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Analyzing the Arguments and Opinions Surrounding Space Privatization

By

Henry Yaeger

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of
Science in Science, Technology and Public Policy

Department of Public Policy

College of Liberal Arts

Rochester Institute of Technology

Rochester, NY

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**Analyzing the Arguments and Options
Surrounding Space Privatization**

*A thesis proposal submitted to the
Public Policy Program at Rochester
Institute of Technology in partial
fulfillment of 0521-703*

By Henry Yaeger

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Abstract

As space exploration technology advances and more private actors engage in independent space activities, national governments and international organizations need to reform and modernize their approach to regulating private space activities in order to better capture and distribute the benefits of those activities. This paper examines several disparate suggestions and ideas found in 38 articles ranging from current space policy literature to international treaties in order to generate four possible policy approaches to private space activities: the Status Quo, Self-Regulation, New International Treaties and Expanded Public-Private Partnership models. It then compares and contrasts these four alternatives to determine which can co-exist, which are mutually exclusive and offer a policy recommendation for resolving the current deadlock in international space policy. Ultimately, governments need to work in close partnerships with their national private space sectors to better regulate those sectors on a nation-by-nation basis now, while new space treaties and policies are created to better deal with the emerging future of private space activities.

1. Introduction

In late 2003, Gregory Nemitz sued the United States for billions of dollars after a NASA spacecraft landed on Eros, an asteroid that Nemitz argued was legally his private property (Kelly, 2004). In the lawsuit, Nemitz claimed that he had a ‘natural right’ to the asteroid because of the Fifth, Ninth and Tenth Amendments of the U.S. Constitution not giving the federal government the power to regulate the ownership of celestial property, and that the failure of the government to recognize his ownership of Eros would have a “chilling effect on future space commerce and the development of space resources” (Kelly, 2004, p. 303). On the other hand, the government claimed that Nemitz had no legal standing for claiming Eros as his property, and as such wanted the lawsuit dismissed (Kelly, 2004). At the heart of this case are two very important questions about how primarily Earth based laws can – or should – be applied to outer space; can private entities claim celestial bodies as their property, and how should national and international law treat private space activities, I.E., the exploration and exploitation of outer space by private entities without constant public approval, direction, contracts or oversight.

These two questions have only become more prominent since 2003, as more and more private sector attitudes and entities are entering into the realm of space exploration in unprecedented ways thanks to the U.S. SPACE Act of 2015. Due to its controversial interpretation of previous international law, the SPACE Act has raised awareness of, and debate about, these policy questions – especially the question of what activities private entities should legally be allowed to do under the current international space policy regime (Johnston, 2003; Nie, 2020; Mahjoom et al., 2019 and Tronchetti, 2015). However, this debate is usually very focused on interpreting the Outer Space Treaty and determining if the outcome of space privatization and the SPACE Act fit within its policy regime. This has resulted in many

policymakers neglecting to consider alternative policy options and ideas that are available to address space exploration and exploitation in the 21st century. In order to find the best answer to the questions surrounding future space activities, policy and decision makers ought to have an understanding of the various space privatization policy options available to them, how these policies interact with each other and what outcomes each option would bring about. As such, this thesis will define and review the major space privatization policy alternatives from the academic literature and the history of industry privatization, investigate how these alternatives could potentially work together and examine the benefits and detriments of several combinations of alternatives in order to conduct a comparative policy analysis on space privatization schemes.

2. Background

2.1 The National Aeronautics and Space Act of 1958

First of all, given the history of government interference in space activities, the role of private entities in the future of space flight must be addressed by public policy. From its inception in the middle of the 20th century to 2015, American space policy and space activities have been dominated by the National Aeronautics and Space Act of 1958 and the Outer Space Treaty (OST) of 1967. Both of these policies place strict limits on the ability of private actors to engage in space activities and contributed to the policy questions we are confronted with in the modern day. The National Aeronautics and Space Act of 1958 was created by Congress as a reaction to the launch of the first several Sputnik satellites by the Soviet Union in 1957 (Maltby, 1959). These launches by America's Cold War rival magnified pre-existing anxiety about America being outpaced in the development of new science and technology, especially since later satellites were put into orbits above the strike range of contemporary American carrier missiles (Maltby, 1959). Rockets, such as the ones that put the Sputnik satellites into orbit, are nothing more than long-range missiles, and American policymakers were worried that the Soviet Union could put weapons – especially nuclear weapons – on a 'rocket' and launch an unstoppable attack against the United States.

