A Neoclassical Realist’s Analysis Of Sino-U.S. Space Policy

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A NEOCLASSICAL REALIST'S ANALYSIS OF SINO-U.S. SPACE POLICY

by

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This thesis, submitted by Christopher David Fabian in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done, and is hereby approved.

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LIST OF ABBREVIATIONS AND ACRONYMS

A2/AD Anti-access/Area Denial

ABM Anti-Ballistic Missile

APRSAF Asian-Pacific Space Agency Forum

APSCO Asia Pacific Space Cooperation Organization

ASAT Anti-Satellite

ASB AirSea Battle

BMD Ballistic Missile Defense

BRI Belt-and-Road Initiative

C2 Command and Control

C4ISR Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance

CAST Chinese Academy of Space Technology

CBERS Chinese-Brazilian Earth Resources Satellite

CCP Chinese Communist Party

CD Conference on Disarmament

CNSA China National Space Administration

CONOPS Concept of Operations

COPUOS Committee on the Peaceful Uses of Outer Space

CSSTEAP Center for Space Science and Technology Education in Asia and the Pacific

EAR Export Administration Regulation

F2T2EA Find, Fix, Target, Track, Engage, and Assess

ICoC International Code of Conduce for Outer Space Activities

INF Intermediate-Range Nuclear Forces

ISR Intelligence, Surveillance, and Reconnaissance

ISRU In-situ Resource Utilization

ISS International Space Station

ITAR International Traffic in Arms Regulations

LEO Low Earth Orbit

MDA Missile Defense Agency

OPIR Overhead Persistent Infrared

OST Outer Space Treaty

PAROS Prevention of an Arms Race in Outer Space

PLA People's Liberation Army

PNT Position, Navigation, and Timing

PPP Purchase Power Parity

PPWT Prevention of the Placement of Weapons in Outer Space and of the Threat of Force against Outer Space Objects

PRC People's Republic of China

RF Radio Frequency

RMA Revolution in Military

RPO Rendezvous and Proximity Operations

SA Situational Awareness

SATCOM Satellite Communication

SLR Satellite Laser Ranging

SSA Space Situational Awareness

SSF Strategic Support Force

SSN Space Surveillance Network

SST Space Surveillance and Tracking

STM Space Traffic Management

TCBM Transparency and Confidence-Building Measures

UNOOSA United Nations Office for Outer Space Affairs

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ABSTRACT

During the Cold War, the United States focused its collective policy acumen on forming a competitive, actor-specific strategy to gain advantage over the Soviet Union. The fragmentation of the Soviet Union resulted in a multi-polar geopolitical environment lacking a near-peer rival for the United States. Overwhelming soft and hard power advantages allowed American policy makers to peruse a general, non-actor specific strategy to maintain its hegemonic position. However, the meteoric rise of China as a near-peer competitor in East Asia has challenged this paradigm. In order to maintain its competitive advantage, or at the very least ensure the safety of its geopolitical objectives through encouraging benign competition, U.S. strategy needs to evolve in both focus and complexity. It is essential for Spacepower, as a key element of national power, to be included in this evolution. In order to do so, this analysis will examine Sino-U.S. space relations using neoclassical realism as a baseline methodology. First, structural elements of the Sino-U.S. relationship will be modeled in a semi-quantitative game theoretical framework, using relative economic and military capabilities as primary independent variables. Second, key assumptions will be tested to ensure that this model accurately represents the current geopolitical environment. Third, the decision making apparatuses of the United States and China will be examined as intervening variables. This will account for imperfect rationality and how it modifies the game theoretical framework. Fourth, this framework will be used to present actionable space policy recommendations for the United States so that space can be incorporated into a competitive strategy for East Asia.

I. Background

A. RESEARCH QUESTION

The rise of China as an economic and military force threatens to upset the status quo of American hegemony in East Asia. Although hard power conflict is not a predetermined aspect of Sino-U.S. relations, structural factors favor a contentious outcome in the long-term. Therefore, the United States must adopt an actor-specific competitive strategy for East Asia that leverages all elements of latent national power to pursue consistent, well-defined national objectives. Spacepower is an important but often overlooked element of national power that plays a unique role in Sino-U.S. relations. Consequently, the focus of this thesis will be how Spacepower may be integrated into a broader competitive strategy for East Asia with the goal of producing policy recommendations for U.S. space policy.

B. RELEVANCE TO U.S. POLICY

On June 17, 2011, four notable academics convened in Toronto to debate the following question: will the 21st century belong to China? Niall Ferguson, internationally renowned author of history and biography, was accompanied by David Li to argue for the pro. Li is an economics professor and member of the Monetary Policy Advisory Committee of the Central Bank of China. Debating for the con were Fareed Zakaria, notable journalist and author, as well as Henry Kissinger. Kissinger has become a de facto authority on Sino-U.S. relations following his tenure as secretary of state under Richard Nixon.[1] The premise of their debate would have been far-

[1] Rudyard Griffiths and Patrick Luciani, *Does the 21st Century Belong to China?* (Toronto: House of Anansi Press, 2011), 3-7.

fetched at the end of the Cold War; however, in the quarter century since, this question has become paramount to the world's collective geostrategic planning. The collapse of the Soviet Union left the United States as the unquestionable global hegemon at the end of the Cold War. However, the subsequent rise of regionally influential actors has resulted in an increasingly multipolar geopolitical environment.[2] The existential threat that the U.S. faced during the Cold War has been replaced by a conglomeration of emerging actors vying for an increasing role in their region, with the precipitous economic development of China and its increasing influence in East Asia heralding this trend. Although this debate was cordial and well informed, it demonstrated the substantial uncertainty that China's rise has created in global politics. The message was clear: there is no clear path forward for the U.S. to accommodate China's rising ambitions.

During the Cold War, the United States executed a well-designed and competitive strategy for counterbalancing the Soviet Union in the wake of World War II.[3] The success of this strategy can be attributed to the following principles:

1. *Think in the long term.* Futurist elements must be integrated into a competitive strategy to account for emerging technologies and trends.[4] Medium to long term analysis reduces the chance that a revolution in military affairs (RMA) will catch a state by surprise, allows for a cost-benefit analysis of allocating resources to a current problem or a more pressing

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[2] Griffiths and Luciani, 62.

[3] Graham Allison. *Destined for War: Can America and China Escape Thucydides's Trap?* (Boston: Houghton-Mifflin-Harcourt, 2017), 204.

[4] Thomas Mahnken, *Competitive Strategies for the 21st Century: Theory, History, and Practice* (Stanford: Stanford University Press, 2012), 100.

one that is anticipated in the future, and allows for consistency in the face of a dynamic political environment.

2. *Ways, ends, and means must be synergistic.*[5] Individual technologies, tactics, and policies should be measured by the effects they produce towards broader strategic goals. Likewise, an understanding of broader strategic goals must be considered when developing policy for a focused area (such as space).[6] Ultimately, the goal of a competitive strategy should be a sustainable status quo congruent with the country's interests.

3. *Know thy enemy.* Competitors get a vote, therefore a deep understanding of their decision making apparatus is required to gauge a move/response/counter-response pattern.[7] Diplomatic, informational, military, economic, and social factors must be understood in the context of strategic culture in order to accomplish predictive analysis.[8] Forming this understanding may be the greatest barrier that the United States faces in developing an actor-specific competitive strategy.[9]

4. *Resource constraints are inevitable.* Allocation of resources (such as money, political will, time, and existing capabilities) is often the deciding factor in the success of a strategy. Inevitably, tradeoffs will need to be made in a way that utilizes a state's strengths to take advantage of a competitor's weaknesses.[10] Conducting a systematic

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[5] Robert Haddick, *Fire on the Water: China, America, and the Future of the Pacific* (Annapolis: Naval Institute Press, 2014), 128.

[6] Thomas Drohan, *A New Strategy for Complex Warfare: Combined Effects in East Asia* (Amherst: Cambria Press, 2016), 12-15.

[7] Mahnken, *Competitive Strategy*, 95.

[8] Drohan, *A New Strategy for Complex Warfare*, 8-9.

[9] Mahnken, *Competitive Strategy*, 24.

[10] Haddick, *Fire on the Water*, 122.

analysis of individual strengths and weaknesses is required to implement this aspect of strategy and prevent overreach.

Space policy and national strategy were closely linked during the Cold War, combining soft and hard power initiatives in service of clearly defined objectives.[11] President Kennedy's moon program was extremely effective in accomplishing its goals because it accounted for every element of combined strategy. The president, despite his rhetoric, did not believe in the intrinsic value of space travel; rather, he understood that it could be a powerful symbol of America's technological and cultural superiority over the Soviet Union. Kennedy saw the Apollo program as an opportunity to win an ideological battle for the hearts and minds of the third world by presenting a strong image of progressive anti-colonialism.[12] It was aimed at exploiting the structural weaknesses in the Soviet system while simultaneously leveraging the productivity of the American technocracy.[13] Most importantly, Kennedy, Johnson, and Webb exercised considerable political acumen to overcome limitations within the American system in order to mobilize the requisite national resources to execute their desired strategy.[14]

In the years since the Cold War, the United States has largely failed to integrate space policy and national strategy. American politicians have tended to focus on replicating Kennedy's grand vision of space travel and mirroring his nationalist rhetoric to score political victories rather than focusing on the mechanics of competitive strategy. President Bush's Space Exploration Initiative and the 2004 Bush space vision fell hopelessly short of stated goals while American strategists

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[11] Joan Johnson-Freese. *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 51-81.

[12] Walter McDougall, *The Heavens and the Earth: A Political History of the Space Age* (Baltimore: The Johns Hopkins University Press, 1985), 303-306.

[13] McDougall, 307-324

[14] John Logsdon, *John F. Kennedy and the Race to the Moon* (Basingstoke: Palgrave MacMillan, 2010), 119-142, 235-237.

became increasingly myopic, concentrating on the tactical military utility of space systems at the expense of other aspects of national power.[15] The counterproductivity of the U.S. space policy can be exemplified with three post-Cold War initiatives: withdrawing from the ABM treaty, export control legislation, and space dominance doctrine.[16]

American strategic planners during the Cold War had the luxury of operating in a bipolar environment where multi-order effects could ultimately be accounted for in the context of the U.S.-Soviet balance of power. However, with an increasingly complex geopolitical environment in which China is emerging as the United States' primary competitor and the rest of the world is developing parity with American technological capabilities, U.S. strategy must become more economical. It is of vital importance that the core tenants of competitive strategy be applied to the development of a similarly effective strategy in East Asia.[17]. This must be accomplished while avoiding the common pitfall of fighting the previous war.[18] The space domain is a microcosm of the broader strategic picture, one that is becoming increasingly complex, with more states fielding space capabilities, rapid technological advancements, the rising importance of space as an element of national power, and the meteoric rise of China. Therefore, it is necessary to reexamine space policy in order to integrate it with a competitive strategy for East Asia.

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[15] Thor Hogan, *Mars Wars: The Rise and Fall of the Space Exploration Initiative* (Washington: NASA History Division, 2007), 159-166.

[16] Johnson-Freese outlines the failures of American space policy since the Cold War in *Space as a Strategic Asset*. These specific programs will be examined at length during subsequent chapters.

[17] Allison, *Destined for War*, 214-240; Mahnken, *Competitive Strategies for the 21st Century*, 101-103; Drohan, *A New Strategy for Complex Warfare*, 4-5, 272, 275-278; Haddick, *Fire on the Water*, 121-138; Henry Kissinger, *On China* (London: Penguin Books, 2012), 534-542.

[18] Mahnken, *Competitive Strategy*, 15.

C. METHODOLOGY

Neoclassical realism is the best theoretical approach to perform the medium-term predictive analysis that competitive strategies require. It acknowledges that structural factors such as relative power and geography are the chief independent variables of international relations in the long-term, ultimately setting the left and right bounds of state behavior.[19] This theory suggests that foreign policy is strongly linked to systemic incentives but asserts that those incentives are not deterministic.[20] Therefore, it accounts for the general trend of conflict that occurs when the global status quo is usurped, while avoiding the propensity for structural determinism inherent to offensive realism. Neoclassical realism emphasizes that building an understanding of structural factors is required as the first step to analyzing international relations, therefore the overarching method through which competitive strategy must be developed is by examining external, systemic variables impacting Sino-U.S. relations. This thesis will examine the unique geography of East Asia, the physics of the space domain, and the relative power dynamic between China and the United States as its primary independent variables.

One of the core tenants of neoclassical realism is the assumption of imperfect rationality. A leader's understanding of structural factors is inevitably refracted as it passes through the lens of cultural perception and behavioral economics, and often functions in combination with a lack of information about an opponent's intentions and capabilities. These influences create misperceptions about the relative power dynamic, causing leaders to make seemingly irrational decisions. As a result, structural factors can only impact states' behavior to the extent that they

[19] Gideon Rose, "Neoclassical Realism and Thories of Foreign Policy," *World Politics* 51, no. 1 (1998): 151.
[20] Rose, 164.

influence the perception and decision making of leaders. This complicates the linear correlation between structural factors and state behavior, making a purely realist analysis less accurate over the short and medium terms. [21] Therefore, neoclassical realism requires that a state's decision making apparatus must be considered as an intervening variable to account for these factors.[22] Internal factors must be studied in conjunction with external factors to be able to perform a comprehensive analysis of state behavior. In order to determine the effects of these intervening variables, this thesis will examine the decision making apparatuses of China and the United States through an examination of unmotivated and motivated biases that affect the Sino-U.S. strategic relationship.

For foreign policy analysis, a neoclassical realist approach seeks to avoid both a heavily quantitative game theoretical analysis or the purely qualitative methods of thick description.[23] A balance must be struck between the tendencies for game theoretical analysis to devolve into structural determinism, or for thick description to become mired in overly-nuanced analysis. A non-quantitative, descriptive game theoretical analysis is able to strike this balance. On one hand, purely quantitative game theoretical framework used for predictive analysis succumbs to exponentially increasing complexity as a greater range of intervening variables is introduced. On the other, a simple 2x2 game is often dismissed as being too simplistic to capture the complexity of international politics.[24] Therefore, a game should be used as a representation of general policy

[21] Rose, 158.
[22] Rose, 152.
[23] Rose, 166.
[24] Duncan Snidal, "The Game Theory of International Politics," *World Politics* 38, no. 1 (1985): 44.

stances, one that can be modified to encompass a wide range of phenomena in order to illuminate the fundamental nature of a policy issue.[25]

The foundation of this analysis will be a basic 2x2 game that seeks to describe the structural dynamic of Sino-U.S. relations. Independent variables such as relative military capability and economic means will be used to set a reference point for each player, assign utility within the function, and establish equilibrium. The game will be then be modified using intervening variables, such as motivated and unmotivated biases, in order to anticipate deviations from perfect rationality. This method is based off Robert Jervis's seminal article *Cooperation Under the Security Dilemma*, in which he sets the theoretical groundwork for integrating game theory, neoclassical realism, and the security dilemma.[26] This analysis will build on Jervis's framework by incorporating actor and domain specific information.

D. LITERATURE REVIEW

The best fit for a literature review when using a neoclassical realist methodology is a top-down approach as it requires a solid appreciation of structural incentives before applying them to the analysis of a given scenario. Therefore, developing a conceptual understanding of the mechanisms of international conflict and how they are modified to account for psychological factors is foundational to this thesis. In order to apply this understanding to Sino-U.S. space policy the structural variables affecting Sino-U.S. space policy must be examined. These includes the geography of the space domain, establishing deterrence in space, its use as an instrument of national power, and the broader Sino-U.S. geostrategic balance. Subsequently,

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[25] Snidal, 37.
[26] Robert Jervis, "Cooperation Under the Security Dilemma," *World Politics* 30, no. 2 (1978).

assessing intervening psychological variables is based on attaining an understanding of Chinese and American security cultures, the perceptions of policy makers about the space and its role in strategy, and domestic variables that impact decision making. Finally, integrating space policy into the thesis schema requires both a review of existing literature on competitive strategy for East Asia and a review of each nations' space capabilities and policies in an attempt to link the two. This will include an analysis of how space capabilities fit into current strategy, how they interact with psychological factors, and conclude with a near-term predictive analysis of technology and policy development.

In his 1978 publication *Cooperation Under the Security Dilemma*, Robert Jervis provides an excellent analysis of structural and cognitive factors influencing the security dilemma in international relations. His fundamental assumption is that international relations exist in a condition of anarchy where a state is responsible for its own security absent an international sovereign.[27] This results in zero-sum relationships where a state's quest for security impedes the security of another. Therefore, when a state seeks to expand its influence in order to increase its own security it upsets the existing status quo, making another state less safe.[28] He uses a game theoretical framework to broadly explain the choices that both states can make, cooperate or defect. Both states can defect and the result is conflict; both states can cooperate and reap gains; or one can cooperate while the other defects, which results in one state losing big and the other winning big. The fear of this third condition is the causal force behind the security dilemma.[29]

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[27] Jervis, "Cooperation Under the Security Dilemma," 167.
[28] Jervis, 169-170.
[29] Jervis, 172.

Jervis expands the theory by adding the offense-defense postulate which examines the circumstances under which the security dilemma is most strong. When technology and geography conspire to give an advantage to an attacker, first strikes are incentivized and the dilemma becomes stronger.[30] Additionally, the security dilemma is heightened when offense is not distinguishable from defense because signaling is inherently ambiguous. When both of these conditions are met, it creates a doubly dangerous scenario where it is difficult to gain security without menacing others. When the opposite condition is true, signaling is effective and a zero-sum relationship is not exaggerated. This results in a doubly stable relationship with a diminished propensity towards the security dilemma. Even when defense has the advantage a security dilemma can result when offensive and defensive postures are indistinguishable because intentions are difficult to predict.[31]

The usefulness of Jervis's work to this analysis would be limited if he had only accounted for structural factors. However, in "Cooperation Under the Security Dilemma" Jervis briefly acknowledges imperfect rationality through the concept of subjective security demands. He purports that if every world leader rationally understood her nation's alignment with this theory, conflict would be obsolete. Therefore, the structural mechanism of the security dilemma is dependent on the psychology and perception of national leaders, which alters their calculus of the security dilemma.[32] Jervis expands this idea in a topical anthology titled *Psychology and Deterrence*. These two works, when taken together, form the basis of a neoclassical realist's analysis of the security dilemma. Case studies involving deterrence failure are used to discern the

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[30] Jervis, 194.
[31] Jervis, 211-214.
[32] Jervis., 174-176.

factors responsible for the underlying miscalculations.[33] Three hypothesis are of particular interest to this thesis. First, the misperception of the offense-defense balance prior to World War I (WWI) contributed to a lack of first-strike stability. Second, culture differences resulting in bad signaling were a factor leading to the Falklands War. Third, a miscalculation of an unacceptable shift in balance of power created an incentive to launch a preemptive attack preceding the Arab-Israeli War of 1973.[34]

The integration of structural and psychological factors in decision making under the security dilemma is accomplished through the application of behavioral economics. Daniel Kahneman and Amos Tversky set the basis for this understanding in their collected works, the capstone of which is *Thinking Fast and Slow*. Cognitive predispositions, the availability heuristic, and motivated biases are all used to explain deterrence failures in *Psychology and Deterrence*.[35] However, the most relevant of their works is *Prospect Theory: An Analysis of Decision Under Risk*. It explains that the linear correlation between risk and gains in a rational model can be modified to account for the propensity of an actor to accept risk based on her satisfaction with the status quo. The result is a non-linear relationship between risk and gains. Their model is often used to account for psychological variables within a game theoretical framework.[36] Kahneman and Tversky propose that actors have the tendency to assess their position in relative rather than absolute terms, therefore those who are dissatisfied with their relative position are increasingly

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[33] Robert Jervis, Richard Nebow, and Janice Stein, *Psychology and Deterrence* (Baltimore: Johns Hopkins University Press, 1991), 11.

[34] Jack Snyder covers the first case in his chapter "Perceptions of the Security Dilemma in 1914", Richard Lebow examines the origins of the Falklands War in "Miscalculation in the South Atlantic: The Origins of the Falklands War", and Janice Stein looks into the third case in the chapter "Calculation, Miscalculation, and Conventional Deterrence: The View From Cairo"

[35] Jervis, Nebow, and Stein, 18-27.

[36] Bonnie Triezenberg, *Deterring Space War: An Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space Warfare* (Santa Monica: RAND, 2017), 35-37.

likely to accept risk while those who are satisfied become risk averse.[37] This dynamic is expected to be especially strong between China and the United States where the U.S. represents a strong status quo power and China is emerging to challenge America's position. Assessing internal variables for China and the United States can set a reference point for each nation and, using prospect theory, perform an analysis of their propensity to accept risk.

After examining models of international conflict and incorporating them within a theoretical framework in order to set the foundation for this thesis methodology, structural dynamics underlying the Sino-U.S. space policy relationship must be examined. Because context is essential to any niche policy arena, the broader Sino-U.S. geostrategic balance is the primary structural dynamic affecting Sino-U.S. space policy. In *Destined for War: Can America and China Escape Thucydides's Trap?* Grahm Allison coins the term Thucydides's Trap to describe the friction caused by a state gaining comparative military, political, and economic power at the expense of an existing hegemon. He uses Thucydides examination of this dynamic in *History of the Peloponnesian War* as the basis of his research and examines 15 additional case studies in which a rising power has displaced a status quo power.[38] By Allison's own admission the use of words like destined or predetermined are misleading. However, he reveals that, "…in all cases we find heads of state confronting strategic dilemmas about rivals under conditions of uncertainty and chronic stress,"[39] and in 12 of 16 cases examined the result has been war

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[37] Daniel Kahneman and Amos Tversky, "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica* 47, no. 2 (1979): 277.

[38] Graham Allison, *Destined for War*, 41-44.

[39] Allison, 43. Allison means "chronic stress" in terms of a cyclic relationship between geopolitical uncertainties and domestic upheaval, which puts pressure on a state's decision making apparatus. It describes a position where a head of state is experiencing political pressure to either maintain relative geopolitical prestige for their state in the face of a challenge from another OR exert newly acquired diplomatic, economic, and/or military power on the world stage.

between the two states.[40] Additional to the zero-sum hard power relationship strongly acting upon both actors to strengthen the security dilemma, Allison proposes that psychological factors can modify the relationship and serve to either dampen or exacerbate Thucydides's Trap. Generally, a rising power's recognized status in the international community lags behind that state's self-perceived importance whereas the status quo power faces fear and anxiety in the face of potential decline.[41] Management of these perceptions is essential to avoiding conflict.

Allison makes the case that the contemporary Sino-U.S. relationship meets the conditions for Thucydides's trap and analogizes it with the pre-WWI dynamic between Britain and Germany. He argues that the rapid expansion (or reemergence) of China's economy is supporting a subsequent increase in military power and political influence in East Asia. This threatens to upset the status quo of American hegemony in the region.[42] Allison examines China's national motivations and internal decision making apparatus and proposes that the Chinese Communist Party's (CCP) mandate is to return Chinese national prestige and recoup national sovereignty. This is supported primarily by a strong nationalist sentiment and continued economic reform.[43] The analysis is useful in that it examines the structural preconditions for conflict, but also conducts a layered neoclassical realist analysis by identifying accompanying psychological factors and suggesting a way forward to help soften the structural predilection for conflict. These actor-specific recommendations may be integrated into a competitive strategy approach to increase its efficacy.

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[40] Allison, 244.
[41] Allison, 44.
[42] Allison, 20-24.
[43] Allison, 107-113.

Robert Haddick's *Fire on the Water* is relevant to this thesis in that it combines an understanding of East Asian geography, the current state of military technology and doctrine, and national motivations to perform a holistic analysis of the Sino-U.S. strategic balance. Although China has substantial coastline, it is viewed as a continental power rather than a maritime one due to the cramped nature of the South China and East China Seas. A series of island chains create a physical barrier that serves to constrain Chinese naval expansion and offers the opportunity for hostile nations to stage attacks into mainland China. China's traditional fear of encirclement, its quest for resources, and unresolved national sovereignty creates incentives for maritime expansion.[44] On the other hand, fear of China's expanding influence among nations along China's periphery has resulted in rebalancing in order to contain China. Furthermore, China's expanded influence threatens U.S. interest in the region, creating the potential to limit access to sea lines of communication and coerce trading partners. This creates a struggle where China must demonstrate the capability to deny U.S. military assets access to the area close to China's maritime borders while the U.S. seeks to maintain the ability to project power into the region and strike at Chinese strategic interests.

This dynamic has two important implications for this thesis. Due to the emphasis on systems warfare and information systems, the current overall military balance lacks first-strike stability. Also, the cost of offensive capabilities is far lower than the capabilities they are designed to defeat. American surface ships and 5th generation air assets are orders of magnitude more expensive and harder to produce than the Chinese anti-access missiles designed to interdict them.

[44] Haddick, *Fire on the Water*, 14-18.

Haddick's assessment of an offensive dominant condition is bleak considering Jervis's observations about how an environment that favors the offense heightens the security dilemma.

More importantly, the tyranny of distance has created an overreliance on space assets in East Asian military operations. It is clear to see through Haddick's analysis that space operations and terrestrial geography are interrelated. He paints a bleak picture where, in the event of hostilities, the area within 2000km of the Chinese mainland would turn into a dead zone where the cost of performing military operations is prohibitive aside from limited probing actions.[45] The United States will likely be deprived of traditional land, sea, and air assets used for performing ISR used for targeting mainland China, which greatly reduces the coercive capability of the U.S. military. The resulting reliance on space assets to perform these functions increases their value as military targets. Likewise, China uses space-based capabilities for targeting U.S. military assets between the Chinese mainland and the second island chain. Aided by their continental position, China's space and ground based ISR assets create a redundant architecture with which to threaten U.S. assets.[46] This creates an asymmetric advantage for China that makes space warfare a possible tool of coercion and deterrence. However, for the Chinese, as the theater of operation's distance from the mainland increases their reliance on space assets is proportionally raised. Therefore, projecting power beyond the first island chain becomes a difficult proposition without space power. Due to the importance of space assets in the East Asian military balance this thesis argues that they will likely be considered as first-strike options by both nations.

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[45] Haddick, 83-96.
[46] Haddick, 175-177.

In addition to the links between terrestrial geography and space power, space has a unique geography in and of itself. Said geography, defined by orbital mechanics and the relentless pull of gravity, must be examined as a fundamental structural component of this analysis. Often times policy makers fail to grasp that realities of orbital mechanics and current state of technology create a very limited right and left bound of what is possible (or at the very least practical) in space. Everett Dolman, author of *Astropolitik: Classical Geopolitics in the Space Age*, argues that space, counterintuitively, is an operationally limited environment. Due to the exponential cost that the rocket equation imposes on lifting objects into orbit, spacefaring nations develop narrow, well-trodden pathways to space in an attempt to minimize this cost.[47] Launch locations and support stations at given latitudes and longitudes are more valuable than others.[48] Also, an orbit's characteristics translate to their relative path along the earth's surface. Therefore, only certain combinations of orbital elements produce an orbit that serves a purpose for terrestrial support functions. These limiting factors create strategic chokepoints through which the entirety of the space domain may be controlled.[49]

Dolman uses his assessment of space geography to apply the geopolitical realist lines of thinking from Mackinder and Mahan's to the space domain. It is arguable that his Realpolitik thought experiment has had disproportional influence on space strategists, but a useful line of thought still comes out of Dolman's analysis. It is evident that space domination is possible given a state with adequate technological prowess and the will to do so. Rather than the cosmos being an impossibly large area out of reach of a single hegemon, a state could physically

[47] Everett Dolman, *Atropolitik: Classical Geopolitics in the Space Age* (New York: Frank Cass, 2002), 36-38.
[48] Dolman, 77-80.
[49] Dolman, 73.

dominate space by controlling the most important chokepoints. These chokepoints may serve as flash points for future conflicts because of space's overall importance to terrestrial conflict.[50] The entire structure of the space law framework set about in the Cold War was not benign, rather it was an attempt by Russia and the United States to prevent the domination of space by the other power considering their own inability to do so.[51] Therefore, with the technological advancements since the Cold War and the removal of the primary buffer against U.S. expansion, the prospect of the U.S. seeking space domination seems more likely. This effectively extends the "border" between the Chinese and Americans and adds another dimension to the already complex relationship. This thesis will argue that the geography of space combined with the American doctrine of space control exacerbates the Chinese fear of encirclement.

In *Heavenly Ambitions: America's Quest to Dominate Space*, Joan Johnson-Freese argues that, despite the impressions of policy makers in both China and the U.S., domination of space is currently impractical due to the current technological development of space systems. Ideologically, her soft-power driven, innerpolitik analysis of space policy is a counterpoint to Dolman. This has won her a similar number of disciples in the space policy realm. Three arguments in particular, which are consistent and well developed through her collected works, contribute to understanding the structural elements of space policy. First, she believes that domination of space is inherently threatening. A space hegemon, unlike one in land, air, or sea would inherently have the capability to violate any nations sovereignty with little posturing, at a

[50] Dolman, 42.
[51] Dolman, 87-109.

moment's notice.[52] This would require the placement of space weapons to interdict all objects passing through space and be omnipresent in scope and duration.[53]

Second, space is an offensive dominant domain. The cost of developing, launching, and maintaining a space asset that provides a terrestrial effect is far greater than the corresponding technology that can defeat it. Anti-Satellite (ASAT) technologies to include on-orbit interdictors, terrestrial based missiles, and electronic jammers are simple, cheap, and efficient, making them accessible to nations less capable than top-tier space powers.[54] Also, the development time of space technologies is far slower than their counter. It is possible to shield on-orbit assets with maneuver capability, shielding, or escorts. However, these assets drastically increase the cost of maintaining a given effect in a hostile environment. When taken in concert, it is clear from Dolman and Freese's work that space hegemony will take a concerted national effort, requiring an expenditure of time, political capital, and money. Also, the window of time between setting out to achieve dominance and actually achieving it would be exceptionally vulnerable to a security dilemma. Even after achieving dominance a hegemon would need to maintain the capability to render an opponent's ASAT technologies useless, a capability which also falls prey to the unfavorable cost relationship of an offensive dominant domain.[55]

Third, in the space domain offensive technologies are difficult to distinguish from defensive ones. The capabilities that make a good weapon are not mutually exclusive with those that have scientific or commercial uses.[56] Very few red flag capabilities exist that give an adversary

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[52] Joan Johnson-Freese, *Heavenly Ambitions: America's Quest to Dominate Space* (Philadelphia: University of Pennsylvania Press, 2009), 1-7.
[53] Johnson-Freese, 67-69.
[54] Johnson-Freese., 71-73.
[55] Johnson-Freese., 9.
[56] Johnson-Freese, 80-92.

certainty as to the purpose of a given platform. This results in the necessity to either judge an adversary by its potential capabilities or take it at face value to be benign. It also results in a delicate situation where technology diffusion between commercial entities of one country and the commercial or military organization of another has national security implications.[57] Even worse, the exact same satellite may be used for civilian or military purposes, sometimes at the same exact time.[58] This complicates the legitimacy of civilian assets as military targets, a line of thought reminiscent of the strategic bombing campaigns during WWII. Also, escalation could occur if third party assets are being used by one of the belligerents. Therefore, it is evident through Freese's arguments that space is susceptible to Jervis's doubly dangerous scenario where technologies are both offensive dominant and offensive-defense indistinguishable.

Continuing the thread of integrating theories of international conflict to the space domain, Forrest Morgan applies the principles of deterrence to space in his RAND monograph *Deterrence and First Strike Stability in Space: A Preliminary Assessment*. Morgan's work operates on the theoretical level, using traditional cost imposition/denial of gains structure in support of a broad analysis. Generally, the point where perceived cost of executing a strategy outweighs the gains reaped from said strategy, deterrence is established. He heavily caveats the work, calling it an empty template for further research. Due to deterrence's subjective nature the deterrent effect of a strategy may be strong on one actor but useless for another.[59] This

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[57] Johnson-Freese, *Space as a Strategic Asset*, 27-30.
[58] Johnson-Freese, 36.
[59] Forrest Morgan, *Deterrence and First Strike Stability in Space: A Preliminary Assessment* (Santa Monica: RAND, 2010), 51.

foundational analysis can be applied to Sino-U.S. space policy if the relative development of the U.S. and China's space capabilities and strategic culture are accounted for.

Morgan points out that the nature of space deterrence has fundamentally changed since the end of the Cold War. First, a decoupling of space and nuclear warfare has destroyed the tacit red lines that guaranteed an attack on space systems would result in nuclear retaliation.[60] Furthermore, technologies have been developed that allow for incremental escalation and non-lethal functional kills of space assets.[61] A paradigm is created where escalation is probable, but the extent to which it will happen is unknown. This is a problem for Sino-U.S. space relations because China is a nuclear capable power who believes itself to have achieved nuclear deterrence with the United States, yet does not have the implied strategic understanding that it took the U.S. and the U.S.S.R. four decades to build. The rules of the game have changed, but the danger of nuclear apocalypse is still real and a risk of miscalculation has increased.

