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Mining CP

#### Counterplan: The appropriation of resources only from asteroids constrained by “beneficial use” in outer space by private entities is just. Revenues should be raised from appropriative activities and distributed to all from a Space Resource Fund.

#### Preserving international mechanisms for dispute management and coop solves a tragedy of the commons BUT appropriation is key to incentivizing asteroid mining

Heise, 18 -- Managing Notes Editor, Michigan Journal of International Law

[Jack, "Space, the Final Frontier of Enterprise: Incentivizing Asteroid Mining Under a Revised International Framework, 40 Mich. J. Int'l L. 189, 2018, <https://repository.law.umich.edu/mjil/vol40/iss1/5>, accessed 6-24-21]

III. A New International Framework to Govern the Space Economy

Asteroid mining creates tension within the OST as an activity that is prohibited by the treaty’s terms but largely in line with the treaty’s purpose. As such, the OST should be modified to allow for greater certainty and predictability with respect to asteroid mining. The possibility that asteroid mining could be illegal under international law likely disincentivizes entry into this new endeavor by adding risk and uncertainty. This section outlines what a revised framework should look like. First, the law governing space should remain international in nature to further the interests of peaceful cooperation and facilitate dispute resolution. Second, this framework should present minimal regulatory barriers for entry given the benefits that asteroid mining could bring to all mankind. The development of whaling law provides a use-ful historical example of how norms and rules for the asteroid mining industry could evolve in a way that facilitates efficient governance of this endeavor.

A. The Desirability of an International Framework

The preservation of space as a zone governed by international law, in contrast to a system predicated on national jurisdiction, is desirable in that it promotes peace, facilitates dispute resolution, and allows for more coordinated efforts in addressing issues relevant to all entities operating in space.98 As illustrated by the recent legislative activity in the United States and Luxembourg, the risk of inaction is the resultant domination of the extraterrestrial environment by individual nations rather than by international agreement.99 It would take only minor changes to the OST to resolve some of the ambiguities in the status quo and help bring the benefits of asteroid mining to humanity as a whole. A revision of this treaty rather than a wholesale abandonment of the agreement—whether that abandonment is in fact or merely in practice—would better maintain the international character of space.

The OST reflects Cold War era concerns about the militarization of space.100 Private companies, now ascendant in the growing space economy, simply do not have the military capacity or intention of sovereign governments. In short, the factual backdrop for the signing of the OST has changed. One straightforward means of authorizing private companies to extract space resources would be to revise the OST to clarify that the language in Article II prohibiting national appropriation does not apply to private companies. This could be achieved by simply adding a sentence to the end of Article VI: Under the revised treaty, companies shall remain under the supervision of the countries in which they are based but are not capable of national appropriation by use or occupation. This revision would create something of a line-drawing problem given the partnerships between sovereign space agencies and private companies,101 as well as a possible loophole by which unscrupulous nations could take advantage of the corporate form. Additional safeguards might be necessary to prevent this possibility. This revision could, however, promote peaceful coexistence and uniformity in space law, as well as create certainty as to the legality of asteroid mining by private companies.

Another possibility is to create a new set of international rules for extraction of space resources. Assignment of such property rights could take the form of a first-come, first-served system102 or it could depend on an Earth-side registration process.103 Arguably, extraction is different than the forbidden uses enumerated in the OST in that it is a temporary occupation and not inherently an exercise of military might or the flexing of sovereign muscle.104 While the United States and Luxembourg both interpret asteroid mining to be legal under the existing treaty,105 the promulgation of rules governing the endeavor would add clarity as to the legality of the enterprise. This approach would have the advantage of treating sovereign actors and private companies alike, but would require more substantial revision of the OST, or a new international agreement altogether.

An amended OST or a new treaty governing the extraction of space resources would have the benefit of maintaining the peaceful order of space. While admittedly the product of a different era, the post-national and peaceable foundation of the OST is still desirable in an international environment where many nations are armed to the proverbial nuclear teeth. Peaceful use of outer space is a laudable objective and one served most effectively by international agreement rather than by competing national claims of sovereignty.106

An international system would also facilitate dispute resolution. In a borderless and extra-jurisdictional realm like outer space, a system predicated on national sovereignty and ownership is not instructive as to whose laws—or whose choice of law rules—would control in the event of disputed title of an asteroid or the commission of a tort between two actors from different nations.107 The United Nations Convention on the Law of the Sea (the “UNCLOS”) established the International Tribunal for the Law of the Sea (the “ITLOS”) as a means of providing a venue in which similar disputes could be adjudicated between actors with conflicting legal regimes.108 Outer space has a great deal of similarity to the high seas: both are vast, both are easily treated as a non-appropriable international commons, and both are an in-between space in the sense of existing between bodies of terra firma. 109 An international mechanism like ITLOS ought to be established for resolving space disputes such that parties can seek a neutral arbiter to resolve conflict and laws can be uniformly applied to all entities irrespective of their country of origin.110

Finally, an international system could more easily allow for cooperation between nations and private entities in addressing issues that affect the spacefaring community as a whole. The emergence of space debris and the use of nuclear power sources in space are examples of developing issues that bear on the ease and safety of space travel for all.111 Left to national governments or individual corporations, it seems plausible that lack of oversight could result in a tragedy of the commons.112 By contrast, an international framework is well-suited to consider the problems of the space ecosystem in a way that transcends national boundaries. The UNCLOS Preamble, for example, demonstrates an awareness that “problems of ocean space are closely interrelated and need to be considered as a whole.”113 The compelling interests of peace, uniformity, and cooperation in outer space illustrate the desirability of an international framework to govern asteroid mining; to tweak rather than jettison the existing law. The resulting clarity and predictability would incentivize asteroid mining through reducing legal risk and uncertainty.

A counterproposal to an international framework is a system in which nations assign property rights according to domestic law. It would be possible to take a terra nullius approach to property rights relating to celestial bodies.114 In the Western Sahara advisory opinion, the International Court of Justice defined terra nullius as “a legal term of art employed in connection with ‘occupation’ as one of the accepted legal methods of acquiring sovereignty over territory.”115 For a nation to peaceably acquire sovereignty through occupation, the land must be “terra nullius—a territory belonging to no-one—at the time of the act alleged to constitute the ‘occupation[.]’ ”116 This legal approach was prevalent during the colonial era: explorers and emigrants acting in the name of European sovereigns declared ownership of territory by right of discovery and occupation.117 By authorizing U.S. citizens to extract materials from asteroids through the Commercial Space Launch Competitiveness Act, the United States has started down a path in which property rights in space flow from the jurisdiction of individual sovereign nations.118 Luxembourg has taken a similar approach through its own legislation.119

There are some notable advantages to this approach. The absence of an international policing or enforcement mechanism in space arguably points in favor of regulation by nations with spaceflight capacity. Given the generally acknowledged challenges of enforcing international law,120 one might wonder whether domestic governments might be better positioned to monitor and control private entities based within their borders. A nation-centric approach would also likely incentivize investment in asteroid mining, prompting countries and private actors to invest more aggressively so as not to lose the new space race.121 Assuming, as this Note does, that the development of the asteroid mining industry is in the interest of humanity as a whole, this approach has some appeal.

However, a nation-centric, first possession framework has drawbacks that highlight the desirability of an international governance regime for asteroid mining. First, the experience of colonization was one that prompted conflict between colonizers.122 The peaceful character of space is one of the great achievements of the OST, and it should not be jettisoned. Second, a regime characterized by national actors could spark a race to the bottom with respect to domestic regulation, leading to the same “flags of convenience” problem present in the maritime context as asteroid mining and spaceflight companies relocate to avoid taxes, labor and safety standards, and tort liability.123 An international framework, by contrast, could more easily prevent this problem by facilitating the creation of uniform standards for labor, safety, and liability, making relocation to under-regulated states a less attractive prospect. The drawbacks of a system governed by individual nations, in conjunction with the advantages of a global system illustrated above, point to the desirability of a revised framework governing asteroid mining that is international in character.

B. A System with Minimal Regulatory Barriers to Entry

Whatever approach is chosen to resolve the ambiguities in the OST ought not to be overly restrictive or create burdensome regulatory obstacles for private asteroid mining companies. Substantial regulation could discourage investment and hamper the development of an already capital-intensive and high-risk industry.124 The ideal regulatory system for asteroid mining should maintain an international character for the reasons described in the previous section but should not impose cumbersome regulation on asteroid mining companies at this stage in their development. Rather, allowing norms to develop over time through the resolution of disputes between asteroid mining companies would likely result in the most efficient regulatory system and would be more attractive to companies and nations that might be tempted to disregard the treaty.

The development of whaling custom offers insight into the extent to which “property rights may arise anarchically out of social custom.”125 The analogy to asteroid mining is strong in that both are extractive, high-risk, and capital-intensive industries that take place in what is effectively mare liberum (free sea).126 Herman Melville in Moby-Dick suggests the whaling industry was not governed by a “formal whaling code,” but rather that the “fishermen have been their own legislators and lawyers in this matter.”127 Over time, the custom developed that “I. A Fast-Fish belongs to the party fast to it [and] II. A Loose-Fish is fair game for anybody who can soonest catch it.”128 While Melville concedes that “the commentaries of the whalemen themselves sometimes consist in hard words and harder knocks—the Coke-upon-Littleton of the fist,”129 he also notes that this code is “universal, undisputed law applicable to all cases”130 that prevents “vexatious and violent disputes [arising] between the fishermen.”131 By and large, whalers were able to govern themselves by crafting norms over time that suited their needs.

Robert Ellickson, in his Hypothesis of Wealth-Maximizing Norms, cited the development of whaling norms as supporting the idea that, “when people are situated in a close-knit group, they will tend to develop for the ordinary run of problems norms that are wealth-maximizing.”132 Ellickson defines wealth-maximizing norms as those that minimize the sum of transaction costs and deadweight losses that the members of a group objectively incur.133 Those involved in the group activity are likely to develop rules in a utilitarian manner, preferring “bright-line rules that would eliminate arguments to fuzzy rules that would prolong disputes.”134 The few asteroid mining companies currently in existence are not only a close-knit group under Ellickson’s definition,135 but are best positioned to create rules that will give rise to greater clarity and reduce transaction costs due to their proximity to and soon-to-be-developed experience with the business of asteroid mining. Rules like these would incentivize asteroid mining through greater legal clarity and predictability, thus facilitating the delivery of asteroid mining’s benefits to all mankind.

The UNCLOS ratification debate helps illustrate why a more substantial regulatory regime might prove counterproductive for the international community. One of the primary reasons cited by American opponents of ratification is that accession to the treaty would subject American mining companies “to the whims of an unelected and unaccountable bureaucracy and would force them to pay excessive fees to the International Seabed Authority for redistribution to developing countries.”136 While other commentators have dismissed these concerns as “pure nonsense,” noting that these same companies favor accession to the treaty for the sake of having a clear legal claim to mined minerals,137 it is easy to imagine that a similar scheme of bureaucratic redistribution in the context of asteroid mining might be disregarded by the United States. A decision by nations leading the way on asteroid mining to opt out of a treaty would for all practical purposes cripple future treaty efforts. A key advantage of the proposed regulatory framework described in this Note is a practical one: it would offer the attractive prospect of legal clarity without an international bureaucratic bogeyman, making it more likely that key national stakeholders like the United States would sign on.

Conclusion

Maintaining the international character of outer space while allowing private companies to develop their own governing norms under a slightly revised OST would preempt the outbreak of a new race by sovereign governments to colonize space; create greater certainty for those undertaking the enterprise of asteroid mining; and permit the development of an efficient system tailored to maximize returns on celestial investment. The asteroid mining industry has the potential to confer benefits on all mankind as a means of facilitating space travel, spurring the development of science and technology, mitigating the potential for a calamitous asteroid impact, and facilitating climate change mitigation efforts. As such, it is in the interest of all nations to revise the OST to allow greater certainty in this endeavor. While the “entire unimaginable infinity of creation”138 is still out of reach based on our existing physics and engineering capabilities, asteroid mining is a critical step in beginning to harness celestial resources and more fully explore the intricacies of the universe around us.

#### “Beneficial use” solves every deficit AND provides incentives- appropriation is key

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[Ross, "The doctrine of appropriation and asteroid mining: Incentivizing the private exploration and development of outer space", Oregon Review of International Law 17, 2015, 183-204, accessed 1-9-22]

THE CURRENT INTERNATIONAL TREATIES THAT REGULATE THE OWNERSHIP OF ASTEROIDS FAIL TO INCENTIVIZE THE DEVELOPMENT AND EXPLORATION OF OUTER SPACE

Currently, there are two outdated international treaties that attempt to adjudicate the use and exploration of space. The first treaty, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1968), is an archaic but influential agreement ratified by nearly all of the world nations that have successfully launched a shuttle into space.47 The second treaty, The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979), was an attempt to reform some of the principles from the Outer Space Treaty that failed to garner popular acceptance because it was not signed by any nations with national space programs.48 While both treaties attempt to deal with many issues, including the ownership of celestial bodies, both fail to allow for the ownership and development of asteroids by government or private entities. Because they were written during the space race in a period of international distrust, it makes sense that these treaties would be concerned with tempering the race to establish sovereign control over celestial bodies. However, as space exploration shifts from being financed and controlled by national governments to being financed by private industry, these concerns may be less important.49

NASA (National Aeronautics and Space Administration), the U.S. space program, was once a well-funded program. It was the focus of the American people in 1961 when President John F. Kennedy announced before a joint session of Congress the ambitious goal of sending a man to the moon.50 The funding for NASA has dwindled in modern times, and the organization now gets around 0.5% of the federal budget, which is the lowest it has been since Kennedy’s 1961 speech.51

Despite a decrease in national space program funding, corporate space missions are on the rise. In 2010, President Obama proposed that NASA exit the business of flying astronauts from Earth to low Earth orbit and move it to private companies.52 Several companies have stepped up to bat, and corporate space programs now include space tourism, supply missions, and in one case a one-way colonization mission to Mars.53 Corporate interest in space tourism and development demonstrates a strong private commercial interest in space as an industry, which could serve to finance the exploration of space in a period where national governments do not have an active financial interest in space. However, under current international treaties, the ownership of asteroids is prohibited, preventing corporations willing to invest in asteroid mining from having a secure claim.

A. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967) Prohibits Commercial Property Claims

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty of 1967), is currently the most influential source of international legislation regarding space law.54 Ratified in 1967 by most of the U.N. nations that had successfully launched a shuttle into space, the Outer Space Treaty of 1967 carries much more weight than the subsequent “Moon Treaty” of 1978.

The Outer Space Treaty of 1967 addresses many different issues, including the military development of space,55 the commission of aid to distressed astronauts,56 international liability for damage caused by space objects,57 and the guaranteed cooperation between state-actors in space.58 While the agreement does an admirable job dealing with many of these issues, it fails to grant any kind of ownership claims over celestial bodies.

Under the Outer Space Treaty of 1967, both government and private entities are prohibited from claiming ownership over celestial bodies. Article II of the agreement explicitly states that, “Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”59

While this statement seems reasonable for preventing a government from, say, claiming the moon, it makes no distinction between the moon and asteroids, planets, meteorites, comets, or other celestial bodies. By preventing the ownership of celestial bodies, even those that have no utility beyond the resources they contain, the treaty effectively destroys the financial gain that could motivate corporations to explore and develop space.

B. The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979) Also Fails to Recognize the Need to Provide Ownership Rights in Celestial Bodies

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979 (The Moon Treaty) also fails to create property rights in celestial bodies in a way that would incentivize space travel.60 Widely considered a failure, the Moon Treaty was an attempt to reform the Outer Space Treaty of 1967, but it was not ratified by any nation that had successfully launched a shuttle into space.

The Moon Treaty took an idealistic approach to international space law, and if it were more effective it would have established an international regime to carry out its goals.61 The stated goals of the regime were to develop the natural resources of the moon and other celestial bodies, rationally manage those resources, and expand opportunities for parties to use and share the resources.62

While the creation of said regime never occurred, it is clear the drafters of the Moon Treaty clearly foresaw the need for international agreement regarding space resources. Among other things, the Moon Treaty prohibits state parties from developing a military presence on the moon or any other celestial body,63 or excluding other state parties from scientific investigation in space.64 The Moon Treaty also attempts to require that any scientific discoveries useful to mankind be shared with the Secretary-General of the United Nations as well as the public and the international scientific community.65 Unlike the Outer Space Treaty of 1967, the Moon Treaty calls for the U.N. to maintain control over space, and has numerous provisions that call for approval by the Secretary-General of the United Nations before a state party can act.

The Moon Treaty was an attempt to rationally manage space resources by creating an international regime to oversee space development. It fell short, however, by failing to grant substantive commercial rights that would incentivize space travel, making no distinction between planets, comets, asteroids, or space debris with respect to its provisions (like the Outer Space Treaty), and by applying its provisions exclusively to state parties with few references to private action.66

Article 11, paragraph 2 of The Moon Treaty states that “[t]he moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any means.”67 Thus, under the Moon Treaty, no entity can lay claim of ownership upon anything in space, regardless of the purpose of the claim. The agreement goes further to say explicitly that the surface, subsurface, and the natural resources in place on the moon will not become property of any state; international intergovernmental or nongovernmental organization; national organization or nongovernmental entity; or of any natural person.68 Put differently, the Moon Treaty explicitly prohibits both private and government actors from making commercial claims over the moon, and since the treaty is meant to apply to any celestial body within the solar system, it follows that the same rule applies to space resources like those found on asteroids. While protecting space resources for science is certainly a laudable goal, the Moon Treaty prevents commercial claims in space, effectively stonewalling space’s development. One can hardly imagine a corporation spending the tremendous amount of money necessary to launch a space mission if the only payoff would be the chance to do research that would ultimately have to be shared with the public, including the corporation’s competitors.

Like the Outer Space Treaty of 1968, the shortcomings of the Moon Treaty demonstrate the need for new international legislation regarding the right to own and use space resources like asteroids. The exploration and development of space could be incentivized and facilitated by a new international treaty that affords property rights to private and government entities in asteroids. The doctrine of appropriation would be a logical governing rule.

III THE APPLICATION OF THE DOCTRINE OF APPROPRIATION TO ASTEROID MINING WOULD INCENTIVIZE CORPORATE SPACE EXPLORATION WHILE PREVENTING WASTE AND ABSTRACT CLAIMS

Like water during the expansion of the American West, the exploration of space can be financed and incentivized by granting rights in resources to those who secure new resources and put them to beneficial use. Some legal scholars have suggested the traditional rule of capture be applied to asteroids,69 or that rights to asteroids be purchased directly from an international agency and owned as chattel.70 However, like water during America’s westward expansion, asteroids are not easily classified under traditional property regimes. Thus, a doctrine of appropriation would be more appropriate for asteroids than a traditional rule of capture or a chattel system, because a system based on the traditional rule of capture or chattel would result in waste, abstract claims, and complicated legal issues.

First, asteroid claims cannot be adjudicated under the traditional rule of capture, or as chattel, because such systems would be incredibly wasteful. As of now, scientists have observed approximately 450,000 asteroids in our solar system.71

But only a fraction of the observable bodies will be cost effective to mine. While it might one day be possible for a single entity to finance several mining missions at once, current costs associated with such a venture would limit almost any space-mining program to one or two asteroids, at least initially.72 The traditional rule of capture could allow an entity to quickly claim multiple asteroids merely by landing on them and planting a flag, without requiring the entity to show it can reasonably use the resources they have claimed. Even worse would be a system where the same corporation could claim asteroids simply by discovering their existence and registering the claim. Allowing this type of unregulated claim would incentivize larger corporations capable of space travel to quickly claim reachable asteroids, but the claims could easily outpace those entities’ realistic expectations on what they could use. Under a traditional rule of capture system, the solar system could be divvied up long before the resources could conceivably be mined. A rule similar to the doctrine of appropriation used for water claims in the United States would alleviate this concern by limiting claims to those where a claimant can show a reasonable beneficial use for the resource.

Another concern posed by the traditional rule of capture or chattel system would be the creation of abstract claims. Some legal scholars have advocated for a system where asteroids would be categorized as chattel, and rights in asteroids would be granted to an entity that could identify an asteroid and register ownership of it with an international agency.73 The advantage of such a system would be that it would allow an international agency to keep track of asteroids, and it would allow for the mapping of the reachable solar system. The problem with this approach, however, is that it would result in abstract claims. If an entity could claim the rights to an asteroid without actual possession, there is nothing to prevent that company from claiming ownership long in advance of any real possibility of landing on it. One of the reasons for creating the doctrine of appropriation was to limit abstract claims over resources that were not being used in any reasonable way. Just as the plaintiffs in Hague had no recourse against the third party who wasted the natural gas reserve, there would be no cause of action against an entity that has the rights to an asteroid, but chooses not to exercise them.74 This may be particularly harmful to society because asteroids contain volatiles that may be essential to creating rocket fuel in space, which, in turn, may be crucial to deep space exploration.

Using asteroid-bound volatiles to make rocket fuel would reduce the cost and increase the range of space exploratory missions, possibly improving the human race’s ability to explore and develop space. Under a system were entities could claim asteroids without actual possession, those entities could exclude others from landing on the asteroids and using such resources, even when such resources are languishing unused in space. To prevent the creation of such abstract claims over asteroids, the doctrine of appropriation could be modified as to only grant rights only to entities who are able to demonstrate both actual possession and beneficial use. This would ensure that asteroids claims are limited to those where the resources are actually being used, thus, maximizing the utility of such celestial bodies to society.

Finally, asteroids cannot be adjudicated under the traditional rule of capture or a chattel system because their unique propensity to collide with other celestial bodies would result in vexing legal issues. Pop culture has popularized the notion of an asteroid crashing into the surface of Earth in movies and books, but interspace collisions may be a real concern. Asteroids are constantly moving through space, and they often crash into other asteroids or space debris, and sometimes onto the surface of planets. So real is the concern that space agencies regularly keep track of NEOs, or Near Earth Objects, which include around 10,000 asteroids large enough to be tracked in space.75 Imagine the scenario in the popular movie Armageddon, where society wrestles with the mechanics of destroying a huge asteroid that is headed straight for Earth.76 It would be strange, indeed, if the situation were further complicated by an entity owning the asteroid. Would the Earth have to compensate the company for the loss of resources, or would the company be forced to assume liability for the damage caused by the collision? What if the asteroid, rather than crashing into Earth, crashed instead into another asteroid owned by different entity? It makes sense that a company with actual possession of an asteroid should have a claim for actual mining equipment destroyed, but it seems unreasonable to treat the entire rock as the entity’s chattel. By limiting asteroid claims under a doctrine of appropriation-like system, society will be saved the headache of attempting to adjudicate such absurd situations.

Because the traditional rule of capture or a chattel system for the ownership of asteroids would result in waste, abstract claims, and absurd legal dilemmas, a modified doctrine of appropriation should replace existing outdated international space law relating to asteroids.

CONCLUSION

The doctrine of appropriation is a reasonable rule for adjudicating asteroid claims, and it could easily be modified to apply to asteroid mining. In the context of water rights, the doctrine of appropriation requires that the claimant be a landowner in order to claim the right to use a water source. It does not make sense, however, for the international community to grant complete ownership over asteroids toa single entity, so the landowner requirement of the rule should be removed. A similar modification would need to be made to the "beneficial use" language of the doctrine.

In the context of water rights, an appropriator obtains rights only to water that he or she can reasonably put to beneficial use. The metals contained in asteroids have a high level of marketability. For that reason, a mining entity could potentially put any amount of obtained metal to beneficial use, in the sense that the resources can be sold. This, however, would defeat the purpose of the rule, which is to limit such unreasonable claims. To ameliorate this problem, the doctrine of appropriation could be modified to define "beneficial use "constructively by providing that beneficial use is assumed for any resources that have been removed from the asteroid that the mining entity can reasonably hope to transport to market in a return journey. With the astronomical cost of undertaking a trip to such an asteroid, this modification would limit mining entities to only what they can carry back, thereby leaving the untapped resources available to other entities capable of making the same trip. Considering the size and profitability of metal deposits on asteroids, this modification to the doctrine of appropriation would not be overly burdensome to corporate interests. At the same time, it would satisfy the economic imperative of promoting the rapid development of asteroid resources.

By changing the landowner requirement, and qualifying the “beneficial use" language, the doctrine of appropriation would be essentially ready for application to asteroid mining claims. The only other changes necessary would be some additional requirements that are common to other space related provisions, like those found in the Outer Space Treaty of 1968. For example, a reporting requirement or clause guaranteeing asylum for other astronauts. A functional rule might read something like this:

State parties or private entities may, upon actual possession, lay claim to natural resources found on or below the surface of asteroids. Rights to appropriate are given in order of seniority, starting with the first party to land on the surface of the asteroid and establish control over the resources, be it water, methane, metal, or any other beneficial substances. A party will be said to have established control over a resource once he has mined the substance and removed it from the asteroid. A senior appropriator may use as much of the asteroid's resources as he can take from the asteroid and put to beneficial use, and may continue to enlarge his share until another junior appropriator begins to appropriate resources from source for beneficial use. For the purposes of this Agreement, "beneficial use “refers to the amount of resources that an appropriator has removed from the asteroid that the actor may reasonably hope to bring home in a return voyage. Resources in excess of what an appropriator can reasonably hope to transport to market in a single voyage do not qualify as having a beneficial use, and are therefore not yet claimed. This means that the extraction of metal from an asteroid does not serve to provide ownership if the appropriator plans on letting the resources languish until another voyage is undertaken to secure the resources and bring them back to Earth. Junior appropriators receive rights in the source of resources (the asteroid) as they find it, and may prevent the senior appropriator from enlarging his share to the junior appropriator’s detriment under a no-injury rule. No state party will attempt to hinder other parties from landing on or using the asteroid, and parties will assist other entities on an asteroid, should they need emergency assistance. Mining claims on asteroids will be reported to the Secretary-General of the United Nations, and state parties agree to release the location of the asteroid, and any scientific findings to the United Nations, the general public, and the scientific community. In the event that the asteroid is on a collision course with any other celestial body, all state parties agree to follow the course of action suggested by the United Nations. Should the United Nations decide the asteroid must be destroyed, no state party may claim liability for resources contained within the asteroid, but not yet captured. This provision applies only to asteroids as classified by the scientific community, and does not apply to planets, comets, meteorites, or any other celestial body not mentioned.

There is no doubt that asteroids may be extremely beneficial to mankind, both as a source of resources and as a jumping-off point to far off locations in space. The human-race has progressed scientifically and technologically to the point that space travel is within commercial reach, and the need for new international laws governing the ownership of space has never been more apparent. The Outer Space Treaty of 1968 made great strides in developing rational rules for space and many of its provisions should be maintained in their original form. However, by allowing ownership of asteroids under the doctrine of appropriation, the international community can incentivize the exploration and development of space in a way that reflects the needs of society in general, without vesting an absolute monopoly in a single entity. The doctrine of appropriation helped drive American westward expansion, and its application to space mining would help drive the human race in its expansion into the space, the final frontier.

#### Even pricing in the costs of mining, the economic benefits outweigh- the counterplan jumpstarts a space economy that spills over to tech innovation, planetary defense, and climate change

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[Jack, "Space, the Final Frontier of Enterprise: Incentivizing Asteroid Mining Under a Revised International Framework, 40 Mich. J. Int'l L. 189, 2018, <https://repository.law.umich.edu/mjil/vol40/iss1/5>, accessed 6-24-21]

A casual Internet search for asteroid mining is likely to turn up sky-high dollar value estimates of asteroids. From Neil deGrasse Tyson saying that asteroid mining will make the first trillionaire,12 to a Goldman Sachs note stating that a single asteroid could contain $25–$50 billion worth of platinum relative to a $2.6 billion cost of an asteroid-grabbing spacecraft,13 to reports that NASA is sending a probe to an asteroid worth $10,000 quadrillion, the profit element of this enterprise is not lost on observers.14 However, these estimates depend on the extraction of metals like platinum, their return to Earth, and sale at the current market price, which, as the aforementioned Goldman Sachs note concedes, would “crater the global price of platinum . . . .”15

Instead of attempting to mine metals, the initial step in asteroid mining proposed by Planetary Resources, the most prominent asteroid mining company in existence today, is to mine asteroids for water.16 By making propellant available in space, asteroid mining “increases the payload capacity of rockets, enables the creation of a space highway with fuel depots located at various points of need throughout the Solar System, and allows spacecraft to travel much farther.”17 In other words, the business of asteroid mining, at least in its infancy, is not about harvesting valuable metals and returning them to Earth,18 but rather about providing raw materials to enable the growth of the space economy.

The impetus to provide in-space materials to the space economy is a matter of physics. Launching an object into space is expensive: SpaceX’s Falcon 9—with the capacity to carry just over 50,000 pounds of payload into low Earth orbit19—costs an estimated $36.7 million to launch and uses between $200,000 and $300,000 in fuel each trip.20 If asteroid mining companies were able to provide some of the propellant in space, that would not only reduce fuel costs, but would reduce the overall launch weight, freeing up more space for payload.21

In sum, should asteroid mining companies be able to provide fuel in space, it could dramatically reduce the costs of transporting rockets and cargo into space—both into low Earth orbit and to more distant targets, like Mars. Having this infrastructure in place could also reduce the long-term costs of the asteroid mining business itself, given that the business model involves launching objects into space. While a 2012 study estimated the total cost of an asteroid retrieval mission at $2.6 billion,22 a substantial reduction in launch costs would result in meaningful savings.23 This model of asteroid mining as a provider of in-space resources, then, can facilitate the growth of the space economy: future forays into space would have their costs greatly reduced by a “space highway with fuel depots.”24

B. Public and Private Actors in the Asteroid Mining Space

Both private companies and the space agencies of sovereign governments bear mentioning in a full discussion of asteroid mining. The role of the private sector in space has expanded substantially in the past decade, leading some commentators to suggest that the private sector has eclipsed the public sector in this arena.25 The asteroid mining industry, as detailed above, both depends upon and tends to facilitate this development. Sovereign space agencies, by contrast, conduct a waning share of activity in space and increasingly operate by way of public-private partnerships as an investor in the space economy.26 This marks an important shift from the factual backdrop of the original OST in that private, independent companies are increasingly taking the wheel.

