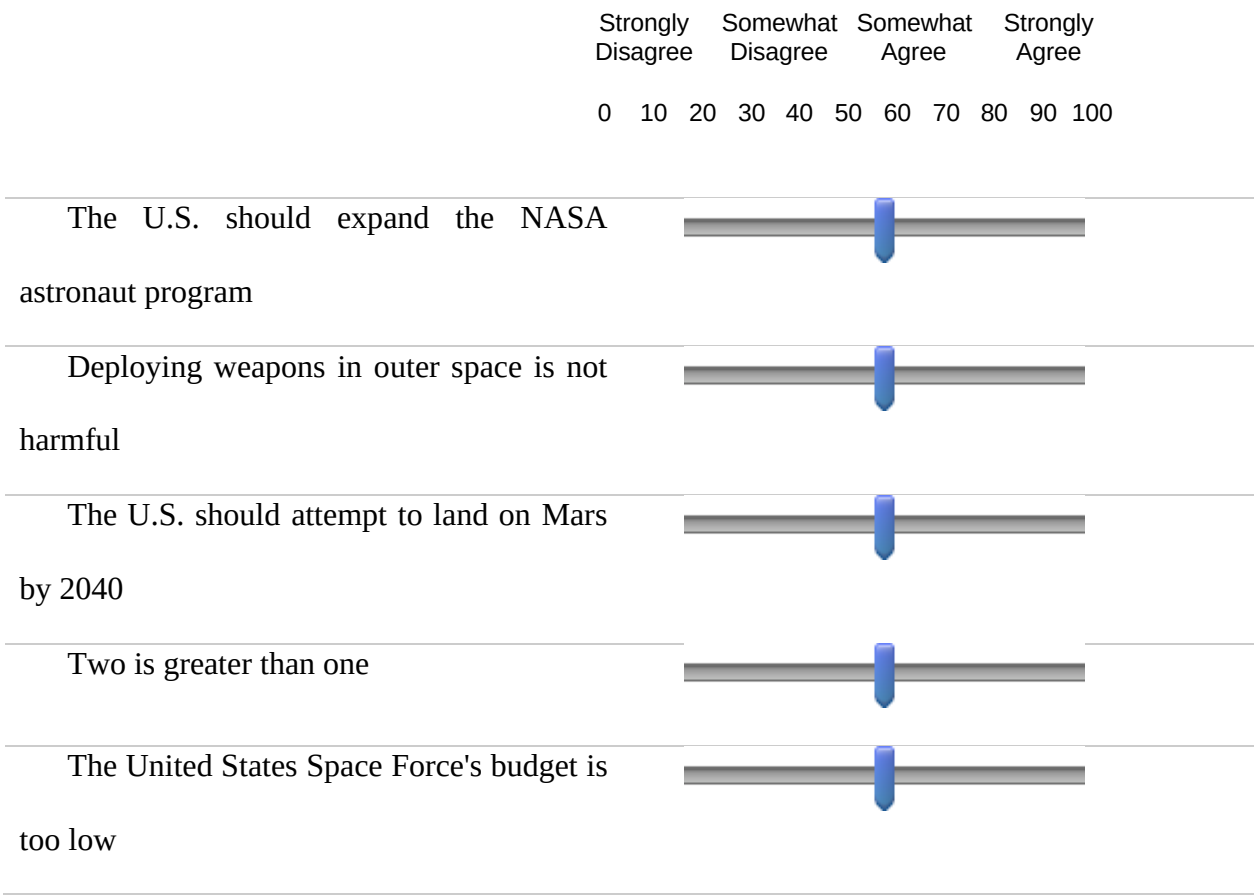

Figure 7.13: Example Attention Check 2

In total, 420 (15.3%) failed 51 or greater after the "Two is greater than one" statement. These respondents were allowed to continue the survey, and while the initial analysis included their response data, I ran further models excluding their data from the sample. The new models returned virtually identical results to the ones presented in the paper and in the appendix tables, showing that attentiveness did not drastically affect perception of the treatment.

7.6 Post-Treatment Manipulation Checks

Table 7.2: Domestic Mission Post-Treatment 1

"Which entity oversaw the observation satellite program?"

	Response Options			
Assigned Treatment	NASA	SpaceX	USSF	Blue Origin
Civil	78.1% (926)	9.4% (111)	11.9% (141)	0.7% (8)
Military	24.8% (288)	9% (105)	65.3 % (760)	0.9% (10)

Table 7.3: Foreign Mission Post-Treatment

"Which entity oversaw the observation satellite program?"

	Response Options				
Assigned Treatment	The Indian Defense Space Agency (DSA)	Skyroot Aerospace	Indian Space Research Organization (ISRO)	Dhruva Space	Pixxel
Civil	17.7% (211)	7% (83)	70.9% (844)	1.7% (20)	2.8% (33)
Military	74.6% (871)	6.9% (81)	12.5% (158)	2% (24)	2.9% (34)

Table 7.4: Private Mission Post-Treatment

"In the scenario you just read, who oversaw the mission?"

	Response Options				
Assigned Treatment	USSF	NASA	A Private Space Company	ISRO	ESA
Public	18.5% (210)	71.8% (814)	5.2% (59)	4.1% (46)	0.4% (5)
Private	18.3% (220)	21.6% (260)	58.3% (701)	3.7% (45)	0.5% (6)

7.7 References

Berinsky, Adam J, Michele F Margolis, and Michael W Sances. 2014. “Separating the Shirkers from the Workers? Making Sure Respondents Pay Attention on Self-Administered Surveys.” American Journal of Political Science 58 (3): 739–53.

Burbach, David T. 2019. “Partisan Rationales for Space: Motivations for Public Support of Space Exploration Funding, 1973–2016.” Space Policy 50: 101331. doi:10.1016/j.spacepol.2019.08.001.

Peyton, Kyle, Gregory A Huber, and Alexander Coppock. 2022. “The Generalizability of Online Experiments Conducted During the COVID-19 Pandemic.” Journal of Experimental Political Science 9 (3): 379–94

Ternovski, John, and Lilla Orr. 2022. “A Note on Increases in Inattentive Online Survey-Takers Since 2020.” Journal of Quantitative Description: Digital Media 2

Whitman Cobb, Wendy N. 2011. “Who’s Supporting Space Activities? An ‘Issue Public’ for US Space Policy.” Space Policy 27(4): 234–39. doi:10.1016/j.spacepol.2011.09.007.