Morgan echoes Johnson-Freese's assertion that the dual-use phenomenon complicates deterrence and extends the reasoning on offensive dominance by adding valuable insight on the state of first-strike stability. In short, first-strike stability is difficult to maintain because the disproportionate gain from a first strike outweighs any cost a recipient can impose in response. The United States' overwhelming reliance on and comparative advantage from space based effects gives a prospective attacker very high payoff and satellites being relatively soft targets increases the likelihood of success and further adds to the benefit of a first-strike.[62] Conversely, the emphasis on system based warfare means that an effective attack on space assets drastically

[60] Morgan, 10-13.
[61] Morgan, 17.
[62] Morgan, 1-3.

reduces the ability of the U.S. to impose costs. Also, its overreliance on space and the fragility of the space environment require an asymmetric response to both avoid a tit-for-tat spiral and protect the continued use of the domain. Furthermore, a lack of space situational awareness (SSA) prevents a rapid response.[63] Chinese military planners are acutely aware of the asymmetric advantage to be gained from a first-strike in space and have integrated it into military doctrine. This further strengthens the argument of space warfare as a flash point in East Asia.

The structural factors examined in the literature thus far paint a bleak picture for a peaceful restructuring of East Asia. However, a bipartisan grand strategy that preempts conflict, is sustained and refined over decades, and has an acute sense of both a competitor and one's own culture and history may be able to subvert structural determinism.[64] When imperfect rationality and miscalculation results in deterrence failure it is difficult to underestimate the importance of understanding a competitor's decision making apparatus. Strategic culture, political climate, and soft power interactions are the core of this apparatus. Joan Johnson-Freese, who is equal parts East Asia policy and space policy expert, asserts that, "it might be generally possible to grasp the mechanics of the Chinese space program without the benefits of historical information, but the likelihood of truly understanding the policy aspects without this contextual information is slightly less, and attempts at analysis and extrapolation become superficial at best."[65] Likewise, competitive strategy will be ineffective absent an understanding of one's own limitations. Resources such as latent military capacity, budget, political capitol, strategic culture, and soft

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[63] Morgan, 26-30.
[64] Graham Allison, *Destined for War*, 204-205.
[65] Joan Johnson Freese, *The Chinese Space Program: A Mystery Within a Maze* (Malabar, FL: Krieger, 1998), 11.

power/international prestige should be easy to calculate, but many times within the space program's short history the failure to grasp internal limitations has been a stumbling block.

Henry Kissinger's On China is a nuanced examination of Chinese strategic culture that benefits from the author's understanding of Chinese history and the nation's role in late-20th/early-21st century global power politics. He conveys a unified message through *On China*, that continual diplomatic engagement between the two powers is the key to peace and develops two motifs throughout the work. First, misapprehension of Chinese intent by western powers has repeatedly resulted in conflict, which could be avoided with better understanding of Chinese strategic culture. Traditional Chinese strategic culture, shaped for millennia by geography and Confucian principals, was not destroyed by Mao and the communist revolution as many assert. Kissinger uses the traditional martial games of wei qi (go) and chess to exemplify Chinese and western strategic cultures respectively. Where wei qi teaches the art of strategic flexibility by emphasizing encirclement, protracted and asymmetric warfare, generating unperceptively small advantages, and momentum; chess teaches total victory achieved by attrition, decisive moves, centers of gravity, and symmetry. Carl von Clausewitz teaches that war is policy by other means, inferring war as a distinct phase of politics; while Sun Tsu emphasizes victory before fighting by achieving psychological advantage with military means as a small part of overall strategy. The ideal Chinese military conflict is geographically limited and easily contained; the American way of war concludes only upon total victory.[66]

Kissinger then describes the feedback loop that results from conflicting strategic perspectives. The western desire for control threatens Chinese freedom of maneuver and

[66] Henry Kissinger, *On China*, 22-32.

exacerbates their siege mentality. In response, China assumes a policy of active defense (preemption) in order to maintain the strategic initiative. This, in turn, is seen as hostile by the west and typically results in escalation in order to establish deterrence through cost imposition. The western idea of deterrence is incompatible with ambiguity and flexibility while Chinese preemption demands it.[67] This results in a distinguishable pattern. First, a state consolidates power on China's periphery, surrounding China and threatening its structural integrity on both physical and psychological levels. Second, ever aware of shi, Chinese strategists employ measures to maintain their strategic flexibility and prevent total encirclement. Third, the peripheral power misinterprets preemption for aggression and escalates the conflict. At this point, China is either able to contain the threat and achieve its geopolitical aims or it is too weak to do so and is thrown into existential crisis. In the 20th century, this pattern has been exemplified by Chinese involvement in the Korean War and its continued support of an independent state to buffer the U.S. alliance bloc from a historical ingress point to the Chinese mainland; its own Vietnam War to prevent the emergence of a competitive power bloc led by Vietnam in Southeast Asia; and Chinese political maneuvering against the Soviet Union to prevent its consolidation of power over the Eurasian landmass. Disregarding the similarities between these disputes and the current Sino-U.S. position in East Asia is impossible.[68]

Second, the Sino-centric worldview is rising in China as she emerges from a century of humiliation to become an economic and military superpower. The over-proselytized American belief that the implementation of democracy should be the end goal of global politics and unapologetically moralist positions conflict with Sino-centrism. It is seen by China as an

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[67] Kissinger, 145
[68] Kissinger, 344, 496.

extension of colonial interventionism and a threat to their fiercely held autonomy. U.S. diplomacy is often contingent on the improvement of China's human rights record. Widespread support for China's various separatist movements and public outcry over the Tiananmen Square incident has exacerbated this problem. American reluctance to recognize the legitimacy of a communist government, give up democratization as long term policy goals, or give China its due in international relations has weakened Sino-U.S. relations. America's moralist rather than pragmatic approach to policy threatens China's delicate social order and undermines CCP legitimacy, resulting in missed diplomatic opportunities.

Other policy analysts are certainly influenced by Kissinger, but add their own insight into Chinese Strategic culture. Kenneth Johnson and Andrew Scobell writing for the Strategic Studies Institute both attribute the apparent cognitive dissonance in Chinese policy to a curious blend of Confucian ideals and realpolitik thought, supporting Kissinger's assertion that Confucianism is not dead. There is a cult of defense within China, accompanying a deeply held belief that China's strategic culture is overwhelmingly pacifist.[69] However, preemptive action is permissible as long as it can be a justifiable "defense" of Chinese strategic interests.[70] In addition, China bemoans aggressive territorial expansion and hegemony by force. This historical sensitivity has only been exacerbated by the "century of humiliation" at the hands of European powers.[71] However, the benevolent expansion of influence and the use of force for Chinese national unification is just. Furthermore, the Chinese fear of encirclement could cause a disproportionate reaction to the U.S.

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[69] Andrew Scobell, China and Strategic Culture. Monograph (Carlisle, PA, Strategic Studies Institute, 2002), 4-5

[70] Scobell, 10-14

[71] Kenneth Johnson, *China's Strategic Clulture: A Perspective for the United States* (Carlisle, PA: Strategic Studies Institute, Army War College, June 2009), 10.

force realignment and restructuring of alliances in East Asia.[72] This could exacerbate the worsening of the security dilemma that alliance forming typically causes.

Joan-Johnson Freese emphasizes the influence of Confucianism in internal decision making and the penchant for isolationism. Confucianism emphasizes peace, order, and knowing one's place within society. This invites authoritarianism and the Chinese people have little experience with participation in the political process. Rather, there is an instability lurking beneath the calm surface of society that leaders must constrain and satisfy in order to maintain their mandate to rule.[73] The social contract has a simple results based nature where political stability and prosperity is exchanged for the continued political power. The Chinese Communist Party then is less beholden to communist ideology than it is to continued prosperity.[74] Also, despite the negative connotation of nepotism in the West, it is an institution of Chinese culture (known as Guan Xi).[75] From the outsider, the familial ties, importance of relationships, compartmentalization, and ambiguity in the Chinese bureaucracy are confusing and frustrating.

This research paints the picture of the U.S. and China as diametrically opposed cultures that are almost designed to create misunderstanding between the two. Therefore, being aware of cultural and political sensitives is necessary to create sound strategy. Michael Pillsbury identifies 16 psycho-cultural pressure points where, if correctly considered in reassurance, cost imposition, or dissuasion strategies, will yield disproportionately effects whether they be positive or negative. Each of these factors are referred to as "fears".[76] Eleven of the sixteen fears are linked

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[72] Scobell, "China and Strategic Culture," 24-25.
[73] Johnson Freese, *The Chinese Space Program*, 23.
[74] Johnson-Freese, 24.
[75] Johnson-Freese, 24.
[76] Michael Pillsburry, "The Sixteen Fears: China's Strategic Psychology," *Survival* 54, no. 5 (2012): 152.

to the ability of the U.S. military to project power into East Asia and the strategic sea lines of communication from the Strait of Malacca to the Bohai Gulf, which is contingent on the ability to deliver space effects in support of U.S. military operation. Pillsbury identifies the fear of attack on their anti-satellite capabilities as a specific Chinese fear, but warfighting in the space domain is intrinsically linked to the other 11. Another of the sixteen fears is the fear of escalation and loss of control. This is particularly important because the Chinese view ASAT weaponry as a legitimate cost imposition option designed to limit conflict. Contrast that with the American strategy of threatening escalation in order to prevent the spread of the conflict into space and implicit red lines that fail to account for limited conflict in a strategic domain. Space's role in soft power links it to two final fears, the fear of regional competitors and the fear of internal instability. Space technology development is essential to the CCP's techno-nationalist narrative as it is assigned great importance internally to strengthen CCP's mandate to rule and externally to legitimize China as a regional leader.

According to Sun Tzu, "if you know the enemy and know yourself, you need not fear the result of a hundred battles."[77] While studying a competitor's strategic culture is useful to avoid mirroring; understanding one's own strategic culture is vital to effectively utilizing national resources and avoiding bias.[78] This thesis benefits from being able to perform a thick analysis of American strategic culture using a panoply of English language sources. Russell Howard describes American strategic culture as that of a traditional sea power with moralistic overtones. The American military is highly constrained by legal and moral considerations, meaning that in order for the U.S. to enter a war there must be an existential threat to its national security or a

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[77] Sun Tzu, *Sun Tzu on the Art of War* (Leicester: Allandale Online Publishing, 2000), 11.
[78] Russell Howard, *Strategic Culture*.(MacDill AFB: Joint Special Operations University, 2013), 5.

crusade of good versus evil.[79] This results in national mobilization so that the U.S. can "bear the burden of a long twilight struggle against the common enemies of man," to borrow from John F Kennedy's inaugural address.[80] America's history is punctuated with these struggles from the Civil War to WWII. This ideology has become more prominent since the Vietnam War, which entrenched the view that, "when America uses force in the world, the cause must be just, the goal must be clear, and the victory must be overwhelming."[81] Max Boot in his three books provides excellent analysis of how the global wars of the 20th century, the rise of technology, and casualty aversion has impacted American strategic thought in the 21st century.[82]

American space power doctrine has shown itself to be a microcosm of its strategic culture rather than an exception to it. In his influential work, *The Heavens and the Earth: A Political History of the Space Age*, Walter McDougall asserts that the space age did not usher in a new era of cooperation, nor was it disconnected from the geopolitical mechanisms of earth-bound policy. Rather, it simply extended business as usual to a new realm.[83] The American technocracy that the genesis of the space age solidified and the international legal framework that U.S.-Soviet competition created persist in the 21st century.

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[79] Howard, 7-10.

[80] Kennedy's moralistic rhetoric was forged in the crucible of the early Cold War and is a prominent theme through his speeches. Look no further than his 1962 Moon Speech and the promise to pay any price and bear any burden during his inaugural address to reveal the moral-martial connection of U.S. strategic culture.

[81] Max Boot quoting George W. Bush at the 2000 Republican National Convention. Max Boot acknowledges the "American Way of War" in his fantastic book *The Savage Wars of Peace: Small Wars and the Rise of American Power* but proceeds to make the case for the importance of limited warfare in America's military history. This does not dismiss the relevance of U.S. strategic culture, rather Boot argues that 21st Century American strategy is crippled by loss aversion and the aversion to ambiguity.

[82] The Savage Wars of Peace: Small Wars and the Rise of American Power; Invisible Armies: An Epic History of Guerrilla Warfare from Ancient Times to the Present; War Made New: Weapons, Warriors, and the Making of the Modern World.

[83] McDougall, *The Heavens and the Earth*, 413-414.

> Eisenhower was surely right-the American system was not set up for central planning, nor did its values condone it. But JFK was also right-the old invisible hand was no longer equal to the foreign challenge in the age of technological revolution. In the end, the United States got the worst of both worlds: a free market twisted at every turn by state intervention and a technocratic state incapable of managing the change it provoked.[84]

John Logsdon chronicles the Cold War space program in two fantastic works, *John F. Kennedy and the Race to the Moon* and *After Apollo: Richard Nixon and the American Space Program,* which echo McDougall's assertions. When examining recent space policy decisions it is easy to see influences of both American strategic culture and vestiges of Cold War policy, not all of which are conducive to the current geopolitical realities.

Sino-U.S. space relations is a niche policy community that has gained relevance as a result of China's military transformation and its expanded influence in East Asia combined with a series of key U.S. policy decisions such as the withdraw from the 1972 Anti-Ballistic Missile (ABM) Treaty, International Traffic in Arms Regulations (ITAR) reform following the 1999 Cox Report, and U.S. Air Force doctrine published during the Bush administration. In particular, the 2007 Chinese kinetic ASAT test that destroyed a defunct weather satellite spawned new interest in the topic. There are fewer than a dozen strategic thinkers that have a disproportionate voice in this community and their tireless analysis can be coalesced into a few common themes.[85] First,

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[84] McDougall, 444.

[85] In no particular order Dean Cheng, Asian Studies Center at the Heritage Foundation; Brian Weeden, Director of Program Planning for Secure World Foundation; Larry Wortzel, U.S.-China Economic and Security Review Comission and director Strategic Studies Institute; Kevil Pollpeter, China space guru extraordinaire; Michael Krepon, Stimson Center; Michael Pillsbury, Chinese Strategy for Hudson Institute; James Clay Moltz, Professor Naval Postgraduate School; Joan Johnson-Freese, Professor U.S. Naval War College and prolific author; Phillip Saunders, Institute for National Strategic Studies.

strategists from both sides see space as a major component of future conflict, including an anti-access/ area denial (A2/AD) campaign in East Asia. Next, space operations are disturbing the equilibrium of strategic deterrence. Finally, the rapid growth of the space industry in China is expediting development of a Chinese technocracy.

Much of the literature on Sino-U.S. space policy focuses on the war fighting domain. The Chinese Direct Ascent ASAT test in 2007 spawned a significant amount of literature pertaining to China's military space strategy and capabilities, particularly focused on how it could threatens to disrupt U.S. space superiority in an East Asian conflict. A short, but insightful peace by Larry Wortzel links space warfare with Chinese national sovereignty. He contends that U.S. space domination threatens Chinese sovereignty because it can be used by the U.S. to project power into East Asia and interfere with Chinese affairs.[86] Also, the ill-defined legal régime for space is commonly viewed as an opportunity for the U.S. to extend its national sovereignty into the space domain at the expense of China.[87] Ashley Tellis, in a journal article titled *China's Military Space Strategy*, emphasizes that China's military space capabilities are not aimed at gaining superiority in space. Rather, they are focused on blunting hegemonic and unilateral action by the United States to establish space dominance.[88] Because Beijing recognizes the comparative advantage that asymmetric counterspace weapons give its military, a legal regime limiting these capabilities is improbable.[89] In *The Chinese Vision of Space Military Operations* Kevin Pollpeter conducts a thorough analysis of Chinese perspectives on space warfare from primary sources. He agrees

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[86] Larry Wortzel, "The Chinese People's Liberation Army and Space Warfare: Emerging United States-China Militry Competition," *International Journal of Space Politics and Policy* 6, no. 2 (2008): 2-4.
[87] Wortzel, 5.
[88] Ashley Tellis, "China's Military Space Strategy," *Survival* 49, no. 3 (2007): 45.
[89] Tellis, 60.

with Tellis that the Chinese military is primarily concerned with preventing U.S. dominance, but emphasizes that offensive weapons and first-strike tactics are at the forefront of Chinese strategy.[90] Also, Pollpeter emphasizes that the PLA does not have parity with U.S. military space capabilities, but is undergoing a concerted effort to eliminate this disparity.[91] Two resources are particularly important for assessing comparative capabilities. First is the 2017 RAND report *The U.S-China Military Scorecard*. This assesses the general threat to capabilities that each side poses to the other and accounts for the tyranny of distance by comparing a Taiwan conflict close to the Chinese mainland with a prospective conflict in the Spratly Islands.[92] Second, Michael Pillsbury examines specific Chinese capabilities against American space targets in his 2007 report to the U.S.-China Economic and Security Review Commission.

Around the same time as the 2007 Chinese ASAT test another strain of literature started growing out of the space policy community that generally describes the changing nature of Sino-U.S. deterrence. It is a response to the Bush Administration National Space Policy (NSP), the U.S. withdrawal from the Anti-Ballistic Missile (ABM) Treaty, and Chinese pushback against these two events. Sitting atop the pantheon of this literature is *The Paradox of Power: Sino-American Strategic Restraint in an Age of Vulnerability* by David Gompert and Phillip Saunders. They argue that the integration of space capabilities into the U.S. national economy and military operations has elevated it to a strategic domain, on par with nuclear weapons in their ability to strike at core national interests. Unfortunately, the offensive dominance of the space domain

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[90] Kevin Pollpeter, "The Chinese Vision of Space Military Operations," in *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army* ed. James Mulvenon and David Finkelstein (Alexandria: CAN Corporation, 2005), 340.

[91] Pollpeter, 345-349.

[92] Eric Heginbotham et al., *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996-2017* (Santa Monica: RAND, 2015), 258.

makes it difficult to deny gains while the asymmetric dependence on space reduces the effectiveness of symmetric cost imposing strategies. In addition to the rather straightforward application of Jervis the authors add two valuable insights. First, China has little fear of escalation into the nuclear domain due to strategic decoupling between space/conventional warfare and nuclear warfare. Second, the monetary and human cost of space warfare is far less than that of nuclear weapons or even conventional warfare.[93] This means that ASAT weapons have become a credible method of strategic deterrence in addition to a powerful conventional warfighting tool. Two separate reports were commissioned to examine how space has changed the nature of Sino-U.S. deterrence and generally agree with Gompert and Saunders.[94] Another important thematic element of the "deterrence revisited" literature is the Chinese fear that U.S. space control and potential weaponization could endanger its strategic nuclear deterrent capability. This subsequently jeopardizes Chinese territorial integrity by making it susceptible to nuclear blackmail.[95] From this literature it is clear that space has a very different purpose for strategic deterrence in the minds of Chinese and American strategists.

The successes of the Shenzhou and Tiangong manned space programs and stated ambitions for deep space exploration spawned another strain of literature focused on the technocratic aims of the Chinese space program. Two works in particular stand out, *The New Space Race: China vs. the United States* by Erik Seedhouse and *Asia's Space Race: National Motivations, Regional Rivalries and International Risks* by James Clay-Moltz. Manned related

[93] Gompert and Saunders, 10-11.

[94] *China Security Winter 2007* ed. By Eric Hagt and *Anti-Satellite Weapons, Deterrence and Sino-American Space Relations* ed. By Michael Krepon and Julia Thompson

[95] Hui Zhang, "Chinese Perspectives on Space Weapons" in *Russian and Chinese Responses to U.S. Military Plans in Space* (Cambridge: American Academy of Arts and Sciences, 2008), 41-44.

and scientific space programs have little direct utility for national security and relatively small return on investment in and of themselves, but still factor into Chinese assessment of comprehensive national power. Seedhouse believes that the pursuit of a manned space program is a demonstration of China's rising technological prowess and self-sufficiency. The program is designed to reap soft power/prestige benefits and position China as a leader in Asia.[96] Moltz echoes Seedhouse's position on motivations, but makes a solid case that China's technocratic demonstration is more for the benefit of other Asian nations rather than the United States. The Asian nations are closely monitoring the gains of their competitors and competing for relative rather than absolute gains.[97] Within China, the space program is being used to promote large-scale educational, economic, and social development as well as enhance the CCP mandate.[98] One of Moltz's students provides a fantastic analysis of how the Chinese space program is being used to reap soft power benefits. He agrees with the assertion that China is occupying an underserved niche by assisting/subsidizing developing nations' space programs in order to increase national prestige without triggering counterbalancing actions.[99] The use of space for political and diplomatic means makes it a powerful tool for the CCP as their capabilities grow. Therefore, space policy could serve as an opportunity to foster cooperation and communication between China, the U.S., and other Asian nations. However, as space becomes intertwined with Chinese national identity the threat that U.S. capabilities present grows proportionally.

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[96] Eric Seedhouse. *The New Space Race: China vs. the United States* (Chichester, UK: Praxis, 2010), 7-8.

[97] James Clay Moltz, *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2012), 7, 21.

[98] Moltz, 21.

[99] Rob Chambers, "China's Space Program: A New Tool for PRC "Soft Power in International Relations?" M.A. Thesis, Naval Postgraduate School, March 2009

E. ROADMAP

Chapter II will form the basis of a game theoretical analysis using purely structural variables (relative economic and military power). First, simplifying assumptions will be outlined. Next, utility will be assigned to each of the four outcomes possible in a 2x2 game by examining the space programs of China and the United States in the context of the broader strategic relationship. Then, the validity of the zero-sum assumption will be tested by exploring technology, geography, and economic factors at play in the space domain. Chapter III assesses the cognitive biases present in China and the United States' decision making apparatuses in order to ascertain how utility may be altered by perception. The analysis will focus on how unmotivated biases affect decision making under risk using prospect theory. Motivated biases will be accounted for by examining the strategic cultures of both players. Chapter IV will perform a short-medium term predictive analysis and present policy recommendations based on the analysis in chapters II and III.

II. Modeling for Structural Factors

A. Building the Game

Chapter II will seek to describe the structural factors underlying Sino-U.S. relations using a realist framework. This framework is highly compatible with game theory and allows for a variety of simplifying assumptions when building a model of Sino-U.S. space relations.[100] The first assumption is that the world order exists in a state of anarchy, precluding the existence of an international sovereign who may put bounds on state behavior.[101] Therefore, a state is assumed to be unrestricted by the expectations placed on it by tertiary actors within the international system. Second, the model assumes perfect rationality, under which each actor has perfect information and will choose the course of action that maximizes their own utility.[102] Third, it is assumed that global utility is constant (zero-sum), resulting in a condition where one player's utility can only be increased at the expense of another. In international relations, this zero-sum relationship occurs when one state's security may only be increased by consequently decreasing the security of another. Since states often seek to control areas outside their own borders for both offensive and defensive reasons, the zero-sum assumption is independent of the power/security seeking dichotomy of offensive and defensive realism.[103] Regardless of intentions, this expansion of responsibilities, commitments, and military power may inherently threaten others. Finally, the game will initially be represented as simultaneous and non-iterative.

[100] Robert Jervis, "Realism, Game Theory, and Cooperation," *World Politics* 40, no. 3 (1988): 318.

[101] Jervis, "Cooperation Under the Security Dilemma," 167.

[102] Peter Bennett, "Modelling Decisions in International Relations: Game Theory and Beyond," *Mershon International Studies Review* 39, no. 1 (1995): 22.

[103] Jervis, "Cooperation Under the Security Dilemma," 170.

The simple 2x2 matrix used in this analysis is represented in Figure 1.

		China	
		C	D
U.S.	C	CC	CD
	D	CD	DD

Figure 1: Simple 2x2 Game Matrix

"C" represents each player's choice to cooperate, which may include a reduction in offensive weapons, treaties, or assuming defensive posture. D represents each player's choice to defect, which may include the buildup of offensive weapons, assuming hostile posture, or taking hostile actions. When both players choose to cooperate (CC), potential gains may be wrought, but when both players choose to defect, excessive arms buildup and war may result in loss by both players. The third possible outcome is when one player cooperates while the other defects (CD). In this scenario, the player that defects can reap significant benefits while the player that cooperates stands to suffer substantial loses. The ordinal preference of each player can be shown in Figure 2. "x" represents the preference order of the U.S. and "y" represents the preference order of China

		China	
		C	D
U.S.	C	x,y	x,y
	D	x,y	x,y

Figure 2: 2x2 matrix with ordinal preferences. U.S. preferences are represented by "x" and Chinese preferences are represented by "y".

The magnitude of these preferences may also be quantified to show the utility the players experience given each outcome (CC, CD, DC, DD). Chapter II will examine each outcome sequentially and determine the utility that the players derive from each one.

B. Defining Preferences

In short, space control is the act of securing the space medium for the purpose of providing freedom of access to space and freedom of action in space, while simultaneously denying the enemy access to the medium.[104] This can be accomplished through kinetic or non-kinetic means, by on-orbit or terrestrial assets, and may act on any part of the space system. In order to maintain access to space, a state must have a functioning space support system. Space support is the ability to sustain satellites and their capabilities on-orbit through day-to-day management and field new systems when required.[105] Although much has been written about space support and space control, it is essential to realize that they are simply a vehicle by which to provide terrestrial effects from space. In a military sense, force enhancement is the mission of space systems to increase the effectiveness of terrestrial military operations, while force application is the ability to impose kinetic and non-kinetic measure from space in pursuit of joint combat objectives.[106] From a policy perspective, space control and space support must not be viewed in isolation; rather, they should be viewed through the lens of the force enhancement mission that they support.

Fundamentally, cooperation between the U.S. and China is based on maintaining the status quo of free access to space in accordance with existing international treaties and customary law. The primary laws governing the peaceful use of outer space, for which China and the U.S. are both signatories, include the Outer Space Treaty (OST), Rescue Agreement, Liability

[104] Benjamin Lambeth, "Airpower, Spacepower, and Cyberpower," in *Toward a Theory of Spacepower: Selected Essays*, ed. Charles Lutes and Peter Hays (San Bernardino: National Defense University, 2017), 317.

[105] M.V. Smith., "Security and Spacepower," in *Toward a Theory of Spacepower: Selected Essays*, ed. Charles Lutes and Peter Hays (San Bernardino: National Defense University, 2017), 342.

[106] Lambeth, "Airpower, Spacepower, and Cyberpower," 316-317.

Convention, and Registration Convention.[107] Article IV of the OST prohibits the placement of nuclear weapons in orbit and forbids the placement of any weapons on a celestial body. Although the OST requires the peaceful exploration and use of outer space, it does not prohibit conventional weapons in space or provide a definition for what could be considered a space weapon. The vagueness of the OST, particularly article IV, amounts to a crisis in space law and will be covered at length in later sections.[108] Despite the previously mentioned ambiguity, this analysis will assume that cooperation entails both the adherence to existing legal regimes and the limitation of the capability to wage war in and from the space domain.[109] This includes limiting space control and on-orbit force application capabilities. Alternatively, defection between the U.S. and China involves preventing free access to space through the manipulation of international law, the building and maintaining of space control capabilities, or the building and maintaining of on-orbit force application capabilities. These broad definitions are essential for two reasons: first, they acknowledge that the Sino-U.S. space policy game is nested inside a larger game of Sino-U.S. geostrategic relations, given that space power is a fundamental element of national power. Second, it accounts for the practical limitations in foundational, codified space law.

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[107] *Status of International Agreements Relating to Activities in Outer Space as at 1 January 2008* (United Nations Office for Outer Space Affairs, 2008), http://www.unoosa.org/pdf/publications/ST_SPACE_11_Rev2_Add1E.pdf.

[108] For a legal discussion on the OST and space weapons see *Legality of the Deployment of Conventional Weapons in Earth Orbit: Balancing Space Law and the Law of Armed Conflict* by Michel Bourbonniere and Ricky Lee.

[109] For a legal discussion on the definition of space weapons and the applicability of existing laws of war and customary international law to the space domain see *Space Weapons and the Law* by Bill Boothby of the U.S. Naval War College.

a. Cooperate/Cooperate

China is highly incentivized by the prospects of mutual cooperation in space. Maintaining free access to space is analogous to free sea lines of communication, which are primarily guaranteed by U.S. military power.[110] This guarantee has allowed China to become the world's largest importer and exporter, accumulating $4.3T of total trade in 2014 and catalyzing a massive economic resurgence.[111] Similarly, there is evidence that China aims to take advantage of free access to space to continue its national rejuvenation into post-industrial future. In 2013, General Secretary Xi Jinping announced the "China Dream" to rejuvenate China by building national pride, engineering an economic revolution, and rebuilding China's military.[112] Xi has linked a "space dream" as a means of fulfilling the "China Dream".[113] After the launch of the manned Shenzhou-10 mission in 2013 he stated, "The space dream is part of the dream to make China stronger. With the development of space programs, the Chinese people will take bigger strides to explore further into space," and went on to compare the Chinese manned space program to the Long March.[114] Similarly, Lt. Gen. Zhang Yulin stated, "The earth-moon space will be strategically important for the great rejuvenation of the Chinese nation."[115] The connection between China's space program and national rejuvenation touted by CCP leaders is particularly

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[110] Hillary Clinton, "America's Pacific Century: The Future of Geopolitics will be Decided in Asia, not in Afghanistan or Iraq, and the United States Should be Right at the Center of the Action," *Foreign Policy*, no. 189 (2011), 62-63.

[111] Mark Thirlwell, "The World's Leading Trading Nations," *Australian Trade and Investment Commission*, 22 April 2015, https://www.austrade.gov.au/News/Economic-analysis/the-worlds-leading-trading-nations.

[112] Manoranjan Mohanty, "Xi Jinping and the 'Chinese Dream'," *Economic and Political Weekly* 48, no. 38 (2013), 34-35.

[113] Evgeniia Drozhashchikh, China's National Space Program and the 'China Dream'," *Astropolitics* 16, no. 3 (2018), 175-176.

[114] Unattributed, "Backgrounder: Xi Jingping's Vision for China's Space Development," ed by Tian Shaohui, April 24, 2018, http://www.xinhuanet.com//english/2017-04/24/c_136232642.htm.

[115] Namrata Goswami, "Waking Up to China's Space Dream," *The Diplomat*, October 15, 2018, https://thediplomat.com/2018/10/waking-up-to-chinas-space-dream/

strong in relation to the manned space program, which has ambitious development milestones planned until 2045.[116]

Space power and manned space accomplishments serve to benefit China in five ways. First, success in space forms a nationalist narrative and creates a positive focal point for national pride, counter to the negative images of the Tianamen Square massacre and China's consistently poor human rights record.[117] Maintaining an independent and self-reliant space program helps the CCP craft a narrative based on technological development, social progress, and sustainable development. This lends legitimacy to CCP leadership of China and stokes nationalism.[118] Additionally, the dissemination and control of satellite communication gives the CCP a medium by which to propagate its own political interpretation of world events.[119]

Second, the economic benefit gained from China's space program is essential to upholding the informal social contract between the Chinese people and the CCP, one that is based on continued economic growth and an increase in quality of life. China seeks to make its space program a driver of economic and technological advancement in a variety of ways. Primarily, they believe that spin-off technologies from the space program could have up to a 1:10 cost to benefit ratio.[120] This creates a cycle where the Chinese space program generates technology, technology spurs economic development, and economic development supports the

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[116] Ma Chi, "China Aims to be World-leading Space Power by 2045," *China Daily*, November 17, 2017, http://www.chinadaily.com.cn/china/2017-11/17/content_34653486.htm.

[117] Johnson-Freese, Space as a Strategic Asset, 204.

[118] Michael Sheehan, "'Did You See That, Grandpa Mao?' The Prestige and Propaganda Rationales of the Chinese Space Program," *Space Policy* 29 (2013), 109-111.

[119] Moltz, *Asia's Space Race*, 104.

[120] Kevin Pollpeter et al., *China Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States* (San Bernardino: National Defense University, 2017), 19-20.

space program.[121] The export of commercial space services will be a driver of economic development as a producer of both jobs and hard currency.[122] Additionally, the space industry spurs the development of a high technology industry by creating a market for high-skill labor and products.[123] The industrial and academic base required for the development of a strong space program is projected to have multi-order effects across other key industries and inspire young Chinese to pursue a career in the sciences.[124] Next, the use of satellite application technologies is critical to China's economic development.[125] The use of geological, weather, and positional data is essential to developing China's limited resources and guarding her fragile environment.[126] A multitrillion-dollar infrastructure project called the Belt-and-Road Initiative (BRI) was announced by Xi in 2013. The purpose of this project is to harness latent Chinese industrial capacity to enhance strategic connection between China and the rest of the Eurasian landmass.[127] China's space development has been specifically linked to BRI by the China National Space Administration's (CNSA) director of international cooperation, Jiang Hui. In a brief to the United Nations Office for Outer Space Affairs (UNOOSA), Hui highlighted a long term plan focused on building the Chinese space industry and leveraging space capabilities (particularly geospatial, communication, and navigation systems) to build a spatial information corridor.[128]

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[121] Chambers, "China's Space Program," 46;

[122] Cheng, "Spacepower in China," 461.