As explored above, the asteroid mining business facilitates the growth of the space economy by reducing launch costs. However, the future of asteroid mining as a lucrative industry also depends upon the existence and growth of a robust space economy. The symbiotic relationships that could develop between private companies deserves emphasis. The viability of asteroid mining depends on a space economy to which asteroid mining companies can sell fuel and metals: the lack of a current market in asteroid resources should resolve itself “when the space population hits critical mass, demanding infrastructure.”27 For spaceflight companies,28 a crucial component to reduce costs is access to propellant in space.29

Sovereign governments continue to play a significant, albeit declining, role in the space economy. NASA’s share of the national budget decreased from 4.4% in 1966 to 0.5% in 2014.30 Its current strategy centers on partnership with the private space economy: “NASA helps mitigate financial risk, while the private sector conducts research and innovation more efficiently than NASA can . . . .”31 Similarly Luxembourg, which lacks its own space agency,32 opened a 200 million Euro fund in 2016 to bring asteroid mining companies to the country.33 Planetary Resources has availed itself of opportunities offered by both NASA and Luxembourg, performing contract work with the former and securing funding from the latter.34

While sovereign governments do hold some of the purse strings relevant to asteroid mining companies and the space economy as a whole, private companies are increasingly displacing national space agencies.35 A private space economy that is increasingly independent from sovereign governments tends to undermine the factual framework upon which the original OST relied.36 Specifically, Article VI assigns responsibility for nongovernmental entities to national governments, the implicit assumption likely being that private entities would be acting at the behest of a sovereign.37 This concern is increasingly unsubstantiated in an environment in which private, independent companies are ascendant.38

C. Global Benefits of Asteroid Mining

Asteroid mining has the potential to facilitate space travel, an outcome the OST holds to be in the interest of humanity as a whole.39 The potential of asteroid mining to reduce the cost of spaceflight, moreover, could facilitate the growth of the space economy. Asteroid mining thus aligns with another stated purposes of the OST in the sense that an expanded space economy could provide substantial benefits to all mankind.40 First, in seeking to face the challenges posed by space travel, the public sector space race gave rise to numerous technological innovations, ranging from LEDs to emergency blankets to memory foam.41 It seems likely that the private space race would result in a similar degree of innovation, the products of which could benefit people across the globe.

Second, a successful mission to Mars could provide benefits beyond a mere sense of interplanetary accomplishment. NASA suggests that, given the parallels between the formation and evolution of Mars and Earth, a voyage there could help “us learn more about our own planet’s history and future.”42 The scientific advancements from such a mission cannot currently be anticipated and are difficult to predict, but “expand[ing] the frontiers of knowledge” in this manner could well bring benefits to all mankind.43

Third, the development of asteroid mining technology could also help advance asteroid diversion tactics. The development of the technology required to conduct successful asteroid mining operations could “help us to divert any incoming asteroids.”44 This is of great importance since NASA recently eliminated its Asteroid Redirect Mission due to funding cuts;45 NASA’s project was hailed by some scientists as a “critical step in demonstrating we can protect our planet from a future asteroid impact . . . .”46 Asteroid mining could step in and fill an important void. While the probability of an Armageddon-causing impact is low, the effects of an impact would be extremely severe.47 Even some mitigation of this risk as a byproduct of asteroid mining would be a benefit to humanity as a whole.

Finally, reduced launch costs could facilitate measures to combat global climate change. One proposed solution for canceling out predicted increases in average worldwide temperature is to “prevent[] . . . about 1% of incoming solar radiation—insolation—from reaching the Earth. This could be done by scattering into space from the vicinity of Earth an appropriately small fraction of total insolation.”48 Asteroid mining could facilitate such measures in that “[t]echnologies that could greatly decrease the cost of space-launch could make a telling difference in the practicality of all types of spacedeployed scattering systems of scales appropriate to insolation modulation.”49 There are certainly intermediate measures to combat climate change that ought to be taken first, but asteroid mining would facilitate this expedited solution. While some of the benefits of asteroid mining would doubtless accrue primarily to those nations with asteroid mining companies within their borders, the benefits noted in this section—space exploration as a general proposition, technological and scientific development, improvement of asteroid diversion technology, and facilitated means of swiftly countering climate change—would inure substantially to the benefit of all mankind.

#### Asteroids cause extinction

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[Seth, Risk-Risk Tradeoff Analysis of Nuclear Explosives for Asteroid Deflection, Risk Analysis, vol. 39, no. 11, November 2019, p. 2427-2442, <https://doi.org/10.1111/risa.13339>, accessed 1-8-22]

4.3 Severity of Asteroid Collision and Violent Nuclear Conflict

Both asteroid collisions and nuclear weapons detonations involve explosions. Their effects are likewise similar. A primary difference is the absence of ionizing radiation from asteroid collisions.

The standard physical measure for the severity of asteroid collisions and nuclear detonations is the amount of energy released, in units of tons (T), kilotons (KT), or megatons (MT) of TNT equivalent.10 The 2013 Chelyabinsk asteroid collision was about 20m in diameter and 500KT (Brown et al., 2013). This is about double the smallest size believed to be able to cause damage on Earth’s surface; smaller collisions explode harmlessly in the upper atmosphere (Harris et al., 2015). The Chicxulub impactor was an estimated 10km and 108MT (Chapman & Morrison, 1994). Nuclear weapons have been made as small as around 10T (the U.S. W54 weapon) and as large as 50MT (the Soviet Tsar Bomba). There is no physical limit to how large of a nuclear weapon can be built. Common nuclear weapon yields are tens to hundreds of KT, and some have yields of several MT (Kristensen and Norris, 2018a, 2018b, 2018c).

The extent of the damage depends on the amount of energy released and the location on Earth. The 1908 Tunguska collision caused ecological damage across a wide area of Siberia but no significant human harm, though if it had collided four hours later it could have hit Saint Petersburg (Longo, 2007). The locations of asteroid collisions are essentially random, so most occur at ocean locations. The locations of nuclear weapons explosions are not random. In military planning, most nuclear weapons are targeted at either cities or military installations, while test explosions are conducted in remote locations or underground to minimize harm.

The local harms from asteroid collisions and nuclear weapons explosions are relatively simple and well understood. The immediate vicinity is disturbed or destroyed. The Hiroshima and Nagasaki bombings provide indicative data. They were hit with bombs of 15-20KT yield detonated at altitudes around 500-600m (to maximize damage) over the center city. Fatalities were about 120,000 people in Hiroshima and 60,000 in Nagasaki; the Hiroshima number is likely larger due to flatter terrain and drier conditions that enabled the blast and accompanying firestorm to spread (Toon et al., 2007). Nuclear detonations with higher yields and at larger cities could bring many times more fatalities.

In comparison, local effects from asteroid collisions could be larger than single nuclear detonations due to their potential for larger event energies. However, local effects from asteroid collisions would typically see less human harm due to their occurrence at random locations, which are likely to be uninhabited or sparsely populated. Asteroid risk analyses commonly calculate local severity based on the population within a 2 to 4 psi blast overpressure damage area (Canavan, 1993, 1994; Garrick, 2008; Mathias, 2017; Stokes et al., 2003), which is based on studies of nuclear weapons (Glastone, 1962; Glastone & Dolan, 1977).

A sufficiently large asteroid collision at an ocean would cause a tsunami. The current literature lacks consensus on how severe the tsunami would be. Gusiakov et al. (2010) propose that several massive asteroid-caused tsunamis have occurred in recent millennia, but this proposition is hotly disputed (Bourgeois & Weiss, 2009; Goff et al., 2010; Pinter & Ishman, 2008). Other studies suggest that asteroid-caused tsunamis are much less severe (Gisler, Weaver, & Gittings, 2011; Korycansky & Lynett, 2005).

The most severe asteroid collisions and nuclear wars can cause global environmental effects. The core mechanism is the transport of particulate matter into the stratosphere, where it can spread worldwide and remain aloft for years or decades. Large asteroid collisions create large quantities of dust and large fireballs; the fire heats the dust so that some portion of it rises into the stratosphere. The largest collisions, such as the 10km Chicxulub impactor, can also eject debris from the collision site into space; upon reentry into the atmosphere, the debris heats up enough to spark global fires (Toon, Zahnle, Morrison, Turco, & Covey, 1997). The fires are a major impact in their own right and can send additional smoke into the stratosphere. For nuclear explosions, there is also a fireball and smoke, in this case from the burning of cities or other military targets.

While in the stratosphere, the particulate matter blocks sunlight and destroys ozone (Toon et al., 2007). The ozone loss increases the amount of ultraviolet radiation reaching the surface, causing skin cancer and other harms (Mills, Toon, Turco, Kinnison, & Garcia, 2008). The blocked sunlight causes abrupt cooling of Earth’s surface and in turn reduced precipitation due to a weakened hydrological cycle. The cool, dry, and dark conditions reduce plant growth. Recent studies use modern climate and crop models to examine the effects for a hypothetical IndiaPakistan nuclear war scenario with 100 weapons (50 per side) each of 15KT yield. The studies find agriculture declines in the range of approximately 2% to 50% depending on the crop and location.11 Another study compares the crop data to existing poverty and malnourishment and estimates that the crop declines could threaten starvation for two billion people (Helfand, 2013). However, the aforementioned studies do not account for new nuclear explosion fire simulations that find approximately five times less particulate matter reaching the stratosphere, and correspondingly weaker global environmental effects (Reisner et al., 2018). Note also that the 100 weapon scenario used in these studies is not the largest potential scenario. Larger nuclear wars and large asteroid collisions could cause greater harm. The largest asteroid collisions could even reduce sunlight below the minimum needed for vision (Toon et al., 1997). Asteroid risk analyses have proposed that the global environmental disruption from large collisions could cause one billion deaths (NRC, 2010) or the death of 25% of all humans (Chapman, 2004; Chapman & Morrison, 1994; Morrison, 1992), though these figures have not been rigorously justified (Baum, 2018a).

The harms from asteroid collisions and nuclear wars can also include important secondary effects. The food shortages from severe global environmental disruption could lead to infectious disease outbreaks as public health conditions deteriorate (Helfand, 2013). Law and order could be lost in at least some locations as people struggle for survival (Maher & Baum, 2013). Today’s complex global political-economic system already shows fragility to shocks such as the 2007- 2008 financial crisis (Centeno, Nag, Patterson, Shaver, & Windawi, 2015); an asteroid collision or nuclear war could be an extremely large shock. The systemic consequences of a nuclear war would be further worsened by the likely loss of major world cities that serve as important hubs in the global economy. Even a single detonation in nuclear terrorism would have ripple effects across the global political-economic system (similar to, but likely larger than, the response prompted by the terrorist attacks of 11 September 2001).

It is possible for asteroid collisions to cause nuclear war. An asteroid explosion could be misinterpreted as a nuclear attack, prompting nuclear attack that is believed to be retaliation. For example, the 2013 Chelyabinsk event occurred near an important Russian military installation, prompting concerns about the event’s interpretation (Harris et al., 2015).

The ultimate severity of an asteroid collision or violent nuclear conflict use would depend on how human society reacts. Would the reaction be disciplined and constructive: bury the dead, heal the sick, feed the hungry, and rebuild all that has fallen? Or would the reaction be disorderly and destructive: leave the rubble in place, fight for scarce resources, and descend into minimalist tribalism or worse? Prior studies have identified some key issues, including the viability of trade (Cantor, Henry, & Rayner, 1989) and the self-sufficiency of local communities (Maher & Baum, 2013). However, the issue has received little research attention and remains poorly understood. This leaves considerable uncertainty in the total human harm from an asteroid collision or nuclear weapons use. Previously published point estimates of the human consequences of asteroid collisions12 and nuclear wars (Helfand, 2013) do not account for this uncertainty and are likely to be inaccurate.

Of particular importance are the consequences for future generations, which could vastly outnumber the present generation. If an asteroid collision or nuclear war would cause human extinction, then there would be no future generations. Alternatively, if survivors fail to recover a large population and advanced technological civilization, then future generations would be permanently diminished. The largest long-term factor is whether future generations would colonize space and benefit from its astronomically large amount of resources (Tonn, 1999). However, it is not presently known which asteroid collisions or nuclear wars (if any) would cause the permanent collapse of human civilization and thus the loss of the large future benefits (Baum et al., 2019). Given the enormous stakes, prudent risk management would aim for very low probabilities of permanent collapse (Tonn, 2009).

#### Warming turns nuclear war and death spirals make resilience impossible.

Beard et al. 21 [S.J. Beard, Lauren Holt, Asaf Tzachor, Luke Kemp, Shahar Avin, Phil Torres, and Haydn Belfield, \* Centre for the Study of Existential Risk, “Assessing climate change’s contribution to global catastrophic risk,” 2021, *Futures*, Vol. 127, https://doi.org/10.1016/j.futures.2020.102673, Table 1 & Fig. 2 Omitted]

3.1. Climate change and planetary boundaries

While most of the impacts of climate change so far have fallen within the range of what was experienced during the Holocene, the rate of change is faster than in the Holocene and we are now beginning to see climate change push beyond these boundaries. In the latest edition of the planetary boundaries’ framework, climate change is placed in the zone of increasing risk, implying that while this boundary has been breached, there remains some potential for normal functioning and recovery (Steffen et al., 2015). It thus lies between what the authors identify as the ‘safe zone’ and other ‘high risk’ transgressions, such as disruption to the biochemical flows of nitrogen and phosphorus and loss of biosphere integrity.

As part of their discussion of BRIHN Baum and Handoh (2014) note that climate change is the planetary boundary for which the risk to humanity has received most meaningful consideration and they suggest that this attention is deserved. Yet little research attention has been paid to climate change’s extreme or catastrophic effects. Kareiva and Carranza (2018) argue that, despite currently falling outside of the area of high risk, climate change has the clear potential to push humanity across a threshold of irreversible loss by “changing major ocean circulation patterns, causing massive sea-level rise, and increasing the frequency and severity of extreme events… that displace people, and ruin economies.” Even if humanity was resilient to each of these individual impacts, a global catastrophe could occur if these impacts were to occur rapidly and simultaneously.

One scenario that has received comparatively more attention is that of the global climate crossing a tipping point that would trigger environmental feedback loops (such as declining albedo from melting ice or the release of methane from clathrates) and cascading effects (such a shifting rainfall patterns that trigger desertification and soil erosion). After this point, anthropogenic activity may cease to be the main driver of climate change, making it accelerate and become harder to stop (King et al., 2015).

Other scenarios can be discerned from the numerous historical cases in which the modest, usually regional, climatic changes experienced during the Holocene have been implicated in the collapse of previous societies, including the Anasazi, the Tiwanaku, the Akkadians, the Western Roman Empire, the lowland Maya, and dozens of others (Diamond, 2005, Fagan, 2008). These provide a precedent for how a changing climate can trigger or contribute to societal breakdown. At present, our understanding of this phenomena is limited, and the IPCC has labelled its findings as “low confidence” due to a lack of understanding of cause and effect and restrictions in historical data (Klein et al., 2014). Further study and cooperation between archaeologists, historians, climate scientists and global catastrophic risk scholars could overcome some of these limitations by identifying how the impacts of climate change translate into social transformation and collapse, and hence what the impacts of more rapid and extreme climatic changes might be. There is also the potential for larger studies into how global climate variations have coincided with collapse and violence at the regional level (Zhang, Chiyung, Chusheng, Yuanqing, & Fung, 2005; Zhang et al., 2006). However, these need to be interpreted and generalized with care given the differences between pre-industrial and modern societies.

Societies also have a long history of adapting to, and recovering from, climate change induced collapses (McAnany and Yoffee, 2009). However, there are two reasons to be sceptical that such resilience can be easily extrapolated into the future. First, the relatively stable context of the Holocene, with well-functioning, resilient ecosystems, has greatly assisted recovery, while anthropogenic climate change is more rapid, pervasive, global, and severe. Large-scale states did not emerge until the onset of the Holocene (Richerson, Boyd, & Bettinger, 2001), and societies have since remained in a surprisingly narrow climatic niche of roughly 15 mean annual average temperature (Xu, Kohler, Lenton, Svenning, & Scheffer, 2020). A return to agrarian or hunter-gatherer lifestyles could thus have more devastating and long-lasting effects in a world of rapid climate change and ecological disruption (Gowdy, 2020).7 Second, modern human societies may have developed hidden fragilities that amplify the shocks posed by climate change (Mannheim 2020) and the complex, tightly-coupled and interdependent nature of our socio-economic systems makes it more likely that the failure of a few key states or industries due to climate change could cascade into a global collapse (Kemp, 2019).

A third set of plausible scenarios stem from climate change’s broader environmental impacts. Apart from being a planetary boundary of its own, Steffen et al. (2015) point out that climate change is intimately connected with other planetary boundaries (see Table 1). Climate change is thus identified by the authors as one of two ‘core’ boundaries with the potential “to drive the Earth system into a new state should they be substantially and persistently transgressed.” This transformative potential was elaborated on in subsequent work exploring how the world could be pushed towards a ‘Hothouse Earth’ state, even with anthropogenic temperature rises as low as 2 °C (Steffen et al., 2018).

The connection between climate change and biosphere integrity (the survival of complex adaptive ecosystems supporting diverse forms of life) is particularly strong. The IPCC is highly confident that climate change is adversely impacting terrestrial ecosystems, contributing to desertification and land degradation in many areas and changing the range, abundance and seasonality of many plant and animal species (Arneth et al., 2019). Similarly, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has reported that climate change is restricting the range of nearly half the world’s threatened mammal species and a quarter of threatened birds, with marine, coastal, and arctic ecosystems worst affected (Diaz et al., 2019). According to one estimate, climate change could cause 15–37 % of all species to become ‘committed to extinction’ by mid-century (Thomas et al., 2004).

Disruption to biosphere integrity can have profound economic and social repercussions, ranging from loss of ecosystem services and natural resources to the destruction of traditional knowledge and livelihoods. For instance, desertification, which threatens a quarter of Earth’s land area and a fifth of the population, is already estimated to cost developing nations 4–8 % of their GDP (United Nations, 2011). Many other rapid regime shifts involving loss of biosphere integrity have been observed, including shifts in arid vegetation, freshwater eutrophication, and the collapse of fish populations (Amano et al. 2020). There is a theoretical possibility of still more profound regime shifts at the global level (Rocha, Peterson, Bodin, & Levin, 2018). However, the contribution of loss of biosphere integrity to GCR is yet to be assessed. Kareiva and Carranza (2018) argue that it is unlikely to threaten human civilization, due both to a lack of plausible mechanisms for this threat and the fact that “local and regional biodiversity is often staying the same because species from elsewhere replace local losses.” However, in their classification of GCRs, Avin et al. (2018) suggest the potential for ecological collapse to threaten the safety boundaries of multiple critical systems with diverse spread mechanisms at a range of scales, from the biogeochemical and anatomical to the ecological and sociotechnological. Note that both these studies were conducted for largely conceptual purposes and should not be taken as rigorous analyses of this risk, this topic warrants further investigation.

3.2. Classifying climate change’s contributions to global catastrophic risk

Climate change’s contribution to GCR goes well beyond its impact on the earth system. Taking Avin et al.’s list of critical systems, we note that previous studies have mostly focused on the effects of climate change on physical and biogeochemical systems (e.g. global temperature and sea-level rise) or the lower-level critical systems that are most directly related to human health and survival (e.g. Heath Stress). However, these represent a very limited assessment of risk as it only accounts for climate change as a direct hazard/ threat and our "ontological" vulnerabilities to it. A more comprehensive risk assessment must consider the higher-order critical systems threatened by climate change passively (through a lack of alternatives) and actively (through intentional design).

The probability of a global catastrophe is higher when sociotechnological and environmental systems are tightly coupled, creating a potential for reinforcing feedback loops. If environmental change produces social changes that perpetuate further environmental change, then this could actively work against our efforts at adaptation. When this change has the potential to produce significant harm, via human vulnerabilities and exposure, we describe such loops as ‘global systems death spirals.’ These spirals could produce self-perpetuating catastrophes, whereby the energy and resources required to reverse or adapt to collapse are beyond the means of dwindling human societies. Feedback loops like this could thus create tipping points beyond which returning to anything like present conditions would become extremely difficult. Global systems would shift to very different states in which the prospects for humanity would likely be bleaker.

In the rest of this section, we explore just one potential spiral, between an ecological system (the biosphere) and two sociotechnological systems (the human food and global political systems). We explore each system and its interactions. Fig. 2 illustrates our model of this spiral.

3.2.1. The human food system

Climate change’s impact on biosphere integrity (discussed in the previous section) could harm the human food system due to loss of ecosystem services, disruption of the cycles of water, nitrogen and phosphates, and changes in the dynamics of plant and animal health (B´elanger & Pilling, 2019). Crossing this planetary boundary is already having severe implications for global food security, including loss of soil fertility and insect-mediated pollination (Diaz et al., 2019).

Systems for the production and allocation of food are already enduring significant stress. The sources of stress include climate change, soil erosion, water scarcity, and phosphorus depletion. The natural resource base, arable land and freshwater upon which food production rely are being degraded. While global food productivity and production has increased dramatically over the past century to meet rising demand from an expanding global population and rising standard of living, these constraints and risks are increasing the vulnerability of our global food supply to rapid and global disruptions that could constitute global catastrophes (Baum, Denkenberger, Pearce, Robock, & Winkler, 2015).

Climate change will further reduce food security in at least three interconnected ways. First, it will affect growing conditions, including direct threats to agricultural yields from heat, humidity, and precipitation in many regions; although initially improving conditions in some (Lott, Christidis, & Stott, 2013). Second, it will increase the range of agricultural pests and diseases (Harvell et al., 2002). Third, it will increase the occurrence of extreme weather events that impair the integrity of food production and distribution networks, from production to harvest, post-harvest, transport, storage, and distribution, thereby increasing our vulnerability and exposure to supply shocks (Bailey et al., 2015). The IPCC estimates, with medium confidence, that at around 2 °C of global warming the risk from permafrost degradation and food supply instabilities will be ‘very high’, while at around 3 °C of global warming the risk from vegetation loss, wildfire damage, and dryland water scarcity will also be very high (Arneth et al., 2019). Very few studies have considered the impacts of 4 °C of global warming or more; however, the IPCC highlighted one study finding that any potential agricultural gains from climate change will be lost by this point and there could be a decrease of 19 % in maize yields and 68 % in bean yields in Africa, an 8 % reduction in yields in South Asia, and a substantial negative impact on fisheries by 2050 (Porter et al., 2014). Furthermore, multiple extreme weather events could disrupt food distribution networks (Bailey and Wellesley, 2017).

While there are opportunities to adapt, disruption to the entire global food system cannot be resolved via food aid alone. Indeed, there is the potential for isolationist or heavy-handed responses that would do more harm than good. Given the high degree of interconnectivity and feedback within the global food system, our initial research suggests that any one of these climate change effects could trigger scenarios that would critically undermine the global food system’s ability to meet the minimum nutrition for well-being; making food security for all an unachievable goal, let alone rise to the challenge of continuing to grow (A. Tzachor, 2019, 2020); this would constitute what Kuhlemann (2019) terms a ‘threshold of significance.’

3.2.2. The global political system

Disrupting the global food system can create and exacerbate conflict and state failure (Brinkman & Hendrix, 2011). However, once again, this needs to be seen against the backdrop of a global political system under stress, with climate change as a significant contributing factor. Climate change influences political systems in many ways, from being a locus of activism and a stimulus for reform to driving rising inequality and population displacement (Arneth et al., 2019; Diffenbaugh & Burke, 2019). This is not a new phenomenon, changes in the climate are believed to have contributed to conflict between people and states throughout human history, driven by resource scarcity, population displacement, and inequality (Lee, 2009; Mach et al., 2019). As part of a comprehensive risk assessment of climate change, King et al. (2015) conducted an extensive literature review on climate change and conflict and used this to inform a series of international wargaming exercises. These found that climate change is expected to increase international conflict while highlighting the role that population displacement, state failure, and water and food insecurity would play in this (see also Mach et al., 2019; Natalini, Jones, & Bravo, 2015).

Quantitative studies of the impact of climate change on violence and conflict have provided more mixed results. A survey of empirical studies by Detges (2017) found that there may be multiple differing trends: extreme weather events appear to have more significant effects on violence than do long-term climate trends, while levels of small-scale conflict and interpersonal violence appear to be more affected than large-scale conflicts and international war. Empirical studies also highlight how climate change’s impact on conflict is predominantly as a risk multiplier and intensifier. Thus, climate change may contribute more by increasing our vulnerability to other conflict-inducing factors, such as loss of livelihood, forced migration, environmental change, and food insecurity, than by acting as a direct cause of conflict (Abel, Brottrager, Cuaresma, & Muttarak, 2019; Hsiang, Burke, & Miguel, 2013; Schubert et al., 2008).8

Of particular relevance to GCR is the effect of climate change on the risk of nuclear war (Parthemore, Femia, & Werrell, 2018). However, to our knowledge, this has never been rigorously assessed, although the potential is certainly there. One recent model of the risk of nuclear war highlighted how varied, and common, incidents with the potential to trigger a nuclear exchange are (Baum, de Neufville, & Barrett, 2018). It outlined 14 different causal pathways to an exchange, including the escalation of conventional wars and international crises, human error, and the emergence of new non-state actors. For all but two of these, they identify historical examples of potentially precipitating incidents, with 60 incidents in total (i.e. a little less than one a year). This suggests that the absence of nuclear war was less due to a lack of potential causes, tan the global political system’s ability to defuse them. Thus, the real significance of climate change may be its capacity to undermine this system: the combination of social, political, and environmental disruption, a lingering sense of global injustice, and rising food, water, and energy insecurity could increase the probability that crises escalate or that false alarms are mistaken for genuine emergencies. This topic needs further research.

3.3. The emergence of a global systems death spiral

Yet, we should not conclude that a nuclear exchange is the only, or even most likely, scenario in which political instability might produce a global catastrophe. Conflict and political instability, even of moderate severity, are themselves two of the most significant drivers of biodiversity loss due to breakdowns in monitoring, governance, and (public and private) property rights (Baynham-Herd, Amano, Sutherland, & Donald, 2018). This closes a potentially reinforcing feedback loop between loss of biosphere integrity, food insecurity and political breakdown.

The mechanisms by which these cascading failures might spread include many of the natural, anthropogenic, and replicator effects identified by Avin et al. (2018), making them harder to contain. At the natural level, climate change involves changes to the global atmospheric and biogeochemical systems and poses other naturally spreading harms, like global ecological collapse. At the anthropogenic level, the global interconnectedness of sociotechnological systems means that while small shocks are easier to recover from, larger shocks can be harder to contain and control. Finally, biological and informational replication can also spread the negative impacts of climate change, from vector-borne diseases and invasive species to climate fatalism and dangerous geoengineering technologies.

Given these numerous spread mechanisms, critical system failures could precipitate global catastrophes. Furthermore, the spiral we have explored is unlikely to be the only set of interlinked systemic disruptions that climate change could initiate (other death spirals could involve bio-insecurity and disease), nor are these the only causal connections between these three systems. Until we understand the nature of such death spirals better, we must act cautiously. We now turn to consider what this would mean.