The National Aeronautics and Space Act of 1958 was created in order to address these anxieties, as it authorized the federal government to create a civilian space agency to lead and coordinate aerospace R&D and gave that agency – which we know today as the National Aeronautics and Space Administration (NASA) – what was effectively a monopoly over American space exploration activities, technology and patents (Maltby, 1959). This policy regime did allow some private entities to participate in space related activities, but that participation was tightly controlled by NASA through the various planning and patent provisions

of the act. For example, sec. 305 subsections (c) and (d) of the act prohibited the patent office from issuing private entities patents “for any invention which appears to the Commissioner of Patents to have significant utility in the conduct of aeronautical and space activities” without extensive extra paperwork that would inform NASA of the invention and give the government the option to patent the invention for itself (National Aeronautics and Space Act, 1958).

Furthermore, as per sec. 305 subsection (a), private entities with NASA contracts were not even given the option to attempt to patent any invention related to the contract – as all such work was automatically the “exclusive property of the United States” unless NASA’s Administrator waived this claim (National Aeronautics and Space Act, 1958). Given these two provisions, and NASA’s mandate to “plan, direct, and conduct aeronautical and space activities” with the cooperation of “other public and private agencies,” it was risky for private actors to conduct their own space activities or space R&D when the “government may assert exclusive ownership to all inventions... regardless of the extent of privately financed contributions” (National Aeronautics and Space Act, 1958, Sec. 203 clauses (1) and (6) and Maltby, 1959, p. 49).

2.2 The Outer Space Treaty of 1967

After almost a decade of continued space race tension between the U.S. and the U.S.S.R., the OST was signed in an attempt to facilitate peaceful international cooperation in outer space, which only further reduced the ability of private entities to engage in their own space activities. One of the main principles underlying the OST was the idea that outer space should be free to be explored and used by all. As such, Articles I and II of the treaty established a *res communis* policy regime in outer space by prohibiting signatory nations from claiming or exercising exclusive rights over outer space and the celestial bodies that inhabit it (Blount and Robison, 2016). The *res communis* status of outer space means that it is “the territory of no nation,” and is subject to international agreements similar to those that govern the use of Antarctica and the

deep seabed (Heim, 1990, p. 820). While this seems like it would promote the use of outer space and encourage space activities, there is a lot of ambiguity in the OST. This ambiguity creates room for interpretation when reading Articles I and II, and the most prevalent interpretation of those Articles is that no nation has the legal power to grant or protect property rights over celestial bodies – as that would involve that nation claiming exclusive rights over the celestial body in question (Blount and Robison, 2016 and Kelly, 2004). Without a nation to guarantee property rights, and therefore profitability, many commentators argue that private entities have no incentive to conduct their own space activities (Blount and Robison, 2016 and Kelly, 2004).

While these laws prevented private companies from conducting their own space activities, it did not prevent them from working in the aerospace industry or from working on space technology with NASA. In fact, NASA has contracted with the private sector for most of its hardware since its founding (Levine, 1982). Historically, NASA strived to keep its private partners at an arm's length via a negotiated contract system to prevent either side from becoming dependent on or responsible for the other (Levine, 1982). Additionally, NASA made all of the decisions on what kind of work was to be done, the end goal of the work, the cost and time constraints and so on (Levine, 1982). These policies resulted in NASA acting more like a buyer of space related goods and patents than a true partner to any aspect of the private aerospace industry, and it also severely limited the ability of the private aerospace companies to influence NASA's decision-making process or space activities. However, these policies have changed in recent years, moving away from the very vertically oriented buyer-seller relationship to more of a horizontal partnership or patronage relationship – especially with the introduction of more elements of public-private partnerships into the space economy, a topic that will be discussed in detail in the results section (Mazzucato and Robinson, 2018).

2.3 Exceptions to the Status Quo and The SPACE Act of 2015

Some exceptions were made to the anti-commercial space status quo that emerged from prevalent interpretations of the OST during the last quarter of the 20th century. For example, with the introduction of the space shuttle in the early 1980s NASA found that it could not meet all of the scientific and commercial demand for satellite launches on its own, which prompted President Regan to authorize the Department of Transportation to encourage, facilitate and license “commercial expendable launch vehicles” that could meet this market need and give the American aerospace industry more freedom to pursue independent space activities related to satellites (Congressional Research Service, 2018). However, despite exceptions such as this and the prevalence of government contracts available to them, many private actors found the remaining limitations imposed by the NASA Act, the OST and their most prominent interpretations harmful, and as the advancement of space exploration technology left Cold War era space policy behind even the federal government recognized that greater privatization of space activities could be beneficial to America (Dodge, 2016 and Hao and Tronchetti, 2019). In order to remedy this situation, and at the insistence of private entities such as SpaceX, the U.S. passed the Commercial Space Launch Competitiveness Act of 2015, which is also known as the SPACE Act (Hao and Tronchetti, 2019). The SPACE Act updated U.S. law to reflect the reality that public-private partnerships dominate modern American space activities, while also making bureaucratic and legal changes to cultivate the possible benefits of fully privatized space activities – most notably by promoting the “right of United States citizens to engage in commercial exploration for and commercial recovery of space resources” and granting citizens the right to “possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law” (SPACE Act, 2015, Sec. 51302 subsection (a) clause (3) and Sec. 51303, Blount and Robison, 2016 and Dodge, 2016). While technically