[123] Chambers, 42-44; Pollpeter et al., *China Dream, Space Dream*, 19.

[124] Dean Cheng, "Spacepower in China," in *Toward a Theory of Spacepower: Selected Essays*, ed. Charles Lutes and Peter Hays (San Bernardino: National Defense University, 2017), 459-461.

[125] Pollpeter et al., *China Dream, Space Dream*, 19.

[126] Chambers, "China's Space Program," 40-42.

[127] Joel Wuthnow, *Chinese Perspectives on the Belt and Road Initiative: Strategic Rationales, Risks, and Implications*, ed. Phillip Saunders (Washington: Institute for National Strategic Studies, National Defense University Press, October 2017), 4-8.

[128] Jiang Hui, "The Spatial Information Corridor Contributes to UNISPACE+50," (presented to UNOOSA, 2018); Andrew Jones, "Chinese Satellites to Provide emergency Response for Belt and Road Countries," *GB Times*, May 03, 2018, https://gbtimes.com/chinese-satellites-to-provide-emergency-response-for-belt-and-road-countries;

Third, China is using spacepower as a way to develop prestige and reap soft power gains. The success of the Chinese space program infers significant leadership connotation in the region and is intended to establish Beijing at the forefront of Asia's technology and economic development.[129] Orbital accomplishments and space technology development is seen as a herald for advancement in agriculture, resource management, communications, and disaster management as well as a symbol of national scientific and economic infrastructures. Therefore, they play a deeply symbolic role in Asia, with significant prestige to be gained by accomplishing space "firsts" within the region.[130] Beijing has made an effort to translate the success of its space program for the purposes of seizing regional leadership, boosting soft power, and incorporating space into BRI.[131] It created the Asia Pacific Space Cooperation Organization (APSCO) in 2008, which consists of China, Iran, Mongolia, Peru, Bangladesh, Pakistan, Turkey, Indonesia, and Thailand.[132] China has donated ground systems, personnel training, and remote sensing data to member countries.[133] Two other major Asian space cooperation organizations exist: the Japanese created and led Asian-Pacific Space Agency Forum (APRSAF) and the Indian created and led Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP).[134] The purpose of these organizations is to reduce the costs of expensive space programs through resource pooling and increasing diplomatic ties between partner nations. Unfortunately, member

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Unattributed, "Spatial Information Corridor to Build, Bringing Opportunities to Satellite," trans Jelly Yi, *Xinhua Finance*, November 24, 2016, http://en.xfafinance.com/html/Industries/Technology/2016/280692.shtml.

[129] Kazuto Suzuki, "The Contest for Leadership in East Asia: Japanese and Chinese Approaches to Outer Space," *Space Policy* 29 (April 2013), 103-106.

[130] Moltz, *Asia's Space Race*, 26-27.

[131] Asif Siddiqi, Asia in Orbit: Asian Cooperation in Space," *Georgetown Journal of International* Affairs 11, no. 1, (Winter/Spring 2010), 133-134; Mingyan Nie, "Asian Space Cooperation and Asia-Pacific Space Cooperation Organization: An Appraisal of Critical Legal Challenges in the Belt and Road Space Initiative Context," *Space Policy* , (January 2019), 1-2.

[132] From APSCO website: http://www.apsco.int/default.asp.

[133] Pollpeter et al., *China Dream, Space Dream*, 24-25.

[134] Siddiqi, "Asia on Orbit," 135-137.

nation overlap is mostly limited to smaller countries, and the presence of three competing organizations in the same region, each with similar missions led by separate space powers, may result in factionalism rather than cooperation.[135]

In addition to strengthening China economically, the export of commercial space services and the use of satellite application technologies may also have far reaching diplomatic benefits. China has served as an eager provider of space services and technologies to international markets, particularly for developing countries.[136] Providing low-cost, partially subsidized space services to developing nations is a powerful diplomatic initiative relating to resource extraction and basing rights.[137] China provided Brazil a low-cost alternative to the LANDSAT remote sensing data via a cooperative venture called Chinese-Brazilian Earth Resources Satellite (CBERS). The cost was split 70/30 by China and Brazil.[138] China manufactured, launched, and operated communications and imaging satellites for oil rich Venezuela.[139] Similarly, China generously subsidized Nigeria's first communications satellite for $550M as part of the BRI, with Nigerian oil rights serving as collateral.[140] Bolivia enjoyed a similar arrangement, as 85% of its first communications satellite was subsidized by loans from China and built by the Great Wall

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[135] James Clay-Moltz, "Asian Space Rivalry and Cooperative Institutions," in *Asian Designs: Governance in the Contemporary World Order* (Ithica: Cornell University Press, 2016), 132-134.

[136] Chambers, "China's Space Program," 51-53; Moltz, *Asia's Space Race*, 103.

[137] Julie Klinger, "A Brief History of Outer Space Cooperation Between Latin America and China," *Journal of Latin American Geography* 17, no. 2 (July 2018), 53-57; Andrew Wight, "China Uses Space Diplomacy to Extend Its Inroads into Latin America," *World Politics Review*, September 10, 2018, https://www.worldpoliticsreview.com/articles/25820/china-uses-space-diplomacy-to-extend-its-inroads-into-latin-america. Laura Delgado-Lopez, "Sino-Latin American Space Cooperation: A Smart Move," *Space Policy* 28 (2012), 7-8.

[138]Jose Filho and Alvaro Santos, "Chinese-Brazilian Protocol on Distribution of CBERS Products, *Air and Space Law* 31, no. 2 (Winter 2005), 271-273.

[139] Delgado-Lopez, "Sino-Latin American Space Cooperation," 10-11.

[140] Zhou Pingjian, "China, Nigeria to Boost Bilateral Win-win Cooperation," *People's Daily*, September 07, 2018, http://en.people.cn/n3/2018/0907/c90000-9498465.html; .Moltz, 57-63.

Industry Corporation.[141] Likewise, China designed, launched, and heavily subsidized a Pakistani geosynchronous communication satellite under BRI in exchange for Beidou ground stations in Karachi and Lahore.[142] This was followed by the development and launch of a remote sensing satellite in 2018.[143] These acts of space diplomacy are consistent with China's larger foreign policy efforts to open international markets.[144]

Fourth, the Chinese space program sets the groundwork for scientific and economic exchange between China and Europe. Since the 1960s, Europe has sought independence from the U.S. space industry. Aside from the general predilection to maintain sovereignty, this desire has been amplified by a series of heavy handed U.S. space policy decisions. During the acquisition and early assembly of the space station throughout the 1980s and 1990s, Europeans were frustrated with the partnership with the U.S. Rapidly changing requirements and budget cuts gave them reason to enter negotiations with less than full faith in U.S. commitments. The nature of this partnership made Europeans feel as though they were being treated as a subcontractor rather than a full partner, and constantly proliferating Department of Defense (DoD) requirements served as an early example of Pentagon influence in civilian space.[145] The Gulf War and the subsequent emphasis on space as a military technology in U.S. policy led Europe to

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[141] Unattributed, "Bolivia Advances with Project to Have a Second Communications Satellite," *The Reason*, December 19, 2016, http://www.la-razon.com/nacional/Bolivia-proyecto-segundo-satelite-comunicaciones_0_2621737842.html.

[142] Ghulam Ali, "China-Pakistan Space Technology Cooperation," *East Asia Forum*, September 09, 2011, https://www.eastasiaforum.org/2011/09/09/china-pakistan-space-technology-cooperation/; Unattributed, "Karachi and Lahore Ground Stations," *Global Security*, https://www.globalsecurity.org/space/world/china/karachi.htm.

[143] Andrew Jones, "Two Chinese Launches in 24 Hours Deliver Pakistan Satellites, Beidou Backup to Orbit," *Space News*, July 10, 2018, https://spacenews.com/two-chinese-launches-in-24-hours-deliver-pakistan-satellites-beidou-backup-to-orbit/.

[144] Testimony of Dennis Shea, "Are We Loosing the Space Race to China?" (Washington: U.S.-China Economics and Security Review Commission, September 27, 2016), 6-9.

[145] Johnson-Freese, *Space as a Strategic Asset*, 177-184. For more on how U.S. policy interactions with Europe affects the Sino-Euro relationship see the cited work chapters 6-7.

grow weary of U.S. shutter control for commercial assets and selective service for government owned utilities.[146] Likewise, the Cox report and corresponding restrictive export control initiatives (ITAR) and Export Administration Regulation (EAR) in the early 2000s caused backlash in Europe, creating a demand for export-control-free products and leading Europe to seek non-U.S. markets for its space technology.[147] Wariness of U.S. restrictions created a mutual desire for ITAR-free products. Europe primarily seeks to gain a market for high technology products while China seeks training and scientific exchange.[148] These desires drive Sino-E.U. cooperation and set the foundation for China's science and technology diplomacy to Europe.[149] In the past decade, increasing parity between U.S. and "rest-of-world" technologies has made ITAR free products more feasible.[150]

Fifth, the opportunity cost of the perpetual "guns verses butter" debate applies to the space domain as well. For example, the U.S. military's space budget is over $12 billion (unclassified spending) while NASA's projected FY2019 budget is $21 billion.[151] A system of mutual restraint would have the benefit of potentially freeing up billions of dollars from the military space budget to dedicate to civilian space spending. Although military space spending would remain high, a significant amount of money could be cut from space control spending

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[146] Johnson-Freese, 184-187

[147] Michael Mineiro, "An Inconvenient Regulatory Truth: Divergence in U.S. and E.U. Satellite Export Control Policies on China," *Space Policy* 27 (2011), 213-216.

[148] Pollpeter et al., *China Dream, Space Dream*, 28-33.

[149] Joan Johnson-Freese and Andrew Erickson, "The Emerging China-E.U. Space Partnership: A Geotechnical Balancer," *Space Policy* 22 (2006), 12-18.

[150] Matthew Burris, "Tilting at Windmills – The Counterposing Policy Interests Driving the U.S. Commercial Satellite Export Control Reform Debate," *Air Force Law Review* 66 (2010), 280-283

[151] Jeff Foust, "House Spending Bill Offers $21.5 billion for NASA in 2019," *Space News*, May 8, 2018, https://spacenews.com/house-spending-bill-offers-21-5-billion-for-nasa-in-2019; Sandra Erwin, "Some Fresh Tidbits on the U.S. Military Space Budget," *Space News*, March 21, 2018, https://spacenews.com/some-fresh-tidbits-on-the-u-s-military-space-budget/.

($2B), reducing the cost of existing military space projects due to loosened requirements on survivability, redundancy, and maneuverability.[152] Although China's government spending is opaque, rough estimates are available. As of 2017, the U.S. spends approximately $610B (3.1% of GDP) annually on defense while China spends only $228B (1.9% of GDP).[153] In terms of purchase power parity (PPP), China's actual budget doubles to $434B.[154] Likewise, China's $3.5B space budget appears to be dwarfed by U.S. space spending. However, when % of GDP and PPP are taken into account, China appears to be much more competitive with the U.S. in terms of space budget.[155] Therefore, it is expected that China will reap similar budgetary benefits from a system of mutual restraint. This adds an even stronger incentive for both nations to cooperate.

In an absolute sense, the benefits of free access to space and the ability to pursue robust commercial utilization gives the impression of a strong desire for mutual cooperation. However, the zero-sum relationship should not be overlooked. The market for space technology is both limited and competitive, meaning that free access to space and the development of the space industry free from tariff or political restriction benefits China significantly, to the extent that it can increase relative market share in the $320 billion space economy.[156] Moving beyond competition within the space industry, the relative gain that the U.S. and China each derive from

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[152] Mike Gruss, "DoD Will Spend $2 Billion on Space Control This Year," *Space News*, March 23, 2016, https://spacenews.com/dod-will-spend-2-billion-on-space-control-this-year/.

[153] From Stockholm International Peace Research Institute Military Expenditure Database, https://sipri.org/databases/milex.

[154] Signey Freedberg, "US Defense Budget Not That Much Bigger Than China, Russia: Gen. Milley," *Breaking Defense*, May 22, 2018, https://breakingdefense.com/2018/05/us-defense-budget-not-that-much-bigger-than-china-russia-gen-milley/.

[155] Marco Aliberti, "China's Space Programme: An Overview," in *When China Goes to the Moon* (New York: Springer, 2015), 24-30

[156] Pollpeter et al., *China Dream, Space Dream*, 19; Near-earth space as a finite resource will be covered in subsequent sub-sections of Chapter II.

the utilization of space modifies the magnitude of preference for mutual cooperation. For example, if China gains X from a system of mutual cooperation while the U.S. gains X + 15, then the magnitude of China's preference for this outcome must be proportionally lower than that of the U.S. Although the multi-order effects of the space industry are difficult to quantify, a simple analysis of spending and space assets can give an estimate of the relative importance of each nation's space program. Table 1 is a quick reference comparing U.S. and Chinese space assets. [157]

Table 1: Total number of U.S. and Chinese satellites by orbital régime and function (as of April 2019).

Total Number of U.S. Satellites: 858			
Civil: 20	Commercial: 494	Government: 178	Military 166
GEO: 189	MEO: 31	LEO: 616	HEO: 22
Total Number of Chinese Satellites: 250			
Civil: 25	Commercial: 46	Government: 113	Military: 100
GEO: 56	MEO:24	LEO: 203	HEO: 1

The current space regime and total absence of space weapons is highly advantageous to the United States.[158] The relative magnitude of preference can be shown in Figure 3.

[157] Data from Union of Concerned Scientists, UCS Satellite Database: https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database.

[158] Michael Krepon, Theresa Hitchens, and Michael Katz-Hyman, "Preserving Freedom of Action in Space: Realizing the Potential and Limits of U.S. Spacepower," in *Toward a Theory of Spacepower: Selected Essays*, ed. Charles Lutes and Peter Hays (San Bernardino: National Defense University, 2017), 391.

		China C	China D
U.S.	C	**6, 3**	x,y
	D	x,y	x,y

Figure 3: China and the U.S.'s utility given a cooperate/cooperate outcome.

b. Defect/Defect

The ubiquity of space technology has also yielded the negative externality of overcrowding the space domain. Despite its seemingly unlimited size, there are a limited number of useful earth-centric orbits to optimize terrestrial coverage. It is projected that there are over 300,000 medium sized objects capable of causing catastrophic failure of a satellite upon collision currently in earth's orbit.[159] Of these objects, 20,000 are actively tracked by the comparatively robust space surveillance network (SSN) of the United States Air Force, only 1,000 are active payloads, and even fewer have maneuver capability.[160] Recent trends indicate that the problem of orbital congestion will only worsen in the coming decades as the barriers to entry are reduced. Launch service cost is rapidly decreasing due to an increased number of service providers and technology revolutions such as reusable rockets. Also, the miniaturization and simplification of satellite payloads further reduces the cost and infrastructure needed to be a spacefairing nation.[161] This is evidenced by the near doubling of state operated satellites from 27 in 2000 to over 50 in 2012, coupled with a near doubling in total space objects from 1997 to 2007.[162]

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[159] Baiocchi, Dave and William Welser. *Confronting Space Debris: Strategies and Warnings from Comparable Examples Including Deepwater Horizon* (Santa Monica: RAND, 2010), 1-2.

[160] Ray Williamson, "Assuring the Sustainability of Space Activities," *Space Policy* 28, no 3 (2012): 154-60.

[161] David Wright, *Colliding Satellites: Consequences and Implications* (Cambridge: Global Security Program, the Union of Concerned Scientists, February 2009), 1-2.

[162] Williamson, "Assuring the Sustainability of Space Activities," 3.

The accumulation of space debris is a vital concern to the sustainable development of the space environment due to the increased probability of conjunction between active payloads and all other objects that results from crowded orbits. This increase in collision probability occurs proportionally to the number of objects in a given orbital domain. The tripling of orbital debris projected to occur in the next century, due to routine use and accumulation alone, would cause a tenfold increase in the probability of collision. In the event of a catastrophic collision between two objects, the resulting debris cloud could cause a cascading effect. Each successive collision increases the probability of another occurrence in a given orbit until an instability threshold is reached. At this threshold, debris removal due to decay would be negligible compared to debris created by subsequent collisions. As the propagation of debris continues, the cost of launching a satellite would eventually outweigh the benefits received due to the probability of that asset being destroyed by errant debris, effectively rendering the given orbit unusable. This debris propagation model and the dangers associated with it are colloquially referred to as the Kessler Syndrome. Kessler asserts unstable regions of low earth orbit (LEO) currently exist and that, barring the addition of more debris, a major collision would occur once every 10-20 years. If debris doubles, as it has in the last decade, the collision rate would increase to 2.5 years. Although most models' time scales are on the order of centuries, it is widely accepted that the current rate of debris accumulation will render critical orbits unusable unless immediate measures are taken to return stability.[163]

There is near universal acceptance of the danger space debris presents, yet little substantive action has been taken to solve the problem. Current debris accumulation and

[163] Donald Kessler and Cour-Palais Burton, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," *Journal of Geophysical Research* 83, no. A6 (1978): 637-646.

propagation models show that earth orbiting domains are finite resources. Continued unsustainable development moving forward may preclude future usage, making earth orbits rivalrous goods.[164] Furthermore, orbital domains are made a non-excludable good by the OST which states, "Outer space… shall be free for exploration and use by all States without discrimination of any kind."[165] As a non-excludable public good, space succumbs to the tragedy of the commons where the privately beneficial strategy of space utilization differs significantly from the socially optimal strategy promoting orbital stability.[166] Understandably, most analysis has focused on solving the problem of orbital instability by addressing the market failure responsible for debris creation. The current reasoning suggests that if actors creating space debris internalize the cost of their actions, a solution can arise. Proposed solutions run the gamut of ideologies from free market tax incentives, to command and control legislation, to restructuring orbital property rights. Scientific solutions have also been proposed, but technological feasibility and cost remain major problems. Furthermore, analogous environments susceptible to the tragedy of the commons have been examined in hopes that they may prove applicable to the problem of orbit instability.[167] This analysis is ultimately useful if the problem is to be solved under nominal conditions, but there is an underlying problem that needs to be addressed before any of these proposed solutions can realistically be enacted.

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[164] Alexander Salter, *Space Debris: A Law and Economics Analysis of the Orbital Commons*, Mercatus Working Paper (Arlington: Mercatus Center at George Mason University, September 2015), 10.

[165] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, Washington, London, Moscow, 10 October 1967, available from http://www.unoosa.org/pdf/publications/STSPACE11E.pdf, 39.

[166] Salter, *Space Debris*, 11.

[167] Dave Baiocchi, *Confronting Space Debris*. This monograph draws extensive comparison between space and other environments experiencing tragedy of the commons.

On January 11, 2007 the Chinese government conducted a direct ascent anti-satellite (ASAT) test on the defunct Fengyun-1C weather satellite. This event is the single greatest source of orbital debris, as it created 3,000 objects greater than 10cm out of 20,000 total tracked by the U.S. SSN, and an estimated 150,000 smaller untracked objects.[168] Due to the limitations of the SSN, the extent of the debris cloud has not been completely characterized, but NASA estimates Fengyun-1C debris comprises one third of LEO debris.[169] Between the 2009 Iridium-Cosmos collision and the destruction of the Fengyun-1C, the number of cataloged fragmentation debris doubled after remaining stable during the 20 years prior. The Fengyun-1C debris cloud has been deemed dangerous to LEO, proving responsible for multiple near collisions or spacecraft damaging incidents. Within six months of the test, NASA's Terra spacecraft and the International Space Station (ISS) both required orbit changes to reduce collision probability with Fengyun-1C debris. In 2013, a Russian cubesat was damaged by a small piece of debris.[170] Alarmingly, the severity of the ASAT test far exceeded NASAs standard break-up prediction model, making Kessler's original predictions seem conservative.[171] Intentional, avoidable debris creating incidents exacerbate an already dire problem, threatening to push affected orbital regimes into instability and eliminate their future usefulness. The Fengyun-1C debris cloud exists in the 750km-900km orbital regime that hosts critical scientific and application spacecraft. The underlying problem is that satellites with a given mission tend to group together in a

[168]Nicholas Johnson et al., "The Characteristics and Consequences of the Break-up of the Fengyun-1C Spacecraft," *Acta Astronautica* 63, no. 1-4 (2008): 128-135.

[169] Nicholas Johnson, "Orbital Debris: the Growing Threat to Space Operations," *Advances in the Astronautical Sciences* 137 (2010): 3.

[170] Johnson, 7.

[171] Johnson, "The Characteristics and Consequences of the Break-up of the Fengyun-1C Spacecraft," 134. Nicholas Johnson has taken up the mantle of Kessler in the realm of space debris modeling. He has extensively researched the 2007 ASAT test and 2009 Iridum-Cosmos collision.

relatively narrow orbital regime because it is physically advantageous for accomplishing that task. ASATs seek to destroy an enemy's capability, but in doing so have the externality of putting other satellites performing a similar mission at risk. Therefore, kinetic ASAT warfare is incompatible with the sustainable development of space.

Despite global outrage over the 2007 test, China maintains a robust ASAT program. In 2008 astronauts conducting the first Chinese spacewalk released a microsat that passed dangerously close to the ISS and was thought to be a demonstration of a co-orbital ASAT capability.[172] Kinetic kill ASAT launches in 2013 and 2015 used the same booster as the 2007 Fengyun-1C test but are thought to demonstrate the ability to hold orbits above LEO at risk.[173] In 2018, a new booster was tested, indicating intentional progression of the kinetic ASAT program through continued technology development.[174] As China's kinetic ASAT program reaches initial operational capability (estimated for 2020), the development of road-mobile assets serves the purpose of increasing the survivability of its ASAT capability.[175] China's official policy emphasizes the peaceful use of outer space and calls for a ban on space weapons. In 2008, China and Russia jointly submitted a draft treaty designed to curb the weaponization of space and prevent a space arms race at the UN Conference on Disarmament. The proposal called for a ban on orbiting weapons, but specifically excluded earth-based weapons, as well as direct ascent

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[172] Richard Fisher, "Closer Look: Shenzhou-7's Close Pass by the International Space Station," *Strategy Center*, October 9, 2008. http://www.strategycenter.net/research/pubID.191/pub_detail.asp.

[173] Bill Gertz, "China Tests Anti-Satellite Missile," *The Washington Free Beacon*, November 9, 2015, https://freebeacon.com/national-security/asat-test-highlights-chinas-growing-space-warfare-capabilities/.

[174] Bill Gertz, "China ASAT Test Part of Growing Space War Threat," *The Washington Free Beacon*, February 23, 2018, https://freebeacon.com/national-security/asat-test-highlights-chinas-growing-space-warfare-capabilities/.

[175] Bill Gertz, "Pentagon: China, Russia Soon Capable of Destroying U.S. Satellites," *The Washington Free Beacon*, January 30, 2018, https://freebeacon.com/national-security/pentagon-china-russia-soon-capable-destroying-u-s-satellites/.

ASATs.[176] The clear desire to continue developing ASAT technology, despite significant soft power repercussions, is indicative that holding an opponent's space capabilities at risk is a key part of China's strategic development. It presents a seemingly usable sub-nuclear option for credible strategic deterrence and may also be used for conventional warfighting.

Anti-satellite weapons existed during the Cold War, but a system of mutual restraint developed by the United States and Russia ensured that the probability of using them remained very low. A conflict in space between the two rivals was likely to expand into other domains, including nuclear warfare. Reciprocity and escalation was expected in the event of a kinetic ASAT attack, and a series of robust firebreaks arose to prevent experimental missteps by both nations. The use of ASATs represented the ultimate no-win situation for either side as there was no significant comparative advantage to be gained from their use.[177] It was necessity and fear that drove the superpowers to establish international conventions, such as the OST and Liability Convention, to codify acceptable behavior in space. The significant consequences of nuclear war meant that the mechanisms of strategic restraint were well developed and well understood by both powers in order to lower the probability of a catastrophic breakdown occurring. However, these mechanisms do not exist in Sino-U.S. relations due to asymmetry in the strategic domains. China has adopted a no nuclear first strike policy and an examination of its current capabilities supports that rhetoric. Its second strike capability is, in its own estimation, only enough to deter a first strike by the United States and avoid escalation dominance in the nuclear domain. The

[176] David Gompert and Phillip C. Saunders, *Paradox of Power: Sino-American Strategic Restraint in an Age of Vulnerability* (Washington: National Defense University Press, 2011), 56-57.

[177] For a detailed discussion on ASAT systems and mutural restraint during the Cold War see: Steve Weber, "Antisatellite Weapons," in *Cooperation and Discord in U.S.-Soviet Arms Control* (Princeton: Princeton University Press, 1991) or Kurt Gottfried and Richard Lebow, "Anti-Satellite Weapons: Weighing the Risks," *Daedalus* 114, no. 2 (1985).

Chinese are unwilling to bear the cost of an expanded nuclear arsenal to counter U.S. capabilities and see little to be gained from a nuclear arms race with the United States.[178] The lack of nuclear parity means that the consequences of space warfare between the two countries are lower because the conflict does not present a substantial risk of escalating to the nuclear domain. This strategic decoupling present in Sino-U.S. relations fundamentally increases the probability of an attack against satellite systems. [179]

Given the risk to the space environment presented by kinetic ASAT warfare and the robust capability of China and the United States to hold the entire domain at risk, it initially appears as if the cost of mutual defection is much greater than the benefit to be gained from mutual cooperation. The cost of mutual defection accounts for the loss of the space domain (for both current and future use) and is proportional to the gain from mutual cooperation. This is represented in Figure 4.

		China C	China D
U.S.	C	6,3	x,y
U.S.	D	x,y	-600, -300

Figure 4: China and the U.S.'s utility given a defect/defect outcome.

However, due to the advancement of non- and low-kinetic ASAT technology, holding an opponent's space assets at risk while continuing to use the domain are not mutually exclusive strategies. Space systems are comprised of space, ground, and user segments integrated through data links. Any of these segments and links can be targeted by an attack to gain the desired

[178] Zhenqiang Pan, "A Study of China's No-First-Use Policy on Nuclear Weapons," *Journal for Peace and Nuclear Disarmament* 1, no. 1 (2018), 115-119.
[179] Gompert and Saunders, 95-105.

effect; the attacks can take place on a variable time scale, with or without creating debris, and causing permanent or reversible damage to a space system. The severity of these effects can be scaled for level of conflict.[180] Electronic jamming of either uplink or downlink signals can impair satellite functionality and serve as a cost-effective soft-kill weapon. Laser weapons impact a satellite's electro-optical detectors and can be used to temporarily blind a satellite or achieve a hard kill. Similarly, radio frequency (RF) weapons can be used to cause a variable amount of damage to satellites, depending on energy levels. Physical attacks on terrestrial ground segments can disrupt weak points in the system. Likewise, cyber-attacks can disrupt functionality without an attack on the space segment. Aside from the kinetic direct ascent ASAT and co-orbital ASAT threats already mentioned, co-orbital rendezvous and grappling can kinetically disable a satellite without creating excessive debris.[181]

The DoD's 2018 annual report to Congress about the Military and Security Developments Involving the People's Republic of China states,

> The People's Liberation Army (PLA) is acquiring a range of technologies to improve China's counterspace capabilities. In addition to the development of directed energy weapons and satellite jammers, China is also developing direct-ascent and co-orbital kinetic kill capabilities and has probably made progress on the anti-satellite missile system it tested in July 2014. China is employing more sophisticated satellite operations

[180] Smith, "Security and Spacepower," 337.

[181] Michael Pillsbury, *An Assessment of China's Anti-Satellite and Space Warfare Programs, Policies, and Doctrines* (Washington: U.S.-China Economic and Security Review Commission, 2007), 26-29; see "Competing in Space" by National Air and Space Intelligence Center, https://media.defense.gov/2019/Jan/16/2002080386/-1/-1/1/190115-F-NV711-0002.PDF.

and is probably testing dual-use technologies in space that could be applied to counterspace missions.[182]

The report also lists the development of solid-state and chemical lasers to be used on ground-based and airborne platforms as a focus of Chinese technological development.[183] A report prepared for the U.S.-China Economic and Security Review Commission noted extensive Chinese academic literature concerning the jamming of U.S. military satellite communications and the development of lasers for military purposes.[184]

China has demonstrated its ability to carry out sub-lethal attacks on space systems. In 2006, the NRO confirmed that Chinese lasers had illuminated U.S. satellites.[185] Although this test did no permanent damage, it is significant for two reasons: first, scaling up power to cause permanent damage is not prohibitively difficult, and second, satellite laser ranging (SLR) is essential to China's counterspace kill chain for direct ascent or co-orbital ASATs.[186] Furthermore, China has demonstrated robust proximity operation and co-orbital rendezvous capability. The SJ-17, a GEO "technical demonstrator" satellite, has executed proximity operations with at least four Chinese satellites, some close approaches coming within 1 km.[187] The satellite has also shown significant maneuver capability, alternating between a 10-20 degree/day drift rate and proximity operations with a relatively stationary object on multiple

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[182] Office of the U.S. Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China* (Washington: Department of Defense, May 2018), 40

[183] Office of the U.S. Secretary of Defense, 87.

[184] Pillsbury, *An Assessment of China's Anti-Satellite and Space Warfare Programs, Policies, and Doctrines*, 38-47; The same report mentions a high amount of Chinese academic literature concerning kinetic kill vehicles (KKV) *prior* to China's 2007 ASAT demonstration.

[185] Unattributed, "NRO Confirms Chinese Laser Test Illuminated U.S. Spacecraft," *Space News*, October 3, 2006, https://spacenews.com/nro-confirms-chinese-laser-test-illuminated-us-spacecraft/.

[186] Heginbotham et al., *The U.S.-China Military Scorecard*, 247

[187] Colin Clark, "China Satellite SJ-17, Friendly Wanderer?" *Breaking Defense*, April 18, 2018, https://breakingdefense.com/2018/04/china-satellite-sj-17-friendly-wanderer/.

occasions.[188] Multiple other close proximity operations and co-orbital rendezvous missions have occurred in the past decade, indicating a technically robust Chinese capability.[189] Most importantly, Chinese cyber warfare capabilities are essential to disabling U.S. space C4ISR capabilities during the initial stages of a conflict.[190] Multiple cyber-attacks against U.S. satellite command and control systems are consistent with Chinese cyber warfare operations; however, cyber-attack attribution is difficult and China denies all involvement.[191]

Although the development of these technologies is in the technical demonstration phase and may be far from initial operational capability, the option to fight a space war on a sub-catastrophic level greatly impacts the game. Rather than a conflict in space inevitably resulting in widespread environmental contamination, China has options for proportionality and escalation. Although China's most robust ASAT capability is direct ascent kinetic kill vehicles (KKV), it is quickly fielding other means of interdicting U.S. space abilities. Therefore, the cost of mutual defection in space is not automatically catastrophic, as it would be in a game of nuclear brinksmanship. It cannot be assumed that in the case of Sino-U.S. conflict that the cost of mutual defection is significantly greater than the benefit to be gained from mutual cooperation. In the case of an arms race, the cost of defection would be the opportunity cost examined earlier. As

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[188] "In-Space Eavesdropping? – China's SJ-17 completes High-Altitude Link-Up," *Spaceflight 101*, December 9, 2016, https://spaceflight101.com/cz-5-maiden-flight/shijian-17-rendezvous-with-chinasat-5a/; Brian Weeden, *Global Counterspace Capabilities: An Open Source Assessment* (Washington: Secure World Foundation, 2018); 1-8.

[189] Brian Weeden, "Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F," *The Space Review*, August 30, 2010, http://www.thespacereview.com/article/1689/1; Unattributed "China's New Orbital Debris Clean-Up Satellite Raises Space Militarization Concerns," *Spaceflight 101*, June 29, 2016, http://spaceflight101.com/long-march-7-maiden-launch/aolong-1-asat-concerns/.

[190] William Reinsch et al. *2011 Report to Congress*, (Washington: U.S.-China Economic and Security Review Commission, 2011), 8-9; Bryan Krekel et al., *Capability of the People's Republic of China to Conduct Cyber Warfare and Computer Network Exploitation*, (Washington, U.S.-China Economic and Security Review Commission, 2009), 6-14.