#### Last plank solves inequality

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[Morgan, and Kevin Orrman-Rossiter, PhD candidate, History & Philosophy of Science, The University of Melbourne, "All of humanity should share in the space mining boom," Conversation, 4-17-16, https://theconversation.com/all-of-humanity-should-share-in-the-space-mining-boom-57740, accessed 6-25-21]

One solitary asteroid might be worth trillions of dollars in platinum and other metals. Exploiting these resources could lead to a global boom in wealth, which could raise living standards worldwide and potentially benefit all of humanity. There are already companies, such as Planetary Resources, hoping to make mining in space a reality. Peter Diamondis, co-founder of Planetary Resources and founder of the XPrize Grand Challenges, believes that the benefits to humanity give us a moral imperative to explore and utilise space. He has also declared “there are twenty-trillion-dollar checks up there, waiting to be cashed!” However, behind the utopian rhetoric and dazzling dreams of riches lie some very real problems. Ownership and the Outer Space Treaty The framework of international space law is given by the Outer Space Treaty (OST), which entered into force in 1967. Among its main principals, the OST includes these statements: the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind and, outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means Because the OST is generally interpreted as preventing anything like private fee-simple ownership, it is sometimes claimed to be an obstacle to commercial ventures in space. But such claims simply do not hold water. There are numerous terrestrial examples where resources are profitably exploited in the absence of fee-simple ownership. Governments routinely licence companies to engage in timber extraction, mining, offshore oil exploration and other activities, receiving royalties payments on production. In the United States, revenues from such royalties totalled some US$13.5 billion dollars in 2014 from federally owned or managed lands alone. Nevertheless, some proponents of mining in outer space argue for serious modification or an end to the Outer Space Treaty and claim, against the evidence, that without fee-simple ownership, there is no incentive for commercial exploitation. The Unites States’ Space Act of 2015 was just one volley – and a deliberately vague one at that – in this ongoing international debate. A balanced approach? The riches exist, but how will humanity benefit from mining in outer space, or for that matter, other global commons such as the deep sea floor? Behind the lofty rhetoric of benefits to humanity, there is a dark shadow of voodoo economics, the shambling, walking dead figure of trickle down economics– and the possibility of a world where a few trillionaires enjoy the view from space while others barely eke a living on its surface. Yet we do suggest that commercial interests and profit seeking can be a healthy part of the exploration of outer space. Yet outer space is not the Wild West frontier of Frederick Jackson Turner, nor do we live in the Gold Rush days of Jack London’s tale of greed and death. In the common heritage of space, with multiple state and private actors engaging in exploration and potentially exploitation, international cooperation and oversight will benefit all. The Alaskan model There is a balanced, pragmatic approach that will promote commercial and profit driven activities, while also producing tangible benefits to all of humanity. Importantly, this pragmatic approach has a well established precedent that has existed for nearly 40 years. And this comes not from a social democracy or left-wing ideology, but was the brainchild of a libertarian, Republican governor of Alaska, Jay Hammond. That model is the Alaska Permanent Fund Corporation (APFC) created in 1976, and its unique “citizen’s dividend”. The APF is a resource wealth fund, which derives its revenue primarily from leases on oil fields. In 1977, Hammond suggested that “rather than permitting government to spend all public monies earned through the exploitation of the public’s resources for what government thinks best, let’s grant shares to Alaskans.” The first dividend payment was made in 1982, and in 2015 that payment amounted to US$2,072. Linking a citizen’s dividend to a sovereign wealth fund was unique, but the idea of a citizen’s dividend has a long and venerable tradition. One of the earliest advocates was no less than the political theorist and American Revolutionary, Thomas Paine. International body How would this work for outer space? We need an international body similar to the International Seabed Authority, which was established by the United Nations Convention on the Law of the Sea, or the International Telecommunications Union, which allocates satellite orbits. This would provide the stable business and investment environment that entrepreneurs seek by ensuring international law and obligations are met. This body could license outer space resources and levy a royalty on production, which is part of standard business practice between petroleum and other mining companies and governments here on Earth. In turn, these revenues, or a significant portion thereof, would be deposited in a Space Resource Fund, possibly under the aegis of the World Bank. And every single citizen on Earth, say aged 18 or above, would receive a dividend on a yearly basis as their rightful share as owners of the common province of humankind. Crucially, we are not suggesting redistribution, which has been an obstacle to the International Seabed Authority and the Moon Treaty in the past, but a fair share dividend of wealth that truly belongs to everyone. Our model doesn’t provide a handout, or a welfare cheque, or charity from a trillionaire philanthopist; it pays every owner in a global commons a share of what is rightfully theirs. Even tiny dividends by the standards of the world’s wealthy nations would make a difference for some developing world farmers. If there truly are trillions of dollars out there, then this might be something fundamentally world changing. We accept that Larry Page and Sir Richard Branson – founding investors and advisors in Planetary Resources – and its founders Eric Anderson and Peter Diamandis, truly want humanity to benefit from outer space, and that they truly believe in corporate social responsibility and a sustainable future. We would encourage them to embrace the idea that the sky really does belong to all of us, as the common “province of all mankind”. By paying rent for the right to exploit resources in space and royalties on production, the same way oil companies pay to exploit oil in the Gulf of Mexico, they’ll be engaging in business as usual. They will have bought the right to make a potentially enormous profit and prove they really are responsible global citizens. And they’d get a citizen’s dividend cheque too.

### 2

Innovation DA

#### Private companies solve best for innovation – reducing costs, investment, and high risk-tolerance. Regulation and lack of property rights kills

Weinzierl and Elbling 2021

(“The Commercial Space Age Is Here,” Matt Weinzierl is the Joseph and Jacqueline Elbling Professor of Business Administration at HBS and a Research Associate at the NBER, Mehak Sarang is a Research Associate at Harvard Business School and the Lunar Exploration Projects Lead for the MIT Space Exploration Initiative, February 12, 2021, <https://hbr.org/2021/02/the-commercial-space-age-is-here>, accessed 1-15-2022)

In 2019, 95% of the estimated $366 billion in revenue earned in the space sector was from the space-for-earth economy: that is, goods or services produced in space for use on earth. The space-for-earth economy includes telecommunications and internet infrastructure, earth observation capabilities, national security satellites, and more. This economy is booming, and though research shows that it faces the challenges of overcrowding and monopolization that tend to arise whenever companies compete for a scarce natural resource, projections for its future are optimistic. **Decreasing costs for launch and space hardware in general have enticed new entrants into this market, and companies in a variety of industries have already begun leveraging satellite technology and access to space to drive innovation and efficiency in their earthbound products and services.** In contrast, the space-for-space economy — that is, goods and services produced in space for use in space, such as mining the Moon or asteroids for material with which to construct in-space habitats or supply refueling depots — has struggled to get off the ground. As far back as the 1970s, research commissioned by NASA predicted the rise of a space-based economy that would supply the demands of hundreds, thousands, even millions of humans living in space, dwarfing the space-for-earth economy (and, eventually, the entire terrestrial economy as well). The realization of such a vision would change how all of us do business, live our lives, and govern our societies — but to date, we’ve never even had more than 13 people in space at one time, leaving that dream as little more than science fiction. Today, however, there is reason to think that we may finally be reaching the first stages of a true space-for-space economy. SpaceX’s recent achievements (in cooperation with NASA), as well as upcoming efforts by Boeing, Blue Origin, and Virgin Galactic to put people in space sustainably and at scale, mark the opening of a new chapter of spaceflight led by private firms. These firms have both the intention and capability to bring private citizens to space as passengers, tourists, and — eventually — settlers, opening the door for businesses to start meeting the demand those people create over the next several decades with an array of space-for-space goods and services. Welcome to the (Commercial) Space Age In our recent research, we examined how the model of centralized, government-directed human space activity born in the 1960s has, over the last two decades, made way for a new model, in which public initiatives in space increasingly share the stage with private priorities. Centralized, **government-led space programs will inevitably focus on space-for-earth activities that are in the public interest,** such as national security, basic science, and national pride. This is only natural, as expenditures for these programs must be justified by demonstrating benefits for citizens — and the citizens these governments represent are (nearly) all on earth. **In contrast to governments, the private sector is eager to put people in space to pursue their own personal interests, not the state’s** — and then supply the demand they create. This is the vision driving SpaceX, which in its first twenty years has entirely upended the rocket launch industry, securing 60% of the global commercial launch market and building ever-larger spacecraft designed to ferry passengers not just to the International Space Station (ISS), but also to its own promised settlement on Mars. Today, the space-for-space market is limited to supplying the people who are already in space: that is, the handful of astronauts employed by NASA and other government programs. While SpaceX has grand visions of supporting large numbers of private space travelers, their current space-for-space activities have all been in response to demand from government customers (i.e., NASA). **But as decreasing launch costs enable companies like SpaceX to leverage economies of scale and put more people into space, growing private sector demand** (that is, tourists and settlers, rather than government employees) could turn these proof-of-concept initiatives into a sustainable, large-scale industry. This model — of selling to NASA with the hopes of eventually creating and expanding into a larger private market — is exemplified by SpaceX, but the company is by no means the only player taking this approach. For instance, while SpaceX is focused on space-for-space transportation, another key component of this burgeoning industry will be manufacturing. Made In Space, Inc. has been at the forefront of manufacturing “in space, for space” since 2014, when it 3D-printed a wrench onboard the ISS. Today, the company is exploring other products, such as high-quality fiber-optic cable, that terrestrial customers may be willing to pay to have manufactured in zero-gravity. But the company also recently received a $74 million contract to 3D-print large metal beams in space for use on NASA spacecraft, and future private sector spacecraft will certainly have similar manufacturing needs which Made In Space hopes to be well-positioned to fulfill. Just as SpaceX has begun by supplying NASA but hopes to eventually serve a much larger, private-sector market, Made In Space’s current work with NASA could be the first step along a path towards supporting a variety of private-sector manufacturing applications for which the costs of manufacturing on earth and transporting into space would be prohibitive. **Another major area of space-for-space investment is in building and operating space infrastructure such as habitats, laboratories, and factories.** Axiom Space, a current leader in this field, recently announced that it would be flying the “first fully private commercial mission to space” in 2022 onboard SpaceX’s Crew Dragon Capsule. Axiom was also awarded a contract for exclusive access to a module of the ISS, facilitating its plans to develop modules for commercial activity on the station (and eventually, beyond it). **This infrastructure is likely to spur investment in a wide array of complementary services to supply the demand of the people living and working within it.** For example, in February 2020, Maxar Technologies was awarded a $142 million contract from NASA to develop a robotic construction tool that would be assembled in space for use on low-Earth orbit spacecraft. Private sector spacecraft or settlements will no doubt have need for a variety of similar construction and repair tools. And of course, the private sector isn’t just about industrial products. **Creature comforts also promise to be an area of rapid growth, as companies endeavor to support the human side of life in the harsh environment of space.** In 2015, for example, Argotec and Lavazza collaborated to build an espresso machine that could function in the zero-gravity environment of the ISS, delivering a bit of everyday luxury to the crew. To be sure, people have dreamt of using the vacuum and weightlessness of space to source or make things that cannot be made on earth for half a century, and time and again the business case has failed to pan out. Skepticism is natural. Those failures, however, have been in space-for-earth applications. For example, two startups of the 2010s, Planetary Resources, Inc. and Deep Space Industries, recognized the potential of space mining early on. For both companies, however, the lack of a space-for-space economy meant that their near-term survival depended on selling mined material — precious metals or rare elements — to earthbound customers. When it became clear that demand was insufficient to justify the high costs, funding dried up, and both companies pivoted to other ventures. These were failures of space-for-earth business models — but the demand for in-space mining of raw building material, metals, and water will be enormous once humans are living in space (and are therefore far cheaper to supply). In other words, when people are living and working in space, we are likely to look back on these early asteroid mining companies less as failures and more as simply ahead of their time. Seizing the Space-for-Space Opportunity The opportunity presented by the space-for-space economy is huge — but it could easily be missed. To seize this moment, policymakers must provide regulatory and institutional frameworks that will enable the risk-taking and innovation necessary for a decentralized, private-sector-driven space economy. There are three specific policy areas we believe will be especially important: 1. **Enabling private individuals to take on greater risk than would be tolerable for government-employed astronauts.** First, **as part of a general shift to that more decentralized, market-oriented space sector, policymakers should consider allowing private space tourists and settlers to voluntarily take on more risk than states would tolerate for government-employed astronauts.** In the long run, ensuring high safety levels will be essential to convince larger numbers of people to travel or live in space, but in the early years of exploration, too great an aversion to risk will stop progress before it starts. An instructive analogy can be found in how NASA works with its contractors: In the mid-2000s, NASA shifted from using cost-plus contracts (in which NASA shouldered all the economic risk of investing in space) to fixed-price contracts (in which risk was distributed between NASA and their contractors). **Because of private companies’ greater tolerance for risk, this shift catalyzed a burst of activity in the sector** — sometimes referred to as “New Space.” A similar shift in how we approach voluntary risk-taking by private-sector astronauts may be necessary in order to launch the space-for-space economy. 2. Judiciously implementing government regulation and support. Second, as with most markets, developing a stable space economy will depend on judicious government regulation and support. NASA and the U.S. Commerce and State Departments’ recent recommitment to “create a regulatory environment in [low-Earth orbit] that enables American commercial activities to thrive” is a good sign that the government is on a path of continued collaboration with industry, but there’s still a long way to go. Governments should start by clarifying how property rights over limited resources such as water on Mars, ice on the Moon, or orbital slots (i.e., “parking spots” in space) will be governed. Recent steps — including NASA’s offer to purchase lunar soil and rocks, last April’s Executive Order on the governance of space resources, and the 2015 Commercial Space Launch Competitiveness Act — indicate that the U.S. government is interested in establishing some form of regulatory framework to support the economic development of space. In 2017, Luxembourg became the first European country to establish a legal framework securing private rights over resources mined in space, and similar steps have been taken at the domestic level in Japan and the United Arab Emirates. Moreover, nine countries (though Russia and China are notably missing) have signed the Artemis Accords, which lay out a vision for the sustainable, international development of the Moon, Mars, and asteroids. These are important first steps, but they have yet to be clearly translated into comprehensive treaties that govern the fair use and allocation of scarce space resources among all major spacefaring nations. In addition, governments should continue to fill the financial gaps in the still-maturing space-for-space economic ecosystem by funding basic scientific research in support of sending humans to space, and by providing contracts to space startups. Similarly, while excessive regulation will stifle the industry, some government incentives, such as policies to reduce space debris, can help reduce the costs of operating in space for everyone in ways that would be difficult to coordinate independently. 3. Moving beyond geopolitical rivalries. Finally, the development of the space-for-space economy must not be undermined by earthly geopolitical rivalries, such as that between the United States and China. These conflicts will unavoidably extend into space at least to some extent, and military demand has long been an important source of funding for aerospace companies. But if not kept in check, such rivalries will not only distract attention and resources from borderless commercial pursuits but also create barriers and risks that hamper private investment. On earth, private economic activity has long tied together people whose states are at odds. The growing space-for-space economy offers exceptional potential to be such a force for unity — but **it’s the job of the world’s governments not to get in the way**. A collaborative, international approach to establishing — and enforcing — the rule of law in space will be essential to encouraging a healthy space-for-space economy. Visions of a space-for-space economy have been around since the dawn of the Space Age in the 1960s. Thus far, those hopes have gone largely unmet — but this moment is different. **For the first time in history, the private sector’s capital, risk tolerance, and profit motive are being channeled into putting people in space. If we seize this opportunity, we will look back on 2020 as the year when we started the truly transformational project of building an economy and a society in space, for space.**

#### Private company innovations driving down cost of space travel

**Cobb 19**

[Wendy Whitman Cobb – Associate Professor of Political Science, Cameron University,” How SpaceX lowered costs and reduced barriers to space,” The Conversation, 03-01-2019, https://theconversation.com/how-spacex-lowered-costs-and-reduced-barriers-to-space-112586

On March 2, SpaceX plans to launch its first test of an unmanned Dragon vehicle which is designed to carry humans into low Earth orbit and to the International Space Station. If the test is successful, later this year, SpaceX plans to launch American astronauts from United States soil for the first time since 2011. While a major milestone for a private company, SpaceX’s most significant achievement has been in lowering the launch costs that have limited many space activities. While making several modifications to the fuel and engines, SpaceX’s [major breakthroughs have come through recovering and reusing](https://spacenews.com/spacexs-reusable-falcon-9-what-are-the-real-cost-savings-for-customers/) as much of the rocket and launch vehicle as possible. Between 1970 and 2000, [the cost to launch a kilogram to space remained fairly steady](https://ttu-ir.tdl.org/handle/2346/74082), with an average of US$18,500 per kilogram. When the space shuttle was in operation, it could launch a payload of 27,500 kilograms for $1.5 billion, or $54,500 per kilogram. For a SpaceX Falcon 9, the rocket used to access the ISS, the cost is just $2,720 per kilogram. [I’m a space policy analyst](https://scholar.google.com/citations?authuser=1&user=JDrYQXAAAAAJ), and I’ve observed that [cost has been a major hurdle](https://jhupbooks.press.jhu.edu/title/faster-better-cheaper) limiting access to space. Since the 1950s, the high cost of a space program has traditionally put it beyond the reach of most countries. Today, state and private actors alike have ready **access** to space. And while SpaceX is not the only private company providing launch services – Orbital ATK, [recently purchased by Northrop Grumman](https://spacenews.com/acquisition-of-orbital-atk-approved-company-renamed-northrop-grumman-innovation-systems/), [United Launch Alliance](https://www.ulalaunch.com/) and Jeff Bezos’s [Blue Origin](https://www.blueorigin.com/) are also players – it has emerged as the most significant. Frustrated with NASA and [influenced by science fiction writers](https://www.publicaffairsbooks.com/titles/christian-davenport/the-space-barons/9781610398305/), Elon Musk founded SpaceX in 2002. [Though it suffered several setbacks](https://arstechnica.com/science/2018/09/inside-the-eight-desperate-weeks-that-saved-spacex-from-ruin/), in 2008 it launched the first privately funded liquid-fueled rocket, the Falcon 1. Falcon 9 flew for the first time the next year, and in 2012, the Dragon capsule became the first privately funded spacecraft to dock with the ISS. SpaceX has since focused on recovering key parts of the Falcon 9 to enhance reusability and reduce costs. This includes the Falcon 9’s first stage which, once it expends its fuel, [falls back through the atmosphere](https://spaceflightnow.com/2019/02/25/scorched-spacex-rocket-returns-to-port-in-florida-ready-to-launch-a-fourth-time/) reaching speeds of 5,200 miles per hour before reigniting its engines to land on a drone recovery ship. In 2018 alone, [SpaceX made 21 successful launches](https://www.forbes.com/sites/jonathanocallaghan/2018/12/23/spacex-launches-final-record-breaking-rocket-of-2018-and-its-first-ever-national-security-mission/#196dc6004854). The new Falcon Heavy rocket – a more powerful version of the Falcon 9 – launched in February. This rocket can lift 63,800 kilograms, equivalent to more than 27 Asian elephants, to low Earth orbit and 16,800 kilograms to Mars for just $90 million. The test payload was Musk’s own red Tesla Roadster, with a mannequin named Starman in the driver’s seat. In addition to the crewed Dragon tests this year, [SpaceX is continuing development of its Starship](https://www.spacex.com/mars), which will be designed to travel through the solar system and carry up to 100 passengers sometime in the 2020s. Musk has also suggested that the [Starship could serve as the foundation for a lunar base](https://www.cnbc.com/2019/02/25/elon-musk-spacex-rocket-starship-will-be-good-for-creating-moon-base.html). SpaceX’s technical advances and cost reductions have **changed** the **direction** of U.S. space policy. In 2010, the Obama administration [moved away from NASA’s Constellation program](https://doi.org/10.1016/j.spacepol.2010.12.010), which called for the development of a family of rockets that could reach low Earth orbit and be used for long-distance spaceflight. With NASA falling significantly behind schedule, because of technological difficulties and budget cuts, the Obama administration was [left with a choice of whether to boost funds for NASA or change direction](https://spacenews.com/nasa-limbo-augustine-panel-issues-final-report/). In 2010, then-President Barack Obama toured Kennedy Space Center and even [met with Elon Musk](https://www.orlandosentinel.com/news/os-xpm-2010-04-16-os-obama-speech-kennedy-space-center-20100415-story.html) to get a firsthand look at SpaceX’s facilities. The administration chose to reorient the program to focus solely on deep space. For missions closer to home, NASA would purchase services from companies like SpaceX for access to low Earth orbit. [Critics objected](https://doi.org/10.1016/j.spacepol.2010.12.010) to budget cuts to NASA as well as concerns about whether the private sector would be able to follow through on providing launch services. While NASA has struggled to develop its Space Launch System, an [analysis from NASA’s Ames Research Center](https://ttu-ir.tdl.org/handle/2346/74082) found that the dramatically lower launch costs SpaceX made possible offered “greatly expanded opportunities to exploit space” for many users including NASA. The report also suggested that NASA could increase its number of planned missions to low Earth orbit and the ISS precisely because of the lower price tag. In addition to substantially affecting human spaceflight, SpaceX has also launched payloads for countries including [Kazakhstan](https://caspiannews.com/news-detail/thanks-to-spacex-kazakhstan-sends-2-satellites-into-space-2018-12-5-27/), [Bangladesh](https://spacenews.com/how-bangladesh-became-spacexs-first-block-5-falcon-9-customer/), [Indonesia](https://www.cnbc.com/2019/02/22/spacex-launches-israeli-moon-mission-indonesian-satellite-air-force-spacecraft.html) and, most recently, Israel. On Feb. 21, 2019, a Falcon 9 [launched a privately built Israeli lunar lander](https://theconversation.com/first-private-spacecraft-shoots-for-the-moon-109994) which, if successful, will be the first privately built lunar probe. Overall, SpaceX has **significantly reduced** the barriers to space, making it more **accessible** and democratizing who participates in space-based commerce and exploration. Despite SpaceX’s successes, it faces significant challenges. Earlier this year, SpaceX [laid off 10 percent of its workforce](https://www.businessinsider.com/spacex-layoffs-jobs-terminated-list-california-headquarters-2019-1) to reduce costs. [NASA remains suspicious](https://www.insurancejournal.com/news/national/2019/02/21/518314.htm) of some of the launch procedures SpaceX plans to use, including the fueling of the rocket with astronauts on board, which [was linked to an explosion](https://spacenews.com/safety-panel-considers-spacex-load-and-go-fueling-approach-viable/) of a Falcon 9 on the launchpad. The Department of Defense’s inspector general has also [announced an investigation](https://www.bloomberg.com/news/articles/2019-02-12/spacex-launch-certification-to-face-review-by-pentagon-watchdog) into how the Air Force certified the Falcon 9, though it is not clear what initiated the probe. Among some in NASA, the [concern is with Musk himself](https://www.washingtonpost.com/technology/2018/09/28/nasa-stands-by-spacex-even-elon-musks-troubles-grow/?utm_term=.d5e8f46f49ff). In a video last year, [Musk was seen smoking marijuana](https://www.cnn.com/videos/cnnmoney/2018/09/07/elon-musk-smoke-weed-orig.cnnmoney), which [prompted NASA to initiate a safety review](https://www.washingtonpost.com/business/2018/11/20/nasa-launch-safety-review-spacex-boeing-after-video-elon-musk-smoking-pot-rankled-agency-leaders/) of SpaceX as well as Boeing, another company aiming to provide launch services. Musk has also found himself in hot water with the U.S. Securities and Exchange Commission regarding his tweets about another one of his companies, Tesla. In recent days, [the SEC has asked a judge](https://www.cnn.com/2019/02/25/tech/elon-musk-sec-settlement-contempt/index.html) to hold Musk in contempt for apparently violating a settlement deal reached last year. While he is undoubtedly the driving force behind both Tesla and SpaceX, erratic behavior could make potential customers wary of contracting with them. Musk, regardless of his personal missteps, and SpaceX have aggressively pushed technological boundaries that have changed minds, my own included, about the potential of private companies to provide safe and reliable access to space.

#### Low-cost key to space colonization

**Morrison 14**

[Chris Morrison – Ph. D Student, B.S., “Why Access to Space Needs To and IS Getting Cheaper,” American Nuclear Society, 11-02-2014,<http://anstd.ans.org/access-to-space-gateway-to-the-moon-mars-and-beyond/>]

If you look into the night you can see the Moon our nearest neighbor. Humans have been there a few times but we aim to “shoot to the moon” more permanently and sustainably. We can see Mars, a planet which sits in the cross hairs of our exploration with its raw resources and atmosphere which could be used to build a civilization. We see other places in our Solar System and beyond that every science fiction movie advertises as our future homes, as places where humanity can unabashedly grow without the looming threat of global catastrophe and scarcity of resources. The future of humanity is in the stars, but how do we move toward it? Governments seem ambivalent, and today it seems with the retirement of the shuttle and lack of a sustained space vision that we are less capable of spaceflight than we were in the days of our parents. Are we going anywhere anytime soon? Any object that has traveled into space is worth its weight in gold. For the past 30 years the price to go to Earth orbit has been $10,000 a pound ($20,000 a kg). Any mission to Mars or the Moon must first travel through the gateway of Earth orbit meaning that economically, our ambitions to travel beyond stand as unsustainable pots of gold at the end of the rainbow. The **staggering cost** of spaceflight has been the single biggest deterrent to extending our reach beyond Earth orbit. Only light-weight robotic missions are even fiscally capable of being implemented. During the early 1990’s the Space Exploration Initiative quoted $500 billion as the cost of a human Mars mission. The many permutations of Mars missions considered by NASA ever since have not been able to lower the bill. There is **no way** to become a space faring civilization with costs this high. Perhaps flags and footprints can be left, but not a sustainable system capable of sprouting a colony on another world. Yet there is a change in the wind. Namely a new company called SpaceX is driving costs down. SpaceX’s Falcon 9 rocket currently boasts a cost per pound to orbit of $1,800. The falcon heavy, a rocket in development, claims a cost less than $1,000 per pound (less than 1/10th the traditional cost). Even more exciting, the company is working on saving and reusing parts of the rocket to drive the cost down by another factor of 10. To put it in context, imagine you’re an astronaut traveling into orbit. The cost of launching you, and your support equipment with Russia is around $70 million. With SpaceX the cost has been reduced to below $7 million and has potential to drop to under $700,000. You might ask why is the cost of spaceflight so exorbitant and how can one company make such a difference? The major factor is sustained vision. John F. Kennedy was the leader of the space age. His leadership and consistent goal of reaching the moon provided the stability required for the Apollo program. Unfortunately after president Kennedy, no leader emerged with a sustained vision for humanity in space. Today there are approximately 500 different visions for US spaceflight in congress. Leaders consistently **fight** over the destination, (Moon, Mars, or Asteroid) the budget, the location of the jobs supporting the mission, etc. Typically projects only last the stretch of a political cycle. It’s no wonder that government contractors have to charge so much. When projects are consistently being canceled, moved, and re-prioritized, a manager must charge many times the actual cost to cover the **risk** that they may lose their contract the next day. Elon Musk the founder and CEO of SpaceX is a man with a vision. As early as 2000 he set his sights on extending humanity’s reach to Mars. He began by attempting to raise money for the Mars Oasis project to place a greenhouse full of plants on Mars. He ultimately learned from the Mars Oasis project that access to space was too expensive to accomplish his goal. He then shifted his focus to create SpaceX to develop cheap access to space and ultimately access to Mars. The Space Shuttle is one of the most advanced spacecraft systems in existence. The shuttle’s liquid oxygen, liquid hydrogen staged combustion cycle engines achieved a vacuum specific impulse of 450 seconds, quite a feat of engineering. The Falcon 9 uses a less advanced gas generator cycle, kerosene liquid oxygen cycle and only achieves a specific impulse in the lower 300’s. Yet, just like the difference between a sports car and a work truck, the simpler technology with lower performance costs less and can get the job done. Whereas the shuttle focused on pushing the performance of the system the Falcon 9 focused on cost and manufacturing. Everything at SpaceX is focused on scalability. Every part from the engines to the tanks to the rocket fairings are built like LEGO pieces that can be mixed and matched. The Falcon Heavy Rocket is literally three Falcon 9 rockets strapped together. In contrast the Space Shuttle was designed by a concert of seven different companies with highly distinct systems resulting in a marvel of system engineering but couldn’t deliver on the original promise of cheap, repeatable access to space. Reusability is the true key piece of the puzzle. With sustained leadership and a focus on scalability the price of space access can drop by a factor of 10. To drop the price by a factor of 100 the rocket must be reusable.

#### Space colonization solves extinction – nuclear war, pandemics, climate change

Baum 09 – (Seth, visiting scholar at Columbia University's Center for Research on Environmental Decisions, PhD candidate in Geography with a focus on risk analysis, “Cost–benefit analysis of space exploration: Some ethical considerations,” Space Policy Volume 25, Issue 2, May 2009, Pages 75-80, science direct)

Another non-market benefit of space exploration is reduction in the risk of the extinction of humanity and other Earth-originating life. Without space colonization, the survival of humanity and other Earth-originating life becomes extremely difficult- perhaps impossible- over the very long-term. This is because the Sun, like all stars, changes in its composition and radiative output over time. The Sun is gradually converting hydrogen into helium, thereby getting warmer. In approximately 500 million to one billion years, this warming is projected to render Earth uninhabitable to life as we know it [25–26]. Humanity, if it still exists on Earth then, could conceivably develop technology by then to survive on Earth despite these radical conditions. Such technology may descend from present proposals to “geoengineer” the planet in response to anthropogenic climate change [27–28].3 However, the Sun later- approximately seven billion years later- loses mass that spreads into Earth’s orbit, causing Earth to slow, be pulled into the Sun, and evaporate. The only way life could survive on Earth may be if Earth, by sheer coincidence (the odds are on the order of one in 105 to one in 106 [29]) happens to be pulled out of the solar system by a star system that passes by. This process might enable life to survive on Earth much longer, although the chance of this is quite remote. While space colonization would provide a hedge against these very long-term astrological threats, it would also provide a hedge against the more immediate threats that face humanity and other species. These threats include nuclear warfare, pandemics, anthropogenic climate change, and disruptive technology [30]. Because these threats would generally only affect life on Earth and not life elsewhere,4 self-sufficient space colonies would survive these catastrophes, enabling life to persist in the universe. For this reason, space colonization has been advocated as a means of ensuring long-term human survival [32–33]. Space exploration projects can help increase the probability of long-term human survival in other ways as well: technology developed for space exploration is central to proposals to avoid threats from large comet and asteroid impacts [34–35]. However, given the goal of increasing the probability of long-term human survival by a certain amount, there may be more cost-effective options than space colonization (with costs defined in terms of money, effort, or related measures). More cost-effective options may include isolated refuges on Earth to help humans survive a catastrophe [36] and materials to assist survivors, such as a how-to manual for civilization [37] or a seed bank [38]. Further analysis is necessary to determine the most cost-effective means of increasing the probability of long-term human survival.

## ON

### FW

#### Extinction outweighs- indicts reflect cognitive biases

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Imagine a world in which each person’s days are filled with beauty, meaning, and commitment—doing deep work, spending plenty of time with friends and family, savoring delicious food, and enjoying exotic holidays. Suppose that everyone can live in perfect health for more than a century. In this world, people are secure in their neighborhoods, without the need to fear for their property or safety.

Now imagine that humanity uses this opportunity to expand our knowledge and wisdom—exploring the frontiers of science and the humanities. Suppose we reshaped careers so that everyone could experience a sense of flow in their job and take a break from work when they wished. Imagine that we solve the problem of commuting—effectively stretching the day so that people can enjoy more leisure, work, or sleep. Think how much better the world would be if we could make a lasting impact on mental illness through better treatments for depression, anxiety, and addiction. Suppose that cancer has been cured, obesity has a simple treatment, and even the common cold has been vanquished.

Think how much more beautiful we could make the spaces around us. To live in an apartment designed by Antoni Gaudí, stroll in a park designed by Martha Schwartz, or enjoy the sculptures of Teresita Fernández is a pleasure reserved for a fortunate few in today’s world. But imagine how much joy it would bring us to live in a world where all our living spaces were conceived by extraordinary designers and constructed by master craftspeople.

Such a world may seem closer to the heavenly paradise offered by the world’s great religions than to our lives on earth. Attaining it is a pipe dream for our generation. Indeed, there is little chance we could attain it in the twenty-first or even twenty-second century. Yet this future is probable if humans can survive for another thousand years. And it is almost certain if humans can survive for ten thousand years. After all, the past ten thousand years has seen humans progress from foraging nomads to digitally connected urbanites, and the pace of change is accelerating, with each century more innovative than the previous one.1

But we have to get there first.

In 1947, a group of concerned scientists created the “Doomsday Clock”—symbolizing how close humans are to Armageddon. Initially, the clock was arbitrarily set at seven minutes to midnight.2 Two years later, when the Soviet Union tested its first nuclear bomb, the clock was moved to three minutes to midnight. With the signing of the partial atomic test ban treaty in 1963, it was moved back to twelve minutes to midnight. Over the years, the Doomsday Clock has been moved forward and backward twenty-four times. In January 2020, it was moved to one minute and twenty seconds to midnight. These scientists estimate that the world is closer to destruction now than at any other time.

The catastrophic risks that threaten our species have been the focus of so many movies that you could run a disaster film festival. We’ve seen movies featuring natural pandemics (Outbreak, Carriers, and Contagion), bioterrorism (12 Monkeys, V for Vendetta, and 28 Days Later), asteroid strikes (Deep Impact, Armageddon, and Judgment Day), nuclear war (Dr. Strangelove, On the Beach, and The Day After), artificial intelligence (Avengers: The Age of Ultron, The Matrix, and Terminator), and climate change (Waterworld, Mad Max: Fury Road, and Blade Runner 2049).

These dangers have had us on the edge of our movie seats, but they haven’t gotten most people off the couch to act. You’re more likely to get robbed if you leave your wallet on a park bench than if you leave your home unlocked. But it doesn’t follow that an unattended wallet is a bigger risk than an unlocked house. Losing everything of value in your house is unlikely to occur, but horribly upsetting if it does.

The same psychological mistake applies to public policy. Policy makers sweat the details of programs to regulate stock markets or build stadiums. But we rarely devote as much attention to reducing long-term risks. Policy deals largely in the world of immediate certainties, not distant hazards.

How likely is it that humanity could end? Experts working on catastrophic risk have estimated the chances of disaster for a wide range of the hazards that our species faces. Adding up the threats, philosopher Toby Ord estimates the odds that humanity could become extinct over the next century at one in six, with an out-of-control superintelligence, bioterrorism, and totalitarianism among the largest risks. He argues that most of the risks have arisen because technology has advanced more rapidly than safeguards to keep it in check. To encapsulate the situation facing humanity, Ord titled his book The Precipice.

A one in six chance of going the way of dodos and dinosaurs effectively means we are playing a game of Russian roulette with humanity’s future. Six chambers. One bullet. Even the most foolhardy soldier usually finds an excuse not to play Russian roulette. And that’s when just their own life is at stake. In considering extinction risk, we’re contemplating not one fatality but the death of billions or possibly trillions of people—not to mention countless animals.

It can seem impossible to imagine our species becoming extinct due to a catastrophe such as nuclear war, asteroids, or a pandemic. But in reality, the danger surpasses plenty of perils we already worry about. One way to put catastrophic risk into perspective is to compare it with more familiar risks. If extinction risk poses a one in six risk to our species over the next century, then it means that it is far more hazardous than many everyday risks. Specifically, it suggests that the typical US resident is fifteen times more likely to die from a catastrophic risk—such as nuclear war or bioterrorism—than in car crash.3

Extinction risk outstrips other dangers too. Ask people about their greatest fears, and you’ll get answers like “street violence,” “snakes,” “heights,” and “terrorism.”4 But in reality, these are much less hazardous than catastrophic risks. People in the United States are 31 times more likely to die from a catastrophic risk than from homicide. Catastrophic risk is 3,519 times likelier to kill than falls from a height, and 6,194 times more likely to kill than venomous plants and animals. If you have ever worried about any of these threats, you should be more fearful about catastrophic risk. Extinction risks aren’t just more dangerous than any of them; they are more hazardous than all of them put together. Catastrophic risk poses a greater danger to the life of the typical US resident than car accidents, murder, drowning, high falls, electrocution, and rattlesnakes put together.

A one in six risk is just the danger in a single century. Suppose that the risk of extinction remains at one in six for each century. That means there’s a five in six chance humanity makes it to the end of the twenty-first century, but less than an even chance we survive to the end of the twenty-fourth century. The odds that we survive all the way to the year 3000 are just one in six. In other words, if we continue playing Russian roulette once a century, it’s probable that we blow our brains out before the millennium is halfway through, and there’s only a small chance that we make it to the end of the millennium.

Part of the reason humans undervalue the future is that it’s hard to get our heads around the idea that our genetic code could live on for millions of years. At present, the best estimates are that our species, Homo sapiens, evolved around three hundred thousand years ago.5 That means we have existed for about ten thousand generations. But we have another one billion years before the increasing heat of our sun brings most plant life to an end.6 That’s plenty of time to figure out how to become an interstellar species and move to a more suitable solar system. Humans could live to enjoy another thirty million generations on earth.

Thinking about the mind-boggling scale of these numbers, I’m reminded of the Total Perspective Vortex machine, created by Douglas Adams in The Restaurant at the End of the Universe. Anyone brave enough to enter sees a scale model of the entire universe, with an arrow indicating their current position. As a result, their brain explodes. As Adams reflects, the machine proves that “if life is going to exist in a universe of this size, then the one thing it cannot afford to have is a sense of proportion.”

Still, let’s try. Imagine your ancestors a hundred generations ago. They are your great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-great-grandparents. These people lived around 1000 BCE, at the start of the Iron Age. They might have been part of Homeric Greece, ancient Egypt, Vedic age India, the preclassic Maya, or Zhou Dynasty China.

Contemplate for a moment about what the hundred generations between our Iron Age ancestors and today have achieved. They built the Taj Mahal and Sistine Chapel, the Angkor Wat and Empire State Building. Thanks to them, we can relish the poetry of Maya Angelou, novels of Leo Tolstoy, and music of Ludwig van Beethoven. An abundance of inventions has delivered us delicious food, homes that are comfortable year-round, and technology that provides online access to a bottomless well of entertainment. If time machines existed, we might pop in to visit our great100 grandparents, but few would volunteer to stay in the Iron Age.

Yet humanity is really just getting started. If things go well, it’s ten thousand generations down, thirty million to go. Imagine what those future generations could do, and how much time they have to enjoy. Here’s one way to think about what it means to have thirty million generations ahead. Suppose humanity’s potential time on the planet was shrunk down to a single eighty-year life span. In that event, we would now be a newborn baby—just nine days old. Homo sapiens is a mere 0.03 percent through all we could experience on earth.

We won’t meet most of those who follow us on the planet, but we should cherish future generations all the same. If you value humanity’s past achievements—the Aztec and Roman civilizations, art of the Renaissance, and breakthroughs of the Industrial Revolution—then the generations to come are just as worthy. This is what political philosopher Edmund Burke meant when he described society as “a partnership not only between those who are living, but between those who are living, those who are dead, and those who are to be born.”7 To appreciate the past is akin to admiring the achievements of distant places. Like geography, history helps us better understand the way of the world.

Politicians like me like to speak fondly about looking after “our children and our grandchildren.” But it usually stops after a generation or two. Policy pays little heed to the many generations that will follow. For my own part, it took a coronavirus-induced shutdown to have the time to spend reflecting deeply about the long term. This book had been rattling around in my head for years, but it was only when all my meetings, events, and travel were canceled that I had the time to write it. Pandemics are one of the threats to humanity that I’ll discuss in this book, but in this instance, it provided a chance to reflect on the long term.

It’s tempting to ignore the distant future. It’s easier to love the grandchildren whom we hug than the great-great-great-grandchildren whom we’ll never get to smile on. But that doesn’t make those far-flung generations any less important. Via my wife, our children can trace their lineage to Benjamin Franklin, but I’m more excited about the potential achievements of the generations yet to be born.

For companies and governments, a major impediment to long-term thinking is the idea of discounting the future. When investing money, this is a reasonable approach. A dollar in a decade’s time is less valuable than a dollar today for the simple reason that a dollar today could be invested and earn a real return. Share markets have good and bad years, but based on returns from the past 120 years, someone who put $1,000 into the US stock market for an average year could expect it to be worth $1,065 after twelve months (accounting for dividends and inflation).8 Approximating these returns, when governments contemplate making investments, they often apply a discount rate of around 5 percent, while companies use rates that are higher still.9

When it comes to growing your greenbacks, this makes perfect sense. If Kanesha offered you $1,000 today, and Jane offered you $1,000 in a year’s time, most of us would think that Kanesha was making the more generous offer. Kanesha’s cash can be put to productive use and would be worth more than Jane’s when the year is out.

But what if we’re talking about Kanesha and Jane themselves? Suppose Kanesha is alive today, and Jane is yet to be born. When discounting is applied to lives, it suggests that Kanesha’s life today is worth twice as much as Jane’s life in fifteen years’ time. It implies that Kanesha today is worth 132 times as much as Jane in a century’s time. So if we’re spending money to keep them safe, a 5 percent discount rate indicates that we should spend more than a hundred times as much to protect Kanesha today than to protect Jane in a century’s time.

The further we stretch the time period, the more ridiculous the results become. Discounting at a rate of 5 percent implies that Christopher Columbus is worth more than all eight billion people on the planet today.10 Naturally, it also implies that your life is worth more than eight billion lives in five hundred years’ time. Even if you value the hug of a loved one over the unseen successes of next century’s generations, is it fair to ruthlessly dismiss the distant future? Discounting is the enemy of the long term.

As philosopher Will MacAskill points out, there is something morally repugnant about concluding that the happiness of those who will be alive in the 2100s is inconsequential simply because they live in the future. MacAskill coined the term “presentism” to refer to prejudice against people who are yet unborn.11 Just like racism, sexism, or other forms of bigotry, he argues that mistreating those who live a long way in the future is unfair. To discriminate in favor of Kanesha against unborn Jane is a form of presentism. If you traveled back in time to the 1500s and met someone who claimed that they were worth more than everyone alive in the 2000s, you’d rightly regard them as an egomaniac. Isn’t it equally narcissistic to ignore the happiness of people in the 2500s?

Some have contended that we should favor the living over the unborn for the same reason that philanthropy favors the downtrodden over the wealthy. If incomes rise over time, the argument goes, then asking today’s citizens to help those in the future is like taking from the poor to give to the rich.12 But this reasoning ignores the fact that we are talking about the survival of future generations. Theoretical riches won’t do them any good if they are practically dead—or if planetary apocalypse snuffs out their chance to be born. Similarly, it misses the possibility that future pandemics, wars, or climate disasters could make coming generations significantly poorer.13

Insights from behavioral science help explain why humans aren’t good at understanding extinction risk.14 Our thinking about dangers is skewed by an “availability bias”: a tendency to focus on familiar risks. Like the traders who failed to forecast the collapse of the securitized housing debt market, we are lousy at judging the probability of rare but catastrophic events. Most important, our instincts fail us as the magnitudes grow larger. In research titled “The More Who Die, the Less We Care,” psychologists Paul Slovic and Daniel Västfjäll argue that we become numb to suffering as the body count grows.15 Humans’ compassionate instincts are aroused by stories, not statistics. Indeed, one study found that people were more likely to donate to help a single victim than they were to assist eight victims. This may help explain why the international community has been so slow to respond to genocide, including recent incidents in Rwanda, Darfur, and Myanmar. As artificial intelligence researcher Eliezer Yudkowsky notes, human neurotransmitters are unable to feel sorrow that is thousands of times stronger than a single funeral.16 The problem is starker still when it comes to extinction risk. Our emotional brains cannot multiply by billions.

### 1NC Capitalism

#### 1. No impact – they say that space capitalism is bad but then don’t provide reasons as to why we should care. This means you should weigh neg on extinction.

#### 2. Turn - Capitalism is self-correcting and sustainable---war and environmental destruction are not profitable and innovation solves their impacts

Kaletsky 11 – (Anatole, editor-at-large of *The Times* of London, where he writes weekly columns on economics, politics, and international relations and on the governing board of the New York-based Institute for New Economic Theory (INET), a nonprofit created after the 2007-2009 crisis to promote and finance academic research in economics, Capitalism 4.0: The Birth of a New Economy in the Aftermath of Crisis, p. 19-21 /DOA: 6/28/2018)//JDi

Democratic capitalism is a system built for survival. It has adapted successfully to shocks of every kind, to upheavals in technology and economics, to political revolutions and world wars. Capitalism has been able to do this because, unlike communism or socialism or feudalism, it has an inner dynamic akin to a living thing. It can adapt and refine itself in response to the changing environment. And it will evolve into a new species of the same capitalist genus if that is what it takes to survive. In the panic of 2008—09, many politicians, businesses, and pundits forgot about the astonishing adaptability of the capitalist system. Predictions of global collapse were based on static views of the world that extrapolated a few months of admittedly terrifying financial chaos into the indefinite future. The self-correcting mechanisms that market economies and democratic societies have evolved over several centuries were either forgotten or assumed defunct. The language of biology has been applied to politics and economics, but rarely to the way they interact. Democratic capitalism’s equivalent of the biological survival instinct is a built-in capacity for solving social problems and meeting material needs.

3

#### 3. Turn - Asteroid mining causes resource abundance that solves the transition to a post-scarcity economy – and makes currency worthless

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These recommendations address another important issue, which is the impact that the influx of all these resources would have on Earth's economy. By tapping resources that are far more abundant than what exists at home, humanity will be able to transcend its current economic models.

For as long as human beings have conducted trade and businesses, scarcity has been a crucial element. By having abundant sources of necessary resources, humanity could effectively become a post-scarcity species. At the same time, if supply should suddenly exceed demand, then the value of these resources will drop considerably, and all the wealth that is measured using them will also suffer.

As such, it is much more likely that asteroid mining - rather than being a savior to Earth's economy - will be one of the means through which humanity expands into space. Saving planet Earth could very well happen as a result, but only in the long run.

#### 4. Space’s lack of inhabitants and ecological problems solves the vast majority of their criticism – but it segregates the capitalists from ruining Earth and generates enough resources to make the planet’s surface into a Communist utopia

Taylor 19 Chris Taylor is a veteran journalist. Previously senior news writer for Time.com a year later. In 2000, he was named San Francisco bureau chief for Time magazine. He has served as senior editor for Business 2.0, West Coast editor for Fortune Small Business and West Coast web editor for Fast Company. Chris is a graduate of Merton College, Oxford and the Columbia University Graduate School of Journalism. "How asteroid mining will save the Earth — and mint trillionaires." Mashable, 2019, mashable.com/feature/asteroid-mining-space-economy. [Quality Control]

All in all, it’s starting to sound a damn sight more beneficial to the human race than the internet economy is. Not a moment too soon. I’ve written encouragingly about asteroid mining several times before, each time touting the massive potential wealth that seems likely to be made. And each time there’s been a sense of disquiet among my readers, a sense that we’re taking our rapacious capitalist ways and exploiting space.

Whereas the truth is, this is exactly the version of capitalism humanity has needed all along: the kind where there is no ecosystem to destroy, no marginalized group to make miserable. A safe, dead space where capitalism’s most enthusiastic pioneers can go nuts to their hearts’ content, so long as they clean up their space junk.

(Space junk is a real problem in orbital space because it has thousands of vulnerable satellites clustered closely together around our little blue rock. The vast emptiness of cislunar space, not so much.)

And because they’re up there making all the wealth on their commodities market, we down here on Earth can certainly afford to focus less on growing our stock market. Maybe even, whisper it low, we can afford a fully functioning social safety net, plus free healthcare and free education for everyone on the planet.

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#### 5. Turn - It doesn’t disadvantage developing nations and the alt is worse

Reinstein, 99 -- JD, Associate, Kirkland & Ellis

[Ezra J., Owning Outer Space, 20 Nw. J. Int'l L. & Bus. 59, 1999, <https://scholarlycommons.law.northwestern.edu/njilb/vol20/iss1/7>, accessed 7-10-21]

B. Problem: What about the concerns of developing nations?

Developing nations have reason to oppose incorporating rights of ownership into the property regimes governing international zones. First, developing nations do not want to be permanently disadvantaged just because they lag in space-capability right now. This is an extremely potent critique, and will be discussed momentarily.

The second rationale is more historical. It is a deep-seated distrust of colonial imperialist doctrine such as that which the world faced in previous centuries. It is a readily understandable distrust: most, if not all developing nations were harmed by European nations who treated the non-European lands as theirs for the taking.

The difference here, however, is that there are no (known) occupants native to outer space.92 The colonialist "right of grab" policy was morally objectionable because it ignored the property rights (and other rights) of those already occupying the "discovered" lands.93 In the absence of prior existing property rights, however, there seems to be nothing inherently immoral about a right of grab.

Except, perhaps, that it may severely disadvantage the lower-tech nations in future. Developing nations fear that by the time they gain the wealth and technology necessary to become players in the space game, the most readily available resources will have already been claimed as private property and be under sovereign control of other nations. The developing nations argue that they will again be left in the economic lurch. This argument against a right-of-grab-based system gains salience when one considers that the reason the developing nations are not yet space-capable may well be attributable to past wrongs the developed nations inflicted on them. The perpetuation of past wrongs thus makes the right of grab doubly objectionable in the eyes of developing nations.

There are two short answers to this concern. First, the universe, for practical purposes, is not finite. Whenever developing nations become space-capable, there will be plenty of available unused space real estate. Second, corporations based in space-incapable nations could, of course, contract out to a space launch company from a space-capable nation. Developing nations can take advantage of space development without themselves being space-capable.

Perhaps less straightforward is the notion that ownership rights, by incentivizing the development of outer space, would fund intense R&D of launch technology. Launches would become more reliable and cheaper. In this way, ownership rights might hasten the day that developing nations are able to afford hiring a launch company, or even to have their own space programs (see infra section VII (b)).

Nevertheless, developing nations will likely continue to oppose rights of ownership in space. This is a political problem, and requires a political solution. For further discussion on this point, see section VII, infra.

We can learn how not to solve the problem from the legal and diplomatic wrangling that has been going on regarding mining of Earth's deep seabed. Exploitation of the deep seabed, like exploitation of space, is a very risky and expensive proposition. And the deep seabed, like space, is considered an international zone. In December, 1982, 120 nations signed the LOS.94 The LOS establishes an "Authority" and an "Enterprise." 95 Mining companies must receive approval from the Authority. Approval, in the form of a license, is only granted if the applicant company satisfies a set of rigorous conditions. The applicant must present two sites of equal value, one of which will be reserved by the Authority for development by the Enterprise.96 The applicant must fully disclose information regarding mining equipment, methods, and technology.97 The applicant must pay an initial sum of $500,000, an annual fee of $1 million until production begins, and (once mining has begun) either $1 million or a percentage of the market value of recovered materials, whichever is greater.9 Finally, and in addition to any domestic taxes incurred, the Authority levies 35 to 70 percent of the net profits.99

The United States, along with several other industrialized nations including the Federal Republic of Germany, France, Great Britain, Japan, and the Soviet Union, refused to ratify the LOS because of the deep seabed mining provisions.'0° There was a strong perception that the treaty's harsh regulations were an attempt to ruin commercial mining projects that would be in potential competition with the dry-land mines of developing nations. As Marne A. Dubs, spokesperson on seabed mining for the American Mining Congress, saw it, if the LOS was enforced "there will be no U.S. ocean mining industry."'O' Instead, the United States passed a domestic law, the Deep Seabed Hard Mineral Resources Act, which recognized the rights of U.S. mining ventures to the full profits of their labors. 02

If space law follows the LOS's lead and asks developed nations to make similarly-excessive sacrifices for the benefit of developing nations, the same political impasse with the resultant disparate and incoherent legal regimes will no doubt reoccur.

#### 6. Commercial mining solves extinction from scarcity, o-pop, climate change, terror, war, shortages, inequality, and disease- timeframe is mere decades- only mining solves BUT now is key

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[Dr. Joseph N., former Chairman of the Board of Trustees and Vice President and Dean of the International Space University as well as the Director Emeritus of the Space and Advanced Communications Research Institute (SACRI) at George Washington University, The New Gold Rush: The Riches of Space Beckon!, Springer, 2017, accessed 1-9-22]

The entrepreneurs are taking over. The hopeful statements in this book and the hard economic and technical data that backs them up are more than a minority opinion. It is a topic of growing interest at the World Economic Forum, where business and political heavyweights meet in Davos, Switzerland, to discuss how to stimulate new patterns of global economic growth. It is even the growing view of a group that call themselves “space ethicists.” Here is how Christopher J. Newman, at the University of Sunderland in the United Kingdom has put it: Space ethicists have offered the view that space exploration is not only desirable; it is a duty that we, as a species, must undertake in order to secure the survival of humanity over the longer term. Expanding both the resource base and, eventually, the habitats available for humanity means that any expenditure on space exploration, far from being viewed as frivolous, can legitimately be rationalized as an ethical investment choice. (Newman) On the other hand there are space ethicists and space exobiologists who argue that humans have created ecological ruin on the planet—and now space debris is starting to pollute space. These countervailing thoughts by the “no growth” camp of space ethicists say we have no right to colonize other planets or to mine the Moon and asteroids—or at least no right to do so until we can prove we can sustain life here on Earth for the longer term. However, for most who are planning for the new space economy the opinion of space philosophers doesn’t really float their boat. Legislators, bankers, and aspiring space entrepreneurs are far more interested in the views of the super-rich capitalists called the space billionaires. A number of these billionaires and space executives have already put some very serious money into enterprises intent on creating a new pathway to the stars. No less than five billionaires with established space ventures—Elon Musk, Paul Allen, Jeff Bezos, Sir Richard Branson, and Robert Bigelow—have invested millions if not billions of dollars into commercializing space. They are developing new technologies and establishing space enterprises that can bring the wealth of outer space down to Earth. This is not a pipe dream, but will increasingly be the economic reality of the 2020s. These wealthy space entrepreneurs see major new economic opportunities. To them space represents the last great frontier for enterprising pioneers. Thus they see an ever-expanding space frontier that offers opportunities in low-cost space transportation, satellite solar power satellites to produce clean energy 24h a day, space mining, space manufacturing and production, and eventually space habitats and colonies as a trajectory to a better human future. Some even more visionary thinkers envision the possibility of terraforming Mars, or creating new structures in space to protect our planet from cosmic hazards and even raising Earth’s orbit to escape the rising heat levels of the Sun in millennia to come. Some, of course, will say this is sci-fi hogwash. It can’t be done. We say that this is what people would have said in 1900 about airplanes, rocket ships, cell phones and nuclear devices. The skeptics laughed at Columbus and his plan to sail across the oceans to discover new worlds. When Thomas Jefferson bought the Louisiana Purchase from France or Seward bought Alaska, there were plenty of naysayers that said such investment in the unknown was an extravagant waste of money. A healthy skepticism is useful and can play a role in economic and business success. Before one dismisses the idea of an impending major new space economy and a new gold rush, it might useful to see what has already transpired in space development in just the past five decades. The world’s first geosynchronous communications satellite had a throughput capability of about 500 kb / s. In contrast, today’s state of the art Viasat 2 —a half century later— has an impressive throughput of some 140 Gb/s. This means that the relative throughput is nearly 300,000 greater, while its lifetime is some ten times longer (Figs. 1.1 and 1.2 ). Each new generation of communications satellite has had more power, better antenna systems, improved pointing and stabilization, and an extended lifetime. And the capabilities represented by remote sensing satellites, meteorological satellites , and navigation and timing satellites have also expanded their capabilities and performance in an impressive manner. When satellite applications first started, the market was measured in millions of dollars. Today commercial satellite services exceed a quarter of a billion dollars. Vital services such as the Internet, aircraft traffic control and management, international banking, search and rescue and much, much more depend on application satellites. Those that would doubt the importance of satellites to the global economy might wish to view on You Tube the video “If There Were a Day Without Satellites?” [ 2 ]. Let’s check in on what some of those very rich and smart guys think about the new space economy and its potential. (We are sorry to say that so far there are no female space billionaires, but surely this, too, will come someday soon.) Of course this twenty-first century breakthrough that we call the New Space economy will not come just from new space commerce. It will also come from the amazing new technologies here on Earth. Vital new terrestrial technologies will accompany this cosmic journey into tomorrow. Information technology, robotics, artificial intelligence and commercial space travel systems have now set us on a course to allow us humans to harvest the amazing riches in the skies—new natural resources, new energy, and even totally new ways of looking at the purpose of human existence. If we pursue this course steadfastly, it can be the beginning of a New Space renaissance. But if we don’t seek to realize our ultimate destiny in space, Homo sapiens can end up in the dustbin of history—just like literally millions of already failed species. In each and every one of the five mass extinction events that have occurred over the last 1.5 billion years on Earth, some 50–80 % of all species have gone the way of the T. Rex, the woolly mammoth, and the Dodo bird along with extinct ferns, grasses and cacti. On the other hand, the best days of the human race could be just beginning. If we are smart about how we go about discovering and using these riches in the skies and applying the best of our new technologies, it could be the start of a new beginning for humanity. Konstantin Tsiokovsky, the Russian astronautics pioneer, who first conceived of practical designs for spaceships, famously said: “A planet is the cradle of mankind, but one cannot live in a cradle forever.” Well before Tsiokovsky another genius, Leonardo da Vinci, said, quite poetically: “Once you have tasted flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return.” The founder of the X-Prize and of Planetary Resources, Inc., Dr. Peter Diamandis, has much more brashly said much the same thing in quite different words when he said: “The meek shall inherit the Earth. The rest of us will go to Mars.” The New Space Billionaires Peter Diamandis is not alone in his thinking. From the list of “visionaries” quoted earlier, Elon Musk, the founder of SpaceX; Sir Richard Branson, the founder of Virgin Galactic; and Paul Allen, the co-founder of Microsoft and the man who financed SpaceShipOne, the world’s first successful spaceplane have all said the future will include a vibrant new space economy. They, and others, have said that we can, we should and we soon shall go into space and realize the bounty that it can offer to us. The New Space enterprise is today indeed being led by those so-called space billionaires, who have an exciting vision of the future. They and others in the commercial space economy believe that the exploitation of outer space may open up a new golden age of astral abundance. They see outer space as a new frontier that can be a great source of new materials, energy and various forms of new wealth that might even save us from excesses of the past. This gold rush in the skies represents a new beginning. We are not talking about expensive new space ventures funded by NASA or other space agencies in Europe, Japan, China or India. No, these efforts which we and others call New Space are today being forged by imaginative and resourceful commercial entrepreneurs. These twenty-first century visionaries have the fortitude and zeal to look to the abundance above. New breakthroughs in technology and New Space enterprises may be able to create an “astral life raft” for humanity. Just as Columbus and the Vikings had the imaginative drive that led them to discover the riches of a new world, we now have a cadre of space billionaires that are now leading us into this New Space era of tomorrow. These bold leaders, such as Paul Allen and Sir Richard Branson, plus other space entrepreneurs including Jeff Bezos of Amazon and Blue Origin, and Robert Bigelow, Chairman of Budget Suites and Bigelow Aerospace, not only dream of their future in the space industry but also have billions of dollars in assets. These are the bright stars of an entirely new industry that are leading us into the age of New Space commerce. These space billionaires, each in their own way, are proponents of a new age of astral abundance. Each of them is launching new commercial space industries. They are literally transforming our vision of tomorrow. These new types of entrepreneurial aerospace companies—the New Space enterprises—give new hope and new promise of transforming our world as we know it today. The New Space Frontier What happens in space in the next few decades, plus corresponding new information technologies and advanced robotics, will change our world forever. These changes will redefine wealth, change our views of work and employment and upend almost everything we think we know about economics, wealth, jobs, and politics. These changes are about truly disruptive technologies of the most fundamental kinds. If you thought the Internet, smart phones, and spandex were disruptive technologies, just hang on. You have not seen anything yet. In short, if you want to understand a transition more fundamental than the changes brought to the twentieth century world by computers, communications and the Internet, then read this book. There are truly riches in the skies. Near-Earth asteroids largely composed of platinum and rare earth metals have an incredible value. Helium-3 isotopes accessible in outer space could provide clean and abundant energy. There is far more water in outer space than is in our oceans. In the pages that follow we will explain the potential for a cosmic shift in our global economy, our ecology, and our commercial and legal systems. These can take place by the end of this century. And if these changes do not take place we will be in trouble. Our conventional petro-chemical energy systems will fail us economically and eventually blanket us with a hydrocarbon haze of smog that will threaten our health and our very survival.

### 1NC Russia

#### The space weaponization advantage:

#### 1. Commercial space peace theory is true and solves all space war- private actors are key- they create linkages that jack up the costs of conflict

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On March 27, 2019, Indian Prime Minister Narendra Modi announced the successful test of an anti-satellite (ASAT) weapon making India the fourth country (following the United States, Russia, and China) to perform such a feat. In his announcement, Prime Minister Modi stated, “India has made an unprecedented achievement today. India registered its name as a space power.”1 Modi’s claim to space power is an interesting one. Many space scholars argue that the achievement of human spaceflight represents the top rungs of space hierarchy, something the Indians have not yet achieved though plans are ongoing.2 By this measure, India does not rank among the space powers of the United States, Russia, and China. On the other hand, the ability to target and destroy a satellite in earth orbit is a significant accomplishment, one which could easily threaten not just India’s adversaries, but all those who utilize space-based assets.