[191] Rajeswari Rajagopalan and Daniel Porras, *Cyber Arms Race in Space: Exploring India's Next Steps* (New Delhi: Observer Research Foundation, November 2015) 3; Pollpeter et al., *China Dream, Space Dream*, 91-92.

more money is spent on defense, less is available to spend on beneficial commercial capabilities. In the case of low to medium-grade conflict the cost of defection relies on a combination of the value of one's own space systems and the opponent's capability to hold those systems at risk. Due to a robust Chinese ASAT program and high value of U.S. space systems, there is a strong U.S. aversion to this outcome. Similarly, U.S. ASAT programs can hold Chinese assets at risk with a variety of means. However, the value of Chinese systems is considerably less than that of the U.S.'s, therefore the Chinese aversion to mutual defection is less than that of the U.S. A conflict where the KKV threshold has not been crossed is shown in Figure 5.

		China C	China D
U.S.	C	6, 3	x,y
	D	x,y	**-3, -1**

Figure 5: China and the U.S.'s utility given a defect/defect outcome where no KKV threshold has been crossed.

c. Defect/Cooperate

The magnitude of each player's preference for Defect/Cooperate (D/C) is dependent on its benefit from establishing space control (maintaining one's own use of space or excluding an opponent from doing so), while the magnitude of its aversion to Cooperate/Defect (C/D) is dependent on the detriment of allowing the other player to do the same. In short, what is to be gained or lost by one player establishing space control? If the players view each other as benign, reasonably expecting that the other player gaining space control will not exclude their own use of the domain, the magnitude of the C/D or D/C choice is negligible. The magnitude becomes substantial when the ability of one player to deny use of the space domain to the other has significant impact on the geostrategic balance of power. The economic benefit gained by being able to deny a competitor access to the marketplace is a clear advantage. However, the effect of space control extends far beyond economics. Space effects play a critical role in the ability of the U.S. and China to project both soft and hard power influence in East Asia.

Generally, space force enhancement functions include intelligence, surveillance, and reconnaissance (ISR), launch detection, missile tracking, environmental monitoring, satellite communication, positioning, navigation and timing (PNT) and navigation warfare (NAVWAR).[192] China and the United States possess operationally mature capabilities that enable them to perform all these functions, and are both actively improving their force enhancement capabilities: communications satellites enable command and control (C2) infrastructure to direct warfighting effort; launch detection and missile tracking allows for force protection through early warning and ballistic missile defense (BMD) enhancement; space-based ISR aids in forming a comprehensive picture of an adversary's infrastructure and capabilities, allows for robust targeting, and contributes to general situational awareness (SA); and PNT increases the effectiveness of precision strike. [193] Therefore, space-based operations remain a vital part of the overall information architecture used to enable joint operations at all stages of a conflict.[194] During a conflict in East Asia, space-based assets will be essential for the U.S. to be able to conduct surveillance of Chinese warfighting capabilities, readiness, and military movements for the purposes of knowing how to concentrate its own forces. Space-based assets would be used to locate and track naval, air, and rocket forces, C2 nodes, ISR sensors, and troop

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[192] Jeffrey Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2018), 89.
[193] Caton, 10.
[194] Shaun Stuger, *Space Based Intelligence, Surveillance, and Reconnaissance Contribution to Global Strike in 2035* (Maxwell AFB: Air War College, 2012), 5-7.

staging areas, and would be used to direct, coordinate, and manage U.S. forces. This functionality makes space a critical component of weapons performance and C2.[195] Both U.S. and Chinese strategists have developed doctrine to account for the importance of integrated information systems in military operations. China has formalized its concept of *local wars under informationized conditions* in a 2004 defense white paper.[196] The U.S. concept of command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) is similar.

Although the use of C4ISR systems is essential to all modern battlefields, they have greater utility when campaigns occur over long distances, large areas, and involve multi-domain forces. Space-based C4ISR becomes particularly important when land, maritime, and air-based systems are forced to operate at a high cost and can no longer provide broad area continuous coverage.[197] Both of these conditions will likely be met during an anti-access, area denial (A2/AD) campaign between the U.S. and China in East Asia. China intends to leverage its continental position to employ weapon systems with longer range and heavier payloads than are available to the U.S., who tends to act in an expeditionary capacity from maritime bases of operation. This offensive capability will be combined with anti-satellite and cyber warfare capabilities to overcome U.S. C4ISR advantage and mitigate its conventional deterrent threat against mainland China.[198]

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[195] Gompert and Saunders, *Paradox of Power*, 100-101.

[196] Dean Chang, "China's Military Role in Space," *Strateguc Studies Quarterly* Spring 2012 (2012): 64-62.

[197] Stuger, *Space Based Intelligence, Surveillance, and Reconnaissance*, 4-5.

[198] David Kearn, "Air-Sea Battle and China's Anti-Access and Area Denial Challenge," *Orbis* 58, no. 1 (November 2013), 133-136;

A2/AD campaigns have precedence in military history, from Salamis in 480 BCE, to the Battle of Britain in 1940.[199] Most recently and relevantly, the Soviet Union fielded A2/AD capabilities against the United States during the Cold War. Beginning in the 1970s, the Soviets fielded capabilities to locate and target U.S. naval assets, including surveillance satellites, submarines, and long-range, land-based reconnaissance aircraft. This was combined with anti-ship cruise missiles and long-range strike aircraft to create significant standoff distance between U.S. carrier groups and the Russian mainland. Although the U.S. responded by fielding long-range, carrier-based strike aircraft, long-range air-to-air missiles, and anti-satellite capabilities to counter the Soviet "reconnaissance-strike complex," there was little continued emphasis on these capabilities after the 1980s, due to the collapse of the Soviet Union.[200] The Chinese are rapidly developing their version of the reconnaissance-strike complex with the benefit of 30 additional years of technological advances.[201]

China possesses a more than adequate supply of SRBMs, Land Attack Missiles, and Anti-ship missiles that are survivable and mobile.

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[199] The Battle of Britain may be the first example of modern A2/AD using information systems. The use of an integrated air defense system including radar to give early warning and central C2 nodes to direct the tactical war gave the British a distinct ability to conduct sortie generation efficiently and protect critical targets.

[200] Haddick, *Fire on the Water*, 66-67.

[201] Office of the U.S. Secretary of Defense, *Annual Report to Congress 2018*, 59-64.

Figure 6: Map of China's offensive IRBM capabilities[202]

It should be noted that the delivery of H-6 with LACM options is dependent on the ability of the H-6 bomber to range into the western Pacific; additionally, the DF-26 is a nascent capability, being revealed publicly for the first time in 2015.[203] This is a distinct advantage over the United

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[202] Office of the U.S. Secretary of Defense, *Annual Report to Congress 2018*, 37.
[203] Office of the U.S. Secretary of Defense, *Annual Report to Congress 2018*, 59.

States, who signed the Intermediate-Range Nuclear Forces (INF) Treaty in 1987, which prohibited it from maintaining ground-launched ballistic and cruise missiles with ranges between 500 and 5,500km.[204] The U.S. withdrew from the INF Treaty on February 01, 2019 ostensibly citing Russia's noncompliance with the treaty.[205] It is likely that the U.S. and its allies will begin to develop their own IRBM centric reconnaissance-strike complex to counter that of China and "level the playing field".[206] However, it may take years for the U.S. and its allies to establish parity with China in IRBM technology, tactics, and deployment.[207] Furthermore, IADS infrastructure and air capabilities within mainland China, and on islands close to China's coast, are designed to prevent the U.S. from utilizing its global strike capability to interdict strategic targets within China.[208] If they are able to do so, China can create a coastal defense zone that U.S. forces cannot penetrate without accepting disproportionate risk.[209] However, offensive

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[204] *Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On The Elimination Of Their Intermediate-Range And Shorter-Range Missiles (INF Treaty)*, Washington, 8 December 1987, available from https://www.state.gov/t/avc/trty/102360.htm.

[205] Tom Nichols, "Mourning the INF Treaty," *Foreign Affairs*, March 4, 2019, https://www.foreignaffairs.com/articles/2019-03-04/mourning-inf-treaty.

[206] Mercy Kuo, "U.S. Withdraw from INF Treaty: Impact on Asia," *The Diplomat*, March 01, 2019, https://thediplomat.com/2019/03/us-withdrawal-from-inf-treaty-impact-on-asia/.

[207] If the U.S. develops significant MRBM capabilities it would give the U.S. considerable deterrent capabilities to pursue a cost imposition strategy against China in response to interference with U.S. space assets. This would increase the cost of mutual defection and decrease the benefit of defect/cooperate for China, resulting in a more stable deterrent relationship. However, establishing first-strike stability with MRBMs could be difficult. The short warning time and considerable incentives to strike first could result in launch-on-warning tactics. This, in turn, could result in uncontrolled escalation and increase the probability of a strategic miscalculation. Also, the use of MRBMs in U.S. tactics would increase the value of its space assets for targeting purposes, which would increase the value of a defect/cooperate scenario for China. The complexities of MRBMs mean that it is too early to tell how they will affect Sino-U.S. space policy. Incorporating the INF withdraw into this analysis could be a topic of further research, but would currently be wildly speculative.

[208] Office of the U.S. Secretary of Defense, *Annual Report to Congress 2018*, 62-63.

[209] David Kearn Jr., "The Future of US Deterrence in East Asia: Are Conventional Land-Based IRBMs a Silver Bullet?" *Strategic Studies* Quarterly 7, no. 4 (2013), 94-97;

systems need to be integrated with an over-the-horizon C4ISR targeting network to operate effectively. Satellite systems are an essential part of this network.[210]

Currently, Chinese space-based ISR coverage lacks both persistence and integrated C2 infrastructure adequate for targeting highly mobile U.S. Navy assets, and remains the weakest link in China's targeting capabilities.[211] In the event of a conflict, these gaps may be temporarily filled with launch-on-demand microsat constellations or repositioning existing capabilities.[212] Airborne ISR assets also have limited capabilities against naval assets, and will be operating in contested airspace.[213] For a more long-term solution, new electro-optical, multi-spectral, and synthetic aperture radar capabilities are top development priorities and are projected to give China the ability to maintain a 30 minute revisit rate on U.S. naval forces by the early 2020s.[214] Additionally, the development of the Chinese Beidou PNT system, slated to be completed in 2020, will drastically improve the accuracy of Chinese munitions.[215] These two developments will allow China to conduct Find, Fix, Target, Track, Engage, and Assess (F2T2EA) operations against both land and maritime assets within range of its land-based missiles.

Within the physically large and geographically complex East Asian theater of operations, the success of conducting or countering A2/AD operations is largely reliant on the ability to maintain C4ISR operations, while denying the opponent the same capabilities. Consequently, both China and the United States are highly incentivized to acquire robust space force

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[210] Andrew Erickson, "Constructing a System of Systems," in *Chinese Anti-Ship Ballistic Missile (ASBM): Drivers, Trajectories, and Strategic Implications Development* (Washington: Jamestown Foundation, 2013), 91-108.

[211] Eric Hagt and Matthew Durnin, "China's Antiship Ballistic Missile-Developments and Missing Links," *Naval War College Review* 62, Number 4 (Autumn 2009), 9-15

[212] Hagt and Durnin, 15-16.

[213] Hagt and Durnin, 7-9; Gompert and Saunders, *Paradox of Power*, 102.

[214] Erickson, "Constructing a System of Systems," 90-91; Haddick, Robert, *Fire on the Water*, 96-97.

[215] Erickson, "Constructing a System of Systems," 99-108.

enhancement capabilities, as well as offensive and defensive space control capabilities, in order to maintain the C4ISR edge. Space becomes increasingly important to A2/AD campaigns as both nations move further from their established bases (for example, if Sino-U.S. military interactions were to expand into the Indian Ocean).[216]

Despite rapidly growing capabilities, there is evidence to suggest that Chinese strategists view themselves as possessing a relatively disadvantageous position in space operations compared to the United States. The strength of the U.S. position and vulnerability of Chinese capabilities is accentuated in PLA literature.[217] They have observed three decades of space support in U.S. military operations and have assessed that the United States has a high reliance on military space effects to support a terrestrial campaign.[218] Observing American operations in the Persian Gulf Wars, Kosovo, and Afghanistan has resulted in the belief that space systems cannot be divorced from their ability to help achieve the goals of terrestrial operations, and that space warfare will be decisive in gaining informational superiority during a regional conflict.[219] Chinese military literature estimates that the U.S. relied on space support for over 90% of all military communications, PNT, and reconnaissance and surveillance information during the Second Gulf War. It is estimated that this reliance has nearly doubled between the First and

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[216] Virginia Marantidou, "Revisiting China's 'String of Pearls' Strategy: Places 'with Chinese Characteristics' and their Security Implications," *Issues and Insights* 14, no. 7 (2014); Muhammad Salman Ahmad et al., "China-Pakistan Economic Corridor: In the Context of 'String of Pearl Strategy'," *International Journal of Business and Social Research* 7, no. 08 (2017).

[217] Michael Chase, *China's Incomplete Military Transformation: Assessing the Weaknesses of the People's Liberation Army (PLA)* (Santa Monica: RAND, 2015), 114-119.

[218] Kevin Pollpeter and Jonathan Ray, "The Conceptual Evolution of China's Military Space Operations and Strategy," in *China's Evolving Military Strategy* ed. Joe McReynolds (Washington: Brookings Institution Press, 2016), 267-271; Wortzel, "The Chinese People's Liberation Army and Space Warfare," 2.

[219] Brian Weeden, *U.S.-China Strategic Relations in Space* (Washington, DC: National Bureau of Asian Research, 2016), 72-77; Timothy Thomas, *The Dragon's Quantum Leap: Transforming from a Mechanized to an Informatized Force* (Fort Leavenworth: Foreign Military Studies Office, 2009), 10-11.

"Whoever controls space controls the earth" is a popular refrain from Chinese space policy. This belief about joint operations has also been partially drawn from the study of U.S. academic literature.

Second Gulf Wars.[220] These campaigns served as a wake-up call within the PLA due to the effective execution of a war under informationalized conditions against a mechanized opponent.[221] Early American "informationalized" campaigns serve as a good analogy to a potential American campaign in the Pacific due to the mechanization of the Chinese military and the expeditionary requirements on the U.S. military.

Given the vast technological advantage that the U.S. holds over China in such a critical warfighting domain, Chinese tacticians will not be able to wage a symmetric war. Rather, their concept of operations (CONOPS) employs asymmetric means in order to wage a limited conflict, with a focus on information warfare to create a temporary, localized advantage. This advantage is intended to deter U.S. intervention by eliminating their ability to hold Chinese assets at risk (denial of gains) while making action against China prohibitive in terms of both monetary and human cost (cost imposition).[222] At the outset of the conflict, China may attack key U.S. capabilities for the purpose of crippling their ability to fight a war including C4ISR systems; logistics, transportation, and support facilities; air bases; sea lines of communication; and the American Pacific fleet.[223] Chinese military literature has emphasized anti-satellite weapons as key capabilities to interdict American C4ISR capabilities and offset American advantage.[224] This

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[220] Cheng, "Spacepower in China," 464-466.

[221] Roger Cliff et al. *Entering the Dragon's Lair: Chinese Anti-Access Strategies and Their Implications for the United States* (Santa Monica: RAND, 2007), 17-27.

[222] Thomas, *The Dragon's Quantum Leap*, 41.

[223] Cliff et al. *Entering the Dragon's Lair*, 51-79

[224] John Costello and Peter Mattis, "Electronic Warfare and the Renaissance of Chinese Information Operations," in *China's Evolving Military Strategy* ed. Joe McReynolds (Washington: Brookings Institution Press, 2016), 182-188

idea has taken hold in the Chinese military to the point that space is often identified as America's Achilles heel.[225]

The Chinese strategy of using counterspace weapons to gain localized, temporary military advantage in order to achieve limited political aims makes two assumptions. First, the effects of Chinese counterspace capabilities must sufficiently disrupt the American F2T2EA process to deny U.S. gains from striking Chinese high value targets. As discussed above, the PLA is acquiring a range of technologies to improve its counterspace capabilities, including directed energy weapons, electronic warfare systems, and kinetic ASAT capabilities.[226] However, it is important to differentiate between aspirational and operationally mature systems.[227] The development of chemical and solid state laser technologies for employment in ground based and/or airborne weapon-grade systems is a top technology development priority for the PLA.[228] Despite a major research effort to this effect, the most tangible demonstration of the Chinese laser program has been a network of seven satellite laser ranging (SLR) stations that are capable of providing high-fidelity observation of space objects. These ranging stations operate at too low of power to damage optical sensors, but could be used as a critical piece of a counterspace kill chain for other anti-satellite systems (for example, a direct ascent kinetic ASAT). [229] Although scaling up the technology does not present a difficult technical problem, fielding a mobile, forward deployable capability may present difficulties.[230] Likewise, co-orbital systems are in the

[225] Tellis, "China's Military Space Strategy," 49.

[226] Office of the U.S. Secretary of Defense, *Annual Report to Congress 2018*, 37.

[227] Pillsbury, *An Assessment of China's Anti-Satellite and Space Warfare Programs, Policies, and Doctrines*, 18; Pollpeter, "The Chinese Vision of Space Military Operations," 352; Ashley Tellis, "China's Military Space Strategy," 52.

[228] Office of the U.S. Secretary of Defense, *Annual Report to Congress 2018*, 82.

[229] Heginbotham et al., *The U.S.-China Military Scorecard*, 246-247.

[230] Zhang, "Chinese Perspectives on Space Weapons," 58-62; Fantastic discussion on the technical aspects of Chinese directed energy technology.

tech-demonstration phase and do not pose an operationally mature threat to U.S. capabilities. Forward deployed electromagnetic counterspace assets have the disadvantage of revealing the very capabilities they are attempting to conceal. Additionally, the U.S. has the advantage of defense in depth due to the sheer number of military space assets that it possesses. There is no guarantee that reversible effects employed against low-density, high demand assets will have the desired effects against American forces.[231] Therefore, creating a C4ISR advantage may be reliant on employing a direct ascent ASAT capability. China has rapidly improved its ASAT capability since the initial 2007 debris causing event, conducting numerous tests and demonstrating its capability to hold objects at geosynchronous orbit at risk.[232] Chinese military units have conducted operational training with ground-based ASAT missiles, which are expected to reach operational maturity within the next few years.[233]

Second, Chinese strikes on U.S. space assets must not result in uncontrolled escalation. The advantage of possessing soft-kill technology is the suitability for low-intensity conflicts, while the use of destructive/non-reversible attacks will not be constrained during high-intensity conflicts.[234] The use of exclusively non-lethal versus a combination of lethal and non-lethal capabilities can serve as strategic signaling about the phase of combat. However, due to a

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[231]Zhang, 253; Early warning IR systems are relatively impervious to directed energy attack due to them operating in different wavelengths and at HEO and GEO. Interference would need to occur via uplink or downlink jamming. Attack against the GPS constellation itself is absurd due to the sheer number of satellites needed to be rendered inoperable before signal degradation occurs. Also, jamming the low-grade signal on earth is much more cost effective. Jamming SAR could have significant benefit, but would also reveal the location of the very asset it is imaging. Weather satellites are generally considered low-value targets. This leaves electro-optical (EO) sensors as the most vulnerable asset due to their vulnerability to directed energy and relatively small numbers. So would the combination of neutralizing American EO capabilities, GPS jamming, SAR jamming, and attacks against data infrastructures prove a sufficient deterrent? Can the Chinese do this with current capabilities?

[232] Vaydeesh Mahajan, "Chinese Anti-Satellite Means: Criticality and Vulnerability of Indian Satellites," *CLAWS Journal* (Summer 2016), 174-180.

[233] Daniel Coats, *Worldwide Threat Assessment of the US Intelligence Community: 2018* (Washington: United States, Office of the Director of National Intelligence), 13.

[234] Pillsbury, "An Assessment of China's Anti-Satellite and Space Warfare," 25.

capability and vulnerability gap, combined with a lack of credible retaliatory threat, a tit-for-tat strategy along a clearly defined escalation ladder may not be a legitimate strategy for the Sino-U.S. relationship. [235] Counterspace action intended to have a tactical/operational effect may cross American strategic red lines, resulting in unintended escalation. For example, an attack on American overhead persistent infrared (OPIR) sensors would degrade their capability to detect conventional medium range ballistic missiles, with targets in the first island chain also interfering with the early detection of nuclear capable ICBMs launched against the U.S.[236] Concerningly enough, there is evidence that the implication of interfering with or destroying strategically important U.S. capabilities has only been appreciated on the tactical and operational levels within the Chinese military.[237] Similarly, a Chinese attack on U.S. space systems at the outset of a low-grade conflict could raise the likelihood of a "space Pearl Harbor," which could, in turn, provoke the United States to contemplate pre-emptive attacks or horizontal escalation on the Chinese mainland.[238] In addition, commercial-military integration and combined efforts may result in escalation with third parties. A significant portion of U.S. military communication and imaging capabilities are purchased from commercial companies or provided by allied nations, meaning that to adequately degrade U.S. military capabilities, an attack on non-military and/or non-U.S. assets is required.[239]

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[235] Rafal Kopec, "Space Deterrence: In Search of a 'Magical Formula'," *Space Policy* (2018), 1-7.

[236] Michael Krepon, "Space and Nuclear Deterrence," in *Anti-Satellite Weapons, Deterrence and Sino-American Space Relations* ed. Michael Krepon and Julia Thompson (Washington: Stimson Center, 2013), 391. The argument will be made that U.S. space warfare doctrine has not evolved sufficiently since the Cold War to incorporate a sub-strategic response to an attack on space assets. NTM, OPIR, MILSATCOM have tactical and operational uses, but are still viewed by the U.S. as strategic assets. This could result in a disproportionate (as seen by the Chinese) reaction by the U.S.

[237] Weeden, "U.S.-China Strategic Relations in Space," 69; Wortzel, "The Chinese People's Liberation Army and Space Warfare," 8-9; Pollpeter, "The Chinese Vision of Space Military Operations," 362.

[238] Tellis, "China's Military Space Strategy," 64.

[239] Heginbotham et al., *The U.S.-China Military Scorecard*, 251.

Chinese strategists cannot sufficiently disrupt U.S. capabilities without the use of kinetic capabilities, yet the use of kinetic capabilities will likely result in unacceptable escalation and threaten their own access to space.[240] Considering this obstacle, China is incentivized to continue developing more robust soft-kill counterspace capabilities to make its deterrent capabilities both credible and usable. However, given the relationship asymmetry, no firmly established red lines, and lack of an articulated escalation ladder, there is no guarantee that a soft-kill strategy will contain escalation either. China may be forced to adopt a strategy of preemption and automatic escalation due to the fear that any attack on space assets will result in American escalation. Nevertheless, this strategy cedes China's ability to conduct strategic signaling during a low-level conflict. For these reasons, a system of mutual restraint has not been established under the current status quo.

Moving forward, the asymmetry between Chinese and American forces in East Asia will become less acceptable to China as its subjective security demands increase. In order to strengthen its deterrent threat in East Asia (through robust A2/AD capabilities), China must continue to develop its space based C4ISR systems. Consequently, the continued development of C4ISR and space control systems risks instigating an arms race with the United States and regional competitors, such as Japan and India. To avoid the potential conflict, China must accomplish this development with the utmost sensitivity and secrecy in order to prevent a counterbalancing reaction. In the context of the game theoretical framework, China is highly incentivized to upset the status quo and has much to gain from a Defect/Cooperate scenario.

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[240] Tellis, "China's Military Space Strategy," 55.

Given the asymmetry in Chinese and American capabilities, China has more to gain from a Defect/Cooperate outcome than they do from mutual cooperation.

If the United States permits Chinese military space capabilities to develop unopposed, two possible dynamics may result. First, as China's reliance on space increases, so will its vulnerability to counterspace threats. This may allow for a system of mutual restraint to be established between the U.S. and China in the space domain.[241] Second, as China's conventional space capabilities achieve parity with U.S. capabilities, the U.S.'s conventional deterrent threat in the region could be weakened, consequently shifting the balance of power in East Asia towards China. Due to the importance of trans-pacific trade in the U.S. economy, it is unlikely that they will accept weakened extended deterrence in Asia. [242] Therefore, the United States shows preference towards the risk of mutual defection to the risk of being taken advantage of in a scenario where it cooperates in the face of Chinese defection. These preferences are shown in Figure 7.

		China: C	China: D
U.S.	C	6, 3	**-5, 8**
	D	x,y	-3, -1

Figure 7: China and the U.S.'s utility given a U.S. cooperate/China defect outcome.

[241] Gompert and Saunders, *Paradox of Power*, 180.

[242] Robert Manning, *The Future of US Extended Deterrence in Asia to 2025* (Washington: Atlantic Council, 2014), 1-4.

d. Cooperate/Defect

The benefit of defecting while an opponent cooperates (i.e. pursuing space dominance) is an attractive option for states seeking to expand their sphere of influence or those that have judged that their security demands outweigh current capability. Although there is evidence that China fits these criteria and that they are motivated by potential gains of Defect/Cooperate, it is the fear of being exploited that makes Cooperate/Defect its most powerful preference. Extremely stable states with low subjective security demands and a favorable strategic position (such as the United States) have the luxury of being able to cooperate while their opponents defect. They can take a relatively relaxed posture in security affairs and wait for others to make their intentions clear before acting.[243] Alternatively, nascent countries in a weak geostrategic position could ultimately face a loss of sovereignty if they chose to cooperate while an opponent defects. If China allows the U.S. to develop its space control capabilities uninhibited and itself remains unable to fight a space war, a loss of sovereignty could result for two possible reasons.[244] First, as covered in earlier chapters, space support enables the United States to project military power into East Asia. If the U.S. can maintain use of its space support capabilities while denying China a vital link in the A2/AD chain, the U.S. is much more likely to have freedom of action close to the Chinese coast. This interferes with China's expanded sovereignty claims in the East China Sea, South China Sea, Taiwan, and even outlying regions of continental China. It also gives U.S. forces strong coercive power by way of their ability to strike at key ground targets within China

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[243] Robert Jervis, "Cooperation Under the Security Dilemma," 173.

[244] In this case, a loss of sovereignty refers more to the Chinese right of self-determinism more than a literal loss of sovereignty within its current established border. The definition of Chinese sovereignty is further muddled by the dissonance between the Chinese government's sovereignty claims (which generally encapsulate the furthest extent of China's historical territorial possessions) and China's internationally recognized boundaries.

and establish a blockade, grinding China's largely sea-based economy to a halt.[245] Likewise, a space blockade could deny China substantial economic benefits.

Second, space control, space weaponization, and space force application are interrelated and legally contentious topics that have national sovereignty implications. The principal of overflight is strongly rooted in customary international law, beginning with the flight of Sputnik I during the Cold War. The ability of any nation to fly a satellite over any other nation on earth without violating its universally recognized national boundaries, combined with the lack of a prohibition of space weapons in the OST, theoretically allows for the delivery of kinetic effects to any nation on earth with only minutes of warning.[246] The major proposed roles of space weapons are: defensive space control, offensive space control, space-to-ground force projection, and BMD.[247] Generally, space based defensive and offensive space control options are limited by exorbitantly high cost, considerable susceptibility to countermeasures, and the availability of cheaper, more effective ground-based alternatives.[248] Space-to-ground force projection options are prohibitively expensive ($66 million/strike) and logistically difficult (40-150 satellites for global coverage).[249] Additionally, due to the offensive nature of space-to-ground weapons, soft power and legal consequences could raise the barriers to entry in developing and deploying such systems.[250] Despite the cost, space-to-ground weapons are appealing due to their ability to impact targets where terrestrial assets are denied access, as well as their importance in shortening

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[245] For more on space's role in a Sino-U.S. conflict in a Taiwan scenario see: Michael O'Hanlon, "Security and Spacepower," in *Toward a Theory of Spacepower: Selected Essays*, ed. Charles Lutes and Peter Hays (San Bernardino: National Defense University, 2017), 403-417; Haddick, *Fire on the Water*, 101-120.

[246] Bob Preston et al., *Space Weapons, Earth Wars* (Santa Monica: RAND, 2002), 23-45.

[247] Bruce DeBlois et al., "Space Weapon: Crossing the Rubicon," *International Security* 29, no. 2 (2004): 51-52.

[248] DeBlois et al., 83-84

[249] Preston, Bob et al., *Space Weapons, Earth Wars*, 142-156.

[250] DeBlois et al., "Space Weapon: Crossing the Rubicon," 68.

the F2T2EA cycle.[251] Space weapons could allow for the U.S. to maintain its global strike capability, even if China successfully employs its A2/AD strategy. This latent capacity would give the U.S. substantial deterrent capabilities if they retain the ability to target high-value assets, as well as considerable coercive propensity during a low-grade conflict.

BMD is the final proposed role of space weaponization. Space systems can bolster a missile defense architecture by producing space-to-atmosphere effects on ballistic missiles, and by using space-based sensing capabilities to conduct tracking and targeting for ground-based BMD interceptors. Many Chinese feel that the development of U.S. BMD capabilities is an intentional first step towards space control.[252] BMD systems can serve the role of ASAT weapon, interdict an opponent's direct ascent ASAT weapon, or even intercept an opponent's space launch. When a state possesses robust BMD capabilities, they have the potential to destroy an opponent's space assets, destroy the ability to counter one's own space assets, and restrict an opponent's access to space, creating an in-atmosphere chokepoint. BMD capabilities are inherently space control weapons. Therefore, progress by the Missile Defense Agency (MDA) to field BMD capabilities, an abundance of American literature on space control via weaponization, and a renewed emphasis on space warfighting within the U.S. military will result in a strong counterbalance from China in an attempt to circumvent U.S. space hegemony.[253] China has repeatedly defended the legal right to conduct warfare in space in response to a threat against its

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[251] DeBlois, 74.
[252] Zhang, "Chinese Perspectives on Space Weapons," 34-35.
[253] Bao Shixiu,"Deterrence Revisited: Outer Space", in *China Security* ed. Eric Hagt (Washington: China Security, Winter 2007), 2-6.

sovereignty.[254] The country's expanding ASAT capabilities (covered in previous sections) will give teeth to this warning.

Setting aside potential secondary functions, BMD's primary capability remains ballistic missile defense. In 2001, the Bush administration withdrew from the 1972 ABM treaty, signed by the U.S. and the Soviet Union. Although China was not party to the treaty and the U.S. was transparent that its proposed missile defense systems were not aimed at China, the Chinese staunchly opposed the pullout and suggested that an increase in nuclear arsenal may be warranted.[255] China viewed the ABM treaty as a cornerstone of its strategic stability.[256] Unlike the U.S. and Russian principle of mutually assured destruction and concerns of a missile gap during the Cold War, China believes that a small nuclear arsenal is adequate to field a minimum deterrent threat.[257] China continues to tout a no first-use commitment, does not have nuclear weapons on alert, and possesses comparatively few nuclear weapons. It believes that if a small retaliatory force survives a U.S. or Russian first strike and is able to create only tens of thousands of casualties for an opponent, enemy loss aversion will create deterrence.[258] Therefore, even a seemingly small, defensive BMD deployment aimed at "rogue states" could be capable of destroying China's small retaliatory force, upsetting Sino-U.S. nuclear deterrence, and leaving China susceptible to nuclear blackmail.[259] Increasing the capability and scope of the BMD program could promote a dangerous escalatory dynamic, which may include pressuring China to

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[254] Baohui Zhang, "The Security Dilemma in the U.S.-China Military Space Relationship: The Prospects for Arms Control," *Asian Survey* 51, no. 2 (2011), 315-318.

[255] Terence Neilan., "Bush Pulls Out of ABM Treaty," *New York Times*, December 13, 2001, https://www.nytimes.com/2001/12/13/international/bush-pulls-out-of-abm-treaty-putin-calls-move-a-mistake.html.

[256] Zhang, "Chinese Perspectives on Space Weapons," 34.

[257] Li Bin, *The Impact of the U.S. NMD on the Chinese Nuclear Modernization. Beijing: Institute of Science and Public Affairs* (Beijing: China Youth College for Political Science, Institute of Science and Public Affairs), 1.

[258] Bin, 2-4.