The test, occurring approximately 300 kilometers in orbit around the earth, created a cloud of debris most of which, because of the relatively low altitude of the test, will eventually burn up in the earth’s atmosphere. However, more than 400 pieces of debris were subsequently identified by NASA with 60 large enough to be tracked. Of those 60, according to NASA Administrator James Bridenstine, 24 were high enough in altitude to threaten the International Space Station (ISS), significantly increasing the chances of the ISS needing to maneuver out of the way of oncoming debris.3 As the space around the earth becomes more crowded and perhaps occupied by humans, the chances of orbital debris impacting valuable spacebased infrastructure, or even a crewed mission, will only increase. Given the extent to which the global economy is dependent on such infrastructure, the destruction of satellites, even if accidental, will likely have such a global and significant impact that it might dissuade countries from engaging in such activities to begin with.4

The timing of the Indian test was also interesting, coming on the heels of an increase in tension between India and Pakistan in February of 2019. Following a suicide attack by a Pakistan-based terrorist organization in Kashmir that killed 40 Indian security personnel, India launched air strikes against Pakistan.5 Though diplomacy prevailed, the provocation in the long simmering dispute over Kashmir heightened fears that the two nuclear powers might engage in further militarized conflict. While there are no indications that the ASAT test was directly intended as a display of power in the wake of the incident (indeed, India attempted an ASAT launch earlier in February which failed), the test and Modi’s assertion of space power can only serve as a warning, not just to Pakistan, but also to India’s other regional rival, China.

India, like its fellow democratic country the United States, is an example of a somewhat paradoxical finding in international relations scholarship. Scholars have noted that democracies tend not to go to war with other democracies though they are just as likely to engage in conflict as non-democracies. The so-called democratic peace is empirically accepted though its causal mechanisms remain in dispute (to be discussed further in this chapter). Some policymakers have seized on the argument and used it to support the expansion of democracy even via military means. In this sense, Erich Weede writes that, “Legitimating current wars by hopes for regime change and future pacific benefits is dangerous.”6 As an alternative, Weede argues that a capitalist peace is far less dangerous than regime change and far more pacifying. Like the democratic peace, proponents of the capitalist peace argue that as countries become more capitalistic and more connected through trade relations and interdependent economies, the cost of conflict to the shared economy between two countries becomes so great that there is no incentive to engage in militarized battle. Given that not all space powers are democracies or capitalists, the various paths to peace that the democratic and capitalist peace theories offer are not applicable to the space environment. Another economically-based argument, however, is.

This chapter briefly reviews the evolution of theories of peace that fall largely under the umbrella of the Kantian peace. As described in Chapter 1, Kant argued that states could attain “perpetual peace” through a combination of democracy, economic involvement, and the usage of international organizations. Following the realization that democracies do not go to war with other democracies, international relations scholars returned to this notion to try to understand causes of peace in the modern world. It is out of this literature that the capitalist, commercial, and economically interdependent peace arguments (some argue the three are distinct, but the terms have been used interchangeably to a point) emerge. While this chapter discusses this research, it is important to make clear what the chapter is not—it is not a full review of the democratic, capitalist, or commercial peace literature nor is it a critique of it. This chapter focuses mostly on the causal mechanisms that scholars have proposed to explain the lack of conflict between certain types of states to build a causal story regarding economic dependence on space-based assets and how that can reduce conflict in space. As I will develop in the following chapter, the commercial space peace theory is built on and derived from research regarding the economic peace in particular. The end of this chapter discusses some of the methodological challenges highlighted by this research that must be confronted in explicating such a theory.

The democratic peace

Though Kant and other Enlightenment thinkers argued for the pacific power of democracy centuries ago, the democratic peace, as well as international organizations and economics, received renewed interest by the end of the Cold War.7 While scholars focused largely on the democratic peace, findings regarding the role of trade and the economy led others to more heavily focus on the role of economic connections. Even though the democratic peace does not play a large role in a theory regarding conflict in space, it is important to the extent that it fostered a more extensive development of economic and commercial peace theories.

In a review of democratic peace research in 2014, Havard Hegre, a prominent scholar in the area, notes that, despite various findings regarding the causes of democratic peace, there is wide agreement that the absence of conflict among democracies is about as close to an empirical law in international relations as can be found.8 It is on the point of causal mechanisms that scholars have strongly disagreed, proposing theories that range from how leaders are selected, the legislative constraints on state leadership, and public opinion, to more normative arguments regarding the nature of democracy itself. One early theory was that the political institutions of a democracy somehow constrain its leaders from going to war. Though there has been some supportive evidence in this vein, if true, these constraints should also prevent democracies from going to war with non-democracies which has not been empirically demonstrated. Given this failing, scholars like Bruce Russett proposed a normative based explanation. Because democracies (generally) resolve internal disputes through non-violent political means, democracies should be able to externalize the peaceful means of conflict resolution, particularly in their dealings with other democratic states. In other words, democracies share a “norm of conduct” which governs their behavior with one another.9 In building on this hypothesis, Erik Gartzke suggests that democracies share similar interests which reduces the chances for conflict among them.10 Despite the appeal of common beliefs, this line of research fell victim to methodological concerns regarding measurement of key variables, the inclusion or exclusion of control variables, and the proper level at which the theory should be tested (at the state level or the dyadic level).11

Bruce Bueno de Mesquita and his co-authors suggest a variation of the institutional theory but focused on the selection of leadership and how leaders can satisfy their “selectorate,” the subset of the electorate that forms a winning coalition which an incumbent leader must continue to satisfy in order to remain in office.12 The leader can use the provision of resources to “pay off” the selectorate and help ensure their reelection. Democratic leaders must “pursue policies oriented toward public goods rather than private goods, because a larger portion of the society participates in the electoral process.”13 As a result, democratic leaders are often more concerned about policy failure which they seek to reduce; in the case of conflict, they are more likely to expend a greater amount of resources than autocratic leaders in order to ensure a victory. While at first glance this may appear to predict more conflict-prone relationships among democracies, “leaders of democratic regimes know about the resolve and resources that another democratic leader is willing to commit to victory, serving as a deterrent to escalation” between two democratic states.14 Later work provided substantial empirical support,15 however, like much of the work on the democratic peace, selectorate theory has also received its share of methodological critiques.16 Ungerer notes that later research focusing on the consequences of losing for autocratic and democratic leaders, an important implication, introduces more wrinkles for selectorate theory which have increased empirical doubt on the idea.17

Yet another concern about the democracy-peace relationship arose in considering whether there was a variable that was inducing democracy to begin with, suggesting that democracy might be an intermediate variable rather than the ultimate cause of peace. Elaborated by Michael Mousseau, economic norms theory proposes that social norms are influenced by economic norms. In those states that develop contract intensive economies,

individuals in developed market economies tend to share the social and political values of exchange-based cooperation, individual choice and free will, negotiation and compromise, universal equity among individuals, and universal trust in the sanctity of contract.18

If, in turn, these economic values are institutionalized in a society, “then it follows that market values favor democratic institutionalization.”19 Democracies, developed in this way, would share common values and outlooks which should lead to more peaceful relations. Mousseau’s empirical analysis finds support for this thesis and in particular finds that democratic peace is stronger in countries that have a greater level of economic development. Mousseau, in a later article, does not mince words:

There is no justification for inferring or implying any evidence herein, direct or indirect, as corroborating the causation from democracy to peace. . . . [T]here is little correlational evidence of democracy causing peace, whether we gauge peace with wars, fatal and nonfatal militarized interstate conflicts, or interstate crises.20

Though Mousseau takes a strong stance on the lack of a role for democracy, several other analyses, including his own, suggest a more interactive relationship between trade, economics, and democracy.21

The democratic peace thesis is not without its critiques, many of them methodological in terms of measuring key elements like conflict and democracy.22 While this is not the place to fully discuss them or the policy consequences arising from the belief that democracy reduces conflict, for the purposes of the analysis here, the democratic peace theory does not offer a viable path to explaining lack of conflict in space. Of the major space powers (Russia, China, and the United States), only the United States is considered democratic and several other non-democratic states are also involved in space activities (these states and their activities will be taken up further in Chapter 6). To date, there has been no actual instances of conflict in space, and while counterfactuals are notoriously difficult to prove, democracy does not appear to be a primary cause leading to the lack of it. Again, what is important to take from this discussion is that renewed interest in the pacific effects of economics has been an important offshoot of this research program.

The economic peace

Space is integral to the global economy. Today, it is used to transmit information across the globe in seconds, enabling economic transactions, stock markets, and real-time communications for companies with multiple locations around the world. Weather data and forecasting, enabled by space-based monitoring, are cornerstones of economic activities including agriculture, resource development, fishing, and tourism. Given the extent to which the global economy is dependent on space-based infrastructure, economic theories of peace provide far more promise in explaining a lack of conflict in space.

What I have termed the “economic peace” has been discussed under a variety of names including the capitalist peace, the commercial peace, or the trade peace depending on the causal mechanism at play. Even among scholars, identification of the capitalist peace, commercial peace, or globalization peace has been quite varied and are usually overlapping. For example, Gerald Schneider and Nils Petter Gleditsch describe the capitalist peace as “various facets of capitalism, ranging from increased development to free trade and foreign investment, are positively related to peace.”23 Weede, in an article about peace through globalization, appears to connect capitalism to globalization itself.24 Other scholars, however, have focused more closely on a commercial peace which involves interdependent and extensive trade relations, just a small part of the capitalist peace described by Schneider and Gleditsch. It is beyond the scope of the book to fully explain these differences; what is important to note is that, like the democratic peace, there are various explanations for how economics translates into peace. This brief review looks at just a few including capitalism, integration with global markets and trade, signaling, and bargaining costs.

The larger capitalist peace literature is a convenient jumping off point to explore arguments regarding the economic peace. However, a definition of it is hard to pin down. As Mousseau points out, the definitions of capitalism are quite diverse and the way in which scholars have tested the idea that capitalism creates less conflict have differed.25 Scholars have used various measures of capitalism including free trade, trade interdependence, the openness of markets, and market norms, none of which automatically equate with capitalism. Even in a symposium on the capitalist peace in the journal International Interactions, three different empirical analyses use three different measures of capitalism.26 The capitalist peace literature suffers from other shortcomings beyond lack of consensus about the definition and operationalization of capitalism. John Mueller argues that the acceptance of capitalism on its own is not enough to lead to peace.27 In addition to capitalistic markets, states also need to accept that economic prosperity and development are worthy goals, see peace as a better motor for economic development, and believe that trade will get them further than conquest. Despite Weede’s assertion that capitalism is more pacifying than democracy, Russett cautions that the democratic peace still holds significant explanatory power and that adequate causal mechanisms that integrate the two are difficult to establish.28 Finally, Richard Rosecrance warns that capitalism, far from promoting peace, may actually cause conflict by heightening inequalities among populations and stimulating nationalist attitudes.29 Indeed, despite hopes at the turn of the twentieth century that economic relations could stem conflict, World War I serves as a significant counterargument that will be discussed further in what follows.

Like democracy, not all states that engage in space activities are capitalist. Instead, it may be more profitable to focus on specific aspects of markets that might reduce the chances of conflict like peace through trade. Solomon Polachek hypothesizes, for instance, that among pairs of countries, mutual trade should reduce conflict because the more countries are dependent on one another, the more likely it is that conflict will disrupt those valuable trade relations.30 Polachek writes, “Ceteris paribus, the greater the amount of trade, the higher the price of conflict, and the less the amount of conflict that is demanded.”31 Conflict is discouraged because of the potential for damage to each country’s economic health. Polachek finds empirical support for the hypothesis and he is far from alone in the finding.32

Other scholars have proposed that it is actually a state’s interdependence with and integration in the global market that explains lack of conflict.33 For them, trade is only one part of an interdependent relationship that can also consist of foreign direct investment and movement of capital. In this variation, the meaning of interdependence is important with much of this literature building on work done by Robert O. Keohane and Joseph S. Nye beginning in the 1970s. In Power and Interdependence, Keohane and Nye define interdependence as “mutual dependence” and identify two dimensions of it, sensitivity and vulnerability.34 “Sensitivity involves degree of responsiveness within a policy framework—how quickly do changes in one country bring costly changes in another, and how great are the costly effects?”35 On the other hand, “The vulnerability dimension of interdependence rests on the relative availability and costliness of the alternatives that various actors face.”36 Interdependence is distinct from interconnectedness in this account specifically in terms of how costly the effects of exchange are: “Where there are reciprocal (although not necessarily symmetrical) costly effects of transactions, there is interdependence. Where interactions do not have significant costly effects, there is simply interconnectedness.”37 For Keohane and Nye, then, a country’s interdependence with one another and the global economy is measured in terms of degree; some countries can be more interdependent than others and the more interdependence there is, the greater the chance for peace.38

While the findings regarding trade interdependence and peace are supportive, there are a number of ways the relationship has been hypothesized to work. One is that trade and increased economic value represent an opportunity cost that is foregone when conflict is pursued; therefore as opportunity costs increase, states should be less willing to go to war. For William Reed, economic interdependence reduces uncertainty and lowers information costs for states that may be contemplating armed conflict.39 From this bargaining perspective, conflict can emerge between two states who are unsure of each other’s resolve in settling disputes with war being one way of demonstrating resolve, albeit a costly way. Recognizing that conflict is likely to harm a country’s economy, a country can demonstrate how far it is willing to go to settle a dispute by the amount of harm the country is willing to absorb economically. In comparing the effect of the opportunity cost and signaling argument, Nam Kyu Kim finds stronger empirical support for signaling as the underlying causal mechanism.40 However, in a comparative case study looking for specific examples where states are actively using economic signaling in the lead up to a conflict, Allan Dafoe and Nina Kelsey find evidence to support the argument only in larger cases of conflict.41

A final strain of economic peace theory specifically speaks to globalization. There is an extensive literature on the effects of globalization in general and, again, it is not my intent for this discussion to have a comprehensive review of it. Instead, I will focus solely on the argument that globalization can have a moderating effect on conflict. Like capitalism, globalization has many definitions.42 Common usage of the term seems to infer globalization as a growing set of connections among countries, their citizens, and their economies that are all serving to “shrink” the globe in some way. No matter the definition of globalization, the hypothesis is that the increased connections made through globalization serve to reduce conflict. For example, in a study comparing the effects of trade and democracy on military expenditures of India and Pakistan, Syed Mansoob Murshed and Dawood Mamoon find that while both globalization and bilateral trade reduce military spending, it is a country’s degree of openness to the world, not bilateral trade, that is the dominant economic factor.43 Further, for some like Seung-Whai Choi, both the positive and negative effects of globalization can help to explain the conflicting findings about the role of trade in reducing conflict.44 Choi writes,

[A]lthough some features of multiple global forces may appear to be mutually incompatible and conflicting, their overall consequences nevertheless converge into a benign force facilitating common peaceful disposition among national leaders who are then likely to prefer peace to war in times of crisis.45

Choi’s analysis, which covers 1970–2001, finds that when globalization is compared to the effects of democracy, trade, and involvement in international organizations (the traditional Kantian triangle), “globalization in its totality . . . promotes peace over and above what researchers have come to expect from the three Kantian perspectives.”46

Gartzke, focusing on globalization as integration of markets, argues that market integration can serve as mechanisms not only through which states reveal information about their resolve but also as a means through which states can coerce each other. “An economically integrated target can be coerced by the threat of losing valuable exchange, but a nonintegrated initiator cannot make its threats credible or informative.”47 His analysis shows that dyads, or pairs of states, with the least integrated markets are about five times as likely to experience a militarized dispute than those with more integrated markets. Further developing the line of argument that globalization can provide a means of signaling, Gartzke and Li assert that “Globalization facilitates costly signaling by making leaders’ talk costly and thus reducing the incentives to bluff.”48 If leaders can bluff and threaten without cost, there is no way to know whether it is simply a feign or a real threat. However, if there is a market consequence to a threat that draws capital and investment away from that leader, the individual assumes a particular cost. If they are willing to accept that cost, it reveals something about the resolve of the leader. If they are not willing to accept the cost, it also shows a lack of resolve. Finally, from a different perspective, Brooks finds that increased globalization reduces the benefits of conquest to such an extent that states should no longer find the benefits of conflict outweigh the costs.49

On the other hand, Christina L. Davis and Sophie Meunier argue that globalization has proceeded to such a point that sunk costs so high that there is no incentive to reduce trade in the case of conflict.

Sunk costs for export firms include information about market conditions for successful product selection and development of distribution, sales, and servicing networks. Once firms have established exports to a particular market, they do not quickly change their trading patterns.50

Instead of globalization as a means to transmit resolve and bargaining information, globalization is absorbing the shocks of the potential threats. Though Davis and Meunier focus only the United States and Japan between 1990 and 2006, they find that trade flows do not decrease following negative events. Additionally, Katherine Barbieri and Jack S. Levy, expecting to find that trade is impacted during periods of crisis between two states, instead find that conflict does not systematically reduce trade, casting doubt on its peaceful consequences to begin with.51

The various arguments that economic connections, whether they be trade, the flow of capital, foreign investment, or globalization hold significant promise for their application to space. While trade is not necessarily taking place in space (states are not physically exchanging goods), the space-based infrastructure serves as vital connections in the global economy that facilitate such exchange. Though conflict in space may arise because of a militaristic or defensive concern, policymakers cannot separate that from the economic consequences a militarized conflict in space will have. Thus, globalization serves to connect not just states and economies, but it creates linkages among policy areas that cannot be ignored.

Before pursuing this line of thought further, however, there are several significant critiques of the various economic peace arguments. First, Paul Krugman notes that states themselves do not engage in trade, firms do.52 Given this, scholars must identify the links between private trade activity and government actions (or inactions) in order to fully develop this type of model. All too often in the economic peace literature, these linkages are taken for granted or not dealt with explicitly, but among those scholars who have taken this deficit seriously, several relationships between private entities and state governments have been supposed. David H. Bearce and Sawa Omori have advanced three potential causal models: One, the presence of commercial institutions increases the opportunity costs for states to engage in war. Two, some commercial institutions provide information on the military status of competing states thereby easing bargaining and information costs. And three, commercial institutions have the capability of bringing states and their leaders together on a regular basis which can promote trust and cooperation, ties which can be important in the lead up to war.53 In both Bearce and Omori’s empirical work and Bearce’s comparative case study, only the third mechanism, increased ties between leaders, is supported.

By no means, though, are these three linkages between states and economic actors the only possible ones. As McDonald notes, governments have a significant role in organizing a state’s economy; they set monetary and fiscal policy, provide subsidies to different industries (for example, agriculture or oil), set tariffs, and can take any number of other actions to encourage or discourage economic behavior on the parts of individuals and corporations.54 But why do states engage in such behaviors? At least in the American context, scholars have long recognized the importance of the overall state of the economy to the election hopes of public officials: if the economy is doing well or has improved, leaders are more likely to ensure their own reelection.55 If leaders want to ensure their reelection, then improving a state’s economy is one way to do so.56 This reelection incentive is one very powerful link between a state’s actions and trade relations. If a conflict could threaten a state’s economy or trading relations with another country and if politicians are sensitive to economic arguments, they may be less likely to engage in conflict with that state out of selfish electoral reasons. Katja B. Kleinberg and Benjamin O. Fordham provide support for this argument by finding that members of the US House of Representatives appear to be influenced by the export orientation and import sensitivity of their districts when voting on issues related to China.57 This line of reasoning shares similarities with Bueno de Mesquita et al.’s selectorate theory as well: leaders, wishing to please their selectorate, pursue policies that will benefit their voters. When times are good economically, the selectorate benefits.

The economy-election hypothesis is a strong one with a long history of empirical support across global contexts. While this does not discount the mechanisms proposed by Bearce and Omori, election offers a powerful and parsimonious explanation for why states are interested in and concerned about trade relations. Of course, this does not guarantee that states will always act with their economic best interests at heart nor that the economy will be the sole concern. Often, states may undertake actions that harm their own economy because they have a stronger noneconomic rationale for doing so. On the other hand, thinking in terms of economic interests could also produce conflict of the type it has been theorized to prevent. This leads to the second serious critique of the economic peace hypotheses.

Prior to World War I, Norman Angell proposed in The Great Illusion the idea that has been discussed here—that economic ties and trade interdependence would make conflict irrational for states to pursue.58 Of course, just two years after Angell’s book was published, Europe found itself in the midst of the Great War. Although this put a damper on economically based theories of peace, it did not stop them altogether. In fact, just a year after the end of World War I, seeking to absolve capitalism from blame for the conflict, Joseph Schumpeter detailed a new version of this theory based on industrialization. Schumpeter proposed a two-stage movement wherein a shift to an industrial mode of production changes society and causes it to become “inevitably democratized, individualized, and rationalized.”59 This in turn influences a state’s leadership to become economically oriented, focusing on profit seeking behaviors as well as anti-imperialist in policy. Finally, these new attitudes are filtered to the mass public who become consumed with the new means of production leaving little time and energy for the activities of war.60 Some modern scholars have tested Schumpeter’s theory that industrialization has induced peace with success. J. Tyson Chatagnier and Emanuele Castelli expand on Schumpeter’s basic thesis by distinguishing between countries with more advanced, industrial systems (those that are heavy in manufacturing and industry) versus countries that are resource rich. In finding that states with larger industrial sectors are less prone to conflict, they argue that the industrialization hypothesis provides an advantage in that the ownership of the means of production becomes irrelevant. In other words, a theory of peace based on industrialization need not depend on whether a country has a free market or a centrally planned economy.61

While Schumpter tries to place the blame for World War I elsewhere, later writers have argued that World War I was either an aberration that should not automatically invalidate trading theories or have interpreted it through a different lens. Gartzke and Yonatan Lupu, for example, doubt the conventional wisdom that “World War I constituted a failure of economic integration to maintain peace” by making three points.62 One, the beginning of the twentieth century witnessed a series of crises among interdependent states in Western Europe which did not result in open conflict. Two, World War I actually began among the less interdependent powers of Austria-Hungary and Serbia. And three, “during the same period in which the highly interdependent European powers were generally able to resolve their crises without resorting to war, the less interdependent powers were typically unable to do so.”63 While not denying that World War I did occur and conflict did break out between interdependent states, Gartzke and Lupu argue that the role of trade has been misunderstood. Similarly, McDonald, who has found that free trade discourages conflict more than trade in general, believes that it was the lack of free trade in the run up to World War I that helps to explain conflict even among trade interdependent countries.64

Though World War I may not necessarily invalidate economic claims to peace, a more general objection is that trade asymmetries can induce conflict through a variety of means. This critique of the economic peace is based on realist international relations theory and the search, by states, for power. Realists have argued that, “Symmetrical ties may promote peace, but asymmetrical dependence creates tensions that may manifest themselves in conflict.”65 In short, if state A is more dependent on trade with state B than state B is dependent on state A, state B holds more power in the relationship. This could influence state A to try to reassert power in the relationship or gain more power, enhancing the chance for conflict. Keohane and Nye, in their study of interdependence, add power to this perspective, arguing that asymmetrical interdependence can be a source of power for the state that is less dependent.66 Further, the more interdependent or connected states are with one another, the more opportunities there will be for states to come into conflict with one another; according to the realist school, conflict is just as likely to emerge from these encounters as cooperation, particularly given their perspective on the nature of states.67

Some research has supported the argument that asymmetrical dependence can increase conflict. James Morrow argues that trade asymmetry might lead to conflict if one state valued the trade more than the other; even if an asymmetry exists, the weaker state in the relationship might not value it as highly as another.68 As such, his analysis finds the effect of trade on conflict to be rather indeterminate. Interestingly, Hans Dorussen, in developing a model of the effects of trade, argues that trade does reduce conflict but the effect actually diminishes as more countries are involved in a trading network.69 Though the model is not tested, his analysis implies that as more countries become interconnected, trade disruptions due to conflict could be made up elsewhere. Gartzke and Li’s findings support this with empirical results that show asymmetry does not contribute to a greater chance of conflict.70

Dale C. Copeland attempts to reconcile both of these objections, the occurrence of World War I and realist international relations principles, with economic interdependence through his trade expectations theory.71 Beginning from a realist perspective, Copeland introduces a key moderating variable: a state’s expectations regarding future trade with another state. If a state who is dependent on another state for crucial resources expects that trade to continue in the future, they have no reason to upset the apple cart by engaging in hostilities. On the other hand, if they fear the trade will be curtailed, “the greater the likelihood that it will choose hard-line policies or all-out war.”72 States, however, operate under imperfect information about both the future and another state’s trade intentions; given this, a trade-security dilemma can arise that is similar to an arms race spiral. If a state fears that their trade will be cut off, Copeland argues their best option is to project military strength into the region to “signal not only one’s determination to protect one’s economic access but also one’s military ability to do so.”73 The other state is likely to see this as an aggressive move and take actions to restrict or cut off trade with the first state or respond militarily.

Both Copeland’s theory and realist work on state power are rooted in the assumption that states seek to protect and enlarge their own power. However, there is reason to believe that the assumption itself is incorrect. Not only are there plenty of examples in history where states have cooperated with one another, James Wood Forsyth, Jr. argues that cooperation is possible even in a world that accepts this Hobbesian view of behavior.74 While Forsyth’s work examines great power cooperation in cyberspace, his argument is still plausible in general and, in particular, for space. He writes:

As each new power grows, its dependencies upon the global commons—sea, air, space, and cyber—will intensify. As dependencies intensify, oligopolistic behaviors will result, where the actions of one great power will have a noticeable effect on the rest. Since the great powers share in and are dependent upon the resources of the commons, the security of each great power will be tightly coupled to the security of the commons. Thus the great powers—for no other reason than survival—will inevitably cooperate and share the costs of providing security even if they might prefer not to.75

Certainly, Forsyth is not talking about trade in general, but he does suggest that the rush to assume that states act to protect interests can be overcome in certain circumstances. While it is not my intent here to engage in a debate regarding realist assumptions of international relations, suffice it to say that there is (and likely will continue to be) ongoing debates about the appropriateness of theoretical assumptions.

A final objection to economic peace also contends that trade interdependence and asymmetries can cause conflict but not through an imbalance of power. Rather, increasing reliance on other states and a growing interdependence of economies can cause both internal and external conflict by stoking latent attitudes of nationalism, economic protectionism, and inequality. The recent wave of nationalist and authoritarian beliefs around the globe are instructive, particularly moves by the United Kingdom to leave the European Union (EU). Peter Hall, writing on the origins of Brexit, argues that its roots can be partially tied to the expansion of the EU in 2004 to include eight east-central European states. At the time, the benefits to the UK appeared substantial: a larger free trade zone within Europe provided more markets for UK products. However, it also allowed the movement of more migrants into the UK.76 While the flows of goods and migrants have provided significant economic benefits to Britain, they also stimulated a backlash. “The referendum vote was won on a wave of public anger sweeping through northern cities and countryside left out of the prosperity that integration into a global economy brought to London.”77 Feeling left out of the economic good times and resentful of immigrants to the country, nationalistic attitudes resulted in a vote to leave the EU with the results still uncertain today. Similar attitudes have been expressed by nationalist-oriented leaders in the United States, Hungary, Brazil, and the Philippines.

It is impossible to deny that globalization has had negative effects. The question is whether they can be overcome or even whether the benefits of globalization outweigh the costs. The larger normative questions regarding the nature and scope of globalization are beyond the scope of this book. The point, however, should be that caution is necessary when considering globalization. Though it may have significant benefits, its side effects can be costly especially when those side effects increase the chances of conflict both inside a state and between states.

Taken as a whole, the economic peace hypotheses suggest that increased linkages, whether they be in the form of trade, globalized capital flows, foreign investment, capital markets, or even globalization, have a peaceful influence on the relationships between states. Though states themselves do not engage in trade, they have an incentive to see that their own economies are healthy; because of that, according to this perspective, they avoid potentially dangerous and damaging conflict which could hurt their economy through disrupted trade patterns and flight of investment and capital. In short, the economic costs borne by war are greater than the benefits of war causing rational states to seek peaceful solutions to conflict.

Methodological lessons and challenges for a theory on conflict in space

The economic peace, more so than the democratic peace, is a fruitful starting point in elaborating a theory regarding space-based dependence and conflict. However, it remains a fact that space is a different environment than terrestrial relations as discussed in the previous chapter. Though it is still dominated by the actions of states, the potential hazards of conflict in space are quite different as is the usage of space and the types of connections that states form through it. Therefore, we cannot simply apply one to one an economically based theory of peace to the domain of space without modification.

While this new theory will be developed in the next chapter, the research into the democratic and economic peace theories provides lessons, as well as potential challenges, for a space bound application. First, most democratic and economic peace research has occurred at either the monadic or dyadic levels; that is, scholars have studied whether certain states are more peaceful than others or whether pairs of states are more peaceful than others. Barbieri and Schneider note that, at least as regards the trade-conflict relationship, little empirical work has been done at the systemic level.78 In specifying a space application for one of these theories, then, it is important to specify at what level of analysis the theory is supposed to work. Is it that relationships among states make individual states less conflict prone in space? Is it that state-state relationships are less conflict prone? Or is it that the system itself, the network of relations among states and private actors, is more peaceful?

Since one state’s actions in space can have significant effects across multiple domains (not just as potential dangers to satellites but as disruptors of military, domestic, or economic behaviors on the ground), the theory advanced here is necessarily systematic. It hypothesizes that given increasing dependence of the global economy on space and increasing economic ties between countries, the system of relationships itself will be less conflict prone in the domain of space. This does not mean that the global system will be less conflict prone on earth. Instead, it treats space as a special area whose connections are far more valuable and vulnerable than terrestrial connections lessening the chances for militarized conflict in space. As a system level theory, it also does not distinguish between regime types or market types; democracies and authoritarian states and capitalist and state-run economies alike are theorized to be equally influenced by these connections. Where there might be variation that influences a state’s behavior, it would come in the form of asymmetrical dependence on the global economy and/or space.

The second challenge for a commercial space peace theory is to specifically link state actions to economic influences. While the attempts of scholars to link these two were discussed previously, I argue that space is a unique domain that enhances the relationship of states and private actors in addition to the mechanisms described earlier. In brief, space is unique for two reasons. One, states like the US, even if they could provide their own independent access to space through governmental agencies, typically contract out and procure both the satellite systems and means of transportation. This gives private space actors leverage with states and an ability to potentially influence a state’s actions and policies. Even if the government is directly providing the launch service, as is the case in China and India, among others, they can still be made to feel the economic pressure. For example, in response to the Indian ASAT test, Brian Weeden, a space analyst with the Secure World Foundation, suggested that companies should boycott India’s space launchers in order to register their objections to the test.79 While there is no indication of such boycotts occurring (at least on a large scale), this type of action is consistent with the economic peace hypotheses discussed previously wherein conflictual type action leads to economic penalties that are greater than the benefits of the action. In addition to withdrawing their business from state actors, private space actors in the future could simply refuse to submit proposals for government contracts or limit the types of launches they are willing to undertake. These possibilities only strengthen the connection between private actors and state behaviors.

The second way in which states and business are linked in space is through government support of technology development, particularly in regard to space. In the United States, investment in space activities, whether it be through NASA or the military, has not been undertaken without political motivations. In the early 1960s, following the establishment of NASA and at the height of the space race, NASA invested a significant amount of money and resources in states and congressional districts whose representatives were powerful in Congress. It just so happened that these members hailed predominantly from the South. As a result, NASA centers sprung to life in Florida, Alabama, Texas, and Louisiana. NASA continues to spend billions of dollars a year at these centers which can amount to a significant economic impact, an economic impact which is not lost on members of Congress representing those areas. In many ways, funding of space activities has become a type of distributive or pork barrel policy, dollars which members of Congress pursue to benefit their district.

This relationship is important for our purposes for several reasons. First, it demonstrates that state actors are sensitive to economic concerns, particularly when it impacts major industries. For example, John Logsdon argues that one of the primary reasons then-President Richard Nixon approved the space shuttle was because of its impact on the spaceflight industry of California, a state whose electoral votes he needed to win reelection.80 This helps to reinforce the electoral connection discussed earlier, especially as it relates to states. Second, space-related industries and corporations are likely to have a far greater impact in political decisions than the public. Public opinion polls have routinely found little salience for space in the United States and often, large majorities express the opinion that too much is spent on space exploration in general.81 As a result, Martin Machay and Alan Steinberg find that, in the case of space, industry influence has a much stronger influence on legislative decisions than public opinion.82 Given these extensive connections, the question ultimately becomes whether private actors should be given preeminence in a theory of space-based dependence. I argue that states remain the leading actors in outer space and therefore worthy of focus. My point here is to demonstrate that a link between the state and economic activity is easily made, specifically with regards to space.

A final lesson from this discussion regards a means of testing the theory. Theories of the democratic and economic peace are subject to rigorous empirical testing precisely because there is variation on the dependent variable: conflict, economic, and otherwise. There is no such variation in terms of space. To date, no actual militarized conflict has taken place in outer space. Testing the theory then, would require the explanation of an event that has yet to take place. Timothy J. Junio and Thomas G. Mahnken call such scenarios future counterfactuals and argue that they are necessary to deal with “high consequence, low probability events” much like a conflict in space.83 Counterfactual accounts usually consist of what if questions, particularly about past cases or circumstances but future counterfactuals, according to Junio and Mahnken, are what if statements about the future. Counterfactuals in general have been “woefully underutilized” in political science.84 James D. Fearon explains this absence as caused by a general feeling that “empirical political science must deal only with actual cases.”85 However, when there are no actual cases of conflict, statistical analysis or even small-N research is not possible. In a survey of uses of counterfactuals and scenarios, Junio and Mahnken find that, when they were used, future counterfactuals consisted of narratives about future warfare—exactly the type of event under consideration here. They further find future counterfactuals to be useful in theory building and development especially for what they call “data poor” research topics.86 While the future counterfactual will be used here to think about the ramifications of conflict in space, it is important to make clear that, unlike tests of the democratic and economic peace hypotheses which are quite voluminous, it is not possible to test this theory in the same manner or to the same degree.

While this chapter has explored the democratic and, importantly, economic peace hypotheses, these ideas only lay the groundwork for the commercial space peace theory. The following chapter will more clearly define key concepts, lay out main assumptions, and detail the main propositions of the theory. Following this, the remaining chapters will take up key elements of the theory including implications and the possible benefits stemming from competition in space.

[\*\*\*FOOTNOTES OMITTED\*\*\*]

Chapter 4: The commercial space peace

Space is often referred to as a global commons which suggests that space is a resource which all actors have access to and can benefit from, also known as a common pool resource or CPR global commons.1 It also means that it is subject to abuse by states whose overuse of it can ruin the common for everyone else. Although describing cyberspace, James Wood Forsyth, Jr.’s description of the problem associated with the commons can also be applied to space:

[C]yberspace is a common property resource—which is to say, no one can be excluded from it. When exclusion is not an option, states have little incentive to pay for a good. Instead, they prefer to be free riders, enjoying the benefits of a good without paying for it. In such a world, overexploitation is the problem.2

Space is experiencing a similar situation. More states and private actors than ever before are utilizing it, there is a growing threat of dangerous debris, and policy coordination is severely lacking. “As a result,” writes Laura Grego, “challenges to stability and security are growing, with ever more satellites and few restrictions on behavior, increasing the risks of costly accidents and of misunderstanding that could lead to conflicts on the ground.”3

This understanding of space as a global commons is derived from work on the tragedy of the commons. The tragedy of the commons, developed by Garrett Hardin in 1968, describes a scenario in which a common resource is depleted over time because of excessive individual use. Hardin uses the metaphor of a common herding area where individuals bring their animals to graze. If the commons can support 100 head of cattle, then ten individuals can each have ten cows. However, one (or more) of the herders may find it entirely rational to add just one additional cow to their herd in order to gain a competitive advantage over the others. If every herder did the same, the resources of the commons would be quickly lost due to overuse. In terms of space, the physical area around the earth is finite. Space is not only a resource that is held in common, no state or entity can claim sovereignty under current space law, but it is also one that can be easily depleted. While this might not have been a major challenge when only a small number of states could access space, the explosion of users of space has complicated matters significantly.

Though there is a debate to be had about whether space qualifies as a commons, assume for the moment that it is. The problem confronting us, then, is how to induce cooperation among actors so that no one actor or set of actors spoils the commons for everyone else. Both political scientists and economists have long recognized the issues surrounding the commons and this type of collective action. Elinor Ostrom, a Nobel Prize winner for her work in this area, examines why some groups do form to solve collective action problems and succeed whereas others do not. Ostrom contends that previous answers to these types of problems ignore the transaction and information costs that can be quite substantial for potential participants and could mitigate any collective action on their part. In turn, she proposes eight principles that contribute to cooperative arrangements to solve collective action problems, including defining clear group boundaries, ensuring those that are affected by the rules participate in modifying them, and providing easy means for dispute resolution, among others.4 These principles suggest that collective action is possible if the members of the group are empowered to create the system in which they are expected to work, can modify the institution as needed, and if the cost of obtaining information and monitoring the common resource is kept low.

Joan Johnson-Freese and Brian Weeden have specifically examined whether some of these principles would be applicable in the management of space as a common pool resource.5 Drawing on Ostrom’s ideas, their “mixed conclusions” are that there are significant caveats, inefficiencies, and disagreements on all sides. They suggest that a tiered system of space users (spacefaring states, space-capable states, and space users) that does not operate based on consensus as the most workable outcome. However, this solution, no matter its format, rules, or procedures, presumes that users of space, whether they are states or private actors, are willing and able to cooperate. Recent history has shown that not to be the case. For example, various countries and non-governmental organizations have proposed new treaty agreements or codes of conduct, but states including the United States have been hesitant to engage on these issues. In 2016, the US withdrew from negotiations on a non-binding International Code of Conduct for Outer Space Activities because of a desire to include a reference to “the inherent right of self-defense in space.”6 Another proposal by China and Russia through the United Nations Committee on Disarmament to ban the placement of weapons in space has faced resistance from Australia, Canada, France, and the United States because of a lack of verification mechanism.7

There does not seem to be high hopes for a formal, or informal, update to the Outer Space Treaty in the near future, but I argue that such an agreement is not necessary to limit the potential for open conflict in space. Instead, all of the mechanisms through which restraint can be found are already present: multiple users, both state and non-state; significant and increasing dependence on space for economic transactions; monitoring; and the danger of cascading effects should conflict emerge are just as capable of reducing, if not preventing, conflict in space. This chapter draws on the findings of the economic peace literature to develop just such a theory. Before outlining its premises, this chapter first discusses key definitions including what is meant by conflict in space. It then lays out the basic assumptions including states as the key actors and rational behavior, common assumptions across various theories of international relations. Then, I make five theoretical claims which constitute the body of the theory. Finally, I explore some of the initial implications that will be taken up in the remainder of the book.

Key concepts

When the term conflict is used, it can be used to define various stages of tension between actors ranging from mild disputes or disagreements to outright war. Part of the methodological tension in the democratic and economic peace literature has arisen from disagreements on the precise meanings and measurements of conflict. If a scholar has a lower bar for what can be termed “conflict,” then there will likely be more of it across the data set. However, if another sets a higher bar, the variation in the amount of conflict will likely be less. While there are no actual cases of conflict yet in space, the meaning of this term for the purposes of this argument is important. Conflict, “a sharp disagreement or collision in interests between two or more actors,” occurs quite often between states involved in space activities.8 Many countries have strongly objected to the Chinese, American, and Indian ASAT tests and there is certainly conflict among states over possible new treaties, agreements, and codes of conduct for space. This does not mean there is a militarized dispute or that conflict will ultimately result in one. Conflict happens. This theory does not argue that increased economic ties to space and increased state ties to the global economy will reduce conflict overall. Instead, the dependent variable of interest here is militarized conflict in space.

The qualification that the conflict occur in space is important; space is a unique domain with its own set of physical rules as detailed in Chapter 2. These differences make space a particularly harsh and unforgiving environment for both people and conflict.9 The environment also increases the costs of engaging in militarized conflict in space. In other words, the costs and benefits of engaging in militarized action on earth are quite different than the costs and benefits of engaging in militarized action in space.

A second reason why the addendum of in space is important is because conflict over space issues or space-based assets could be borne out on earth rather than in space. It is easy to imagine a scenario where one space power, concerned about how another state may utilize space or assets in orbit, might attack one or more of these terrestrial facilities. Spoofing, jamming, and hacking of the signals moving between the earth and various satellites has already happened and will likely happen again. However, should this occur, it would not fall under the rubric of this theory because states would be considering a different set of costs and benefits than if they were carrying out an attack in the environment of space.10

This discussion highlights another distinction, noted in Chapter 1, that should be reiterated here. Weaponization of space is different than the militarization of space. Because of the dual-use nature of space, space has already been militarized. Intercontinental ballistic missiles (ICBMs) travel through the lower reaches of space to reach their targets. Interceptor missiles designed to protect from ICBMs do as well. GPS systems are used to locate hostile targets and guide missiles to their intended targets. There is an argument to be made that the use of such space systems is not peaceful thereby breaking the Outer Space Treaty which preserves space for peaceful uses only. However, the uses of space noted previously are passive rather than active. The systems themselves are not weapons but are used to assist military services. This coincides with the US’s historical understanding of “peaceful” in the OST to mean “non-aggressive.11 In engaging in active conflict in the space environment, a line would be crossed from the militarization of space to the weaponization of space or the use of active, aggressive weaponry in space. More importantly, it does not necessarily matter, at least for the purposes of this theory, whether such use is offensive or defensive. Defensive militarized action is still militarized action that will come with the same consequences as offensive action, at least as regards debris and the potential for damaging cascades of it.

One final concept requires clarification before examining the theory and that is the idea of dependence. As will be shortly argued, to the extent that countries are dependent or interdependent on the global economy and the global economy is dependent on space, the risk of conflict should be lessened. But what does it mean to be dependent? Interdependence, according to Robert O. Keohane and Joseph S. Nye, is state of mutual dependence.12 Although the utilization of space to its fullest is somewhat dependent on the economy (good economic times means more spending and more innovation), we cannot say that space itself is completely dependent on the economy. Therefore, the term dependence is more appropriate in talking about the relationship between space and the economy. Interdependence is the more appropriate term in terms of the relationship between states and the global economy. As discussed in the previous chapter, interdependence has two faces, vulnerability and sensitivity. While I will discuss the interdependence of states and the global economy in what follows, suffice it to say at this point that the concept of interdependence, as defined by Keohane and Nye, will be used to describe relationships between states and the economy.

Assumptions

There are two main assumptions to the theory: one, that states are the central players and two, that they are rational actors. Since these are often taken for granted in the international relations literature, it hardly seems necessary to lay them out here. However, space is a significantly different environment with a growing number of non-state actors. Given the activities of companies like SpaceX or Blue Origin, can it still properly be said that states are the central players? This question mirrors similar ones about the role of the state in both a system of growing globalization as well as in a related domain, cyberspace. In terms of the impact of globalization, the argument is that as state economies are increasingly subsumed by the international economy, states will have less power to determine, at a minimum, economic outcomes. Paul Hirst and Grahame Thompson summarize this argument:

Nation states in this new perspective have become the local authorities of the global system. They can no longer independently affect the level of economic activity or employment within their territories; rather, that is dictated by the choices of internationally mobile capital.13

Lester C. Thurow even makes the bold prediction that many countries will not exist several decades from now because in a world where “countries need corporations more than corporations need countries, the relative bargaining power of governments and multinational corporations is shifting in favor of corporations.”14 Lindy Newlove-Eriksson and Johan Eriksson make the direct argument that space is increasingly “characterized by strong indicators of globalization” and that private authorities are growing in preeminence and power.15

Despite the predictions, however, states are still the main players on the international stage and fully in charge of their economic futures. As was pointed out in the previous chapter, some research shows the globalization and increases in trading relationships can have backlash effects that cause conflict rather than reduce it. As states begin to be tied to one another, internally, those who have been left out of the economic benefits create rising tides of nationalism contributing to political pressure that limits international involvement and acts to implement protectionist policies. The rise of conservative populist leaders in the United States, Europe, and South America is just one example of this phenomenon.16 Such actions only serve to reinforce the role of the state.

Another line of argument regarding the place of the state has been made in terms of cyberspace where the cost of entry is far lower and access more widely available. As information becomes a major source of power, some theorists have argued that increasing internationalization and privatization in the realm of cyber diminishes the importance of the state.17 Daniel Drezner argues that even in such a situation, “States, particularly the great powers, remain the primary actors for handling the social and political externalities created by globalization and the Internet.”18 Similarly, although there has been a proliferation of non-state actors in cyberspace, Hamoud Salhi notes that states still have the “sole ownership of the legitimate use of force.”19 Drezner, too, recognizes a growing role for both peripheral state powers and non-state actors in cyberspace but finds that their influence is mostly marginal.20 In terms of actual conflict in cyberspace or cyberwar, Erik Gartzke argues that the influence of states is actually reinforced—while non-state actors may be able to disrupt, temporarily, the actions of states in cyberspace, unless those attacks are backed up by terrestrial force, they are likely to be merely temporary distractions that states will soon overcome.21

All of these arguments about the centrality of states to cyberspace can also be applied to space. States, having the sole legitimate use of power and far more resources than private companies, have the capability of regulating space activity, particularly launches as well as pressing any military advantages that space may offer. Private actors may engage in hostilities in space, but states can prevent potentially lethal systems from launching in the first place and unless the private actor has a way to take advantage of a space attack through ground attacks, they likely receive no benefit. Further, under international law, states are held responsible for the actions of their nationals in outer space. Henry R. Hertzfeld writes, “it will be difficult, if not impossible, for a company to operate in space without supervision” and, as a result, “unless the major legal tenets of space activity change, commercial interests will be subservient to national interest in space.”22 Therefore, though the number of private players is growing and they play a significant role in preserving peace in space, it is still appropriate to treat states as the main actors in the space domain.

The second assumption is that states behave as rational actors in the global sphere, that is, they make decisions that are consistent with what they believe to be in their national interest. Often glossed over, the assumption that states act rationally is itself based on the assumption that states have correctly identified their own selfinterest and can correctly identify the best means by which that can be achieved. This implies a world of perfect information; without it, misperceptions can run rampant.23 This also assumes that states act in a coherent manner and yet, there are many actors within a state, each of which may have different ideas about the national interest and how it is best achieved. These caveats add a certain number of wrinkles to the idea that states are both unitary and rational actors, but theories must necessarily include simplified abstractions such as these to achieve parsimonious explanation. All of this is to say that states may, and indeed do, make miscalculations as to the national interest, thereby straining the bounds of rationality. It is my argument that states behaving rationally will not see benefit in engaging in conflict in outer space because of its potential costs. It does not rule out that rogue states might take the opposite tact.

Theoretical premises

This section introduces five theoretical premises on which a space economic peace is built. They are:

1 States are interested in promoting economic success.

2 The global economy is increasingly dependent on space.

3 State economic success is increasingly dependent on space to the extent that a state’s economy is integrated with the larger, global economy.

4 The more dependent on space the economy is, the greater economic costs of conflict in space.

5 In considering conflict in space, states have to consider danger to space-based assets and possible economic costs. The benefits of attacking a satellite or other asset have to be greater than the economic consequences that could possibly arise.

The theory suggests that the more dependent the global economy is on space, the chances of conflict are decreased because the economic costs of engaging in conflict are simply too high. The unique nature of space adds to these high costs, amplifying the peaceful effects that increased commercial ties have on the ground. To decrease the chances of conflict in space, increased economic and commercial ties between space and the terrestrial economy should be pursued.

With an understanding of the critique often leveled in economic peace research regarding linkages between the state and private economic activity, the first premise is that states are interested in promoting overall economic success. To the extent that a state’s economy is integrated with global markets, then states also have an interest in ensuring that the global economy thrives as well. It is not entirely necessary to specify the specific mechanisms through which this interest works (at least for the purposes of this argument), but it is important to establish that it is plausible that states are interested in a good economy. The previous chapter suggested several causal mechanisms from the economic peace literature that link the economy to the state including the reelection motivation for elected leaders and Bruce Bueno de Mesquita’s and his colleagues’ selectorate theory. In addition to these ideas, there is a long history of government protection of commerce, whether through protection of trading routes (either over land, in the air, or on the sea) or the imposition of tariffs to protect domestic economies. The state would not engage in such costly activities if it was not concerned with economic matters. Purchases of government debt by another country only add another layer to this. For example, as of early 2020, China held $1.1 trillion in US debt, more than a quarter of the American debt held by foreign countries.24 Not only does China influence the US economy through these purchases, it also increases the amount of danger to the Chinese economy (and government) should the US economy decline.

The unique environment of space adds substantial backing to this premise. States that utilize private actors to build their space infrastructure and launch it are dependent on the success of these private actors which, in turn, is partially predicated on the state of the economy overall. Second, heavy state investment in the development of space technologies not only benefits certain states and congressional districts (adding to the weight of the reelection hypothesis) but technological advancement can stimulate the economy directly. Eli Ginzburg, James W. Kuhn, Jerome Schnee, and Boris Yavitz detail several early studies on the economic impact of NASA, including one that found that with each dollar spent on research and development, returned “slightly more than $7.00 in gross national product over the eighteen year period following the expenditure” and that the “$25 billion (in 1958 dollars) spent on civilian space research and development during the 1959–69 period returned $52 billion through 1970 and will continue to produce payoff through 1987, at which time the total gain will have been $181 billion.”25 A 2013 report finds that the agency develops 1,600 new technologies per year, all of which are transferred to industry and for “every dollar NASA spends on employees, businesses, universities, and others generates $2.60 of output in the economy, as compared to the federal non-military average of $2.30 and the federal military average of $2.00.”26

Admittedly, demonstrating that government investment in space technology impacts the general economy is not the same as demonstrating the government has an interest directly in the economy. However, spending on space is routinely justified by government officials precisely because it is a net positive to the economy.27 In the United States, this justification began early. In April 1963, in response to a request from President John F. Kennedy to review NASA’s budget, Vice President Lyndon B. Johnson justified the spending on space largely in economic terms, writing,

It cannot be questioned that billions of dollars directed into research and development in an orderly and thoughtful manner will have significant effect upon our national economy. No formula has been found which attributes specific dollar values to each of these areas of anticipated developments, however, the “multiplier” of space research and development will augment our economic strength, our peaceful posture, and our standard of living.28

More recently, in a March 2019 announcement tasking NASA to return to the moon by 2024, Vice President Mike Pence invoked economic rationales several times to justify the project:

The United States must remain first in space, in this century as in the last, not just to propel our economy and secure our nation, but above all because the rules and values of space, like every great frontier, will be written by those who have the courage to get there first and the commitment to stay.29

This justification of space development in terms of its economic potential is not limited to the United States. Both Russia and China have concerned themselves with the economic and commercial potentials of their space programs.30 The Chinese government in particular has emphasized the commercial applications of its launch systems since it entered the global launch market in the 1980s. For China, space development is not just a means of enhancing their economy but also of connecting their disparate population centers with outlying areas and of further supporting space development.31 If politicians are supporting space funding, even in part, because they believe it benefits the economy, then this first premise, that states are interested in a successful economy, is more than plausible.

The second premise of a space economic peace is that the global economy is increasingly dependent on space. Chapter 2 outlined some of the many ways in which space-based instruments contribute directly to economic activities including satellite television, radio, and communications, imaging, weather forecasting, satellite imagery, and location services. Satellites also serve as a means of transmitting economic data and information and facilitating exchange and economic transactions. Given the wide use of space-based assets, there is little agreement on measures of economic impact and even fewer of the extent to which the global economy relies on space. That being said, at the end of 2018, the global space economy was worth approximately $400 billion, 80% of which was commercial activity.32

To my knowledge, the only comprehensive study addressing this question economically was undertaken in 2018 by the European Commission. In assessing this question, the Commission differentiated between direct dependence, indirect dependence, and peripheral dependence on space-based assets and its findings are stunning. In terms of direct dependence,

[T]he size of the European downstream market is estimated to be in the order of EUR 40.7 billion of revenues per year, yielding a G[ross] V[alue] A[dded] in the order of EUR 21.1 billion. This represents around 0.16% of the total European GDP. Although this may seem low, the sector is actually more than three times as large as the fishing and aquaculture sector in economic terms and comparable to the passenger rail transport or forestry and logging sectors. In the event of a loss of space assets, the complete dependence of this sector would lead to a total loss of revenues for European companies involved in this market. A complete loss of assets would also impact the 200 000 jobs in the European space downstream sector.33

Further, the report identifies 11 macro-sectors that are indirectly dependent on space whose space dependent activities represent 786.9 billion euros of annual gross value added.34 For context, that approximates just over $887 billion. When considering the full impact of a loss of space assets on the European economy, between 300 and 800,000 jobs would be at risk with significant losses both socially and strategically as well. The report concludes that such dependence can only be expected to grow.35

It is clear from this report that the EU’s economy is significantly dependent on space-based assets. Assume for the moment that, in the event of a major loss of space infrastructure, only the EU was affected. While this is certainly implausible, even if the EU were the only ones affected, the consequences would no doubt ripple through the global economy quite quickly. Further, even if some states are less dependent on space assets than the EU, the United States, or other major powers, they would likely still experience economic interruptions depending on how integrated they are into the global market.

One specific area of space dependence that has direct economic impact is the Global Positioning System or GPS. Though some backups exist, if GPS were disrupted, many economic and financial transactions would be immediately disrupted.36 We can consider the global economy’s dependence on GPS through Keohane and Nye’s two facets of interdependence, vulnerability and sensitivity. “Sensitivity is the extent to which one country is affected by the actions of another, whereas vulnerability is the extent to which a country can insulate itself from the costly effects of events that occur elsewhere.”37 In terms of sensitivity, we can ask how quickly would disruptions in GPS affect the economy and at what cost? In January of 2016, the US Air Force, as it was taking one of the 31 GPS satellites offline, introduced a tiny error of 13 millionths of a second into the timing system. The error immediately disrupted GPS-based systems around the world for more than 12 hours. “In parts of the US and Canada, police, fire, and EMS radio equipment stopped functioning. BBC digital radio was out for two days in many areas, and the anomaly was even detected in electrical power grids.”38 The error was eventually fixed, but it took no time at all for its consequences to be felt. And that was a situation in which there was no loss of an actual satellite or satellites.

As for vulnerability, we may consider whether there are alternatives/options to GPS that can quickly take over in the event of a change in space. Though the EU is completing its Galileo system and Russia has its GLONASS system, neither are as dependable or widely available as GPS.39 It is fairly safe to accept the premise that the global economy is dependent on GPS specifically and space more generally. And that dependence is only growing.

The third premise of the commercial space peace theory is that state economic success is increasingly dependent on space to the extent that a state is enmeshed in the global economy. Because a state’s economy is, at a minimum, interconnected and at maximum, highly interdependent with the global economy and because the global economy depends on space, then a state’s economy is dependent on space too. It is well known from empirical findings that state economies are increasingly enmeshed in the global economy. Globalization has been variously measured in studies via levels of trade, foreign direct investment, and foreign portfolio investment. Given that it is a multidimensional concept, Axel Dreher introduced a composite index of globalization, the KOF, in 2006 that has now become the most widely used globalization measure when studying economic globalization.40 The KOF index looks at what the authors call de facto and de jure globalization: “While de facto globalization measures actual international flows and activities, de jure globalization measures policies and conditions that, in principle, enable, facilitate and foster flows and activities.”41 Figure 4.1 displays the global KOF de jure and de facto indices from 1970 to 2017. There is no mistaking a rapid increase in both types, particularly following the end of the Cold War, though it has leveled off some in recent years.

To be sure, globalization, particularly in relationship to space, is not inevitable and comes with significant costs. Hertzfeld notes that regulatory limits put in place by states to prevent unfriendly states from acquiring certain types of technology (for example the International Traffic in Arms Regulations enforced by the United States) limit the degree of international trade.42 Further, if security and defense issues continue to increase in importance, it could “easily lead to a decline in market-based commercial space applications as government demands and regulations supplant the development of private markets.”43 Other negative externalities associated with globalization might also play a role in restricting its growth, including internal conflict spurred on by economic losses in some segments, a backlash to international trade, and an increase in general trade barriers. However, global dependence on space does not appear to be ebbing any time soon and Hertzfeld even acknowledges that such trends are unlikely to be deterred. Thus, we should expect to see the global market increase its dependence on space for the foreseeable future.

[\*\*\*FIGURE OMITTED\*\*\*]

The fourth premise proposes that the more dependent on space the economy (global or state-based) is, the greater the economic costs of conflict in space. To understand why this might be the case, consider a scenario where only a state’s military space assets are targeted with no collateral damage. Even though scholars and military analysts recognize the immense dependence of many military forces on space resources, assume also that militaries have redundancies and workarounds so that destruction of one asset does not cripple their capabilities. In that case, the costs of conflict are not sufficiently high so as to dissuade the countries from engagement. However, even if only a military target was engaged, there is no way to ensure that the debris created in the attack will have no further threat to other assets, military or otherwise. Uncontrolled debris could easily impact with other satellites on which economic activities depend initiating a Kessler syndrome-type cascade. And unlike the military, the global economy does not have sufficient backups and workarounds to compensate for the loss of a satellite or satellites. Roger Handberg, in examining the assumptions of space war writes: “Globalization has been fostered through satellite technologies. Their disruption can be devastating for all parties, regardless of who is the winner or the loser.”44 The implications of this are catastrophic. No satellite or space-based asset would be protected, and the resulting debris field could make usage of particular earth orbits impossible for both public and military uses. Attacking another country’s satellite comes with the possibility of harming your own.

Closely related to this premise is the final one which states that as countries contemplate militarized conflict in space, they must consider the possible economic costs of their actions. States should only engage in conflict where the potential benefits outweigh the costs. As the cost of conflict in space rises, states should be less likely to find the attack to their benefit. And the more the economy is dependent on space, the higher the costs are likely to be. Handberg puts the situation quite bluntly: “What may occur is the graveyard of the modern economic system. No potential space participants would be immune to the damage, regardless of whether or not they were participants in the actual conflict.”45 This idea is nothing different than what is argued in the trading variant of the economic peace literature: the benefits of conflict have to be greater than potential economic costs. What is different here is the causal mechanism—rather than conflict mediation through the trading relationships between states, it is the network of relationships between space, the economy, and states that increase costs beyond the potential benefits.

One objection to this argument is similar to the critique that states do not engage in economic activity: perhaps economic costs are not factored into military planning. Some analysts may argue that if a state’s security is at risk, economics be damned; the state should pursue all avenues to increase its power and security. However, economic power not only influences other states but serves as the foundation for military capabilities. For example, Alfred Mahan, who significantly influenced theories on maritime power with his writings in the late nineteenth century, argued, “a nation that could protect its own maritime commerce while disrupting that of its opponent could shift the balance of national resources decisively in its favor.”46 The US military’s Joint Planning doctrine published in 2017 explicitly recognizes a discussion of costs and benefits when planning operational activities.

Joint planning identifies military options the President can integrate with other instruments of national power (diplomatic, economic, informational) to achieve those national objectives. In the process, joint planning identifies likely benefits, costs, and risks associated with proposed military options.47

If attacks in space harm the economy, these costs and risks, according to US military doctrine, will be, at a minimum, considered; it is the argument here that they will likely outweigh the benefits of such a course of action. Thus, for states that are heavily dependent on space, whether directly or indirectly through their ties to the global economy, the potential economic costs of engaging in a militarized conflict in space should be high enough to dissuade them from pursuing such courses of action.

Like the empirical findings on trade, another similar counterargument can be made against the pacific effects of trade and increased dependence on space: asymmetrical dependence could be just as likely to increase the chances of conflict.48 The states that are heavily dependent on space are also major powers like the US, Russia, China, and India, all of whom have demonstrated the capability of using anti-satellite weapons. Given each of those states’ reliance on space and the global economy, the benefits of conflict should be less than the potential costs of conflict. But what about states who are less dependent on space, either directly or indirectly? It is possible that they see this decision calculus differently and believe that the benefits of conflict are greater than the costs. These states are also likely to be weaker militarily to begin with. Like Erik Gartzke notes in terms of attacks on cyber space, an attack, whether it be in space or in cyberspace, would not be meaningful unless paired with a terrestrial attack as well.49 Whatever advantage a less space-dependent state gains from an attack on a space asset is likely to be minimal, temporary, and lead to no further advantage in the long term.