[259] Bin, 5-8.

reduce the vulnerability of its arsenal by delegating launch authority, increasing mobility, increasing the total number of available ICBMs, pursuing advanced reentry vehicle technology, putting ICBMs on alert, and adopting a limited deterrence posture.[260] There is evidence that some of these efforts are already underway.[261] Any of these possibilities would have a counterproductive effect of decreasing nuclear stability. Most dangerously, growing U.S. missile defense capabilities have forced space war and nuclear deterrence to become increasingly intertwined in the minds of Chinese strategists.[262]

U.S. domination of space is dangerous to China for three reasons. First, it would give the U.S. military a conventional military advantage in East Asia. This degrades the Chinese deterrent within the first island chain, strengthening the resolve of a pro-U.S. alliance in the region. Second, a U.S. space blockade of Chinese space capabilities could be a complimentary step to a sea-based blockade, disrupting the Chinese economy and giving the U.S. strong coercive power. Third, a robust BMD program, protected and enhanced by space domination, disrupts the Sino-U.S. strategic balance and leaves China susceptible to nuclear blackmail. China may not be able to dominate space globally, limiting the positive utility of a potential DC outcome. However, a CD outcome where the United States is able to achieve space domination, rather than space superiority, would be catastrophic for Chinese sovereignty. China must remain capable of denying the U.S. space domination, resulting in a strong preference against CD. Alternatively,

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[260] Keir Lieber and Daryl Press, "The Future of the Chinese Deterrent," in *China Security* ed. Eric Hagt (Washington: China Security, Winter 2007), 66-70; Michael Chase and Evan Medeiros, "China's Evolving Nuclear Calculus: Modernization and Doctrinal Debate," in *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army* ed. James Mulvenon and David Finkelstein (Alexandria: CAN Corporation, 2005), 152-153.

[261] Baohui Zhang, "The Modernization of Chinese Nuclear Forces and Its Impact on Sino-U.S. Relations," *Asian Affairs* 34, no. 2 (2007): 90-93.

[262] Baohui Zhang, "The Security Dilemma in the U.S.-China Military Space Relationship: The Prospect for Arms Control," *Asian Survey* 51, no. 2 (2011): 320.

the U.S. has a slightly weaker preference for this outcome. It already enjoys space superiority, and the marginal benefit between space superiority and space domination is minimal. These preferences are represented in Figure 8.

		China C	China D
U.S.	C	6, 3	-5, 8
U.S.	D	**8, -10**	-3, -1

Figure 8: China and the U.S.'s utility given a Cooperate/Cooperate outcome.

e. Analysis

Generally, nuclear weapons do not vary by kind, but by scale. In reality, the menu options range from large explosion to slightly larger explosion delivered in different ways; any combination of size and delivery method causes mass casualties. There is a strong moral compunction against using nuclear weapons, which has resulted in two major thresholds being formed during the Cold War. The first threshold was the use of nuclear weapons themselves. The second was their implementation as strategic, rather than tactical, weapons.[263] On the other hand, ASAT weapons are vastly varied by kind and effect. They range from a possible nuclear detonation, causing wide scale environmental degradation, to a low-power laser resulting in temporary effects. Consequently, the ASAT weapon threshold does not hold the same weight as the nuclear threshold. This threshold was crossed when Chinese and Russian lasers targeted U.S. satellites and no symmetrical escalation resulted. A threshold for the use of non-reversible effects could emerge, but this is more likely to be seen as an extension of conventional warfare.[264]

[263] Gompert and Saunders, *Paradox of Power*, 106-109.

[264] Gompert and Saunders, 108; For more on creating a system of mutual restraint between China and the U.S. in space see The Paradox of Power.

Similar to nuclear weapons, debris causing ASAT events (explored in prior sections) have the potential to preclude the future use of space and cause strategic damage to all states. As a result, the most likely firebreak on which a system of mutual restraint could be based on is the debris causing threshold. Therefore, ASAT weapons can be implemented on both conventional/operational and strategic levels, depending on their capability to generate debris. Understanding this dichotomy is essential to analyzing space strategy within a game theoretical framework. It is represented by two 2x2 matrices in Figure 9. The left matrix represents a scenario where the threshold of debris causing ASAT events has been crossed, and the right represents a scenario where non-debris causing ASATs are in play.

With Debris

		China	
		C	D
U.S.	C	6,3	-5,8
	D	8,10	-600, -300

Without Debris

		China	
		C	D
U.S.	C	6,3	-5,8
	D	8,-10	-3, -1

Figure 9: Comparing utility in two scenarios. The 2x2 matrix on the left shows utility when the debris causing threshold has been crossed. The 2x2 matrix shows utility in a sub-threshold conflict.

Due to asymmetry in the magnitude of utility, preferences can be represented as ordinal for the purpose of simplification. A scale of 1-4 shows actor preferences from least strong to most strong.

With Debris (Chicken)

U.S. \ China	C	D
C	3,3	2,4
D	4,2	1, 1

Without Debris (Security Dilemma)

U.S. \ China	C	D
C	3,3	1,4
D	4,1	2,2

Figure 10: Shows ordinal preferences for both scenarios. Ordinal preference does not represent the magnitude of actor preferences, but is a better visual representation of the game.

If debris causing ASATs are introduced into the game, the resulting dynamic is one in which crossing the debris threshold would cause both China and the U.S. to end up with their worst possible outcome. The space environment faces long-term damage, both countries lose out on future gains from utilizing space, and their ability to use space support to wage a conventional war is reduced. However, each side has more to gain by defecting than moving to the globally optimal solution of mutual cooperation. The choice to develop space control capabilities can give either player strategic and operational advantages, a benefit neither player is willing to sacrifice. The first to change its strategy to cooperate, rather than risk the consequences of the annihilation of space, cedes this advantage to its opponent, essentially losing the game. Each player weighs the probability and consequences of the catastrophic outcome occurring against the probability of the other player backing down and gaining advantage. This results in brinksmanship, a race to establish commitment and credibility in an effort to cause the other to back down.[265] A game with these characteristics is commonly known as chicken.

[265] Peter Bennett, “Modeling Decisions in International Relations,” 23-24; The game of Chicken refers to a scenario where Nash Equilibria are Cooperate/Defect and Defect/Cooperate AND the risk of Defect/Defect outweighs the risk of Cooperate/Defect.

In a struggle for space control without the introduction of debris-causing ASATs, the worst possible outcome for either side would be getting taken advantage of when choosing to cooperate, while the other side defects. Mutual cooperation remains the globally optimal solution and mutual defection remains the global minimum. Similar to a game of chicken, both players can gain from exploiting the other, more than they can in a cooperative scenario. However, the dynamic that prevents players from moving to the globally optimal solution is the fear of being exploited in a Cooperate/Defect scenario, rather than the fear of Defect/Defect resulting in an environmental catastrophe. Therefore, increasing the value of mutual cooperation and decreasing the probability of the other side defecting becomes important in order to decrease fear of a Cooperate/Defect scenario. The game is about establishing trust in order to engender cooperation, rather than establishing credibility to cause the other side to back down. This is known as a security dilemma.[266] In a security dilemma, modeled in figure 9, the choice of both players can be predicted. If China believes that the United States will defect, it must also defect, lest it be taken advantage of. If China believes that the United States will cooperate, it will also defect to take advantage of U.S. cooperation. Since this is a symmetric game, the United States' choices will be the same. Therefore, according to the game theoretical model presented, Sino-U.S. space relations are engaged in a downward spiral of arms racing and competition.

C. Testing the zero-sum assumption:

When defining the game in previous chapters, it was assumed that global utility was constant, resulting in a zero-sum game. In the practical application of game theory, a zero-sum relationship

[266] Bennett, 24-25. The game of prisoner's dilemma (security dilemma) refers to a scenario where Nash Equilibria are Cooperate/Defect and Defect/Cooperate AND the risk of Cooperate/Defect outweighs the risk of Defect/Defect.

is essential to the security dilemma operating as modeled. When one state seeks security, it does so at the expense of another, driving fear of Cooperate/Defect. However, if a state will not decrease the security of another by increasing its own, there is no reason to fear Cooperate/Defect and the security dilemma fails to operate. There are two crucial variables in determining how strong the zero-sum assumption is (and how strongly the security dilemma operates): whether defensive weapons and policies can be distinguished from offensive ones, and whether the offense has the advantage.[267] A combination of these variables creates four worlds in which the security dilemma operates at different magnitudes.

		Offense-Defense	
		Offense Advantage	Defense Advantage
Distinguishability	Distinguishable	Doubly dangerous security dilemma	Security dilemma, requirements may be compatible
	Not-Distinguishable	No security dilemma, but aggression possible	Doubly Stable

Figure 11: Four worlds created by offense-defense balance and distinguishability, in which the security dilemma operates at different strengths. [268]

f. Offense/Defense Balance:

In order to determine an offense-defense balance, two questions must be asked. The first is an economic one: is it more cost effective to build offensive or defensive weapons? [269] In this case, the question can be modified to: is it more cost effective to provide space effects or disrupt them? Currently, it is much more economically efficient to disrupt space effects for two reasons.

[267] Jervis, "Cooperation Under the Security Dilemma," 186-187.
[268] Jervis, 211
[269] Jervis, 188-194.

First, the geography of the space domain makes it favorable to the offense. The high fuel cost required to significantly alter satellites' orbits keeps them in relatively stable, predictable orbits that make tracking and targeting straightforward.[270] China already employs seven ground-based satellite SLR stations on the Chinese mainland to detect, track, and characterize space objects with sub centimeter level accuracy.[271] However, they are expanding their space surveillance efforts with an SLR station in Argentina, the deployment of space surveillance and tracking ships, and multiple international data sharing agreements.[272] Due to recent, rapid improvements in SSA capabilities, passive means of defense, such as cover and concealment, have become lost despite the vastness of space. Furthermore, efficient travel in space requires adherence to economically favorable lanes of travel, creating strategic chokepoints through which satellites in any regime must pass. Likewise, there are a limited number of economically advantageous orbits, allowing space control efforts to be focused at a few central nodes.[273] Defensive principles, such as defense in depth and extended lines of communication, have weak analogies in the space environment. Sheer numbers of satellite systems can create defense in depth, but space is largely absent of the geographic features that would normally be used. These combined factors make passive defense in the space environment problematic, therefore favoring offensive tactics.

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[270] Forrest Morgan, *Deterrence and First Strike Stability in Space*, 31.

[271] Yousaf Butt, "Effects of Chinese Laser Ranging on Imaging Satellites," *Science and Global Security* 17, no. 1 (2009): 22; Heginbotham et al., *The U.S.-China Military Scorecard*, 246-247.

[272] Yao Jianing, "China Advances Maritime Space Monitoring and Control Capability," *China Military Online*, June 23, 2017, http://eng.mod.gov.cn/news/2017-06/23/content_4783536.htm; Yousaf Butt, "Effects of Chinese Laser Ranging on Imaging Satellites," 22; Ernesto Londono, "From a Space Station in Argentina, China Expands Its Reach in Latin America," *New York Times*, July 28, 2018, https://www.nytimes.com/2018/07/28/world/americas/china-latin-america.html.

[273] Everett Dolman, *Atropolitik*, 69-76.

Second, the current state of technology favors the offense. Active means of defense add cost by adding complexity and weight to already expensive satellite systems. Adding fuel in order to make satellites more maneuverable adds extraneous weight to a system and proportionally increases launch costs at $20k/kg into LEO.[274] Due to the exponential nature of the rocket equation, the mass penalty increases rapidly as total ΔV (maneuverability) increases.

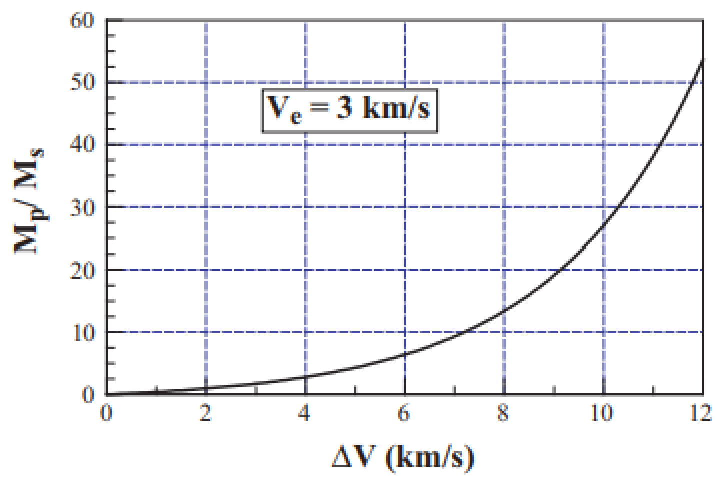

Figure 12: The ratio of propellant mass to satellite mass required to produce a given ΔV using conventional propulsion. [275]

Look, shoot, look procedures commonly in practice for DAASAT weapons and the high maneuverability of co-orbital ASAT systems mean that preparing a satellite to avoid either of these threats would require it to perform a series of costly maneuvers. This increases on-board fuel requirements, mass, and ultimately, cost. Additionally, added maneuverability is not an effective countermeasure against ground-based threats, such as jammers and lasers. Employing bodyguard satellites may be a solution to protect key systems, but their effectiveness against a

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[274] Joan Johnson-Freese, *Heavenly Ambitions*, 71.

[275] David Wright, Laura Grego, and Lisbeth Gronlund, *The Physics of Space Security* (Cambridge: American Academy of Arts and Sciences, 2005), 70.

determined opponent is dubious and adds cost to the system.[276] The same principles hold true for physical shielding. On the other hand, ASAT systems are smaller, less massive, more maneuverable, and less complex than the space systems they are designed to defeat.[277] Due to the fragility of space systems and the massive kinetic energy of a small object traveling at 7,600 m/s, space is a scenario in which a well-aimed brick beats a multimillion-dollar engineering marvel. Lifting a satellite into orbit is much more demanding than simply lifting an ASAT to high altitude in order to conduct an attack.[278] Further, the relatively complex, fragile, and physically long lines of communication on which space systems rely are susceptible to attack via a multitude of means.[279] When taken together, these factors mean that space disruption is much more cost effective than constructive use.[280] Therefore, as is true in the current state of technology, when each dollar spent on offense can overcome each dollar spent on defense, the players are incentivized to build offensive forces.[281]

The second question necessary to determine offense-defense balance is one of military utility: has first-strike stability been established? When a successful attack will weaken the other side to the point where victory becomes quick, bloodless, and decisive, this increases the incentives to strike first and makes establishing first-strike stability difficult.[282] The Chinese desire to use counterspace assets for the purpose of creating a temporary, localized advantage

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[276] Wright, Grego, and Gronlund, 138-139.
[277] Forrest Morgan, *Deterrence and First Strike Stability in Space*, 32-33.
[278] Wright, Grego, and Gronlund, *The Physics of Space Security*, 15.
[279] Two monographs cover the subject of ASAT weapons in depth. Bruce DeBlois *Space Weapon: Crossing the Rubicon* and David Wright *The Physics of Space Security: A Reference Manual*. Also reference Brian Weeden *Global Counterspace Capabilities: An Open Source Assessment* for an overview of existing ASAT technology. China's implementation of counterspace capabilities and the possibility of attacking multiple segments of a space system's architecture has already been covered at length.
[280] Joan Johnson-Freese, *Heavenly Ambitions*, 71-72.
[281] Jervis, "Cooperation Under the Security Dilemma," 188.
[282] Jervis, 189.

within the East Asian theater (which has already been covered at length) suggests that they are highly incentivized by the prospect of a first-strike that disrupts U.S. expeditionary capability.[283] In a simple denial of gains versus cost imposition equation, the high value of U.S. space systems, and the distinct lack of defensive measures to protect them with, means that creating deterrence through denial of gains is unlikely. Cost imposition strategy has its own set of concerns. First, a symmetric U.S. deterrent threat has little credibility. Engaging in a tit-for-tat exchange with ASAT systems is not a credible deterrent because China has more to gain from this strategy.[284] Whereas, an asymmetric attack using conventional forces (for example, an attack on terrestrial segments of space systems within China) or other domains (nuclear, cyber, terrestrial) risks horizontal escalation, broadens the scope of conflict, and could allow China to seize the narrative.[285] Second, remaining U.S. deterrent options lack proportionality. If China applies sub-lethal counterspace options against the high value of space systems, the gains China reaps from ASAT attacks will outweigh perceived cost (unless the U.S. threatens a seemingly disproportionate response).[286] This has created a gap between credible threat and proportionality, where any U.S. response has either a credibility or proportionality problem, limiting options for establishing first-strike stability.

g. Dual-Use Problem

The second crucial variable in testing the zero-sum nature of the game is whether defensive weapons can be distinguished from offensive ones. Offense-defense differentiation alleviates the

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[283] James Lewis, "Reconsidering Deterrence for Space and Cyberspace," in *Anti-Satellite Weapons, Deterrence and Sino-American Space Relations* ed. Michael Krepon and Julia Thompson (Washington: Stimson Center, 2013), 76.

[284] Lewis, 65.

[285] Morgan, *Deterrence and First Strike Stability in Space*, 30.

[286] Lewis, "Reconsidering Deterrence for Space and Cyberspace," 69.

security dilemma by allowing states to act in ways that are clearly defined as offensive or defensive, bolstering the efficacy of strategic signaling. This is due to three underlying mechanisms. First, each player can clearly signal that its military capabilities are in line with its subjective security demands, curtailing the belief that it is expansionist and threatening another state's security. Second, when the buildup of offensive forces is obvious, it allows other players to obtain advance warning of aggression. This advance warning lowers the gains from a surprise attack and alleviates the fear of being taken advantage of in a Cooperate/Defect scenario. Third, clear differentiation between offensive and defensive weapons, as well as military and civilian technologies, allows for clear arms control agreements to be put in place.[287] This dynamic operates in the traditional sense, where offensive weapons are those used to attack or interdict an opponent's military and expand one's own territory. Therefore, if space systems are used specifically to disable an opponent's space systems, prevent it from using the medium, or disrupt its use of space effect, it can be labeled as offensive. However, some space technologies may be used for either offensive or defensive purposes. The ubiquity of space effects in military operations mean that some space systems are inherently neutral but can be treated as offensive or defensive depending on the terrestrial operations they support. Furthermore, military and civilian uses of space systems are difficult to differentiate, confounding all three underlying mechanisms. These factors make offense-defense differentiation extremely difficult, further confounding the Sino-U.S. security dilemma.

The current state of technology in space is resoundingly unfavorable to offense-defense differentiation. Many closely related technologies may either serve as ASAT weapons, as

[287] Jervis, "Cooperation Under the Security Dilemma," 200-201.

defensive weapons, or completely benign tools to further the peaceful uses of space. For example, a satellite with the ability to conduct rendezvous and proximity operations (RPO) can be used as an offensive counterspace weapon to disable an opponent's satellite systems, conduct signal jamming, or collect intelligence; it can also be used as a defensive counterspace weapon to serve as a "host" satellite. Additionally, the satellite may be used for benign purposes, such as conducting refueling, cleaning up debris, or being used as a technology demonstrator for human spaceflight missions.[288] It has even been suggested that developing a satellite capable of active debris cleanup is a method of simultaneously developing ASAT capabilities without arousing global outcry.[289]

China currently operates five technology demonstration programs that further its knowledge of RPOs. However, it has not conducted a destructive intercept of a target and there is no definitive proof that these programs have direct counterspace purposes.[290] Western observers first raised the alarm in 2008, when the BX-1 (hosting a photo imaging payload) was released from the Shenzhou-7 capsule during a spacewalk. It conducted limited proximity operations around the capsule, then appeared to maneuver in order to conduct an intentional flyby of ISS.[291] Although further assessment has concluded that the ISS flyby was benign, it has raised concerns that the test could give China the operational and technical expertise necessary to develop a co-

[288] Kevin Pollpeter, "China's Space Robotic Arm Programs," *UC San Diego: Institute on Global Conflict and Cooperation*, October 2013 (2013): 5; Weeden, *Global Counterspace Capabilities*, 1-9.

[289] Bohumil Dobos and Jakub Prazak, "To Clear or to Eliminate? Active Debris Removal Systems as Antisatellite Weapons," *Space Policy*, (2019), https://doi.org/10.1016/j.spacepol.2019.01.007.

[290] Weeden, Global Counterspace Capabilities, 1-2. The SJ-17 is the fifth. It is not mentioned in this section as it was discussed in previous chapters.

[291] Brian Weeden, "China's BX-1 Microsatellite: A Litmus Test for Space Weaponization," *The Space Review*, October 20, 2008, http://www.thespacereview.com/article/1235/1.

orbital ASAT.[292] In 2010, the SJ-12 conducted a series of RPO maneuvers with a target payload (SJ-06F) culminating in a physical "bump" that caused perturbations in the satellites' orbits.[293] Chinese media stated that the SJ-12 was "designed for carrying out scientific and technological experiments including space environment probe, measurement and communications."[294] However, some American experts believe that its true mission is intelligence collection, while others view it as a precursor to the first docking of a Shenzhou space capsule with the Tiangong-1 space station in the following year.[295] They remain in disagreement as to whether it represents a significant ASAT capability.[296]

The Chinese RPO demonstration that has caused the most consternation among American observers is a series of maneuvers conducted by the SY-7, CX-3 and SJ-15 satellites, starting in 2013. One of the satellites was equipped with a robotic arm built by the Chinese Academy of Space Technology (CAST) that was designed to capture a micro target satellite.[297] They conducted a series of tests over multiple years, which may have resulted in a successful grapple.[298] It has been suggested that the SY-7's robotic arm was a predecessor of an arm destined to be launched aboard China's large space station (slated for launch in 2020 or beyond),

[292] Todd Harrison, Kaitlyn Johnson, and Thomas Roberts, *Space Threat Assessment 2018* (Washington: Center for Strategic and International Studies, 2018), 8; The ISS flyby was probably a coincidence. The timing of the release and test was apparently dependent on proximity to China's SSA network.

[293] Brian Weeden, "Dancing in the Dark," 1-2.

[294] Leiying Xu, "China Sends Research Satellite into Space," *Xinhua*, August 19, 2010.

[295] Kevin Pollpeter et al, *The Creation of the PLA Strategic Support Force and Its Implication for Chinese Military Space Operations* (Santa Monica: RAND, 20017), 10.

[296] Weeden, "Dancing in the Dark," 3; Weeden hypothesizes that the lack of published scientific research is a red herring for a counterspace capability, but due to the secrecy of the Chinese space program in general this is at best inconclusive.

[297] Weeden, *Global Counterspace Capabilities*, 1-3.

[298] Marcia Smith, "Did China Succeed in Capturing One of its Own Satellites? – Update," *Space Policy Online*, October 26, 2016, https://spacepolicyonline.com/news/did-china-succeed-in-capturing-one-of-its-own-satellites/.

a test of space maintenance capabilities, or an experiment on the collection of space debris.[299] Alternatively, Pentagon officials believe that it is a test of China's secret ASAT program and represents a real concern for U.S. national defense.[300] This is a case study for the differentiation problem in space. It was most likely developed to be a stepping stone in the Chinese manned space program, but was also built by a military contractor with military capabilities also in mind.[301] Similarly, the Aolong-1 (The Roaming Dragon) was built by CAST and launched in 2016. Its mission is to rendezvous with a "non-cooperative" target to collect man-made debris in space, but CAST researchers noted that the Chinese military acknowledges its usefulness as an ASAT technology.[302] However, its purpose as either a weapon, junk collector, or technology demonstrator for the space station has not been established and remains hotly debated.[303] This demonstrates that differentiation in space is largely accomplished by examining intent rather than technological specifications.

The line between offensive and defensive technologies does not get clearer when comparing BMD and ASAT technologies. From the point of view of arms control and policy, ASAT technology and BMD are near polar opposites, but technological similarities means that

[299] David Leonard, "Mysterious Actions of Chinese Satellites Have Experts Guessing," *Space.com*, September 09, 2013, https://www.space.com/22707-china-satellite-activities-perplex-experts.html.

[300] Bill Gertz, "China Testing New Space Weapons: China Conducts Satellite Capture in Space as Part of Star Wars Military Program," *The Washington Free Beacon*, October 02, 2013, https://freebeacon.com/national-security/china-testing-new-space-weapons/.

[301] Kevin Pollpeter, "China's Space Robotic Arm Programs," 2.

[302] Stephen Chen, "Is China Militarising Space? Experts Say New Junk Collector Could be Used as Anti-Satellite Weapon," *South China Morning Post*, July 20, 2016, https://www.scmp.com/news/china/diplomacy-defence/article/1982526/china-militarising-space-experts-say-new-junk-collector.

[303] David Axe, "Is China's Mysterious New Satellite Really a Junk Collector—or a Weapon?" *The Daily Beast*, July 5, 2016, https://www.thedailybeast.com/is-chinas-mysterious-new-satellite-really-a-junk-collectoror-a-weapon; Morris Jones, "Chinese Space Garbageman is not a Weapon," *SpaceDaily*, June 28, 2016, http://www.spacedaily.com/reports/Chinese_Space_Garbageman_is_not_a_Weapon_999.html; "China's new Orbital Debris Clean-Up Satellite raises Space Militarization Concerns," *Spaceflight101*, June 29, 2016, http://spaceflight101.com/long-march-7-maiden-launch/aolong-1-asat-concerns/.

BMD and ASAT systems are functionally interchangeable.[304] The United States has demonstrated the ability to use the SM-3, which is part of the ship mobile Aegis BMD system, to destroy satellites in LEO.[305] The Ground Based Interceptor system deployed to Alaska and California have not demonstrated the ability to function as an ASAT system, but the program could have greater potential as an ASAT system than the SM-3.[306] China's test of BMD and ASAT capabilities are also closely linked. The SC-19 System was tested twice before it intercepted the Chinese FY-1C weather satellite as an ASAT demonstration.[307] The SC-19 (DN-01) was tested again in 2010, 2013, 2014, and possibly 2018, with each of these tests involving the interception of a ballistic missile.[308] Since the debris-creating 2007 ASAT test, which caused significant public outrage, China has been careful to frame SC-19 testing as peaceful, defensive BMD tests.[309] The DN-02 and DN-03 variants also intercepted ballistic targets and were framed as BMD tests, but American officials are adamant that these are continued tests of ASAT capabilities.[310] Again, due to the difficulty of differentiating BMD from ASAT technology, American strategists cannot rely on technological nuance to determine if China's recent tests

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[304] Ashton Carter, "The Relationship of ASAT and BMD Systems," *Daedalus* 114, no. 2 (1985): 173-176.

[305] Brian Weeden, *Global Counterspace Capabilities*, 3-9.

[306] Weeden, 3-10.

[307] Gertz, "Going on Defense: China, U.S. Conduct Missile Defense Tests," *Washington Free Beacon*, January 27, 2013, https://freebeacon.com/national-security/going-on-defense/.

[308] Gertz, "China Tests Anti-Satellite Missile."

[309] Zachary Keck, "China Claims That It Has Tested a Mid-Course Missile Defense System," *The National Interest*, February 11, 2018; https://nationalinterest.org/blog/the-buzz/china-claims-it-has-tested-mid-course-missile-defense-system-24434; Timothy Farnsworth, "China Conducts Missile Defense Test," *Arms Control Today*, February 28, 2013, https://www.armscontrol.org/act/2013_03/China-Conducts-Missile-Defense-Test; Zhang Zhihao, "China Conducts Missile Interception Test," *China Daily*, February 6, 2018, http://www.chinadaily.com.cn/a/201802/06/WS5a79570ca3106e7dcc13b193.html; Bill Gertz, "Going on Defense: China, U.S. Conduct Missile Defense Tests."

[310] Kevin Pollpeter et al., *The Creation of the PLA Strategic Support Force* , 9; Gertz, "China Tests Anti-Satellite Missile;" Gertz, "China ASAT Test Part of Growing Space War Threat."

represent an expansion of offensive or defensive capabilities. Rather, they must surmise Chinese intent, which is exponentially more difficult.

It is estimated that 95% of space technology has dual use for both civilian and military purposes.[311] For example, research in rocketry during the Cold War was originally used to deliver nuclear weapons but became the forbearer of technology that supported the Apollo program, and more recently allowed middle school students to launch a satellite into a polar orbit.[312] Very few technologies are inherently military or civilian. Therefore, in the majority of cases, civilian and military differentiation cannot be accomplished via function alone. This creates a conundrum where the U.S. is forced to choose between attempting to control all space technology, lest it be used by China, or maintaining a monopoly on only a small number of technologies vital to national security. It has continually chosen the former.[313]

[311] Johnson-Freese, "A New U.S.-Sino Space Relationship: Moving Toward Cooperation," *Astropolitics* 4, no. 2 (2006), 131.

[312] Sarah Peters, "Gardens Middle School Students' Satellite Launched into Space," *The Palm Beach Post*, December 20, 2018, https://www.palmbeachpost.com/news/20181220/gardens-middle-school-students-satellite-launched-into-space.

[313] Johnson-Freese, 47.

Table 2: A more complete list of space technologies with their civilian and military uses. [314]

Generic Technology Application	Civil Use	Military Use	Dual Use?
Communications Satellites	Fixed Satellite service	Fixed satellite service	Yes
	Broadcasting satellite service	Broadcasting satellite service	Yes
	Mobile satellite Service	Mobile satellite service	Yes
	Land, maritime, and aeronautical mobile intersatellite services	Land, maritime, and aeronautical mobile intersatellite services	Yes
Remote Sensing	Earth resource observations	Reconnaissance systems	Yes
	Environmental monitoring	Environmental Monitoring	Yes
	Atmospheric research		No
	Geophysics	Precision targeting	Yes
	Oceanography	Oceanography	Yes
	Cartography	Cartography	Yes
		Nuclear test detection and surveillance	No
		Early-warning system	No
	Treaty compliance verification	Treaty compliance verification	Yes
Satellite navigation systems	Navigation services	Navigation services	Yes
Rocket Propulsion	Space launch systems	Space launch systems	Yes
	Propulsion systems	Propulsion Systems	Yes
	Reaction and control systems	Reaction and control systems	Yes
		Ballistic missiles	No
		Anti-ballistic missiles	No
	Interceptor propulsion and grappling systems	Interceptor propulsion and grappling systems	Yes
Search and Rescue Systems	Search and rescue services	Search and rescue services	Yes
Space science and exploration	General space science		No
	Manned observation and mission staging	Manned observation and mission staging	Yes

The registration convention dictates that launched objects are registered with the UN containing, at a minimum: name of launching state, designator, basic orbital parameters, and

[314] Johnson-Freese, *Space as a Strategic Asset*, 32.

general function.[315] With this information, it is easy to determine which systems are directly owned and operated by a state's military and intelligence apparatus. However, military use of civilian satellite systems and vice versa confounds even this apparently simple distinction. The first U.S. PNT system (NAVSTAR) was launched in 1974 with military navigation and nuclear detection missions, followed by 11 more satellites between 1978 and 1985. However, President Reagan opened the data for civilian use, ostensibly in reaction to the Russian shoot-down of Korean Air flight 007.[316] Since that time, PNT has become integrated into the global economy by providing location based services; enabling navigation for roads, aviation, rails, and maritime environments; providing precision agriculture and surveying; aiding in construction and mining; and for precise timing and time synchronization used in broadcasting, mobile phones, and internet transactions.[317] U.S. economic benefit from NAVSTAR is conservatively estimated at $68.7B and global economic benefit around $260B.[318] Civilian and military use of PNT is intertwined to the point where attacks that cause widespread signal degradation could risk horizontal escalation. Likewise, disabling NAVSTAR for tactical operations risks escalating the conflict to the strategic level, due to importance of the system to the U.S. economy.

To further complicate the dual use problem, the U.S. DoD has expressed an interest in hosting military payloads on both commercial and non-U.S. satellites. In 2011, the Air Force

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[315] *Convention on Registration of Objects Launched into Outer Space*, New York, 12 November 1974, available from http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/registration-convention.html.

[316] Mark Sullivan, "A Brief History of GPS," *PC World*, August 9, 2012, https://www.pcworld.com/article/2000276/a-brief-history-of-gps.html.

[317] Irv Leveson, "The Economic Benefits of GPS," *GPSWorld*, September 1, 2015, https://www.gpsworld.com/the-economic-benefits-of-gps/.

[318] Irv Leveson, *GPS Civilian Economic Value to the U.S., Interim Report* (Beltsville, MD: National Executive Committee for Space-Based Positioning, Navigation and Timing, ASRC Federal Research and Technology Solutions, Inc., August 2015), 68; Report is an extremely comprehensive analysis of the U.S. NAVSTAR market. For discussion on the civilian application and value of PNT in general and NAVSTAR in particular, this is a fantastic resource.

created the Hosted Payload Office to facilitate matching government payloads with hosts and has launched three payloads on commercial assets, with more on the way.[319] During the 2018 Space Symposium, Secretary of the Air Force, Heather Wilson, announced plans to host DoD payloads on partner nations' satellites, including Australia, Great Britain, Canada, New Zealand, Norway, and Japan. Secretary Wilson was clear that the intent of the policy was to change the decision calculus of potential aggressors.[320] Months later, the United States Government Accountability Office published a report recommending that the DoD continues to pursue hosted payloads in order to streamline the acquisitions process and provide increased strategic resiliency.[321] The 2018 Joint Chiefs of Staff publication on Space Operations listed utilizing commercial assets to increase space mission assurance by providing resiliency and diversification from military owned assets.[322] For that reason, targeting a payload owned and operated by the U.S. military will increasingly involve attacking commercial and partner nations' assets by proxy.