To illustrate the point, imagine a scenario where a less space-dependent state like North Korea, Iran, or even a terrorist organization manages to launch a physical attack on a key American military satellite. While there are most likely ways for the US military to work around such an attack (transmissions could be sent through another satellite or uncrewed aerial vehicles), the US would also likely strike back. If the attacking state is really less dependent on space, there will be fewer spacebased assets on which a retaliatory strike could take place. Given the lack of space assets to attack, the US might consider one of two options: a land-based attack or a space-based attack on a state that supports the original instigator. For example, in the case of North Korea, the US might consider an attack on a Chinese space asset while for Iran, it could be Russia. If the US chose the first option, again, North Korea or Iran would have to be aware that they would be quickly overwhelmed. If the US chose the second option, they would need to consider the potential for collateral damage that could end up harming the United States to a far greater extent economically rather than just militarily as well as the costs of dangerous escalation among space powers.

Finally, given the involvement of an ever-larger number of private actors in space, states also need to consider the lost opportunity costs if private actors choose to forego research, development, and deployment of new technologies because the danger in space is too high. As space becomes more commercialized, these private actors can exert pressure on states to behave peacefully in order to promote further economic development. Gartzke and Quan Li argue that this can happen through the movement of capital from conflict-prone states or areas to non-conflictual states.50 This is not necessarily applicable to space because there is no area in space which is formally protected, but commercial space actors may choose not to engage in new economic investment which can in turn affect a state’s economic performance. To date, the size of the space sector is comparatively small, so, arguably, the potential economic loss would not be that great. Where the harm comes from is state reliance on private actors for military and national security space services. As states contract out space services to a greater extent, private actors exert an even greater influence over the state by having a capability they do not.

Why might private companies want a more conflict-free space? If there is weaponized conflict in space, they could potentially benefit through new launches to send up replacement satellites; this is similar to an argument that war can actually be beneficial to an economy because companies are needed to create materiel and weapons.51 But, in a debris filled environment, sending replacements is more difficult and dangerous. Some private companies want to engage in human spaceflight; a conflictual or more dangerous orbital environment would likely prevent those activities or increase their costs to such an extent that it becomes economically infeasible. James Clay Moltz argues specifically that “the growing presence of space tourists in low-Earth orbit would greatly increase the incentives for restraint in any future [ASAT] test programs.”52 Those foregone development costs and commercial activities can have a similar cost to states simply by discouraging private actors from participating in the market.

Implications

While the theory described previously is based on the economic peace literature, it is not the economic relationships among states that lead to peace in space, rather, it is the global economy’s dependence on space that does. This idea is not as farfetched as it may seem. Following the immense amount of debris generated by China’s ASAT test in 2007, there has been a growing acceptance that such tests should be avoided in the future precisely because the increase in debris makes operations in space, both peaceful and militarized, more difficult. Shortly after India’s March 2019 test, US Air Force General John Hyten warned a Senate committee that there is increasing danger from space junk, saying,

If we keep creating debris in space, eventually we are going to get to the point where it’s very difficult to find a place to launch, very difficult to find a place to put a satellite, to operate a satellite without having to maneuver it all the time to keep it away from debris.53

While Gen. Hyten was speaking specifically in reference to military needs, the same restrictions would also apply to commercial space assets.

Thus, the major implication of this theory is that the more dependent a state is on space, whether economically or militarily, the lower the chances of that state initiating or becoming involved in a military conflict in space. Granted, the theory does not address military dependence specifically, but that too, is increasing. As early as the mid-1990s, Jeffrey Caton described the US military’s dependence on space and wrote that,

An attack on our space assets could impact every element of national power— political, diplomatic, economic, and military. . . . An enemy has much to gain by exploiting the dependency link between our terrestrial forces and forceenhancing space systems.54

The point, however, is that space is not just used for military purposes—if it was, the chances of conflict are likely far higher. The fact that there is a significant economic use for space restricts choices in space militarily because of the economic impact of the conflict.

This theory also does not rule out the weaponization of space or the deployment of weapons whether offensive or defensive in nature. It does argue, however, that they should not be used. The danger, of course, is that any sort of weaponization of space could increase tension and contribute to a growing arms race in space, something that will be discussed further in the next chapter. Writing on the attitudes of the Americans and Soviets at the high point of the Cold War, Steer argues that “the unique nature of the environment meant that weaponization could endanger each state’s own sovereign interests as much as any adversaries.”55 In analyzing today’s strategic environment, Johnson-Freese echoes the argument:

[W]hile space weapons might offer the United States a short-term advantage, in the long term they would actually weaken US security by instigating an arms race that cannot be won, by anyone. Further, space weapons could potentially provoke a first strike by an adversary, create a “use it or lose it” mentality among US forces, and risk rapid and dangerous—perhaps even nuclear—escalation.56

Weaponization will likely stimulate a space arms race but to the extent that a state is rational and interested in reducing and mitigating potential economic, weaponization should still be avoided.

This theory also does not rule out other motivations for reducing conflict in space, including the limitation of a potential opponents use of space through diplomatic means. This would follow a pattern established during the Cold War where

Following a series of arms tests in space, both the United States and the USSR realized that if they wanted to continue to have access to space for intelligence, reconnaissance, and surveillance purposes, they would need to come to some compromises as to its use.57

The resulting diplomatic outburst produced not just the Outer Space Treaty, which banned the placement of nuclear weapons in orbit, but the Agreement on the Rescue of Astronauts, the Convention on the International Liability for Damage Caused by Space Objects, and the Convention on Registration of Objects Launched into Outer Space. In other words, economic concerns can serve to restrict military conflict in space with other concerns, including diplomatic, reinforcing the effect, further reducing the chances of conflict.

As described at the beginning of this chapter, while work on codes of conduct for space or new international agreements is ongoing, to this point, there does not appear to be any momentum to conclude any such talks. It is possible that major space states could suddenly realize the impact of their own actions in space and work to reduce tension like the US and Soviet Union did in the late 1960s. However, should that not be the case, this theory suggests that an international regulatory framework or code of conduct is not absolutely necessary to restrain state behavior. Instead, as commercial and economic dependence on space grows and the space market is encouraged to expand, economic restraints can fill the void until such time that an international agreement becomes feasible. Moltz argues that this option of “muddling through,” or engaging in a piecemeal fashion, could continue, but that it has several significant drawbacks.58 These include a failure to include considerations of national and military power and lack of enforcement against those who violate norms. However, in viewing conflict in space through the theory presented here, the economic realm does not have to take into consideration military concerns as long as economic costs are considered in military planning. And as long as states behave in a rational way, we can assume that they will. States have a strong, rational interest not only in protecting the economic wellbeing of their states but also in increasing their economic standing. As detailed earlier in this chapter, economic considerations are already rooted in American military doctrine. In terms of sanctions for violating norms, they could be carried out through loss of economic activity as the economic peace literature proposes. States who violate acceptable standards of behavior may find space commerce fleeing from their country and a lack of partners who may want to work with them. While “muddling through” might not be the optimal strategy, it is one that has worked to this point.

The value of competition

As noted in the first chapter, a subsidiary argument offered here is that, even if a space race should break out, military or civilian in nature, competition is not necessarily a bad thing. Much of the technological development noted previously that arose from space investment came at the height of the space race as both the US and the USSR were pouring billions of dollars into a race to the moon. The race itself had a civilian face with a military undertone, but its benefits were on the whole, positive. No overt military conflict arose, there was a significant investment in research, development, and technology, and the two space powers realized that they needed some sort of international framework to preserve their ability to operate in space. Both of these elements continue to be present today.

First, the increased threat of conflict in space could, coming as it does with an increased number of public and private actors and a greater economic threat, impress upon space participants the need to reign in dangerous actions and rhetoric. While it took an atmospheric nuclear test on the part of the Soviets to encourage both the US and USSR to come to the table in the 1960s, increasing awareness of economic and military dependence and the consequences arising from conflict in space could increase the enthusiasm to pursue new international agreements. For its part, the US military increasingly recognizes the dangers and the need to mitigate them, however, mitigation efforts have largely concentrated on offensive rather than defensive capabilities.59 A focus on offensive weapons can only aggravate the situation and there are still significant technological hurdles in developing on-orbit offensive weapons. As such, a move away from such rhetoric, like Johnson-Freese argues for, is necessary.

Competition can also increase technological capabilities and those technological capabilities can in turn enable cooperation.60 China is a case in point. In the 1990s and early 2000s when they were beginning to restart a human spaceflight program, Chinese officials often stated their desire to work with other powers in space, particularly the United States. China did in fact forge ties with other countries via space, in particular Brazil. However, as Chinese spaceflight technology advanced, the rhetoric of cooperation was pulled back some over a desire to enter into a partnership on equal footing. Once the Chinese could establish their abilities in space, they would be able to cooperate with potential partners as an equal, rather than junior, partner.61

As more countries develop space technologies, the ability to help one another out also increases. The Agreement on the Rescue of Astronauts obligates signatories to “take all possible steps to rescue and assist astronauts in distress and promptly return them to the launching state.”62 More states with the ability to conduct crewed operations in space will only facilitate this type of help and cooperation. While fictional, this is just the type of scenario that played out in the book (and later movie) The Martian. When a supply rocket blows up on launch, NASA turns to China for a replacement that enables a Mars crew to return to Mars to rescue a stranded astronaut. These types of cooperative activities can in turn foster greater cooperation in areas other than space and science. In fact, one of the causal mechanisms through which the economic peace is hypothesized to act is via increased connections between people and private actors which can foster communication and mutual trust.63 Similarly, sociological liberalism embraces the importance of links among people to create more peaceful global relations.64 As greater cooperation emerges in space, it can spill over into other areas of interstate relations.

To return to the discussion of space as a global commons, the increased competition and potentially increased cooperation could lead to the type of situation that Ostrom finds powerful in fostering collective action. Increased ties, diplomatically and/or economically, can reduce the costs of engaging in collective action. Historically, space itself has been used to monitor and verify international agreements, thereby lowering the information costs for participants. The openness of space and the vulnerability of space infrastructure makes it an arena that is easily monitored; it takes a fairly low level of technology to track satellites in their orbits. States can provide the means through which private actors are coordinated and norms enforced. Private actors, given their increasing role in the commercial and military aspects of space can also be empowered and lend considerable weight to the discussions. Thus, while the commercial space peace theory presented here may seem rather pessimistic about the possibility of cooperation among states, it can also be seen as an optimistic vision where increased economic ties between space and among actors, state and non-state alike, bring countries to the negotiating table and create the conditions needed to ensure collective action.

The remainder of this book will take up various aspects related to this argument. The next chapter examines military and geopolitical considerations in space conflict while Chapter 6 discusses the various actors involved. Chapter 6, in particular, focuses on the new non-state actors that are driving significant change in earth’s relationship to space. Finally, Chapter 7 looks at the possibility of space races in the future given this new space environment with its proliferation of players. It ends with several policy suggestions that could be pursued to reduce the level of tension among space powers and create a scenario that recognizes both the dangers and promises of space.

#### 2. No arms racing or war impact- space war is not inevitable AND interdependence solves

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This competition has already begun in space, and the United States must decide now what its space policy will be in the face of a clear and present danger. Because the Soviets have assuredly decided to compete in a determined way, we cannot afford the consequences of muddling through in a struggle that could spell disaster.1

The coming war with China will be fought for control of outer space. . . . [T]he unavoidable conclusion is that the United States and the People’s Republic of China (PRC) are on a collision course for war.2

Though written nearly three decades apart, the authors of these passages believe both that a coming war is inevitable and that the United States must begin to prepare for it militarily in space. In the first case, written in 1981, the authors, Dino A. Lorenzini and Charles L. Fox, warn of imminent conflict with the Soviet Union, a conflict we now know never occurred. In the second passage, Everett C. Dolman warns in 2012 that conflict with China is not only unavoidable but possibly already underway. Dolman recognizes that “Inevitability is a crass and unsubtle divination,” but he also argues that “The past foreshadows the future—and the calculation of probability over time, combined with risk, is more persuasive than platitudes.”3 If past is prologue, however, what does the fact that the “inevitable” space war with the Soviet Union never occurred tell us about warnings of an inevitable space war with China? The weight of history may not be on the side of conflict, instead it may be on the side of cooperation and stabilization. In fact, this is the very argument advanced by Cameron Hunter who, in analyzing American archival national security documents, argues that the Chinese space program was seen as a threat at the dawn of the space race by American officials. That this “threat” could be overcome demonstrates that today’s supposed threat from China is instead “politically contingent.”4

While Dolman may be incorrect in his prediction of conflict with China in space, he is certainly correct that history has much to teach us. In the case of space, there have been several periods where analysts and military strategists have believed conflict to be imminent and yet, in each of those periods, space powers have chosen to step back from the breech and discover that cooperative restraint, if not outright cooperation, provides a better path for themselves and for all. The argument that conflict is inevitable demonstrates a sort of fatalistic attitude. Space states have a choice in whether to pursue weaponization of and conflict in space and have chosen not to for reasons of self-interest; to call conflict inevitable is to assume that states do not have a choice and therefore have no power. As will be discussed in what follows, as both the Soviet Union and the United States realized the security advantages that passive space systems for reconnaissance and monitoring granted them, they each became concerned with protecting their ability to operate freely in space. Though doing so out of pure, rational, self-interest, the decisions by the Soviet Union and the US in the mid- to late-1960s protected space from conflict. Since then, not only have states recognized the military advantages that space systems offer, they, and the rest of the world, have recognized and come to rely on the economic advantages of space. Today, as we contemplate yet another period in history where space conflict may appear inevitable, the motivating rational self-interest is not just in the military and security spheres but in the economic.

If we are in a new space race today, as some, including Dolman, have argued, then considering the space race of the past is appropriate. It is not my intention here to review the history of the space race or to even provide a broader historical examination; excellent studies on this topic are available elsewhere.5 What is important for our purposes is understanding what prevented the space race from erupting into conflict in the first place and the lessons that may have for preventing conflict today. My argument here is that although economic consequences did not play a significant role in constraining space-based conflict in the 1960s, the space states of the time, the US and USSR, did consider the costs and benefits of conflict for their own national security strategies. At that time, they came to the conclusion that any open hostility in space had the possibility of inhibiting their own spacebased operations. Today, the basic conclusion remains the same for all states: any open conflict in space has the potential of negatively affecting all states through the global economy. Thus, while the conclusion and the self-interested rationale have not changed, the basis on which the conclusion is drawn has.

Before examining the original space race, this chapter first briefly explores the logic of arms races. To call the space race a “race,” implies a state of competition between entities. This language clearly draws on the concept of arms racing; Lorenzini and Fox and Dolman both explicitly accept that an arms race is ongoing in their respective time periods, whether the US realizes it or not. To say that we are engaged in a space race, then, does not connote just a competition but also one that has a militarized underpinning in the seeking of weaponry or advantages in weaponry. With just one previous space race, it is dangerous to draw generalizable conclusions. Fortunately, general arms races have occurred more frequently and the study of them provides important context for considering a space race. As such, following a brief discussion of arms races in general, this chapter examines restraint in the original space race. Finally, I will consider the possibility of a new space race today. Though a civilian space race does not seem to be developing, there is evidence of a new push to develop military space systems that could be radically destabilizing. However, just as the US and USSR came to believe their actions in the 1960s were destructive of their own ends, space actors and states today can come to the same conclusion and utilize similar strategies to walk back from the brink.

The logic of arms races

The concept of an arms race is an old one. The Greek historian Thucydides recognized the dynamic in the wars between Athens and Sparta: as one powerful nation-state is challenged by a rising one, the established state feels threatened and consequently builds its military force. The emerging state sees this and furthers its capabilities, resulting in the war that was feared. This so-called Thucydides’ trap predicts that the rise of an emerging power necessarily leads to war has also come to be known as an arms race or security dilemma. Colin Gray, writing in 1971, defines an arms race as the following:

[T]here should be two or more parties perceiving themselves to be in an adversary relationship, who are increasing or improving their armaments at a rapid rate and structuring their respective military postures with a general attention to the past, current, and anticipated military and political behavior of the other parties.6

In other words, as country A builds up its arms, whether out of defensive or offensive motivations, country B feels threatened and feels the need to do the same. Country A, seeing the actions of country B, sees continued purpose in their endeavor and the rush to acquire weapons soon leads to out and out conflict.

Despite the attention given to the quantity of armaments, Samuel Huntington proposed in the late 1950s a dichotomy between qualitative and quantitative arms races. Quantitative arms races focus only on the numerical acquisition of arms and qualitative arms races on improvements in military technologies that make a weapons system more advanced than an opponent’s or improve upon the manufacturing techniques used in producing them. Qualitative arms races, in this sense, are just as destabilizing as quantitative—a country’s investment in a revolutionary new weapon that, if even just one was purchased and used, could make all others obsolete, is considered a revolutionary, not evolutionary, military advancement. An example of such a qualitative arms race is the race to understand, design, and build nuclear weaponry during World War II. The race that followed, that concentrated on the number of nuclear weapons, is a quantitative arms race.

With the rise of tensions in the Cold War, understanding the dynamics of arms races became a significant topic for academics in the mid-twentieth century. These scholars moved away from definition to an analysis of motivations and causes. In 1960, Lewis F. Richardson built a mathematical model of this process based on three underlying motivations for an arms race: revenge or hostility, fear, and a tendency to reduce armaments so that they are more economical.7 Far from leading to a state of mutual deterrence based on equal amounts of power, his equations postulated a spiraling tendency to arms races that inevitably lead to war. Coming as it did in the midst of an actual arms race, many scholars found this argument not only credible but persuasive. Michael Wallace, in seeking to quantify the frequency of conflict with arms races finds that arms races escalated to war in 23 out of the 28 cases of war he studied.8 However, in the ensuing academic debate, little evidence was found to support the notion that arms races were early indicators of coming war.

At the same time scholars were testing mathematical models of arms races, game theoretic models were created using the form of the prisoner’s dilemma. These specifically included uncertainty about the actions of an opponent in contributing to arms races. If two states had perfect information about one another—their motivations and capabilities—an arms race is not rational. But in the case of uncertainty, defection (in the form of an arms race) is rational. Andrew Kydd, more recently, hypothesizes that arms races develop when there is uncertainty specifically in regard to the economic ability of the other state to bear the costs of a buildup.9 In this manner, arms races reduce uncertainty about the costs a state is willing to bear along with their military capabilities. Toby J. Rider concurs with the idea but focuses more acutely on uncertainty over the policy positions of a state’s leadership. He finds that arms races are more likely early in a state leader’s tenure, when global uncertainty about them is highest.10

Additional motivations for states to undertake arms races go beyond deterrence and uncertainty. Gray summarizes seven of these including: deterrence, defense, diplomacy, functional threats, vested interests, reputation, or technology development.11 While defense and deterrence are implicit in the previous descriptions, diplomatic motivations find states increasing their arms in order to have a stronger hand at the bargaining table. If other countries believe or perceive a country to have certain capabilities, they may be more willing to engage and conciliate than otherwise apt to. In addition to these external factors, some arms races may be motivated by more domestic and state-based variables. Functional threats have a close relationship to bureaucratic politics in that “domestic institutions seeking to maintain or enlarge their budgetary and influence bases need to enlist or harness the functional hostility of an external rival.”12 In other words, bureaucrats, seeking more money, emphasize the risk or threat from another country in order to pad their budgets and resources. Similarly, vested interests in the form of a country’s defense industry could also push the storyline that the state is threatened in order to increase their bottom line. Joan Johnson-Freese identifies these two dynamics as contributing to the drumbeat for further space weapons development in the United States currently. In Space Warfare in the 21st Century, she writes:

These companies [military-industrial companies including Raytheon, General Dynamics, Boeing, and Lockheed Martin] inherently have a vested interest in maintaining and expanding systems, including weapons systems, which absent clear and direct external threats, may have limited political justification. Additionally, government counterparts to these for-profit companies have concurrently grown—some might say, ‘become bloated’—and in many cases, a codependent relationship has developed between them.13

Thus, bureaucrats working with industry both have an incentive to stoke fears of an adversary so that they benefit from increased budgets and a purpose of mission.

Finally, states may engage in arms races to protect their reputation or for technological gains. Technological improvements, according to Gray, can stimulate arms racing for fear that better technology abroad will make a state’s current technological capacity obsolete. Though it might seem out of place given the previous list of motivations, prestige and reputation can also be a significant motivator to invest in arms. A race for reputation is certainly applicable to the early space race where the launch of Sputnik 1 created a public relations nightmare for the United States. Gabriel Almond, in analyzing the effect the Soviet launch had on global public opinion in 1960, found that America’s reputation was significantly damaged and the “belief in the scientific and technological superiority of the United States rudely shaken.”14 Most, if not all, space historians acknowledge the role that prestige and reputation had in the creation and sustainment of the space race. Even today, the Chinese space program is predicated on the idea that its space successes bring them global credit, recognition, and respect thus sustaining the idea that space races are, at the very least, undergirded by the motivation of prestige.

One might argue at this point that the motivations of an arms race matter little if the end result is war or if they do not lead to conflict as some scholars have argued.15 To this, there are (at least) two answers: One, the underlying causes could lead to different types of races with different outcomes and two, the causes have much to do with possible outcomes. In the first instance, races carried out for prestige purposes or deterrence may not lead to war. In the second, if an arms race occurs in the context of enduring and preestablished rivalry, that pair of states could already be heading for conflict, regardless of an arms race. Charles Glaser argues that scholars must first consider why states undertake arms races and then determine whether it is rational for them to do so.16 If a state’s international security environment is so threatening that an arms race is a rational response, then the arms race did not cause any eventual conflict, the security environment did. If a state undertakes an arms race irrationally, that is in response to a non-threatening security environment, “they make war unnecessarily likely.”17

While more recent research suggests a modest increase in the chance of war as a result of an arms race, it is also clear that arms races are still not associated with most wars.18 Since the space race did not end in a space war, how arms races end is also of interest here. George M. Downs, David M. Rocke, and Randolph M. Siverson contend that

the majority of arms races that have ended in cooperation have done so not because one side adopted a particular cooperative strategy, but because the basic character of the race was altered by events that were not directly connected with it.19

These outside events can include larger changes in the balance of power, the unilateral behavior of another power, or changes in economic circumstances. The economic cost of an arms race can be a powerful limiting factor. Gray writes that when the economic costs of pursuing a military exploitable strategy are so high that they are prohibitive in cost, those arms races can become dampened or “nonself-aggravating.”20 Similarly, John C. Lambelet argues that unstable arms races can in fact be limited by economic capacity.21 The Soviet Union in the 1980s found that it simply did not have the economic ability to match American investment in space as a result of Reagan’s Space Defense Initiative (SDI) and so pursued more cooperative, diplomatic strategies.22

That economic limits can place a ceiling on arms races is important given the commercial imperative advanced in this book. The research cited in Chapter 2 focuses mostly on economic effects on conflict in general, but some studies have looked at the relationship between trade and arms races specifically. Rafael Reuveny and John Maxwell find that trade may not always dampen an arms race.23 Some states may choose to direct the profits of commercial trade towards investment in arms races; in that case, the competition is not resolved. Reuveny and Maxwell argue that the only means through which free trade can reduce or end arms races is if a state can be persuaded that it will receive greater utility from investing their profits in a non-military sector than using them to purchase more arms. On the other hand, Syed Mansoob Murshed and Dawood Mamoon find a conflictreducing effect of trade in their analysis of relations between India and Pakistan.24 Though their study focuses only on one pair of states, their findings are instructive. Bilateral trade has an effect of reducing military expenditures, but the more significant influence was each country’s degree of openness to the global economy.

In sum, states may engage in arms races for a number of reasons including defense, deterrence, prestige, and domestic factors. While arms racing can contribute some to the chances of open conflict, war is far from inevitable. The more likely result is for arms races to be ended by some outside factor that either solves the underlying political conflict or turns a country’s attention away from the dispute. Arms races can be stabilizing to a degree and in turn can be stabilized by technological and economic limits. Thus, arms races do not create inevitable spirals of action and reaction leading to war in general, and, specifically, in terms of space.

The Cold War space race

Many of the dynamics discussed previously are apparent in the Cold War space race, including a competition for prestige, an economic limit to the potential for competition, and pressure from internal factions to increase arms. Before Sputnik was even launched in 1957, there was an ongoing arms race between the two countries. While it was not yet totally focused on missiles and missile technology, the massive buildup in terms of nuclear weapons was already well underway. Though the number of Soviet nuclear weapons never approached the quantity of the United States, the US’s fleet of B-52 bombers, a proportion of which were always in the air, gave the US a strategic advantage in terms of their use.25 Given their startling disadvantages, the Soviets emphasized missile technology as a means of delivering a nuclear punch. The early development of rocketry and its relationship to missile technology is discussed elsewhere; for our purposes, the importance of the start of the Cold War space race is that it inaugurated a new, non-militarized arena in which the US and Soviet Union compete.26

Because of the close linkage of missiles with rockets, the space race is often considered either in tandem or implicitly with the missile race of the late 1950s. In the public’s mind, particularly at the time, the two issues were often conflated. The launch of Sputnik initiated something of a panic in many Americans, if not in their top political leadership. Despite concerns among citizens about the apparent gap in Soviet and American technology following Sputnik’s launch, they were reinforced by the lack of a response from the Eisenhower administration. Walter A. McDougall makes two points about Eisenhower’s rather muted reaction. First, Eisenhower and his administration possibly preferred that the Soviets launch a satellite first in order to establish the flyover right of satellites (though this has been doubted by other space historians). Second, most in the president’s leadership team knew that no missile gap existed; while this finding and the evidence for it could not be released to the public, Eisenhower believed the public outcry over Sputnik was unfounded.27

This supposed missile gap stoked fears among the American public and caused political leaders, particularly in Congress, to push for new initiatives. Eisenhower, fearing an enlargement of the budget, remained steadfast in his opposition not only to a missile gap but to significant increases in funding which he believed were unnecessary. The Soviet rocket that launched Sputnik was a technological revolution, but it was quite unsuited as an intercontinental ballistic missile (ICBM).28 The rocket, which was liquid fueled, required hours of preparation time before launch; in the event of a nuclear war, it would be near impossible to fuel the missile and launch it before any attack took place. Further, the administration had evidence via U-2 overflights that construction of launch pads, a prerequisite to an ICBM capability, had not fully started.29 However, critics of Eisenhower in Congress used the opportunity to push not just for more funds but also for additional missiles to close the supposed gap. The public pressure grew. “Although Eisenhower opposed the concept of racing in space,” Moltz writes, “officials in the administration could no longer deny that something needed to be done to address this crisis of credibility in regard to US space capability, particularly in the highly visible civilian area.”30 It was out of this debate in 1957–1958 that Eisenhower made the decision to split responsibility for space between a civilian agency, the new National Aeronautics and Space Administration (NASA), and the military.

Between 1958 and 1960, Eisenhower walked a middle ground, at once both trying to restrain the competitive urge brewing in the United States and appearing responsive to public and congressional concerns. Budgets for the Department of Defense rose, NASA was created, and the National Defense Education Act was passed providing funds for education in science, mathematics, and languages. Despite this, there was still a great deal of frustration with Eisenhower’s response. During the 1960 presidential campaign, candidate John F. Kennedy used fears of a missile gap to criticize the administration and Vice President Richard Nixon, Kennedy’s opponent. Nixon, knowing the missile gap did not, in fact, exist, attempted to downplay the threat and emphasize an American lead in technology. However, “With Kennedy’s victory, a cautious military-led program that had rejected racing was replaced by a daring, expensive, and highly competitive program with the unabashed goal of establishing the United States as the leading space power.”31 Further setbacks in regard to the Communist threat early in Kennedy’s administration (the failure of the Bay of Pigs invasion and Yuri Gagarin’s launch among them) pushed Kennedy to consider potential American responses that demonstrated resolve and ability to the rest of the world. The need to reestablish American prestige and respect contributed to Kennedy’s call in May 1961 for an American mission to the moon by the end of the decade.

The search for prestige and respect played a role from the beginning in establishing the purposes of the space race. In a National Security Council policy document released in August of 1958 and approved by Eisenhower, “the NSC judged that continued Soviet superiority in space might undermine US prestige and security.”32 By January of 1960, the administration fully recognized the psychological impacts of space achievements and their ability to influence American prestige. “Hence, US policy was to demonstrate an overall superiority in outer space, stress projects which offer the promise of obtaining a demonstrably effective advantage, and proceed with manned spaceflight ‘at the earliest practicable time.’”33

The space race continued into the 1960s on two different tracks, one that was civilian focused, premised on prestige and a second in terms of developing military capabilities in space. While the full implications of space were not yet clear by 1960, the United States got off to an early lead in developing passive systems for reconnaissance and communications. The Soviet Union attempted to protest such missions for fear of spying, but they soon developed similar capabilities and realized advantages in these areas as well. The growth of ICBMs and improvements in their technologies also caused both states to consider anti-ballistic missile systems (ABM) with launch sites on the ground and potentially in space. However, James Andrew Lewis argues that the development of these systems was incremental and fragmented, a pattern “indicative of early attitudes about the military utility of space.”34 To Lewis, this fragmentation demonstrates that military planners of the time saw space systems as tools and accessories and not a military capability. The scattershot approach to the military purposes of space soon began to interact with the civilian space race in ways that highlight the nature of the space environment and limit potentially destructive activity.

In the early 1960s, as both states began to engage in human spaceflight and conduct high altitude nuclear tests, participants began to notice the effects that radiation and electromagnetic pulses generated by the explosions were having on the space environment. Though there seemed to be a growing recognition that further weapons testing was harmful to both sides, the scientific and military momentum on each side propelled further development. In 1962, Kennedy pressed his advisors for limits on US nuclear testing. Failures in several American nuclear tests as well as their effect on satellites “caused the president to change his mind about nuclear testing in space” in the summer of 1962.35 As a result, Kennedy set new limits on nuclear testing in space, something which went against the desires of air force officials at the time.36 These concerns, coupled with the impact of the Cuban missile crisis, led both sides to reconsider hostile actions in space because of the possible danger to the space environment. Out of this, a period of “cooperative restraint” emerged that found both the Soviet Union and the United States engaging in renewed diplomatic efforts as well as rolling back potentially dangerous military applications of space including the Air Force’s sought after Manned Orbiting Laboratory (MOL). Cooperative restraint set the stage for increased cooperative relations between the two space programs, all culminating with the Apollo-Soyuz Test Project in 1975.

While this is a rough sketch of the events of the early space race, it is instructive in considering what pulled these two countries back from the brink. Clearly, both were interested in space for military purposes and plans were being made to exploit space-based advantages. However, as both sides realized their actions in terms of nuclear tests and debris were harming the space environment in ways that limited their freedom of operations, moves to weaponize space were curbed.37 Moltz calls this idea “environmental interdependence”—states interested in space are interdependent on the space environment (in this case for the purposes of national security) and must act accordingly. To this, I would add that the civilian side of the space race, the race to launch humans into orbit and eventually to the moon, reinforced the concept of environmental interdependence. Part of the reasoning behind Kennedy’s decision to limit high altitude nuclear tests was over concern about their impact on upcoming American spaceflights. In order to continue racing on the civilian track, it was necessary to curb competition on the military track to limit the dangers that astronauts and cosmonauts faced in near-earth orbit.

This notion is not at all inconsistent with the commercial space peace theory proposed in this book. During the early space race period, the economic impacts of space were not yet clear or exploitable, thus economic impacts could not serve to restrain conflict. What did put a damper on the danger of conflict was the recognition that weaponization of space would detrimentally affect other activities that states wished to undertake. By the early 1960s, EMPs set off by a nuclear test disabled several Soviet and American satellites and there was growing evidence that debris posed a dangerous problem in near-earth orbit. The logic of conflict avoidance was the same: the interdependence of states with the space environment constrained conflict. In the 1960s, it was on the basis of national security; today, in addition to national security concerns are economic concerns that involve far more states, commercial entities, and individual people than ever before.

Under the umbrella of cooperative restraint and the stability it encouraged, major states engaged in renewed diplomatic exchanges and economic development of space began. The United States created the Communications Satellite Corporation (COMSAT) in 1963 which led to the founding of the International Telecommunications Satellite Consortium (INTELSAT) to foster the development of communications satellites. By the early 1980s, the Reagan administration introduced new policy directives designed to support a private space industry in the United States.38 However, by that point, tension in space between the two powers was once again increasing. Lorenzini and Fox, discussed at the beginning of this chapter, leveled their warning of coming conflict in 1981. Richard L. Garwin, instrumental in the creation of the hydrogen bomb, also expressed concern of a new arms race in space in 1981, using the opportunity to push for new bilateral arms control agreements.39 Both of these warnings occurred before Ronald Reagan’s announcement of SDI in 1983 which represented a new push for the potential weaponization of space. SDI, with its proposed significant increases in research and development for a space-based ballistic missile shield, threatened the stability of space competition with the possible introduction of ABM launchers in outer space, contrary to the Anti-Ballistic Missile Treaty of 1972. Though the budget for the Department of Defense and space research and development increased, the plan faced stiff resistance among the public, Democratic majorities in Congress, and some in the DOD who recognized the dangers inherent with SDI. Congress in particular was concerned not just with the large price tag but with the potential for violating the ABM Treaty and the technical feasibility of the program.40 Added to that, new ASAT development and testing occurring outside of the SDI at this time revived concern about the possibility of troublesome debris in earth orbit.

The Soviets responded to these developments by calling for greater arms control negotiations, particularly given major setbacks in their civilian spaceflight program and the inadequacies of their military space programs.41 Soviet leadership changes also greatly affected Soviet responses. Mikhail Gorbachev, having come to power in the mid-1980s, not only “moved to break the stranglehold of the military on the space program” so that the US would be assured of their non-aggressive motives in space but also sought to use space technology commercially on the global market.42 Soviet ambitions economically would be greatly harmed by conflict stimulated on the part of SDI. Thus, by the mid-1980s, a less hostile position on the part of Reagan following his reelection and Soviet efforts at transparency and openness in terms of space cooled the fever of increased competition.

Like the 1960s, recognitions of interdependence also served to restrain possible conflict in space in the 1980s. Interestingly, in addition to concerns about the possibility for debris in earth orbit, the Soviets now added an economic motive to curbing competition. This demonstrates not just a “relearning” process as Moltz argues but the incorporation of new bases for decisions as the economic importance of space began to increase. Ironically, the economic concern came on the part of the Soviet Union, a communist state with a heretofore state-controlled economy. This is important not only because it demonstrates that space-based economic concerns can influence and even constrain state actions in space but also that states organized along similar lines to the Soviet Union can be affected by economic motivations. Though China’s economy today is not as controlled as it once was, the state is still heavily involved, particularly in space. That there is historical evidence of economic concerns influencing the actions the Soviet Union in space speaks to the fact that China could be just as easily impacted today especially since economic dependence on space and economic globalization has increased dramatically since the 1980s.

The Cold War, as we know today, did not lead to the inevitable conflict predicted by analysts throughout the period. The more general arms race between the Soviet Union and the US was, to an extent, stabilizing. The race for prestige in space presented a contest that could be pursued through less militarized means, thereby providing an outlet for competitive tendencies.43 Internally, bureaucratic agencies pushed for new investments in space technology, but cost concerns often limited them as was the case in both the US and Soviet Union in the 1980s. And finally, as the economic dimension of space came to be understood, an additional constraint was introduced into the calculations of the two superpowers.

A new space race? Lessons in a period increased tensions

Today, we find ourselves in a situation where tensions in space are once again increasing. India’s ASAT test in March of 2019, China’s increased military activities with regards to space, and calls for the United States to create a new Space Force are just some of the indicators of growing risk. The withdrawal of the United States from the ABM Treaty by George W. Bush in 2001 opened the doors to development of ABM systems that could be partially (or even fully) located in outer space. While the US has encountered significant difficulties in developing even ground-based systems, the fact that the US moved to develop them was seen as threatening particularly by an emerging China. As reported by Moltz, in 2005, China’s ambassador to the UN Conference on Disarmament “argued that spacebased defenses would ‘undermine international security,’ damage the current arms control environment, and trigger a ‘new arms race.’”44 Despite their public statements of concern, China’s ASAT test in 2007 also upped the ante. A pull back from more aggressive actions in space with the Barack Obama administration was ended as the inauguration of Donald Trump as president has brought with it an increased focus on strong defense capabilities and protection of US capabilities in space, consistent with the idea of space nationalism.

This situation has led some to believe there is a new space race. When announcing new American plans to return to the moon by 2024, Vice President Mike Pence stated, “Make no mistake about it—we’re in a space race today, just as we were in the 1960s, and the stakes are even higher.”45 Citing the successful Chinese landing of its Chang’e-4 lunar probe on the far side of the moon in January 2019, the vice president argued that it “revealed [China’s] ambition to seize the lunar strategic high ground and become the world’s pre-eminent spacefaring nation.”46 While Pence argues there is an ongoing race, neither Russia nor China seem to be engaging in it, at least from a civilian spaceflight perspective. China has continued on a slow, steady pace in their program with no apparent moves to speed up the process. Russia’s space program is experiencing severe economic restraints that has led them to actively consider working with the Chinese on their upcoming space station project.47 Pence’s invocation of a global competition based on an obvious military rationale (seizing the lunar high ground) is reminiscent of the original space race motivations of reclaiming prestige based on a seemingly strategic goal. In terms of civilian spaceflight, at least, the hoped-for competition that might spur greater support for crewed missions to the moon does not appear to be emerging.

There is perhaps more evidence to support an increasing military space race focused not just on passive space systems but weapons as well. Vice President Pence, who has been at the forefront of space issues for the Trump administration, wrote in an op-ed for The Washington Post in February 2019 that “China and Russia are aggressively developing and deploying capabilities—including anti-satellite weapons, airborne lasers, menacing ‘on-orbit’ capabilities and evasive hypersonic missiles—that have transformed space into a warfighting domain.”48 Russia, for its part, conducted a test of a new anti-satellite weapon in late 2018 and a new space-based interceptor designed for use by 2022 and launched from a Russian MiG-31was photographed as well.49 More generally, a declassified US government report, “Competing in Space,” from the National Air and Space Intelligence Center claims that “[a] number of foreign countries are believed to be testing on-orbit, space-based anti-satellite technologies and concepts” and that because of reduced costs, more actors will seek to integrate military capabilities with space-based systems in the coming years.50 Thus, while there does not appear to be any pressure to quicken the pace of civilian spaceflight, there is increasing interest in space for both militarized and weaponized purposes.

The tension in space suggests that space leaders have once again “unlearned” the lessons of the 1960s and 1980s. Despite some similarities to those periods in terms of the space environment, the differences are quite significant and serve to heighten the importance of avoiding conflict. For one, debris concerns, present since the 1960s, are exponentially greater today. The US Joint Space Operations Center currently tracks more than 23,000 larger than 4 inches but there is an estimated 500,000 pieces of debris between 0.4 and 4 inches that are not actively tracked.51 The problem is only getting worse. US Air Force General John Hyten, testifying before Congress shortly after the Indian ASAT test, reiterated his concerns about debris that he believes will endanger future missions and the use of space.52 Combined with the increasing number of actors, both government and private, involved in space, and the significant economic and military reliance on space, the stakes have never been higher.

Given this, past lessons can help contribute to new learning about these risks in order to mitigate them. In the 1960s, the US and Soviet governments had to learn for the first time about these dangers by experiencing early consequences. In the 1980s, changes in leadership and attitude toward the Soviets pushed a more aggressive stance which was restrained by an institutionalized memory regarding the necessity of debris avoidance as well as an institutional dedication to the norms and agreements. In the Soviet Union, new recognition of the economic potential of space technology taught a new generation of leaders that to foster their own economic goals, they had to restrict behavior in the military realm. Today, leaders who are themselves reflective of more nationalistic feelings in their own countries are once again pushing the boundaries. There is evidence, however, that institutional memory is still present. In the US, military leaders continue to express concern about the problems of space junk which is often reflected by Chinese leaders as well. Commercial actors with profits at stake also clearly understand the risk posed by debris. In the past, it took significant incidents in space to reinforce the lessons: in the 1960s, EMPs had to disrupt Soviet and American satellites. In the 1980s, the Soviets experienced significant setbacks in their civilian and military space programs including the destruction of a nuclear-powered satellite over the Atlantic Ocean.53 One argument might be, then, that it will take some sort of dramatic incident for leaders in space states to pay attention to these concerns as this is often the case for public policy problems in general. In this instance, there is little evidence to support it. The Chinese ASAT test in 2007, the collision of an inactive Russian communication satellite and an active US-based communications satellite in 2009, and the more recent 2019 Indian ASAT test, all dramatically increased the amount of debris in near-earth orbit and yet the hostile rhetoric in space has continued.

Another reason for conflict avoidance particularly in the 1960s was that it posed a risk to the civilian space race which was a political priority for both the USSR and US. With the renewed push in civilian space exploration by both the United States and China today, this could be one way to siphon off more aggressive instincts in space. Other countries and private corporations are also planning for human spaceflight: India has plans to send its first crewed spacecraft into orbit by 2022 while Virgin Galactic could be sending paid passengers on suborbital trips in the very near future. As more people seek to explore space for themselves, the imperative to protect life in an environment that is already incredible hostile to it can once again reassert itself to restrain conflictual behavior. Though this is possible, there are still significant hurdles for both private companies and government organizations to overcome in their human spaceflight plans including funding and successful demonstrations of their technology and capabilities.

Finally, diplomatic efforts engaged in by the two Cold War superpowers in the mid- to late-1960s helped to cement the cool off in space and institutionalize norms of behavior. Diplomatic engagement could also provide a solution today, but given American actions over the past 20 years, formal diplomatic efforts are likely to face significant hurdles if not outright failure. The Bush administration’s withdrawal from the ABM Treaty in 2001 removed one of the significant restraints on the development of weapons in space, opening the doors not just to research and development on the part of the US but for Russia as well. While the Obama administration was more open to diplomatic efforts, the political conditions at home were not suitable; in order for the United States to formally join a treaty, it must be approved by the US Senate. With an almost even split between Democrats and Republicans, the administration would likely have found a difficult bargaining environment as it did with the Trans-Pacific Partnership and Paris Climate Accords, agreements that were deeply unpopular with the Congress in general. The Trump administration has been even more openly hostile to international agreements, withdrawing the US from both the TPP and Paris Agreement upon taking office. More recently, Trump also withdrew the US from the Arms Trade Treaty, initially signed by Barack Obama in 2013 but never ratified by the Senate. In doing so, he stated, “Under my Administration, we will never surrender American sovereignty to anyone.”54 Although the treaty was unlikely to be approved by the Senate (reinforcing the idea that diplomatic negotiations likely had little chance under Obama anyway), the statement reflects the more nationalistic tone of the Trump administration.

Learning and relearning the dangers of conflict, redirection of attention to civilian spaceflight, and diplomacy have all helped in the past to reduce the chances of conflict in periods where some saw war as just about inevitable. In fact, these solutions might be more applicable today than previously particularly as the threat of debris grows and more actors require greater international coordination. Kai-Uwe Schrogl, head of the Strategy Development Department for the European Space Agency, wrote in a reflection on the OST that maintaining the “situational structure [of space] is probably more influential than any attempt to prevent an arms race in outer space by negotiating a treaty.”55 But just because they are more applicable does not mean they are more likely. In each instance, there is clear evidence that in the recent past, the danger of debris, a political commitment to human spaceflight, and diplomatic efforts have all failed at reducing the threat of conflict in space. If the tensions cannot be stopped, the chances of a renewed arms race in space, particularly in terms of military space between the major powers, are even more real.56

If this is the case, we can consider for a moment the policy prescription that analysts like Lorenzini and Fox and Dolman have proposed. If weaponization of space is inevitable, then the US should make reasonable preparations to be the one to do so and exert control over the space environment. Dolman writes,

To be sure, China’s increasing space emphasis and its cultural antipathy to military transparency suggest a serious attempt at seizing control of space is in the works. A lingering fear is the sudden introduction of an unknown capability (call it Technology X) that would allow a hostile state to place multiple weapons into orbit quickly and cheaply. The advantages gained from controlling the high ground of space would accrue to it as surely as to any other state, while the concomitant loss of military power from the denial of space to America’s already space-dependent military forces could usher in a significant reordering of the international system. The longer the United States dithers on its military responsibilities, the more likely a potential opponent could seize low-Earth orbit before it is able to respond.57

Though Dolman acknowledges that such moves are likely to result in “severe condemnation and increased competition in peripheral areas,” he does not believe it heralds an arms race.58 On the contrary, it can actually prevent one by allowing the US to focus on space weapons systems that would replace ground-based systems and troops stationed around the world. By reducing ground armaments and relying on space-based instruments of power, other states would seemingly feel less threatened by US moves.

Matthew Burris responds directly to Dolman’s argument and more generally to the arguments pursued by space nationalists.59 He argues that conflict with China is not inevitable especially because of the global environment we now find ourselves in that employs a variety of cooperative organizations like the UN, recognizes international norms and laws, and finds itself deeply intertwined economically. While a Thucydides’ trap might have been hard to avoid in the past, the context in which a power is rising has significantly changed so that it may be avoidable today. Further, Burris argues that other states will not let US development of means of control in space go unanswered: “Are we to assume,” he asks, “they are patiently awaiting the completion of an ‘unstoppable’ constellation of space weapons?”60 Burris concludes that utilizing Dolman’s own “power politics thesis,” he is precipitating the very arms race he seeks to avoid by encouraging US domination in space.61 He points out that US reliance on space weapons over ground-based weapons would be its Achilles’ heel. “A space hegemony strategy, pursued at the expense of combined arms, would represent a potential single point of failure for the national security of the United States.”62

The logic of space hegemony or space nationalism in order to avoid conflict or even an arms race is not, on the whole, persuasive. This is not to say that a new space race is avoidable or unavoidable, simply that the solution of US domination of space (or really, domination of space by any state) is not feasible nor is it strategically sound. We are left in a situation, then, of increasing space tensions where responses on both ends of the spectrum, complete internationalization of space control and complete state domination, are unlikely to occur. Past solutions also seem unlikely at this point, but there are additional actions that might help introduce a new détente. Downs, Rocke, and Siverson, in their analysis of arms races, discuss four types of unilateral strategies that can reduce the intensity of arms races.63 First, states can focus on defensive rather than offensive weapons technology. Though they find little historical evidence of such actions actually reducing the heat in an arms race, in terms of space, this strategy might be helpful. John Klein has noted that far more attention has been paid to offensive space weapons as opposed to defensive despite the argument that defensive weapons may be stronger and more important.64 ASATs are, by their very nature, offensive in nature. The recent focus on them by states including the US, Russia, China, and India can only heighten tension.

A second strategy is defensive alliances, however, this, like defensive weapons, finds little support in Downs, Rocke, and Siverson’s analysis. Countries could try to extend their current alliances, for example, the North Atlantic Treaty Organization (NATO), into the space realm.65 For instance, if a member of NATO had a satellite destroyed by a non-member, it is unclear whether article 5, the collective security clause, could be invoked precisely because the rules of war in space are unclear. For example, an ASAT that destroys a NATO-member’s satellite might be considered an act of war because the OST prohibits “non-peaceful” activities in space. The US has interpreted “non-peaceful” to mean “non-aggressive”; an attack by a kinetic ASAT would certainly be considered non-peaceful and quite aggressive. However, if a state’s satellite were disabled by a laser or some other close means, would that be considered an attack? The attacking country could claim that they disabled the satellite out of a defensive purpose and argue their action was therefore “peaceful” since defensive operations are allowed under international law. The lack of clarity on an issue such as this would likely prevent NATO, or any defensive alliance, from agreeing on whether to invoke the premise of collective security unless space was specifically protected under the alliance agreement. On the other hand, defensive alliances could create a cascade of war as they did with World War I, making their extensive use unlikely.

Downs, Rocke, and Siverson’s third unilateral strategy is the creation of buffer states but that is not applicable to a region such as space. However, the fourth unilateral strategy is that of “acquisition and surrender of intelligence information.”66 States may be motivated to reveal information and preferences so as to convince others of their intentions and purposes of action. However, such information and cooperation can come about in other ways as well. During the Cold War space race, collaborative efforts between the Soviet Union and the US helped not only to smooth tension between the two but cooperation also gave them a chance to exchange information. Granted, the information exchanged was often not very technical or militarized in nature; it usually consisted of scientific exchanges or, at times, cooperative spaceflight efforts. Regardless, lower level technical and scientific cooperation and exchange can be important. Steven J. Majeski argues that in arms races in general, cooperation can slow the ramping up effects of technological innovation.67 In terms of space specifically, a number of analysts have argued that cooperation with China today can reduce hostile competition and mitigate dangerous outcomes.68 Cooperation, even beginning at a low level, can be an important step to building trust and paving the way for further work in the future.

The logic of cooperation is powerful and beneficial. Cooperation becomes even more important as the number of actors grows, the common resource (in this case, space) dwindles, and the environmental and economic interdependence of space grows. While cooperation between the US and China, the US and Russia, or even Russia and China can contribute to reduced tension militarily, in order to truly secure the space environment for all interested parties, all space users must be prepared to cooperate. As the number of users grows, the potential for free riders, those who take advantage of the actions of others, grows as well. Tension in space is no longer predicated along bilateral lines, it is now globalized, requiring cooperation from all to achieve a common good. In this sense, the solutions of the past may simply not be applicable to today’s space operating environment.

What is applicable and what is of concern to most, if not all, space users are the economics of space. Whether a state or private actor, access to space and space systems costs money; the easier it is to access space and operate there, the lower the costs will be. Even for state governments, the costs of a system are a limitation. Congress was concerned by the cost of Reagan’s SDI in the 1980s. China placed an emphasis on the commercial aspects of their launch technology before they started their current human spaceflight program. The Soviet Union, now Russia, has been perpetually beset by economic concerns in their spaceflight programs and industry. Thus, one thing that all space actors have in common, regardless of their intentions or whether they are public, private, commercial, or scientific, is a concern with cost. Those actions which increase the costs of space hurt everyone and must be restrained.

The costs of space are on top of the costs to global economy if space-systems and/or access to space were interrupted. Given the one-two economic punch a state would receive if conflict were to occur in space, they have all the more reason to take actions that do not contribute to such a scenario to create a more secure space environment. Short of international negotiations to create a space code of conduct or more formal international agreements, the least states can and should do is make prudent policy choices that do not inflame tensions or create scenarios where conflict is likely to occur.

This chapter has argued that even during the original space race, the US and Soviet Union recognized the impact that each other’s actions could have on freedom of movement in space. That interdependence has evolved over time to include more and more extensive dimensions of interdependence, more states, more actors, and more problems. While the means of dissolving space-based tension that were used in the space race remain real and palpable today, the current space environment has created a condition where economic concerns can play a far larger role in constraining conflict. While much of this chapter has focused on state actors like the US, Russia, China, and India, commercial and private actors are playing an increasingly important role in space. Not only are they developing means of launching space systems, but some even plan on extensive solar system exploration. Because of this, they are likely to be concerned about the economic costs of space, but they are also in a position to influence government actions on this front as well. The next chapter discusses these “new space” actors, their motivations, and their capability, and willingness, for action.

#### 3. No appropriation key warrant- it’s about collaboration- how does that have anything to do with private entities appropriating outer space? The plan doesn’t end private entities in space, it just stops them from appropriating it

#### 4. The CSIS card is terrible-

#### (A) There’s a million alt causes to successful coop like Ukraine, NATO expansion, election interference, Black Sea disputes, SolarWinds hacking, new Putin-Xi summit, and sanctions. Private space cooperation is a drop in the bucket. All of them prove the aff is woefully insufficient to solve US-Russia relations

#### (B) It has no warrants- it’s quoting Jim Bridenstine, doesn’t say cooperation spills-over, doesn’t say anything about appropriation, doesn’t say it’s reverse causal, and it’s from 2018 so clearly all the alt causes thump

#### 5. No ‘space war’ – Insurmountable barriers and everyone has an interest in keeping space peaceful

**Dobos 19**

[(Bohumil Doboš, scholar at the Institute of Political Studies, Faculty of Social Sciences, Charles University in Prague, Czech Republic, and a coordinator of the Geopolitical Studies Research Centre) “Geopolitics of the Outer Space, Chapter 3: Outer Space as a Military-Diplomatic Field,” Pgs. 48-49] TDI

Despite the theorized potential for the achievement of the terrestrial dominance throughout the utilization of the ultimate high ground and the ease of destruction of space-based assets by the potential space weaponry, the utilization of space weapons is with current technology and no effective means to protect them far from fulfilling this potential (Steinberg 2012, p. 255). In current global international political and technological setting, the utility of space weapons is very limited, even if we accept that the ultimate high ground presents the potential to get a decisive tangible military advantage (which is unclear). This stands among the reasons for the lack of their utilization so far. Last but not the least, it must be pointed out that the states also develop passive defense systems designed to protect the satellites on orbit or critical capabilities they provide. These further decrease the utility of space weapons. These systems include larger maneuvering capacities, launching of decoys, preparation of spare satellites that are ready for launch in case of ASAT attack on its twin on orbit, or attempts to decrease the visibility of satellites using paint or materials less visible from radars (Moltz 2014, p. 31). Finally, we must look at the main obstacles of connection of the outer space and warfare. The first set of barriers is comprised of **physical obstructions**. As has been presented in the previous chapter, the outer space is very challenging domain to operate in. Environmental factors still present the largest threat to any space military capabilities if compared to any man-made threats (Rendleman 2013, p. 79). A following issue that hinders military operations in the outer space is the predictability of orbital movement. If the reconnaissance satellite's orbit is known, the terrestrial actor might attempt to hide some critical capabilities-an option that is countered by new surveillance techniques (spectrometers, etc.) (Norris 2010, p. 196)-but the hide-and-seek game is on. This same principle is, however, in place for any other space asset-any nation with basic tracking capabilities may quickly detect whether the military asset or weapon is located above its territory or on the other side of the planet and thus mitigate the possible strategic impact of space weapons not aiming at mass destruction. Another possibility is to attempt to destroy the weapon in orbit. Given the level of development for the ASAT technology, it seems that they will prevail over any possible weapon system for the time to come. Next issue, directly connected to the first one, is the utilization of weak physical protection of space objects that need to be as light as possible to reach the orbit and to be able to withstand harsh conditions of the domain. This means that their protection against ASAT weapons is very limited, and, whereas some avoidance techniques are being discussed, they are of limited use in case of ASAT attack. We can thus add to the issue of predictability also the issue of easy destructibility of space weapons and other military hardware (Dolman 2005, p. 40; Anantatmula 2013, p. 137; Steinberg 2012, p. 255). Even if the high ground was effectively achieved and other nations could not attack the space assets directly, there is still a need for communication with those assets from Earth. There are also ground facilities that support and control such weapons located on the surface. Electromagnetic communication with satellites might be jammed or hacked and the ground facilities infiltrated or destroyed thus rendering the possible space weapons useless (Klein 2006, p. 105; Rendleman 2013, p. 81). This issue might be overcome by the establishment of a base controlling these assets outside the Earth-on Moon or lunar orbit, at lunar L-points, etc.-but this perspective remains, for now, unrealistic. Furthermore, **no contemporary actor will risk full space weaponization in the face of possible competition and the possibility of rendering the outer space useless.** No actor is dominant enough to prevent others to challenge any possible attempts to dominate the domain by military means. To quote 2016 Stratfor analysis, "(a) war in space would be devastating to all, and preventing it, rather than finding ways to fight it, will likely remain the goal" (Larnrani 20 16). This stands true unless some space actor finds a utility in disrupting the arena for others.

#### 6. Strong US/Russian relations are impossible---their fundamentally strategy is irreconcilable with the U.S. and no policy change can alter that

Thomas Graham 19, Managing Director at Kissinger Associates, Senior Russia Expert on the National Security Council Staff During the George W. Bush Administration, “Let Russia Be Russia: The Case for a More Pragmatic Approach to Moscow”, Foreign Affairs, November-December 2019, https://www.foreignaffairs.com/articles/russia-fsu/2019-10-15/let-russia-be-russia

Since the end of the Cold War, every U.S. president has come into office promising to build better relations with Russia—and each one has watched that vision evaporate. The first three—Bill Clinton, George W. Bush, and Barack Obama—set out to integrate Russia into the Euro-Atlantic community and make it a partner in building a global liberal order. Each left office with relations in worse shape than he found them, and with Russia growing ever more distant.

President Donald Trump pledged to establish a close partnership with Vladimir Putin. Yet his administration has only toughened the more confrontational approach that the Obama administration adopted after Russia’s aggression against Ukraine in 2014. Russia remains entrenched in Ukraine, is opposing the United States in Europe and the Middle East with increasing brazenness, and continues to interfere in U.S. elections. As relations have soured, the risk of a military conflict has grown.

U.S. policy across four administrations has failed because, whether conciliatory or confrontational, it has rested on a persistent illusion: that the right U.S. strategy could fundamentally change Russia’s sense of its own interests and basic worldview. It was misguided to ground U.S. policy in the assumption that Russia would join the community of liberal democratic nations, but it was also misguided to imagine that a more aggressive approach could compel Russia to abandon its vital interests.

A better approach must start from the recognition that relations between Washington and Moscow have been fundamentally competitive from the moment the United States emerged as a global power at the end of the nineteenth century, and they remain so today. The two countries espouse profoundly different concepts of world order. They pursue opposing goals in regional conflicts such as those in Syria and Ukraine. The republican, democratic tradition of the United States stands in stark contrast to Russia’s long history of autocratic rule. In both practical and ideological terms, a close partnership between the two states is unsustainable.

#### 7. Solving one issue doesn’t spillover to broader Russia relations

Beebe 19 [George Beebe is a former chief of CIA’s Russia analysis who served on Vice President Cheney’s staff from 2002-2004. How Trump Can Avoid War with Russia. August 12, 2019. https://nationalinterest.org/feature/how-trump-can-avoid-war-russia-73031]

Broaden our focus. One common cause of failure in dealing with a wicked problem is to treat it as if it were a narrow linear problem, rooted in a single or primary cause that can be resolved through a focused and determined effort. The United States has repeatedly crashed into this shoal in its attempts to deal with Russia since the Cold War’s end. We have habitually sought to compartmentalize issues, preferring to focus on disputes that are salient to U.S. domestic politics and on selective opportunities that we hope will advance American goals. We have tended to look for primary causes of bilateral maladies, recently attributing the growing dangers in the U.S.-Russian relationship to the nature of Putinism and Russia’s endemic expansionism, believing resolute counter-pressure will quell Russian appetites for aggression. We have attempted to seek progress through incremental steps, in the hope that making headway on such issues as counter-terrorism can build momentum toward larger U.S.-Russian success.

This incremental and compartmentalized approach makes abundant sense intuitively. Why complicate things, when one can break the problem down into its component parts and focus on what is most salient or easily achievable? It is also driven by the bureaucratic silo effect, which encourages narrow specialization while discouraging cross-organizational integration. But it has not worked in practice. Despite our best efforts, the U.S.-Russian relationship has spiraled ever deeper into dysfunction and distrust from administration to administration since the end of the Cold War. As planning expert Russell Ackoff has observed about “messes,” his term for wicked problems, “if we do the usual thing and break up a mess into its component problems and then try to solve each one separately, we will not solve the mess.’’