Additionally, military organizations buy key services from commercial space providers. The same Joint Chiefs document listed reliance on commercial space systems for communication and imagery as a key DoD dependency.[323] Prior to September 11, 2001, DoD satellite communication (SATCOM) demands were largely filled internally and relied on commercial

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[319] Government Accountability Office, *DOD's Use of Commercial Satellites to Host Defense Payloads Would Benefit from Centralizing Data* (Washington: Government Accountability Office, July 2018), 8-13; Three payloads already launched are Internet Protocol Routing in Space (IRIS) that connects ground and space based internet nodes for USSTRATCOM, Commercially Hosted Infrared Payload (CHIRP) an infrared sensor technology demonstrator, and Responsive Environmental Assessment Commercially Hosted (REACH) used to characterize the space environment. Three scheduled launches are Spacebased Kill Assessment (SKA) used by the MDA, Phoenix Program: Payload Orbital Delivery (POD) a DARPA project, and Enhanced Polar System Recapitalization (EPS-R) a polar tactical communication payload.

[320] Marcus Weisgerber, "U.S. Air Force to Put Sensors on Allies' Satellites," *Defense One*, April 21, 2018, https://www.defenseone.com/threats/2018/04/us-air-force-put-sensors-allies-satellites/147622/.

[321] Government Accountability Office, *DOD's Use of Commercial Satellites to Host Defense Payloads Would Benefit from Centralizing Data*, 23.

[322] Joint Publication, *Space Operations* (Washington: Joint Chiefs of Staff, April 2018), 8-9.

[323] Joint Publication, 6.

SATCOM for surge capability; however, DoD reliance on commercial SATCOM has increased 800 percent since then.[324] Current estimates are that more than 80% of DoD SATCOM bandwidth is purchased from commercial companies, with demand continuing to grow and no military capability slated to fill demand.[325]

Commercial remote sensing data is more controversial and more complicated than commercial communications. The Land-Remote-Sensing Commercialization Act of 1984 authorized the Secretary of Commerce to market Landsat data commercially and allowed for the licensing of private remote-sensing space systems.[326] It was replaced by the Land Remote Sensing Policy Act of 1992, which added language that requires privately licensed companies to comply with national security concerns.[327] Since then, multiple high-resolution imagery satellites have launched under U.S. license, with Digital Globe/GeoEye currently monopolizing the U.S. market. Due to the classification of DoD imaging satellites, it is difficult to precisely gauge how reliant the U.S. is on commercial data, though a good indicator is that the U.S. government accounts for half of GeoEye's revenue and heavily subsidizes its technology development.[328]

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[324] Government Accountability Office, *Defense Satellite Communications: DoD Needs Additional Information to Improve Procurements* (Washington: Government Accountability Office, 2015), 9; This is even more impressive considering that during that time the DoD acquired and launched WGS as a supplement/follow up to DSCS III. WGS has 10x the capacity of DSCSIII.

[325] Keith Norton, "Commercial SATCOM Remains Vital to Military Operations," *Defense Systems*, August 22, 2011, https://defensesystems.com/articles/2011/08/08/industry-perspective-commercial-satellite-communications.aspx; Benjamin Forest, "An Analysis of Military Use of Commercial Satellite Communications," M.A. Thesis, Naval Postgraduate School, 2008, 9-16; Ricky Lee and Sarah Steele, "Military Use of Satellite Communications, Remote Sensing, and Global Positioning Systems in the War on Terror," *Journal of Air Law and Commerce* 79, no. 1 (2014): 79.

[326] U.S. Congress, Land Remote-Sensing Commercialization Act of 1984 (Washington, DC, Congress, 1984).

[327] U.S. Congress, Land Remote Sensing Policy Act of 1992 (Washington, DC, Congress, 1992).

[328] Peter Eisler, "Commercial Satellites Alter Global Security," *ABC News*, November 6, 2018, https://abcnews.go.com/Technology/story?id=6201845&page=1.

Given this cross-flow of data between DoD, civilian, and private agencies, civilian/military differentiation by owner is also muddled.

As commercial imaging capabilities continue to improve, they have greater utility in terms of military intelligence. [329]

Table 3: Privately owned, commercially available high and medium resolution imaging satellites and their capabilities. [330]

Country of Origin	Operator	Name	Panchromatic	Multispectral
United States	DigitalGlobe (US)	Worldview-1	50cm	
United States	DigitalGlobe (US)	Worldview-2	46cm	1.84m
United States	DigitalGlobe (US)	Worldview-3	31cm	1.24m
United States	DigitalGlobe (US)	Worldview-4	30cm	
United States	DigitalGlobe (US)	GeoEye-1	41cm	1.65m
France	Spot (FR)	Pleiades-1 Pleiades-2	50cm	2m
France	Spot (FR)	SPOT-6 SPOT-7	1.5m	6m
Germany	Planet Labs (US)	RapidEye 1-5	5m	
United States	Planet Labs (US)	Dove x88		3-5m
United States	Planet Labs (US)	SkySat 1-15	72cm	1m
India	21st Century (PRC) (Future)	TripleSat 1-3	1m	4m

[329] Laurance Nardon, *Satellite Imagery Control: An American Dilemma* (The Centre Français sur les Etats-Unis, 2002), 15.

[330] Data from: Land Info Worldwide Mapping LLC, http://www.landinfo.com/satellite-imagery-pricing.html; also, Gunter's Space Page, https://space.skyrocket.de/index.html. This does not include government owned systems whose data is commercially available.

Table 4: Resolution needed to observe military targets. [331]

Target	Detection	Identificatior	Precise identification	Description	Technical analysis
Troops	6 m.	2 m.	1.20 m.	30 cm.	15 cm.
Vehicles	1.50 m.	60 cm.	30 cm.	6 cm.	4.5 cm.
Airplanes	4.50 m.	1.50 m.	1 m.	15 cm.	4.5 cm.
Airports	6 m.	4.50 m.	3 m.	30 cm.	15 cm.
Nuclear arms components	2.50 m.	1.50 m.	30 cm.	3 cm.	1.5 cm.
Missile bases (surface-to-surface and surface-to-air)	3 m.	1.50 m.	60 cm.	30 cm.	4.5 cm.
Rockets and artillery	1 m.	60 cm.	15 cm.	5 cm.	4.5 cm.
Surface vessels	7.50-15 m.	4.50 m.	60 cm.	30 cm.	4.5 cm.
Surfaced submarines	7.50-30 m.	4.50-6 m.	1.50 m.	1 m.	3 cm.
Roads	6-9 m.	6 m.	1.80 m.	60 cm.	40 cm.
Bridges	6 m.	4.50 m.	1.50 m.	1 m.	30 cm.
Radar facilities	3 m.	1 m.	30 cm.	15 cm.	1.5 cm.
Radio equipment	3 m.	1.50 m.	30 cm.	15 cm.	1.5 cm.
Command and control centers	3 m.	1.50 m.	1 m.	15 cm.	9 cm.
Equipment storage	1.50-3 m.	60 cm.	30 cm.	3 cm.	3 cm.
Minefields	3-9 m.	6 m.	1 m.	3 cm.	--
Urban areas	60 m.	30 m.	3 m.	3 m.	75 cm.
Coasts, landing beaches	15-30m.	4.50 m.	3 m.	1.50 m.	15 cm
Ports	30 m.	15 m.	6 m.	3 m.	30 cm.
Railroad facilities	15-30 m.	15 m.	6 m.	1.50 m.	40 cm.
Terrain	--	90 m.	4.50 m.	1.50 m.	75 cm.

Source: Ann Florini, "The Opening Skies: Third Party Imaging Satellites and U.S. Security," *International Security*, vol. 13, no 2, autumn 1988, p.98.

Definitions:

Detection: location of a kind of component, of objects or of activities of military interest.

Identification: determination of a certain type of target.

Precise Identification: distinction among several kinds of targets within the same category of targets.

Description: size/dimension, configuration/organization, construction of components, itemization of units, etc.

Technical Analysis: detailed analysis of specific components.

Note: The sources do not specify whether the resolution is expressed in pixels or in points.

[331] Nardon, *Satellite Imagery Control*, 16.

The clear overlap between the resolution of commercially available images and the resolution needed for identification of military targets should be concerning for both players. It provides a source of high-quality intelligence that may be difficult to interdict for political reasons. The U.S. government has fought to restrict selling high resolution imaging data, but due to the proliferation of commercially available data and rapidly increasing capabilities, it has little choice but to make concessions, lest the U.S. private sector be left behind.[332] For either player to deny high resolution data to the other, it must mitigate the other's military collection capability, as well as its ability to purchase commercially available products; however, this capability is often provided under the license of third party nations. Again, this increases diplomatic complexity, limits credible threats, and risks horizontal escalation during a conflict.

[332] Sarah Scoles, "How the Government Controls Sensitive Satellite Data," *Wired*, February 08, 2018, https://www.wired.com/story/how-the-government-controls-sensitive-satellite-data/; Johnson-Freese, *Space as a Strategic Asset*, 32; Nardon, *Satellite Imagery Control*, 32-41.

III. Decisions Under Risk

Thus far, this analysis has exclusively focused on the independent variable of systemic incentives that face China and the United States. This classical realist's approach takes into account only relative material power capabilities and assumes perfect rationality within a state's decision making apparatus. These variables set the bounds of state behavior and account for long-term trends, but their impact on foreign policy in the short and medium term is ultimately indirect and complex. Rather, systemic pressures and external variables must be translated through intervening variables at the unit level in order to undertake robust predictive analysis.[333] If statesmen in China and the United States were to correctly identify the structural security dilemma at play and trust the other to do the same, the dilemma would be relatively easy to diffuse. In a world with perfect rationality, mutual confidence building initiatives would be received well and increase the incentive for cooperation. Likewise, a tit-for-tat strategy could increase the cost of defection without risk of escalation. The zero-sum assumption crumbles under the belief that the recognition of shared goals and security for all players is not a mutually exclusive event.

However, decision makers tend to act in terms of the vulnerability they feel, which often differs from the reality of relative material power dynamics.[334] A state's subjective security demands are a compilation of psychological biases, cultural values, and historical factors that can alter the utility of outcomes described by a realist's analysis of the security dilemma.[335] A player will act rationally in the sense that is chooses the course of action that it believe provides the

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[333] Rose, "Neoclassical Realism and Theories of Foreign Policy," 146.
[334] Jervis, "Cooperation Under the Security Dilemma," 174.
[335] Arnold Wolfers, *Discord and Collaboration* (Baltimore: Johns Hopkins Press, 1962), 151-154.

greatest payoff. Whether or not their belief is in alignment with the "ideal" depends on how their perception is affected by motivated and unmotivated biases.[336] This is the basis for the neoclassical realist assumption of bounded rationality over the realist assumption of perfect rationality. Therefore, a fundamental question should be: does a perceptual security dilemma accompany the structural security dilemma?

A series of biases stemming from inherent cognitive fallacies fundamentally alters the perception of risk, reward, and probability. This leads statesmen to underestimate the extent to which their actions threaten other states, overestimate the compatibility of their own goals with an opponent's goals, and misinterpret signals from an opponent. These misperceptions exacerbate the problem at the core of the security dilemma: a player believes that the other player prefers defection, while they themselves are trying to cooperate.[337] Additionally, a series of biases stemming from a system of beliefs and cultural factors (strategic culture) alters a player's perception of utility.[338] Due to the diversity of strategic cultures among the world's states, player preferences are likely to diverge from realist predictions that measure relative material power alone. Therefore, it is imperative to account for cognitive biases and cultural belief systems in order to determine the extent to which they modify the security dilemma presented in previous chapters.[339] Furthermore, preconceptions about an opponent limit the imagination and empathy necessary for the correct appreciation of threats.[340] Conversely, a shared value system (or at least

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[336] Bonnie Triezenberg, "Deterring Space War," 21.

[337] Jervis, "Realism, Game Theory, and Cooperation," 337-338.

[338] Howard, "Strategic Culture," 1-6; Jervis, "Realism, Game Theory, and Cooperation," 340-344; Strategic culture refers to a nation's traditions, values, attitudes, patterns of behavior, habits, symbols, achievements and particular ways of adapting to the environment and solving problems with respect to the threat or use of force. This is derived from history, geography, and political culture.

[339] See Jervis, Nebow, and Stein *Psychology and Deterrence* chapters 1 & 2 for the impact of unmotivated biases on decision making in international relations.

[340] Jervis, Nebow, and Stein, *Psychology and Deterrence*, 19-22.

cultural understanding) dampens the zero-sum assumption that drives the security dilemma by causing one player to value the wellbeing of the other.[341]

A. China under Prospect Theory

A. Decisions under risk

The primary unmotivated bias that causes players to violate expected utility theory is the tendency to improperly value outcome while under risk. This is known as prospect theory, first published in 1979 by Daniel Kahneman and Amos Tversky. They found that players view outcomes in terms of deviation from a reference point, meaning that they perceive outcomes as gains or losses rather than final states. They demonstrated that players generally prefer a smaller, but more certain gain when compared to a larger, though less certain gain. Players will violate expected utility by choosing a non-optimal course of action because they value certainty, creating a loss aversion when in the domain of gains. However, when confronted with losses, the outcome is reflected. Players generally prefer to risk a larger, but uncertain loss when compared to a smaller, but more certain loss. In the domain of losses, players are violating expected utility because they become risk seeking. A function of value and gains under perfect rationality is linear. However, loss aversion in the domain of gains and risk seeking in the domain of losses, combined with the diminishing returns of both gains and losses as a player gets further away from its reference point, results in convex and concave regions of a value curve. As a player in the domain of losses moves further from its reference, it will accept increasingly high amounts of risk for the prospect of a return to the

[341] Jervis, “Realism, Game Theory, and Cooperation,” 340-342.

reference. Conversely, when a player in the domain of gains moves further from its reference, they are less likely to accept risk for an identical gain.[342]

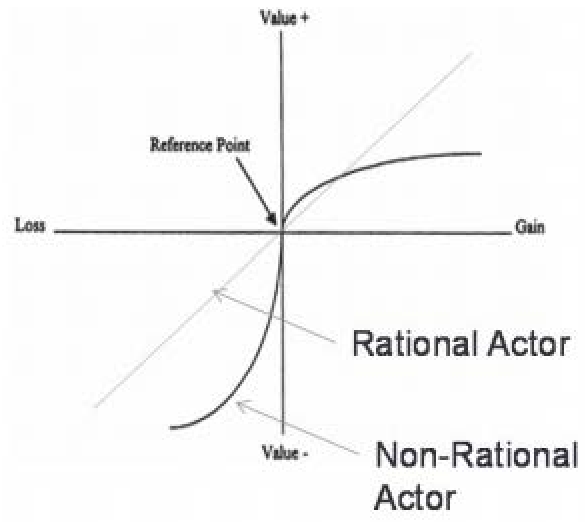

Figure 13: Value function under prospect theory. [343]

In international relations, an actor's reference point is set at the relative power status they feel entitled to, which is based on prior standing or aspirational goals.[344] The dissonance between its reference point and the current status quo will determine whether it is operating in a domain of gains or domain of losses. If an actor is satisfied with the status quo, it will be in the domain of gains. A state in the domain of gains forgoes the opportunity to improve its position (which would entail accepting additional risk), opting for the certainty of the status quo. If a state is dissatisfied with the status quo, it will be in the domain of losses. A state in the domain of losses will accept additional risk in order to improve its relative position, rather than accept the unfavorable status quo.[345] As a result, the security dilemma is

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[342] Kahneman and Tversky, "Prospect Theory," 263-291.
[343] Triezenberg, "Deterring Space War," 26.
[344] Triezenberg, 26.
[345] Jeffrey Berejikian, "A Cognitive Theory of Deterrence," *Journal of Peace Research* 39, no. 2 (2002): 173.

heightened when one or both states are in the domain of losses but dampened when both are in a domain of gains.

When structural asymmetry exists (one player being in a domain of gains and the other in a domain of losses), it results in a fundamentally unstable relationship that creates a security dilemma.[346] The dilemma can be exacerbated when there is dissonance between the structural realities of relative power and the perception of one's rightful place within the international system. The rising power believes that its newly found (or rediscovered) material power entitles it to an increased place in the international system. It is in the domain of losses seeking gains. The status quo power is hesitant to relinquish the hegemonic position and demands respect from the rising power. It is operating in the domain of gains, seeking stability. The slowly changing international system cannot incorporate the rising power into its schema rapidly enough, resulting in war between the status quo and rising power. This interplay between the structural factors of security dilemma and the psychological factors of prospect theory has been termed "Thucydidess' Trap".[347] In the last 500 years, the international system has been subjected to the dynamics of Thucidides's Trap 16 times; 12 of those incidents have resulted in a war between major powers.[348]

Applying prospect theory to the Sino-U.S. security dilemma has worrying consequences if China is in a domain of losses and the United States is in a domain of gains. This results in a very important dynamic: under prospect theory, China is incentivized to upset the status quo, while the U.S. is incentivized to maintain it. This amplifies the outcomes of a scenario

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[346] Berejikian, 176-178
[347] Allison, *Destined for War*, xiv-xx.
[348] Allison, 244-286.

where China defects and the U.S. cooperates. The security dilemma is deepened because the benefits of defection are more attractive for China and U.S. losses are exaggerated. At the same time, China's benefit from cooperation is decreased because it has little to gain from maintaining its current position. In all cases, China's incentives to defect are increased.

Without Prospect Theory

		China C	China D
U.S.	C	6,3	-5,8
U.S.	D	8, -10	-3,-1

With Prospect Theory

		China C	China D
U.S.	C	8,1	-7,10
U.S.	D	6,-6	-5, 0

Figure 14 Game under prospect theory. Prospect theory strengthens the structural security dilemma observed in Chapter II.

B. China and the "Century of Humiliation"

China has existed for millennia, less as a nation-state and more of a permanent natural phenomenon whose protected geography and unique cultural unity have resulted in a nearly continuous existence in unification. Throughout the long existence of this geographic entity, periods of disunity and turmoil were treated as an aberration.[349] Although external threats were present throughout China's history, its ability to deflect, absorb, or conquer barbarians while simultaneously maintaining unity created China's identity as an enduring, universal entity.[350] This idea, combined with its historical economic preeminence, led to the belief in China's

[349] Kissinger, *On China*, 1-7.
[350] Drohan, *A New Strategy for Complex Warfare*, 34.

centrality. China was not a civilization; it is civilization, the "Middle Kingdom" with all other societies assessed as graduations from it.[351]

It is unsurprising that Confucianism took root in this environment. Confucianism is a conservative philosophy that values recognition of hierarchy, social harmony and internal stability, observation of "correct" conduct, and a desire for isolation.[352] The Confucian philosophy is evident in Chinese diplomatic relations. China rarely engaged in balance of power diplomacy because it viewed itself as the Central Kingdom, dominating All Under Heaven. Due to this centrality, it was not required to deal with other states on the basis of equality due to its hegemonic position in East Asia.[353] Furthermore, Confucianism has pervaded all aspects of Chinese culture and is not conducive to democratic rule.[354] Rather, the sovereign possesses the "Mandate of Heaven", lost only if it shows signs of weakness and is usurped by a stronger ruler, who would then possess the same mandate.[355] Through periods of isolation, political turmoil, and chaos, the state ultimately survives and returns to equilibrium. The Cultural Revolution under Mao sought to destroy China's Confucian tradition; but today China remains Maoist in name only, while Confucian tradition is resurgent.

> He [Mao] was passionately and publicly anti-Confusion, yet he read widely in Chinese classics and was wont to quote from the ancient texts…Maoist governance thus turned into a version of the Confucian tradition through the looking glass, proclaiming a total break with the past while relying on many of China's traditional institutions, including an imperial style

[351] Kissinger, *On China*, 10-11.
[352] Johnson Freese, *The Chinese Space Program*, 14-15.
[353] Kissinger, *On China*, 16-17.
[354] Joan Johnson Freese, *The Chinese Space Program*, 23-24.
[355] Thomas Drohan, *A New Strategy for Complex Warfare*, 25.

of governance; the state as an ethical project; and a mandarin bureaucracy that Mao loathed, periodically destroyed, and in the end, equally periodically was obliged to re-create.[356]

The latest era of turmoil and uncertainty began with The First Opium War. It ushered in a 110 year era between 1839 and 1949 where Western military and diplomatic advantage allowed for unprecedented imperialist intervention in China, known as the "century of humiliation". Military superiority allowed Western diplomats to impose a series of unequal trade agreements, resulting in the opening of Chinese markets to foreign trade. These treaties contradicted the idea that China was the Central Kingdom and all other states are tributaries within China's sphere of influence. Furthermore, foreign intervention led to the erosion of Chinese territorial integrity. Treaties with Western nations forced cession of a number of territories, including Hong Kong; Japanese military invasion led to China losing control over parts of Manchuria and Taiwan; and independence movements in Tibet, Mongolia, and Xinjiang led to further reductions in China's territory. Additionally, this era was punctuated with severe internal turmoil that destroyed the traditional imperial government and killed millions.[357] Western imperialism in China was not focused on territorial conquest, nor did it seek to administer Chinese territory, but it did force China to accept a world order fundamentally incompatible with its existing one.[358] China was no longer the Middle Kingdom, but a tributary of the West. During the century of humiliation, China became far removed from its historic reference point as the Middle Kingdom.

[356] Kissinger, *On China*, 95.

[357] Testimony of Alison Kaufman, "The 'Century of Humiliation' and China's National Narratives," (Washington: U.S.-China Economics and Security Review Commission, March 10, 2011), 1.

[358] William Callahan, "National Insecurities: Humiliation, Salvation, and Chinese Nationalism," *Alternatives* 29, no. 2 (2004): 207; Kissinger, On China, 57.

The Century of Humiliation ended with national unification under Mao. Since then, China's economy has experienced massive growth, surpassing the U.S. as the world's largest economy by many metrics.[359] Despite this meteoric return to economic preeminence and an apparently stable internal hierarchy, China remains far from this historical reference point. The legacy from the Century of Humiliation remains deeply ingrained in the Chinese consciousness: "China is often portrayed as having suffered three kinds of loss during the Century of Humiliation: a loss of territory; a loss of control over its internal and external environment; and a loss of international standing and dignity. Each of these represents an injustice to be rectified."[360] CCP leaders are aware of China's tenuous internal balance and capacity for swift and radical change.[361] Thus, rectifying these injustices, along with continuing economic prosperity, remains at the core of the CCP's social contract.[362] The CCP has portrayed itself as the protector of China against Western interference and the driver of its economic success.[363] A new nationalist narrative (driven by the Central Propaganda Department) has emerged that is less about celebrating China's strength than commemorating its weakness; it is based in restoring China as a nation worthy of the designator "Middle Kingdom" and reclaiming the rightful place of China in the international system.[364] For this reason, China can be said to operate in a domain of losses seeking gains.

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[359] Graham Allison, *Destined for War*, 3-24.
[360] Kaufman, "The 'Century of Humiliation' and China's National Narratives," 4.
[361] Joan Johnson Freese, *The Chinese Space Program*, 23.
[362] Allison. *Destined for War*, 107-113.
[363] Kaufman, "The 'Century of Humiliation' and China's National Narratives," 3.
[364] Peter Gries, "A 'Century of Humiliation'," in *China's New Nationalism: Pride, Politics, and Diplomacy* (Berkeley: University of California Press, 2004), 52-53; Callahan, "National Insecurities," 214.

C. Chinese Space Program and Techno-nationalism

Although utilization of the space domain is a recent phenomenon when compared to the ancient Chinese empire, this does not preclude Sino-U.S. space competition from the tenants of prospect theory. Rather, similar patterns can be identified in Sino-U.S. space relations because it is an essential marker of national technological, economic, and military capabilities. Not only does a vibrant space program yield significant material advantage, it demonstrates a nation's ability to mobilize its science and technology infrastructure for a unified purpose and advances a clear nationalist narrative.[365] A 2016 white paper on China's space activities stated that a cornerstone of Chinese space policy was "to provide strong support for the realization of the Chinese Dream of the renewal of the Chinese nation."[366] Not only is the development of China linked to that of its space program, China aims to become a space power that can compete with the United States and Russia. In his 2016 Space Dream speech, president Xi Jinping expressed that China aspires to become a space giant, an aerospace power.[367] There is good evidence that China is using the development of its space program to rectify its losses during the Century of Humiliation.[368] Although Chinese scientists and bureaucrats may not be in agreement as to the primary goal of the program, they agree that all three losses are addressed by the Chinese space

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[365] McDougall, *The Heavens and the Earth*, 178, 317-324.

[366] White Paper, "China's Space Activities 2016," People's Republic of China, Information Office of the State Council, December 27, 2016.

[367] Unattributed, "Make China a Global Space Giant: Xi Jinping," *Economic Times*, April 24, 2016, https://economictimes.indiatimes.com/news/international/world-news/make-china-a-global-space-giant-xi-jinping/articleshow/51967279.cms.

[368] Loss of territory; a loss of control over its internal and external environment; and a loss of international standing and dignity. These "losses" impacted both quantifiable measures of national power (GDP, military strength, ext.) and Chinese psychology. See Namrata Goswami, *China in Space: Ambitions and Possible Conflict* for the link between rectifying the losses of the "Century of Humiliation" and the space program.

program.[369] First, China's civilian space program is a powerful soft power tool used to improve its international standing. Second, China's ambitious space exploration plans can be related to its expansionism, territoriality and resource nationalism in the terrestrial domain. Third, ambitious space exploration achievements would give China legitimacy to reshape international norms. Fourth, the focus on space weapons development may be an attempt to generate a RMA to upset the status quo of U.S. military superiority.

a. Spaceflight and National Prestige

Although many milestones of the Chinese space program were first accomplished by the U.S. and Soviet Union during the Cold War, China has adopted a series of ambitious space policy objectives designed to prove that China is Asia's science and technology leader, and that they are able to compete on the international stage.[370] In particular, China is pursuing manned spaceflight milestones as an instrument of soft power. These profoundly public demonstrations are valuable in terms of displaying regional leadership, improving China's reputation in the field of high technologies, and attracting young engineering talent.[371] China's civilian space program has two notable advantages. First, it spends $2-3 billion annually (0.05% of GDP), compared to NASA's yearly budget of $19 million (0.10% of GDP).[372] The notable spending indicates that China's accomplishments have occurred at a discounted rate and, as long as China's economy continues to grow, budgets have room to expand as well. Second, due to the continuity of CCP

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[369] Namrata Goswami, "China in Space: Ambitions and Possible Conflict," *Strategic Studies Quarterly*, Spring 2018 (2018): 77-80.

[370] Seedhouse, *The New Space Race*, 7; Moltz, *Asia's Space Race*, 103.

[371] Max Grimard, "Will the US Remain the Real Leader of Human Space Exploration? A Comparative Assessment of Space Exploration Policies," *Acta Astronautica* 75, June-July 2012 (2012): 1-14.

[372] Peter Gwynne, "China's Space Ambitions," *Research-Technology Management* 61, no.3 (2018): 1.

leadership, China is able to utilize consistent policy, long-term planning, and incremental development, which are requisite for a successful space program.[373]

The power of incrementalism has been evident in the last decade as each major milestone has served as a building block for the program. The first Chinese astronaut was launched in 2003 aboard the Shenzhou-5 (manned crew capsule). The nation's first spacewalk occurred in 2008 aboard the Shenzhou-7. In 2012, the Shenzhou-9 docked with the Tiangong-1 (prototype space station) in order to demonstrate docking/undocking capability requisite for shuttling crews to and from a space station.[374] October 2016 witnessed the docking of the Shenzhou-11 and the Tiangong-2, followed by a 30 day stay by Chinese astronauts that demonstrated the ability to assemble a station and support continual habitation that is projected to begin in 2022.[375] China's 5 year goals outlined in the 2016 space white paper have been mostly achieved. The Tianzhou-1 (automated resupply capsule) conducted a series of tests with the Tiangong-2 that demonstrated the ability to resupply astronauts during their stay.[376] However, the rocky development of a heavy launch capability may postpone the entire deep space exploration, interplanetary, and manned spaceflight programs. An initial flight of the Long March 5 (heavy launch vehicle) in November 2016 was successful, but was followed by a notable setback when a July 2017 launch

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[373] Patrick Besha, "Policy Making in China's Space Program: A History and Analysis of the Chang'e Lunar Orbiter Project," *Space* Policy 26 (2010), 214-221; Grimard, "Will the US Remain the Real Leader of Human Space Exploration?" 12.

[374] Jonathan Amos, "Shenzhou-9 docks with Tiangong-1," *BBC News*, June 18, 2012, https://www.bbc.com/news/science-environment-18481806.

[375] Jeff Foust, "China's Shenzhou-11 Docks with the Tiangong-2 Module for Month-long Stay," *SpaceNews*, October 19, 2016, https://spacenews.com/chinas-shenzhou-11docks-with-the-tiangong-2-module-for-month-long-stay/; "China's Shenzhou 11 Docks at Tiangong 2 Space Station," *BBC News*, October 19, 2016, https://www.bbc.com/news/world-asia-china-37700404; Andrew Jones, "Backgrounder: China's Tiangong-2 Space Lab," *GBTimes*, September 15, 2016, https://gbtimes.com/backgrounder-chinas-tiangong-2-space-lab.

[376] Stephen Clark, "China's Tianzhou-1 Supply Vehicle Re-enters Atmosphere," *Spaceflight Now*, September 22, 2017, https://spaceflightnow.com/2017/09/22/chinas-tianzhou-1-supply-vehicle-re-enters-atmosphere/.

experienced a first stage failure.[377] The success of the return-to-flight scheduled for 2019 will likely determine the timelines for a mission to Mars originally scheduled for 2020, a lunar sample return mission slated for 2019, and the assembly of the Chinese space station.[378] It may also determine the fate of the Long March 9 (Saturn V class booster), which is planned to conduct Martian sample return missions, manned lunar landings, and support the space solar power program.[379]

The relentless forward progress of the Chinese civilian space program demonstrates the dedication of CCP leadership to the program thus far. Watching their reaction to inevitable failures and delays in the program will be essential in gauging long-term dedication to competing with the U.S. It is clear that if CCP leadership maintains the prioritization of these programs through inevitable technical failures, cost overruns, and periods of economic uncertainty, they may very well supplant the United States as the world's premier space power.[380] U.S. policy makers should take Chinese timelines seriously, as well as gauge their geoeconomic ramifications, considering the consistency with which the Chinese space program has met its stated goals over the last half century.[381]

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[377] Andrew Jones, "China Reveals Cause of Long March 5 Failure; Lunar Sample Mission to Follow Return-to-Flight," *Space News*, April 16, 2018, https://spacenews.com/china-reveals-cause-of-long-march-5-failure-lunar-sample-mission-to-follow-return-to-flight/.

[378] Andrew Jones, "Chinese Long March-5 Heavy-lift Launcher Ready for January 2019 Comeback Flight," *GB Times*, October 09, 2018, https://gbtimes.com/chinese-long-march-5-heavy-lift-launcher-ready-for-january-2019-comeback-flight.

[379] Andrew Jones, "China Reveals Details for Super-Heavy Long March-9 and Reusable Long March-8 Rockets," *Space News*, July 5, 2018, https://spacenews.com/china-reveals-details-for-super-heavy-lift-long-march-9-and-reusable-long-march-8-rockets/.

[380] Ma Chi, "China Aims to be World-Leading Space Power by 2045," *China Daily*, November 11, 2017, http://www.chinadaily.com.cn/china/2017-11/17/content_34653486.htm; Bai Yang, "China to Become World Space Power by 2045," *People's Daily*, October 22, 2017, http://en.people.cn/n3/2017/1022/c90000-9283262.html.

[381] Namrata Goswami, "China in Space," 87-89; Nichole Kobie, "The Epic Tale of China's Out of This World Plan for Space Domination," *Wired*, September 29, 2018, https://www.wired.co.uk/article/china-space-moon-base-mars-landing.

b. Resource Nationalism

Resource nationalism is a state-led effort to exhibit mercantile control of natural resources through export restrictions, extraction control, taxation, and resource exploration, with the expressed intent of benefiting one's own geoeconomic position. This is broadly brought about by increased resource demand caused by growing populations and industries, uneven distribution of resources, and an uncertain global trade environment.[382] Being the largest mining economy in the world, China has had the opportunity to engage in resource nationalism through targeted export restriction and heavy resource extraction in the Tibetan region.[383] China's expanded resource extraction efforts in the South China Sea go hand-in-hand with its claims of national sovereignty in the region.[384] Apart from its sovereignty claims, China has been aggressively exploring the international resource extraction market, with emphasis on Africa, South America, and the Arctic.[385] Given China's assertive behavior with regard to "lost territories," intertwined with the idea of national resources, it is possible that China's quest for space-based resources would be informed by a similar logic.[386]

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[382] A Horizon Scanning Research Paper, "Resource Nationalism," (London: Horizon Scanning Programme, Resources Demand and Supply Resource Nationalism Community of Interest, December 2014), 2.

[383] John Childs, "Geography and Resource Nationalism: A Critical Review and Reframing," *The Extractive Industries and Society* 3, no. 2 (2016): 541.

[384] James Manicom, "Resource Development in the East China Sea, 2005-2008," in *Bridging Troubled Waters: China, Japan, and Maritime Order in the East China* Sea (Washington: Georgetown University Press, 2014), 128-131; Joshua Kurlantzick, "South China Sea: From Bad to Worse," *Counsel on Foreign Relations*, July 23, 2012, https://www.cfr.org/expert-brief/south-china-sea-bad-worse; Buo Xi, "The South China Sea Case and China's New Nationalism," *The Diplomat*, July 19, 2016, https://thediplomat.com/2016/07/the-south-china-sea-case-and-chinas-new-nationalism/.

[385] Anne-Marie Brady, China's Rise in Antartica?" *Asian Survey* 50, no. 4 (2010): 759-761; Anne-Marie Brady, *China's Expanding Antarctic Interests: Implications for New Zealand* (Small States and the New Security Environment, Research Project Policy Briefs, 2017), 1-20); Eleanor Albert, "China in Africa," *Council on Foreign Relations*, July 12, 2017, https://www.cfr.org/backgrounder/china-africa; Joseph Biden et al., *China's Foreign Policy and 'Soft Power' in South America, Asia, and Africa*," Report to Congress (Washington: Committee on Foreign Relations, United States Senate, April 2008), 4-5.

[386] Namrata Goswami, "China in Space," 77-80.

With recent advances in space technology, space may be the next location of a resource scramble.[387] Given heavy initial investment and two decades to establish an asteroid mining infrastructure, it is possible to make a very lucrative profit and significantly impact the world's supply of platinum group metals (PGMs). This is of significant note as earth-based resources become increasingly scarce.[388] Effective space mining operations from even a single asteroid could have disruptive effects on the global iron, nickel, PGM, and precious metal economies, especially if that supply is controlled by a single state.[389] A small bastion of China experts believe that its exploration and exploitation of space will mirror its resource extraction initiatives on earth, that current space science efforts are heavily biased towards exploring and exploiting natural resources in near earth objects and the moon.[390] They argue the manned space program is building towards a permanent presence on the moon, which would serve as a focal point for the expansion of resource extraction efforts. [391] Mining the moon itself is unlikely to prove profitable.[392] However, given a large scale operation, in-situ resource utilization (ISRU) from the moon can significantly reduce the cost of asteroid mining efforts in the long term through propellant synthesis.[393] Additionally, the utilization of lunar ISRU could be a viable (even cost

[387] Childs, "Geography and Resource Nationalism," 543.

[388] Dana Andrews et al., "Defining a Successful Commercial Asteroid Mining Program," *Acta Astronautica* 108, March-April 2015 (2015): 116-118.

[389] Shane Ross, Near-Earth Asteroid Mining (Control and Dynamical Systems Space Industry Report, 2001), 5-6.

[390] Namrata Goswami, "China in Space," 85-87. John Bellflower, "The Influence of Law on Command of Space," *Air Force Law Review* 65 (2010), 138-143. Bellflower makes the argument that China's expansion of maritime sovereignty claims are mirrored in their expansion of outer space sovereignty claims.

[391] Peter O'Dowd, "China Wants To Establish A Base on the Moon, Space Program Expert Says," *NPR: Here & Now*, Interview, January 04, 2019, https://www.wbur.org/hereandnow/2019/01/04/china-us-space-program-lunar-landing.

[392] Ross, "Near-Earth Asteroid Mining," 9-10.

[393] Hoki Ho et al., "Dnamic Modeling and Optimization for Space Logistics Using Time-Expanded Networks," *Acta Astronautica* 105, no. 2 (2014): 442.

saving) alternative to NASA's Human Exploration of Mars Design Reference Architecture for manned lunar expeditions.[394]

The Chinese lunar program (Chang'e) has made great progress in the last decade. The Chang'e-2, launched in October 2010, conducted a flyby of an asteroid and surveyed the lunar surface for future missions.[395] In 2013 the Chang'e-3 was the first spacecraft since the Soviet Luna-24 mission in 1976 to conduct a soft landing on the moon. Although the lunar rover was only partially successful, it was a significant step in the Chinese lunar program.[396] The program matched its goal of landing the Chang'e 4 lunar probe on the far side of the moon, which was outlined in the 2016 white paper.[397] This success prompted the revelation of a more ambitious plan to launch at least four additional lunar probes, plans for the construction of a moon base, and confirmation that the projected 2020 Mars probe was still on schedule.[398] Ye Peijian, chief commander and designer of China's lunar exploration program, announced plans to capture an asteroid and bring it into lunar orbit by 2020 with the expressed intent of mining.[399] Establishing a lunar base, mining asteroids, and establishing a presence on Mars are three simultaneous,

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[394] Ishimatsu Takuto, "Generalized Multicommodity Network Flow Model for the Earth–Moon–Mars Logistics System," *Journal of Spacecraft and Rockets* 53, no. 1 (2016): 25-38.

[395] From: "Sharing Earth Observation Resources, Chang'e-2," European Space Agency, https://earth.esa.int/web/eoportal/satellite-missions/c-missions/chang-e-2

[396] From: "Sharing Earth Observation Resources, Chang'e-3 Moon-landing Mission," European Space Agency, https://earth.esa.int/web/eoportal/satellite-missions/c-missions/chang-e-3

[397] White Paper, "China's Space Activities 2016;" Steven Myers and Zoe Mou, "New Chapter in Space Exploration as China Reaches Far Side of the Moon," *The New York Times*, January 02, 2019, https://www.nytimes.com/2019/01/02/world/asia/china-change-4-moon.html.

[398] Yang Yi, "China Unveils Follow-up lunar Exploration Missions," *Xinhau*, January 14, 2019, http://www.xinhuanet.com/english/2019-01/14/c_137743306.htm; Sarah Kaplan, Gerry Shih, and Rick Noack, "China Lands Spacecraft on the Far Side of the Moon, a Historic First," *The Washington Post*, January 3, 2019, https://www.washingtonpost.com/science/2019/01/03/china-lands-spacecraft-far-side-moon-historic-first/?utm_term=.b12cb0b27b18; Lifang, "China Focus: Flowers on the Moon? China's Chang'e-4 to Launch Lunar Spring," *Xinhua*, April 12, 2018, http://www.xinhuanet.com/english/2018-04/12/c_137106440.htm.

[399] Stephen Chen, "China Plans Ambitious Space Mission to Hunt and Capture Asteroids by 2020," *South China Morning Post*, June 12, 2017, https://www.scmp.com/news/china/policies-politics/article/2093811/china-plans-ambitious-space-mission-hunt-and-capture.

interrelated lines of effort; therefore, it remains to be seen whether China's lunar focus is a base for resource nationalism, a jumping off point for more prestige oriented missions to Mars, or both. However, both are consistent with the risky, speculative, but high payoff projects expected of a power that is in the domain of losses seeking gains.

c. The New Space Law Régime

> Compared with economic and military heft, institutional power takes time to cultivate. As China produces ever more scientists, academics, and professionals who operate at the cutting edge of their fields, increasing numbers of these individuals will take on positions of influence in institutions around the world and even create institutions of their own. China's ability to influence the regional and global discourse on a wide range of issues will increase correspondingly. In areas like cyber and space, where international norms have yet to be settled upon, this growth in institutional soft power will be particularly valuable.[400]

This is especially true concerning space law and policy, whose development was essentially a continuation of U.S. Cold War strategy. The space law régime maintained the delicate balance of power between the Soviet Union and the United States, allowing for the seamless incorporation of another competitive domain into the context of great power competition. Therefore, U.S. space strategy was aimed at the establishment of a legal regime that complemented the American propaganda line of openness and cooperation. It simultaneously preserved American freedom to pursue military missions in space that were needed to protect and perfect the nuclear deterrent.[401]

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[400] Mikail Kalimuddin and David Anderson, "Soft Power in China's Security Strategy," *Strategic Studies Quarterly* 12, no. 3 (Fall 2018), 135.

[401] McDougall, *The Heavens and the Earth*, 178.

The use of the word “peaceful” rather than “nonmilitary” allowed for widespread use of military space assets, which was essential for maintaining the deterrent balance during the Cold War.[402] The Committee on the Peaceful Uses of Outer Space (COPUOS) became dominated by the U.S. and Soviet Union, and has been effective in keeping the space law régime favorable to the major powers.[403] The initial development of space law was not intended to be a boon for collective humanity, rather it began as an instrument for great powers to maintain the global status quo. Although China has recently acquired the means to compete with the United States and Russia as a great spacefaring power, there are vestiges in current international law that run counter to China’s interest. This may not have been the case if China had been given a stake in its development.[404] The debate over the concept of *res communis* in space law is an example of the consternation this has caused between less developed countries and the major spacefaring powers (i.e. the United States and Soviet Union).[405] Recent technological advancement and a changing geopolitical environment has led to debate about the fundamental soundness of the OST.[406]

In addition to China having very little say in the current space law régime, it has also been isolated by U.S. space policy. The perception that China intends to use space technology

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[402] McDougall, 189-191

[403] McDougall, 185.

[404] Particularly on the issue of space weaponization and militarization.

[405] From conference proceedings by: J.I. Gabrynowicz, “The ‘Province’ and ‘Heritage’ of Mankind Reconsidered: A New Beginning,” (Houston: NASA, The Second Conference on Lunar Bases and Space Activities of the 21st Century, 1992), 691-695; The major spacefaring powers define res communis in space along the lines of “province of all mankind” outlined in the OST as opposed to the less developed countries’ definition of “common heritage of mankind” contained in the moon agreement. Province infers the sharing of knowledge rather than resources. The major spacefaring powers have held fast to this definition.

[406] Adam Quinn, “The New Age of Space Law: The Outer Space Treaty and the Weaponization of Space,” *Minnesota Journal of International Law* 17, no. 2 (Summer 2008), 487-496. Quinn argues that the OST’s breadth has undermined its strength, with too much language being left up for interpretation; that, with recent militarization of national space policy, the OST is no longer relevant to modern space policy; with technological advances, the OST is not capable of integrating the inevitable weaponization of space gracefully; and it lacks flexibility, which is important considering the rise of space privatization and proliferation of spacefaring nations.

largely for military purposes has undermined its reputation and role as a responsible space actor in the international community. Its reputation is largely responsible for a series of export control measures by the United States that have resulted in a bottleneck in China's efforts to expand its space cooperation.[407] The first major blow to cooperative efforts between China and the U.S. occurred in the reactionary wake of the factually dubious 1999 Cox Committee Report and the 1998 Report of the Commission to Assess the Ballistic Missile Threat to the United States.[408] This effort has resulted in China developing indigenous technologies, creating a market for ITAR free products, and creating a new generation of Chinese intellectuals resentful and suspicious of the U.S.[409] However, bilateral efforts were beginning to produce civilian space cooperation until 2011, when a House bill prevented congressionally appropriated funds from being used by NASA or the White House Office of Science and Technology Policy "to develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China".[410] This rendered Sino-U.S. cooperation essentially nonexistent and eliminated the possibility of Chinese participation with the ISS program, which they would have readily accepted.[411]

That being said, China's own policy decisions are mixed in regards to international cooperation. China's 2007 DAASAT test either indicated that it does not fundamentally understand the risk that kinetic ASAT weapons pose to the continued use of space, that it simply

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[407] Xiaodan Wu, "China and Space Security: How to Bridge the Gap Between its Stated and Perceived Intentions," *Space Policy Journal* 33, no 1 (2015): 21.

[408] Joan Johnson –Freese, "China's Space Ambitions: It's Not All About the U.S.," *Georgetown Journal of International Affairs* 15, no. 1 (2014): 142-143.

[409] Gregory Kulacki, "US and China Need Contact, Not Cold War," *Nature* 474 (2011): 444-445.

[410] Kulacki, 444.

[411] Kobie, "The Epic Tale of China's Out of this World Plan for Space Domination"; Wu, "China and Space Security," 28.

did not care about the risk to the space domain, or that the civilian leadership is disconnected from PLA decision making. The inconsistency and opaqueness of China's space policy decision making stymies international outreach. Furthermore, military control of civilian space program is problematic for China's space science community when it seeks to build lasting relationships with other spacefaring nations. These factors make China a difficult target for transparency and confidence-building measures (TCBMs) that could set the basis for a mutually beneficial space law régime. Also, China has arguably violated the spirit of the OST with its 2006 lasing of a NRO payload or its 2007 ASAT test. Therefore, any concessions that the U.S. makes while renegotiating its space policy with regards to China should seek to increase China's transparency, reduce the role of the PLA in its civilian space program, and ensure non-interference with U.S. space assets.

At the same time, China has demonstrated that it is willing to work within the framework of the existing international space law regime and utilize established methods of introducing and changing international space law. The development of Chinese domestic space law looks towards international law and the law of other states (the United States particularly) for precedent.[412] China has sought an active role in the international space community. Its 2016 white paper stated the desire for cooperation and peaceful development and it has been an important participant in the UNCOPUOS and the Conference on Disarmament (CD).[413] China

[412] Xiaodan Wu, "China's Space Law: Rushing to the Finish Line of its Marathon," *Space Policy Journal* 46, November 2018 (2018): 40-41; Li Juqian, "Progressing Towards New National Space Law: Current Legal Status and Recent Developments in Chinese Space Law and Its Relevence to Pacific Rim Space Law and Activities," *Journal of Space Law* 439 (2009): 439-469.

[413] White Paper, "China's Space Activities 2016." "China persists in combining independence and self-reliance with opening to the outside world and international cooperation. It actively engages in international exchanges and cooperation on the basis of equality and mutual benefit, peaceful utilization, and inclusive development, striving to promote progress of space industry for mankind as a whole and its long-term sustainable development."

and Russia jointly submitted the Draft Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat of Force against Outer Space Objects (PPWT) to bring the letter of international law more in line with the spirit of the OST.[414] The PPWT failed to garner U.S. support because it did not ban ground-based ASATs, which led to concern that it was a method for China and Russia to gain military advantage over the U.S.[415] Although this effort failed, it served to revive the debate about a treaty on the Prevention of an Arms Race in Outer Space (PAROS) and serves as an example of China working within the current space law régime to achieve policy goals.[416] Although the purpose of the PPWT was to paint China and Russia in a positive light and highlight the U.S.'s militarization of space, the fact that China introduced the legislation through the established legal framework rather than taking unilateral or bilateral action is significant.

China's willingness to interact with the current space law régime can be attributed to the regime's weakness, rather than its representativeness of China's interests. The most important ramification of the weak space law régime is the opportunity for China to set customary international law or, at the very least, guide the interpretation of existing law as it is applied to new space exploration milestones. The prevailing interpretation of the OST has defined the ambiguous "peaceful purposes" to mean non-aggression rather than non-militarization. This has resulted in the United States gaining military freedom of action in the domain and has raised

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[414] Jinyuan Su, "The Peaceful Purposes Principle in Outer Space and the Russia-China PPWT Proposal," *Space Policy* 26, no. 2 (2010): 81-90.

[415] Fabio Tronchetti, "Preventing the Weaponization of Outer Space: Is a Chinese-Russian-European Common Approach Possible?" *Space Policy* 27, no. 2 (2011): 84.

[416] Hao Liu and Fabio Tronchetti, "United Nations Resolution 69/32 on the 'No First Placement of Weapons in Space': A Step Forward in the Prevention of an Arms Race in Outer Space?" *Space Policy* 38, (2016), 66-67; See Nuclear Threat Initiative, "Proposed Prevention of an Arms Race in Space (PAROS) Treaty," https://www.nti.org/learn/treaties-and-regimes/proposed-prevention-arms-race-space-paros-treaty/.

worries about the U.S.'s desire to dominate space through weaponization.[417] Similarly, international law is notably ambiguous and open to interpretation concerning space mining and resource utilization.[418] This represents an opportunity to work within the current system to produce an outcome consistent with China's long-term goals.[419] Due to the rapid technological advancements in space, the codified space law régime often does not adapt to keep pace with international practices; rather, established practices often precede and inform the creation of international law.[420] China has the opportunity to shape international space law if it can jump to the forefront of space exploration, particularly if it is able to be the first to conduct ISRU or space mining. Considering this, a space race may be less about prestige and more about reshaping international space law, an undeniably appealing prospect to a nation in the domain of losses.

d. Space Weapons for a Revolution in Military Affairs

RMAs occur when a transformational technology accompanied by sound tactics, organization, strategy, leadership, training, and national infrastructure produces an innovative warfighting approach that has a disruptive effect on the current military paradigm.[421] Revolutionary organizations and weapons that have low financial/high organizational cost are

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[417] Blair Kuplic, "The Weaponization of Outer Space: Preventing and Extraterrestrial Arms Race," *North Carolina Journal of International Law and Commercial Regulation* 39, no. 4 (Summer 2014), 1144-1152.

[418] Virginie Blanchette-Seguin, "Reaching for the Moon: Mining in Outer Space," *Journal of International Law and Politics* 49 (2017): 959-969; Scot Anderson, Korey Christensen, and Julia La Manna, "The Development of Natural Resources in Outer Space," *Journal of Energy and Natural Resources Law* (2018): 12-15.

[419] Liu Hao and Fabio Tronchetti, "Should the Red Dragon Arise? Assessing Chinas Options Vis-à-vis the Enactment of a Domestic Space Resource Utilization Law," *Space Policy* 39-40, May 2017 (2017): 10.

[420] Vladlen Vereshchetin and Gennady Danilenko, "Custom as a Source of International Law of Outer Space," *Journal of Space Law* 22 (1985): 31-35.

[421] Max Boot, *War Made New: Weapons, Warriors, and the Making of the Moddern World* (New York: Gotham Books, 2006), 7-16.

particularly dangerous to the existing status quo.[422] The PLA was profoundly impacted by the U.S. military's integration of information systems to produce battlefield effects, starting with the Gulf War. The common consensus was that the U.S. had ushered in a RMA that could not be ignored when building a 21st century military.[423] Luckily for China, these paradigm shifting observations came at a time when the PLA was beginning rapid military modernization and revitalization enabled by massive economic growth. The PLA officers overseeing this transition witnessed the late-20th century American military at its most effective during a critical point of their professional development. These officers realized that a facsimile of the American way of war was untenable. Rather, they are developing weapons, organizations, and doctrine that seek to avoid American shortcomings and adapt Chinese strategic culture for information warfare.[424] Therefore, the threat that China may pose to American military superiority lies not in replication of currently employed tactics, but in their disruption. Chinese military doctrine designed to produce this disruption is focused on system-versus-system warfare in multiple domains. Its goal is to wage decisive, preemptive war using asymmetric weapons to attack enemy information systems in order to create a temporary, localized advantage, enabling the accomplishment of

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[422] Triezenberg, "Deterring Space War," 29-31.

[423] Timothy Thomas, *The Dragon's Quantum Leap*, 10, 28; For more on revolutions of military affairs see *War Made New: Weapons, Warriors, and the Making of the Modern World*, specifically chapter 10 on the First U.S.-Iraq War. The air campaign devised by Chuck Horner was essentially an integrated air defense system (IADS) rollback area access strategy adapted and made much more effective utilizing command, control, communications, and intelligence (C^3I) systems. In particular; NAVSTAR GPS was used to guide troop movements and conduct precision strike bombing; air and space overhead reconnaissance systems were used to conduct battlefield characterization and battle damage assessment; and OPIR were used to provide early warning from and targeting of enemy ballistic missiles. These technologies, fielded in the wake of difficulties in Vietnam and a numerically superior Soviet army, served as a proof of concept for information warfare, resulted in a thorough defeat of Iraqi forces, and ushered in the 21st century concept of operations (CONOPS) that would later be refined during the Global War on Terror.

[424] Thomas, 19-36.

political objectives. The implementation of sophisticated, high-tech space weapons and evolved space doctrine are a large piece of fighting an informationalized war.[425]

A white paper on China's Military Strategy, published in 2015, was prefaced by the importance of RMA.

> The world RMA is proceeding to a new stage. Long-range, precise, smart, stealthy and unmanned weapons and equipment are becoming increasingly sophisticated. Outer space and cyber space have become new commanding heights in strategic competition among all parties. The form of war is accelerating its evolution to informationization. World major powers are actively adjusting their national security strategies and defense policies, and speeding up their military transformation and force restructuring. The aforementioned revolutionary changes in military technologies and the form of war have not only had a significant impact on the international political and military landscapes, but also posed new and severe challenges to China's military security.[426]

The white paper calls for a logistics modernization in order to mobilize national resources, development of innovative weapons through thorough civil-military integration, reformed training of military personnel, and the development of doctrine and strategy that focuses on a dynamic operating environment and capability integration.[427] These are all key ingredients of a RMA. China has sought to make organizational changes in order to support this military

[425] Dean Cheng, *U.S.-China Competition in Space* (Washington: The Heritage Foundation, 2016), 1-17; Allison, *Destined for War*, 163; Pillsburry, "The Sixteen Fears," 159-160; Thomas, *The Dragon's Quantum Leap*, 199, 204, 215, 243; Specific weapons and doctrine were covered at length in Section II.

[426] White Paper "China's Military Strategy 2015," People's Republic of China, Information Office of the State Council, May 27, 2015.

[427] White Paper "China's Military Strategy 2015."

strategy; shortly after the 2015 white paper was published, a major organizational restructuring took place within the PLA.[428] As a part of this restructuring, the Strategic Support Force (SSF) was created, a force which has no analog in the U.S. Military. Rather, it combines space, cyberspace, psychological, and electronic warfare into a unified force that conducts technology development, recruitment, and training for all three mission areas.[429] This reorganization enables the doctrine of system-versus-system warfare and is consistent with an active defense strategy.[430] Overall, the SSF represents a revolutionary reorganization that could produce a significant disruption, but whose efficacy has yet to be tested.

B. Availability

During the decision making process, humans engage in shortcuts, judgements, and substitutions (known as heuristics) in order to simplify complex systems. Using heuristics leads to systematic errors, which in turn create biases.[431] One bias observed under prospect theory is the tendency to overestimate small probabilities, which leads to overweighting the effect of rare events in decision making.[432] Kahneman and Tversky suggest that the major mechanism at fault for this bias is the availability heuristic.[433] This heuristic relies on human beings estimating the frequency of an event based on the ease with which similar events may be recalled. Events that are easy to construct or imagine will be perceived as occurring more frequently than those that

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[428] Pollpeter et al, *The Creation of the PLA Strategic Support Force*, 14.

[429] John Costello and Joe McReynolds, *China's Strategic Support Force: A Force for a New Era*, ed. Phillip Saunders (Washington DC, Institute for National Strategic Studies, National Defense University Press, October 2018), 1-55.

[430]Costello and McReynolds, 44-48.

[431] Daniel Kahneman, *Thinking Fast and Slow* (New York: Farrar, Straus, and Giroux, 2011), 129-131

[432] Kahneman and Tversky, "Prospect Theory," 280-284; Kahneman, *Thinking Fast and Slow*, 322-333.

[433] Amos Tversky and Daniel Kahneman, "Judgment under Uncertainty: Hursitics and Biases," *Science* 185, no. 4157 (1974): 1124-1130.

are more difficult to recall.[434] Therefore, events with high emotional intensity, or whose memory is recalled with high frequency of repetition, become more available, resulting in an overestimation of the probability of their occurrence. An American policy maker whose academic education included frequent exposure to the Japanese attack on Pearl Harbor, and who can vividly recall Al-Qaeda's attacks on September 11, 2001, may be prone to overestimating the frequency of these kind of catastrophic events.[435]

Likewise, associative strength within a class of events can alter the judgement of an event's frequency. When similarity exists between a highly available event in the past and a case under current consideration, there is a tendency to correlate the events. This leads to the expectation that what has happened in the past will reoccur.[436] In addition to frequency or intensity of recall, availability is increased when associative bonds are formed between two events. For example, 9/11 and Pearl Harbor are naturally simplified and grouped together despite significant differences. This leads to an increased likelihood that current conditions will be judged as a precursor to this class of event. When policy makers ignore the actual probability of an event occurring (base rate) due to heuristics, they are likely to judge others as having intentions that are rare or anticipate events that are very unlikely.[437] In turn, they are likely to take measures (buy insurance) to reduce the probability that an undesirable event will occur.[438] This can take the form of a buildup in latent military capability or forming alliances, which often have a paradoxical effect.

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[434] Amos Tversky and Daniel Kahneman, "Availability: A Heuristic for Judging Frequency and Probability," *Cognitive Psychology* 5, no. 2 (1973): 207-211.

[435] Kahneman, *Thinking Fast and Slow*, 137-145.

[436] Tversky and Kahneman, "Availability," 223-228.

[437] Jervis, Nebow, and Stein, *Psychology and Deterrence*, 22-24.

[438] Kahneman and Tversky, "Prospect Theory," 269-271.

The United States is aware of the disruption that a new way of fighting war in space could bring; it is painfully aware of its reliance on space and the vulnerability that creates. A milestone *Report of the Commission to Assess United States National Security Space Management and Organization* (often known as the Rumsfeld Commission) makes five key assessments that have been largely influential on U.S. policy makers. First, space security should be a top national security priority due to the U.S. vulnerability in the domain. Second, a reorganization of space forces is required in order to keep up with evolving security demands. Third, military and intelligence infrastructures need to increase synergy. Fourth, conflict in the space domain is coming and the U.S. needs to be prepared. Fifth, revolutionary technologies are needed to maintain superiority in the domain.[439] The commission recommends salient and relevant reorganization within the U.S. policy and military infrastructures, similar to the lines of effort China has undertaken with respect to RMA in the last two decades.

The report embodies the U.S.'s hyperawareness to vulnerability when discussing that, "The U.S. is an attractive candidate for a 'Space Pearl Harbor'" and names China explicitly as a candidate for carrying out such an attack.[440] The provocatively phrased warning was quickly embraced by U.S. decision makers. The language of "space Pearl Harbor" to describe a catastrophic attack on U.S. capabilities has often been evoked by politicians, military leaders, and strategists since many in military leadership take a "when, not if" approach to space

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[439] Rumsfeld et al. *Report of the Commission to Assess United States National Security Space Management and Organization* (Washington: Commission to Assess United States National Security Space Management and Organization, Committee on Armed Services of the U.S. House of Representatives, January 2001), 9-10.

[440] Rumsfeld et al., 13-14; The report specifically names China as trying to bring about RMA in space and calls out a conflict in the Taiwan Straits as one of three scenarios in which space vulnerabilities are worrisome.

warfare.[441] This is relevant, less because it exposes American vulnerability, but more because it demonstrates that U.S. policy makers are affected by prospect theory via the availability heuristic. The idea of a catastrophic surprise attack that threatens U.S. strategic interests is highly available to policy makers. They have categorized a prospective Chinese attack on U.S. space assets with 9/11 and Pearl Harbor, increasing their estimation that such an attack will occur due to representative association. The recent emphasis on space warfighting in U.S. policy circles serves the purpose of taking out probabilistic insurance aimed at reducing the probability of space war occurring or diminishing the effect if it does.[442] Although Russia's counterspace capability is arguably more robust than that of China, Russia is less often the target of alarmist thinking.[443] This is due to three key aspects of Sino-U.S. relations that increase the availability of an adversarial relationship between China and the United States.

e. Preemption Meets Deterrence

Players primarily hypothesize their adversary's course of action from history, anticipating that an opponent will follow a similar strategy to one they have implemented in the past.[444] Unfortunately, historical Sino-U.S. relations are fraught with misunderstanding and conflict. Fluctuating American power in the Pacific, due to economic cycles and other security commitments, has repeatedly resulted in China expressing self-determinism and expanded

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[441] Mike Rogers, *Chairman Rogers and Ranking Member Cooper Joint Statement on Fundamental Space Reform* (Washington D.C: Office of Congressmen Mike Rogers, 2017); Jonathan Broder, "Why the Next Pearl Harbor Could Happen in Space," *Newsweek*, May 04, 2016, https://www.newsweek.com/2016/05/13/china-us-space-wars-455284.html; Sandra Erwin, "Air Force Chief Goldfein: 'We'll be fighting from space in a matter of years'," *SpaceNews*, February 24, 2018, https://spacenews.com/air-force-chief-goldfein-well-be-fighting-from-space-in-a-matter-of-years/.

[442] Nirmal Ghosh, "U.S. Seeks to Stay Ahead of China, Russia in Space Race," *The Straits Times*, December 11, 2017, https://www.straitstimes.com/world/united-states/us-seeks-to-stay-ahead-of-china-russia-in-space-race.

[443] Weeden, *Global Counterspace Capabilities*, 1-23.

[444] Triezenberg, "Deterring Space War," 28.

sovereignty by testing American resolve. This is demonstrated by multiple Taiwan Strait crises and continual diplomatic rebalancing among China, Russia, and the United States.[445] Recent Chinese rapprochement with Russia, as well as Chinese expansion in the East and South China Seas in the wake of the 2008 financial crisis, gives the impression of this same pattern reemerging. China's recent expansion in counterspace capabilities could be perceived as a part of a broader pushback against American hegemony, especially considering how integral space capabilities are to a regional conflict in East Asia.

Similarly, Western intervention in Asia has repeatedly been met with unexpected hostility from China due to its fear of encirclement.

> When the Chinese view of preemption encounters the Western concept of deterrence, a vicious circle can result; acts conceived as defensive in China may be treated as aggressive by the outside world; deterrent moves by the West may be interpreted in China as encirclement. The United States and China wrestled with this dilemma repeatedly during the Cold War; to some extent they have not yet found a way to transcend it… [In the case of Korea] a Chinese offensive was a preemptive strategy against dangers that had not yet materialized and based on judgements about ultimate American purposes toward China that were misapprehended. [446]

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[445] Kissinger, *On China*, 113-147; Gompert and Saunders, *Paradox of Power*, 39-51.

[446] Kissinger, 133-138, 340-348; By sending the American fleet to the Taiwan strait to guarantee a divided China while simultaneously conducting military operations to support South Korea, President Truman 'placed two stones on the wei qi board, both of which menaced China with the dreaded encirclement'. The administration drastically underestimated how amenable Mao would be to American troops controlling a traditional invasion route to mainland China. Similarly, China supported North Vietnam during the American's Vietnam War less for ideological reasons and more because it was afraid of American encirclement. American control of Vietnam would have meant another base at the border of China in addition to Korea, Japan, Taiwan, Okinawa, and the Philippines. A quick glance at a map shows how continued American presence in Vietnam is the last piece of a near total encirclement.

The assertion of American space superiority and the capability to deny China access to the domain can be seen as yet another aspect of strategic encirclement. This pattern makes it difficult to expect peaceful outcomes. Resentment of American bullying has led for some in China to call for it to consolidate gains and assert a claim to superpower status. On the other hand, misunderstanding of China's active defense posture has strengthened the view within American policy circles that Sino-U.S. relations are zero-sum.[447]

h. Cultural Differences

War has a tendency to become ritualized when opponents share a common culture and/or civilization and are highly invested in international norms. The result is adequate signaling before an attack occurs, strict rules of engagement, and tactics that reduce collateral damage.[448] During the Cold War, strategic warfare between the U.S. and Russia became ritualized due to repeated crisis and diplomatic interaction. A system of mutual restraint in space emerged because space capabilities were inherently linked to treaty verification and early warning. However, due to conventional-strategic decoupling, no first-strike nuclear posture, and lack of firebreaks, no such system has emerged between China and the U.S.[449] Disparate views on strategic deterrence and China's unwillingness to conform to normative behavior further solidified the divide. As Mao famously stated "I'm not afraid of nuclear war. There are 2.7 billion people in the world; it doesn't matter if some are killed. China has a population of 600 million; even if half of them are

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[447] Kissinger, 504.

[448] Triezenberg, "Deterring Space War," 32.

[449] Gompert and Saunders, *Paradox of Power,* 95-105; Due to strategic decoupling and disparate nuclear doctrine, a Chinese laser attack on a U.S. missile warning satellite has different implications than a similar attack carried out by Russia. A Russian attack on an early warning satellite would be likely viewed as a precursor to nuclear first strike. A Chinese attack would be considered a precursor to a tactical military action against Taiwan or the American fleet.

killed, there are still 300 million people left."[450] Or, "If the worst came to the worst and half of mankind died, the other half would remain while imperialism would be razed to the ground and the whole world would become socialist; in a number of years there would be 2.7 billion people again and definitely more."[451] This sharply juxtaposes the nuclear taboo that developed between the U.S. and Soviet Union.

i. Preconceptions

Third, preconceptions limit imagination and empathy in ways that distort perception of threat. Unfortunately, preconceptions are generally oversimplified or overgeneralized lessons learned from a biased history.[452] These lessons are cemented in an individual or collective conscious through confirmation bias.[453] Therefore, cultural narrative is likely to alter threat perception by shaping availability. Strategic culture is the shared, culturally embedded social, economic, and political values and priorities of a society, relevant to security preferences, as historically shaped by successful interactions with and adaptations to their prevailing bio-physical and strategic environment.[454] Americans tend to view war in terms of crusades, fought on behalf of truth, justice, and the American way (democracy, freedom of the seas, and self-determination); they fight wars for ideals rather than for an objective.[455] Therefore, the goal for warfare tends to be the unconditional surrender and the overthrow of the adversary's system of

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[450] Jon Wolfsthal, "How to Reason With a Nuclear Rogue," *Foreign Policy*, July 12, 2017, https://foreignpolicy.com/2017/07/12/north-korea-nukes-icbm-test-nuclear-weapons/.

[451] Zachary Keck, "China's Mao Zedong 'Seemed to Welcome a Nuclear Holocaust'," *The National Interest*, December 14, 2017, https://nationalinterest.org/blog/the-buzz/chinas-mao-zedong-seemed-welcome-nuclear-holocaust-23648.

[452] Jervis, Nebow, and Stein, *Psychology and Deterrence*, 18-22.

[453] Kahneman, *Thinking Fast and Slow*, 331-333.

[454] Malanie Graham, "Redefining Strategic Culture," M.A. Thesis, University of Northern British Columbia, 2014, 3.

[455] Samuel Huntington, *The Soldier and the State: The Theory of Politics of Civil-Military Relations* (Cambridge: Belknap Press, 1957), 152.

government.[456] This requires the overwhelming use of force and advanced technology to bring about swift and decisive victory.[457] It inherently demands a worthy foe who deserves U.S. attention.

The ideological roots of the United States' China policy are firmly grounded in its vestigial understanding of China as a Communist threat from the Cold War era. American strategic interactions with China are often framed by China's human rights record, domestic reform, and even régime change, especially in the wake of Tiananmen.[458] Mistrust and suspicion characterizes American's view of China, believing that the emergence of China may be a threat to world peace.[459] This increases the availability of a Chinese challenge to the status quo; potentially causing U.S. policy makers to overestimate the risk of a Chinese challenge to American hegemony and/or misinterpreting Chinese signaling. The opaqueness of China's decision-making apparatus and apparent internal debate as to what role China desires to play in the world further convolutes this dynamic.

Why does it matter if scenarios involving an opponent's defection are highly available? Fear and mistrust brought on by high availability of a catastrophic Cooperate/Defect scenario lead players to "buy" probabilistic insurance through increased readiness posture, the formation of alliances, and arms buildups. This, in turn, increases tension between the players, making it more

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[456] Thomas Mahnken, *United States Strategic Culture*, Course Material (Washington: Defense Threat Reduction Agency Advanced Systems and Concepts Office, 2006), 5-9.

[457] Mahnken, 11-14. For more on the Powell Doctrine and American casualty aversion see *Savage Wars of Peace: Small Wars and the Rise of American Power* by Max Boot Chapters 14-15. The Powell Doctrine, steeped in the lessons of the Vietnam War, sought to fight a decisive battle with full U.S. military commitment, overturn the existing status quo, then leave before the U.S. could be engaged in a guerrilla conflict. It sought to prevent committing U.S. troops to struggles whose objectives were unclear or not completely vital to national security. Due to the complex 21st Century security environment, this is likely to be nearly unattainable.

[458] Kissinger, *On China*, 447-456.

[459] Johnson, "China's Strategic Clulture," 1-2.

difficult to build trust and see gains from mutual cooperation. Policy makers' biases involving the other player's hostile intentions are confirmed, further entrenching them in the decision-making apparatus. This mechanism acts strongly in an offensive dominant environment.[460] The players become trapped in the cyclical pattern of the security dilemma. In current Sino-U.S. relations, the danger of this self-fulfilling prophesy is exceptionally high due to the attention that Chinese policy makers pay to American doctrine, literature, and policy. This is especially true when U.S. policy makers make their suspicion of China public and tout the inevitability of a space war in the very near future.[461]

[460] Jervis, "Cooperation Under the Security Dilemma," 189.
[461] Wu, "China and Space Security," 21.

IV. Conclusion

During the current tumultuous period of time, the creation of new modes of international order is inevitable. However, if the previously discussed pattern of separate arrangements devolves into many spheres of activity, competing world orders could come into existence. Should this be the case, one goal of coevolution would be to ensure that the United States and China pool efforts internationally to bring about an agreed world order. In the absence of common goals and agreed rules of restraint, institutionalized rivalry is likely to escalate beyond the calculation and intentions of its advocates. In an era in which unprecedented offensive capabilities and intrusive technologies multiply, the penalties of failure could be drastic and perhaps irrevocable.[462]

The evolution of the world order does not necessarily require accommodating China's rise at the expense of America's influence in the Pacific, nor does it necessitate dividing into opposing power blocks (as was the case during the Cold War). Further, it does not require seeing the U.S. undermine China's emergence through economic, social, and military means, and does not demand friendly cooperation between the U.S. and China. There is room for a competitive relationship that redefines the world order, while simultaneously preserving the shared core interests of both parties.[463] Ultimately, the stability of mutual restraint is advantageous to the U.S. and China, therefore disarming the inherently unstable security dilemma present in Sino-U.S. relations should be the primary concern of U.S. space policy.

[462] Kissinger, *On China*, 543.

[463] Allison, *Destined for War*, 221-231. Ultimately, the preservation of national sovereignty and the safety of the global economic order are core interests of both nations.

The unstable equilibrium of the security dilemma can be dampened by shifting the Nash equilibrium from defection to cooperation for both players. This can be accomplished by altering the players' utility in three ways: first, increase the benefit of mutual cooperation; second, decrease the benefit gained from a Defect/Cooperate outcome; third, reduce the cost of a Cooperate/Defect outcome. The security dilemma can also be dampened by making offensive and defensive postures distinguishable from one another, as well as creating an environment in which defense has the advantage over offense. These mechanisms operate by altering the players' perception of the zero-sum nature of the game, thereby altering their utility of the Cooperate/Defect and Defect/Cooperate outcomes. Furthermore, revealing and accounting for cognitive biases allows for a more accurate perception of threat, reducing the probability that a player will view the other's actions as harmful and ultimately increase the likelihood of cooperation.

The weakness of the current space law régime has resulted in multiple efforts to develop a code of conduct or an arms control agreement for space for the purpose of limiting the proliferation of debris and protecting the continued use of the domain. However, these efforts have been held hostage by a China-U.S. strategic stalemate.[464] On one side, China has demonstrated a heavy reliance on asymmetric anti-satellite warfare (primarily composed of kinetic direct-ascent and laser ASAT weapons) to supplement their A2/AD strategy in East Asia. Therefore, they have staunchly rejected any ban on terrestrial based or debris-causing ASAT weaponry. The PPWT, introduced jointly by Russia and China, failed to garner support from the United States because it did not limit the use of ground-based weapons, failed to introduce a

[464] Theresa Hitchens and David Chen, "Forging a Sino-US 'Grand Bargain' in Space," *Space Policy* 24 (2008), 128-129.

coherent definition of space weapons, and did not include a verification régime.[465] This was seen by Washington as a blatant attempt to preserve China's deterrent threat while removing a key U.S. military advantage. A resolution against "no first placement" of weapons in outer space further confirmed U.S. fears that the PPWT was aimed at reducing U.S. warfighting capability. In 2014, the European Union proposed the International Code of Conduct for Outer Space Activities (ICoC), but it failed to gain traction in the U.S. due to concerns that it would constrain space capabilities, including space-based missile defense interceptors and anti-satellite weapons.[466] A cornerstone of U.S. policy is the avoidance of policy decisions that would limit the use of existing ASAT weapons against Chinese space systems during a regional conflict.[467] This is particularly true when taking into consideration that the concepts of space warfighting, space superiority, and space control are thoroughly integrated with national policy.[468]

A. Policy Recommendations

j. The U.S. military must reduce reliance on space.

It is difficult to codify international norms involving space weaponization and free access to outer space when the two most influential actors have diametrically opposed strategic interests. China will likely block initiatives that reduce its own ability to utilize debris causing or terrestrial ASATs, while simultaneously attempting to limit conventional U.S. military advantage by pursuing a ban on space weapons. The United States, reluctant to block its path to potential space

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[465] Scott Pace, "Security in Space," *Space Policy* 33 (2015), 52.

[466] Pace, 53.

[467] Stephen Biddle and Ivan Oelrich, "Future Warfare in the Western Pacific: Chinese Antiaccess/Area Denial, U.S. AirSea Battle, and Command of the Commons in East Asia," *International Security* 41, no. 1 (Summer 2016), 44.

[468] Mark Hilborne, "China's Rise in Space and US Policy Responses: A Collision Course?" *Space Policy* 29 (2013), 125-126.

dominance, is unlikely to support a definitive ban on space weaponization; yet, it is incentivized to create international norms that limit the creation of debris in outer space to protect its high-value space assets.[469] This dynamic is unlikely to change unless China's space-based ASAT capability reaches operational maturity, thus reducing its reliance on direct ascent ASATs. Alternatively, China's space capabilities may mature to the extent that they are symmetric with the United States, allowing for a system of implicit mutual restraint to develop.

The U.S. and China are unlikely to come to an agreement until the structural security dilemma is addressed. To accomplish this, the United States must reduce the benefit that China gains from the continued development of debris causing anti-satellite weapons through a denial of gains strategy. The primary U.S. strategy must be to reduce its reliance on space by substituting terrestrial capabilities for space-based capabilities in its AirSea Battle (ASB) concept. This will reduce the role of space in the F2T2EA chain and devalue ASATs as a tactical and operational weapon. When Chinese strategists believe that the tactical value of direct ascent ASAT weapons are outweighed by the international stigma of their use, the U.S. may be able to gain traction in banning such weapons. It may be attractive for U.S. policy makers to pursue a denial of gains strategy by hardening U.S. space assets against attack because it allows for the continued reliance on space capabilities. However, this is not an economical strategy due to an unfavorable offense/defense balance.[470]

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[469] Hitchens and Chen, "Forging a Sino-US 'Grand Bargain' in Space," 129.
[470] Morgan, *Deterrence and First-Strike Stability in Space,* 30-33.

k. Reducing fear of U.S. space domination (Reduce fear of C/D)

The dual-use of space technologies results in an inability to conduct offense/defense differentiation, and creates mistrust, misperceptions, and miscalculations that can undermine political and strategic stability involving the space domain.[471] When offense/defense differentiation cannot be accomplished, developing acceptable norms of responsible behavior, if only to reveal benign intentions and ritualize conflict, is preferable to an attempt to identify and ban specific technologies and capabilities.[472] Therefore, the United States should seek to introduce a series of top-down TCBMs that codify a space code of conduct, work toward a treaty that bans the testing and use of destructive methods against space objects, and increase transparency and trust in U.S. space policy. Collectively, these initiatives could alleviate the fear of U.S. space domination.

The infrastructure for introducing TCBM to the international community is well established. The UNCOPUOS is the principal international forum for the development and codification of laws and principles governing activities in outer space.[473] A set of Space Debris Mitigation Guidelines was endorsed by the UNCOPUOS in 2007; however, this set of guidelines was non-binding and contained ambiguous language, such as: “avoid intentional destruction and other harmful activities,” rather than specifically banning debris-causing space weapons.[474] A working group under the Scientific and Technical Subcommittee set forth guidelines for the long term

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[471] Peter Martinez et al., “Criteria for Developing and Testing Transparency and Confidence-Building Measures (TCBMs) for Outer Space Activities,” *Space Policy* 30 (2014), 91; Jervis, *Cooperation Under the Security Dilemma*, 199-205.

[472] Martinez et al., 92.

[473] Peter Martinez, “Development of an International Compendium of Guidelines for the Long-Term Sustainability of Outer Space Activities,” *Space Policy* 43 (2018), 14.

[474] *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, available at http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

sustainability of space in 2016, but (like the Space Debris Mitigation Guidelines) these were non-binding.[475] The UN General Assembly adopted the non-binding Resolution 69/32 that advised against the first placement of weapons in space with 126 in favor, 4 against (including the United States), and 46 abstentions.[476] These measures, introduced through UNCOPUOS and the Conference on Disarmament (CD) show that space we aponization and debris mitigation TCBMs have received adequate attention in the United Nations. The United States' decision to remain aloof in these forums in the face of the international consensus will damage U.S. prestige, raise fear of space weaponization, and threaten its space leadership.

The United States should work through the CD to provide an alternative to China and Russia's PPWT proposal. This proposal should ban the testing and use of debris-causing ASAT weapons and include a definition of "debris-causing" that allows for minor satellite breakups. This would keep space free of massive debris causing incidents in the event of a conflict, while simultaneously allowing the continued development of counterspace capabilities. No binding resolution will be established without an agreement between China and the United States, but (as discussed previously) a misalignment of strategic interests makes that outcome unlikely. Therefore, the United States must be prepared to make substantial concessions in order to gain acceptance from China. A variety of concessions may induce Chinese ratification: first, the U.S. could include a sidecar that bans on-orbit force application technologies in order to assuage fears that the U.S. intends to expand its global strike capability through the deployment of space weapons; second, the U.S. could reconsider its position on an ABM prohibition; third, the U.S. could pursue a bilateral non-first use pledge with China; fourth, the U.S. could open up the ISS

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[475] Martinez, "Development of an International Compendium," 16.
[476] Liu and Tronchetti, "United Nations Resolution 69/32," 64.

program to China; and fifth, the U.S. could restructure ITAR regulations to increase interaction between Chinese and American commercial markets.

In the absence of a formal treaty, the United States must nonetheless continue to work towards implementing TCBMs that seek to increase transparency, familiarity and clarity of intentions, and provide a basis for strengthening mutual trust building and confidence amongst states.[477] Improving space situational awareness (SSA) through an international outreach effort is the ideal platform through which to accomplish these goals. SSA is vital to the long-term sustainability of the space environment because it helps mitigate natural environmental threats and identifies behavior that would be detrimental to responsible use and long-term sustainability.[478] Therefore, SSA will be a foundational verification mechanism for potential treaties as well as an opportunity for cooperative trust building.[479] SSA is generally made up of two components: space surveillance and tracking (SST) and space traffic management (STM). First, SST involves using ground-based and space-based optical sensors and radars in order to track, characterize, and analyze space objects. Second, STM utilizes SST data in order to ensure safe passage through the space environment.[480] Both SST and STM require cooperative efforts to be successful. SST necessitates a diverse, geographically dispersed sensor network to provide timely, accurate data on objects in a wide array of orbits.[481] A single nation is not able to provide the geographical coverage needed for a comprehensive SST network. STM requires agreed upon

[477] Peter Martinez, "Criteria for Developing and Testing Transparency and Confidence-Building Measures (TCBMs) for Outer Space," 92.

[478] Gerard Brachet and Xavier Pasco, "The 2010 US Space Policy: A View from Europe," *Space Policy* 27 (2011), 13.

[479] Laurence Nardon, *Space Situational Awareness and International Policy,"* (Paris: Institut Français des Relations Internationales, 2007), 4.

[480] Brian Green, "Space Situational Awareness Data Sharing: Safety Tool or Security Threat?" *Air Force Law Review* 75, no 96 (2016), 56-60

[481] Green, 59-60.

standards of behavior to ensure spaceflight safety.[482] There is currently no standardized regime for conducting the broad SSA mission in order to analyze and communicate threats to the space domain.[483] This creates an opportunity for the U.S. to utilize its position of technical superiority in order to score a soft power coup by taking the lead in a global SSA initiative.

The major obstacle to building an international SSA coalition is the military utility SST data, which can be used to reveal classified military capabilities and conduct ASAT targeting.[484] The United States possesses the most comprehensive network of SST sensors and maintains a database of 20,000+ space objects.[485] However, the U.S. military did not share this data until an Iridium satellite collided with a Russian military satellite, prompting the amendment of 10 U.S.C. § 2274 to authorize the provision of SSA services if they were consistent with national security interests.[486] After this event, the U.S. Strategic Command's SSA sharing program grew exponentially, providing close approach notices to satellite owner operators and freely sharing SST data on its website.[487] This was a good first step, but an increase in the quantity of SST sensors in the past decade has done little to bolster space traffic management efforts due to the disjointed nature of the data.[488] As the space community attempts to consolidate SST data as part of a broader SSA régime, multiple nascent SST data sharing organizations show that a U.S. centric model is not guaranteed.[489] The U.S. could put itself in a dangerous situation if it

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[482] Air traffic control is the best analogy for an STM architecture.

[483] Jana Robinson, "Transparency and Confidence-Building Measures for Space Security," *Space Policy* 27 (20011), 30.

[484] Green, "Space Situational Awareness Data Sharing," 45-46.

[485] Brian Weeden, *Space Situational Awareness Fact Sheet*, (Washington: Secure World Foundation, 2017), 2

[486] Green, "Space Situational Awareness Data Sharing," 94.

[487] Duane Bird, *Sharing Space Situational Awareness Data*, Technical Paper (Maui: AMOS Advanced Maui Optical and Space Surveillance Technologies Conference, 2010).

[488] Weeden, *Space Situational Awareness Fact Sheet*; Robinson, "Transparency and Confidence-Building Measures for Space Security," 31; Green, "Space Situational Awareness Data Sharing," 97-100

[489] Stefan Kaiser, "Legal and Policy Aspects of Space Situational Awareness," *Space Policy* 31 (2015), 6-7.

attempts to control SST data for the purposes of military use; this could potentially result in having complete control over only a fraction of the SST market, while American commercial SST companies lose their competitive edge.[490]

In order to leverage the proliferation of SST sensors, increased interest in orbital debris mitigation from the international community, and the extant U.S. technological advantage in SST, the U.S. needs to encourage a *U.S. centric* data sharing model. The first step in this process will be separating the SSA mission from its military origins. *Space Policy Directive-3, National Space Traffic Management Policy*, issued by President Trump on June 18, 2018, indicates that the White House intends to act in that manner. The space policy directive orders the U.S. government to do the following: pioneer new SST technologies, encourage the commercial SST market, create SST data interoperability, develop STM standards and best practices, improve U.S. domestic space object registry, and encourage SST data sharing. All this will be accomplished primarily by the Department of Commerce, reducing the role of the DoD in the SSA mission.[491] SPD-3 is absolutely in line with the recommendations of this thesis.

While the United States is attempting to build bridges in the international space community, it may be burning others at an equivalent rate. In order to reduce Chinese fear of U.S. space domination, American decision makers must be careful to avoid inflammatory and militaristic rhetoric. The groundwork for space warfighting was set by the George W. Bush administration on the heels of the Rumsfeld Commission's "Space Pearl Harbor" warning. The 2006 U.S.

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[490] Kentaro Tanaka, "Applicability of Remote Sensing Policies to Space Situational Awareness," *Space Policy* 42 (2017), 90; Mariel Borowitz, "Strategic Implications of the Proliferation of Space Situational Awareness Technology and Information: Lessons Learned from the Remote Sensing Sector," *Space Policy* 47 (2019), 23-26.

[491] Donald Trump, *Space Policy Directive-3, National Space Traffic Management Policy*, (Washington: White House, 2018).

National Space Policy maintained the right to deny adversaries use of space if those capabilities are hostile to *U.S. national interests*.[492] Note that the policy does not say "deny adversaries use of space if those capabilities are hostile to U.S. space assets," which would infer a natural right to self-defense. Rather, the language of the space policy suggests that the U.S. has the right to interdict an adversary's space capabilities if they provide space effects that are disadvantageous to national security. This is consistent with the militaristic vernacular in the *United States Space Command Vision for 2020,* which promises to provide full spectrum space dominance hinging on space control capabilities. The *Vision for 2020* compares space to other warfighting domains (land, air, and sea) and asserts that during the early 21st century, space power will evolve into a separate and equal medium of warfare.[493] This rhetoric, combined with technological developments during the Bush administration, made the prospect of U.S. space domination seem incipient to Chinese policy makers and reignited conversation about space weaponization.[494]

The Obama Administration brought more moderate rhetoric by excluding inflammatory language in the 2010 National Space policy, recommending space arms control, suggesting TCBMs for space stability, as well as allowing Bush era technology programs expire.[495] This policy was received very well in Asia, allowing the Obama administration to open high level strategic dialog about space cooperation with China and strengthen relations with East Asian

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[492] Policy Directive, "U.S. National Space Policy," The White House, August 31, 2006. Emphasis added.

[493] U.S. Space Command, *Vision for 2020*, (Colorado Springs: U.S. Space Command, 1999), 4.

[494] Jonathan Grandoff and Craig Eisendrath, *United States-Master of Space? The U.S. Space Command's "Vision for 2020"*, (New York: Global Security Institute, 2005); Zhang, "The Security Dilemma in the U.S.-China Military Space Relationship", 315-322.

[495] Laura Lopez, "Predicting an Arms Race in Space: Problematic Assumptions for Space Arms Control," *Astropolitics* 10, no. 1 (2012), 49-52; Marcia Smith, "President Obama's National Space Policy: A Change in Tone and a Focus on Space Sustainability," *Space Policy* 27 (2011), 20-23; Jon Mariel *Comparing the 2010 National Space Policy to the 2006 National Space Policy* (Colorado Springs: Space Foundation); Warren Ferster, "Missile Defense Agency Retires NFIRE Satellites," *Space News,* September 29, 2015, https://spacenews.com/missile-defense-agency-retires-nfire-satellite/.

allies.[496] However, inflammatory and militaristic rhetoric returned with the Trump administration. Secretary of the Air Force Heather Wilson and other top Air Force leaders resurrected the idea of space as a warfighting domain during testimony to Congress, saying that the Air Force needed to maintain its capability regardless of consensus on international norms.[497] In 2017 Air Force Space Command created the National Space Defense Center to integrate space capabilities and C2 methods in order to help conduct a space war.[498] President Trump echoed that space is a war-fighting domain by signing the *Space Policy Directive-4* on 19 February 2019, which proposes the creation of a Space Force as the sixth branch of service.[499] These reorganizations alone are not as inherently threatening or substantive as the weapons development programs pioneered during the early 2000s. However, the incendiary rhetoric that accompanied these reorganizations may have counteracted the potentially powerful TCBMs outlined in SPD 2-3. The White House should emphasize cooperative, collaborative space initiatives as part of future space policy directives, rather than set a course for unilateralist (America First) action.

l. Pursue active cooperation. (Increase benefit of CC)

The U.S. space community must pursue active cooperation with China in order to increase the potential benefit of a Cooperate/Cooperate outcome. Robust bilateral cooperation between

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[496] Yasuhito Fukushima, "An Asian Perspective on the new US Space Policy: The Emphasis on International Cooperation and its Relevance to Asia," *Space Policy* 27 (2011), 5-6; John Logsdon, "Change and Continuity in U.S. Space Policy," *Space Policy* 27 (2011), 2.

[497] Marcia Smith, "Top Air Force Officials: Space Now is a Warfighting Domain," *SpacePolicyOnline*, May 17, 2017, https://spacepolicyonline.com/news/top-air-force-officials-space-now-is-a-warfighting-domain/.

[498] David Thompson, Gregory Gagnon, and Christopher McLeod, "Space as a War-fighting Domain," *Air & Space Power Journal* (Summer 2018), 6-8; Mark Pomerleau, "Space Center Critical to Pentagon's Third Offset, Future of Warfare," *Military Times*, July 23, 2017.

[499] Eric Mack, "Trump's Space Force: Here's What You Need to Know," *CNet*, January 16, 2019, https://www.cnet.com/news/trump-space-force-everything-you-need-to-know/.

the U.S. and China could increase trust and transparency, as well as improve signaling by engendering repeated diplomatic and scientific interaction, increase interdependence by giving each country a stake in the success of the other's space program, foster China's interest in space sustainability, and give China and the United States insight into each other's space program.[500] China could benefit by learning from a more technologically advanced partner, while the United States learns about the capabilities and organization of a traditionally opaque bureaucracy.[501] Collaboration may also have significant cost sharing benefits, especially considering that the ISS may be reaching end of life and funding is precarious.[502] Additionally, active engagement with China on manned space exploration and deep space science may prevent the development of a China-led space station, which could solidify its diplomatic ties within Europe and East Asia.[503] For these reasons, increased cooperation with China has the potential to yield great results; however, U.S. decision makers must take care to avoid pitfalls of past space cooperation projects when crafting Sino-U.S. policy.[504]

China has showed an openness to bilateral cooperation, particularly between NASA and the China National Space Administration (CNSA) regarding manned space exploration and space science.[505] In 2006, NASA Administrator Michael Griffin and other top NASA officials toured

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[500] James Rendleman and Walter Faulconer, "Improving International Space Cooperation: Considerations for the USA," *Space Policy* 26 (2010), 144-147.

[501] John Baker and Kevin Pollpeter, "A Future for U.S.-China Space Cooperation," *The Rand Blog*, December 13, 2004, https://www.rand.org/blog/2004/12/a-future-for-u_s_-china-space-cooperation.html.

[502] Rendleman and Faulconer, 144-145; Peter de Selding, "ESA Chief Lauds Renewed U.S. Commitemnt to Space Station, Earth Science," *Space News*, February 3, 2010, https://spacenews.com/esa-chief-lauds-renewed-us-commitment-space-station-earth-science/.

[503] Jie Long, "China's Space Station Project and International Cooperation: Potential Models of Jurisdiction and Selected Legal Issues," *Space Policy* 36 (2016), 35-36.

[504] Rendleman and Faulconer, "Improving International Space Cooperation," 150-151.

[505] Loretta Whitesides, "China Wants to Partner on the International Space Station," *Wired*, October 18, 2007, https://www.wired.com/2007/10/china-wants-t-1/.

Chinese space facilities in a landmark visit on the invitation of Laiyan Sun, administrator of the CNSA.[506] This event was followed shortly after by a second visit by NASA administrator Charles Bolden (Griffin's successor) in 2010.[507] Additionally, in October 2010, Secretary of Defense Robert Gates and China's Defense Minister Liang Guanglie emphasized the need for dialog about space security and bilateral TCBMs.[508] This high level engagement could have marked a significant breakthrough in Sino-U.S. space relations, and been preceded by lower-level technical discussions, had the U.S. Congress not passed Public Law 112-55, Sec. 539 in 2011, which banned NASA from engaging in bilateral agreements and coordination with China.[509] Current NASA administrator Jim Bridenstine and CNSA administrator Zhang Kejian discussed SSA and deep space exploration as potential areas of cooperation in 2018, but this was not followed up by technical discussion.[510]

In order to foster cooperation between China and the United States, domestic reforms need to be made. First, NASA should be the focal point for Sino-U.S. space cooperation: Public Law 112-55, Sec. 539 should immediately be repealed to allow for NASA-CNSA engagement. Likewise, long-awaited domestic export control reforms would need to take place in order to streamline scientific and technical exchange and prevent further legal barriers to cooperation.[511] Additionally, the U.S. must be prepared to make a long-term commitment to China-U.S. joint

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[506] From *NASA News* archives, https://www.nasa.gov/about/highlights/griffin_china.html.

[507] From *NASA Administrator Statement on China Visit*, https://www.nasa.gov/home/hqnews/2010/oct/HQ_10-270_Bolden_China.html.

[508] Yasuhito Fukushima, "An Asian Perspective on the new US Space Policy," 5.

[509] Arthur Villasanta, "NASA's Bolden Makes Brave but Pointless Appeal for U.S.-China Space Cooperation," *China Topix*, May 25, 2016, http://www.chinatopix.com/articles/88677/20160525/nasa-s-bolden-makes-brave-pointless-appeal-u-china-space.htm.

[510] Jeff Foust, "NASA Opens Door to Additional Cooperation with China," *Space News*, October 1, 2018, https://spacenews.com/nasa-opens-door-to-additional-cooperation-with-china/.

[511] Chambers, "China's Space Program," 92-94.

projects to assuage the fear of American political volatility.[512] After these steps have been accomplished, the U.S. should clarify that joint NASA-CNSA projects will only take place for programs that have been removed from military control.[513] The delineation between military and civilian control may address U.S. domestic concerns about technology transfer and set a groundwork for civilian control of space programs in China, potentially weakening the security dilemma by alleviating part of the dual-use conundrum.

B. Summary

The confluence of current Sino-U.S. relations and the state of space technology creates a structural security dilemma: the United States is excessively reliant on space support to conduct military operations in East Asia, which incentivizes China to pursue the development of technological and tactical innovations to deprive the U.S. of its operational advantage. This development threatens the U.S.'s conventional deterrent threat in the region, undermining strategic relations with key East Asian allies. The U.S. lacks a symmetrical response to China's ASAT threat and must develop other means of deterrence, increasing the likelihood of horizontal escalation. Simultaneously, the offense-dominance of the space domain results in the lack of first-strike stability. These factors increase the likelihood that space will serve as a flash-point for a regional conflict in East Asia, and attempts to mitigate this threat are unlikely to succeed due to the inherent dual-use of most space technologies. Cognitive biases further worsen this security dilemma. Furthermore, China's historic "century of humiliation" and rising technonationalism explain its position of losses seeking gains, making Chinese decision makers more likely to take

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[512] Rendleman and Faulconer, "Improving International Space Cooperation," 149.
[513] Baker and Pollpeter, "A Future for U.S.-China Space Cooperation,"

over-weighted risk in order to overturn the existing status quo. Key cultural differences proliferate conflict between the U.S. and China, further altering leaders' decision calculus and creating an opportunity for self-fulfilling prophesy. Despite this grim prescription, arms race and conflict between the two nations is not inevitable. The implementation of top-down TCBMs designed to build trust and transparency can direct both nations towards a globally optimal outcome.

C. Further Research

This analysis is by no means exhaustive. In some cases, dozens of peer reviewed sources were boiled down to a sentence or two for the sake of brevity and conciseness. For example, the interaction of space law and this international relations focused analysis was only examined at a surface level. In many cases, sweeping generalizations replaced the minutia on which a legal analysis often hinges. As a result, this analysis is more effective for understanding the structural dynamic of Sino-U.S. space policy, than it is presenting detailed proposals and recommendations that a space lawyer would consider actionable. However, it does explain why current proposals for changing the space law régime have failed to gain consensus from China, Russia, and the United States. Future research should incorporate the "lessons learned" from this analysis in an attempt to develop a space code of conduct that can garner the agreement of the major spacefaring powers.

Also, it is clear from this analysis that establishing a threshold in order to distinguish between chicken and the security dilemma is vital to avoid uncontrollable escalation. Future research must attempt to establish a clearly defined escalation ladder for space warfighting. It must also find methods to conduct strategic messaging between the U.S. and China so that these new rules of the game can be ritualized. In order to do this, the game theoretical framework must expand to account for a sequential game.

Furthermore, it should be notable that two very important events were mentioned only superficially in this analysis; the U.S. withdrawal from the INF treaty and India's ASAT demonstration, which both occurred in early 2019. An examination of the treaty withdrawal would be a natural topic for further research, because it has the potential to significantly upset the current strategic status quo; leading to increased regional tension, a realignment of strategic posture, the proliferation of nuclear material, and creating an opportunity for strategic miscalculation. These factors are fundamental to this analysis; therefore, an inevitable influx of new information will necessitate a reexamination of this topic within a very short time. Luckily, the current framework is adequate to account for this development. On the other hand, the Indian ASAT demonstration is a milestone event in the space law and policy world that will require an expansion in the scope of this analysis. The ASAT demonstration raises questions about the proliferation of ASAT technology and the rise of India as a major regional competitor. In order to account for this, the game theoretical framework would need to expand to include India, Japan, Russia, and possibly Europe as players. This expansion adds considerable computational complexity and ultimately uncertainty.

As a parting statement: India's ASAT test and the withdrawal from the INF treaty are indicative of a major strategic upheaval; an increasingly multi-polar world and strategic rebalance is coming faster than many anticipate. Rapid technological advances in spacelift, computing, and man-machine integration will impact the space domain in unpredictable ways. China remains opaque, but it is impossible to avoid the sense that Xi Jinping's rise to power is the most significant event in China since Mao's death. The complete collapse of the Chinese economy and social structure, leading to global recession; a rapid Chinese expansion leading to regional conflict; a slow, peaceful Chinese usurpation of the U.S. led world order; or continued competitive, but peaceful coexistence between the U.S. and China are all equally likely outcomes. These trends were completely obvious with the benefit of hindsight, but what they mean for the future remains unclear.

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