compliant with the language of the OST, the SPACE Act presents a radical and near unilateral new interpretation of the *res communis* policy regime in outer space and has prompted several other nations to debate similar policy changes (Krolikowski and Elvis, 2019). However, it has not brought about an international debate over the global benefits and detriments of space privatization – or a deeper examination of other possible approaches to space activities. There are more solutions to the disagreements over the legality of property rights in and private use of outer space than just the *res communis* status quo and privatization – which this paper will discuss in depth in later sections.

3. Literature Review

3.1 Space Activity Policy Literature Overview

There are many on all sides of the discussion calling for various approaches to private activity in outer space, ranging from those who simply want greater government protections for private space activities, those who want to keep space a *res communis*, and those who want private companies to lead the way to the stars. After studying the variety of viewpoints on the topic, I have summarized several of the most relevant proposed policy alternatives here, and also created several tables to generate a broad overview of the focuses, methods and trends of existing discussion on this topic.

There is a broad consensus in a large subsection of the literature on private space activities that some kind of international discussion – and eventually regulation – is needed to address how national and international space policy should move forward in the 21st century, mostly due to the precedent set by the OST (Kelly, 2004; Tronchetti, 2015; Blount and Robison, 2016; Hao and Tronchetti, 2019 and Chrysaki, 2020). However, most of these papers do not have a specific policy recommendation beyond a vague ‘precedent suggests this is an international, rather than national, issue.’ There are some specific recommendations, notably Blount and Robison’s (2016) argument that the SPACE Act of 2015 is a “state interpretation of the content of Article II” of the OST rather than a violation of it (p. 177). This means that other nations ought to treat it as such and either accept, and follow, its interpretation of international law or reject it, reiterate their commitment to the current interpretation and pressure the U.S. to change its policy (Blount and Robison, 2016). Another notably international policy recommendation comes from Nie’s (2020) paper on China’s space privatization policy, which discusses the “space arms race” between China, the U.S. and India before recommending that a new international treaty, the “Treaty on the Prevention of Placement of Weapons in Outer Space and the Threat or

Use of Force against Outer Space Objects,” be drawn up to prevent this militarization and affirm existing international space law that is being ignored by those nations (p. 3).

Several other papers approach issues of space privatization from the context of a particular spacefaring nation, most commonly but not limited to the U.S., and focus on national, rather than international, space policy. Depending on the rigor of these papers, they will explain the national space policy context of the nation in question in detail before discussing the issue at hand and providing more vague policy recommendations. Most of these papers call for either an expanded role for private entities in outer space or the “exploration” of greater cooperation between the public and private sectors in the form of public-private partnerships (Dodge, 2016; Nagendra and Basu, 2016 p. 7; Mahjoom et al., 2019; Nie, 2020 and Platt, Jason and Sullivan, 2020). A common policy recommendation in these papers, especially those not focused on the U.S., is the demilitarization of a nation’s space activities and the introduction of civilian commerce and industry into the space market (Mahjoom et al., 2019 and Nie, 2020). Other papers recommend that national governments should clarify or update their existing space laws to help private actors better understand what they can and cannot do in outer space and “promote the growth of the... space private sector” (Dodge, 2016; Nagendra and Basu, 2016; Hao and Tronchetti, 2019 p. 5; Krolikowski and Elvis, 2019 and Nie, 2020).

It is important to note that, even though much of the literature calls for privatization in some way, there will still be a place for government/public space activities in many of these suggested policy regimes. In fact, many of the papers calling for privatization recognize that government support for space activities is vital in a system focused on public-private partnerships or the creation of an independent civilian space industry (Johnston and Cordes, 2003; Blount and Robison, 2016; Dodge, 2016; Nagendra and Basu, 2016; Mahjoom et al., 2019

and Nie, 2020). The most articulated recommendation in this regard comes from Johnston and Cordes (2003), who were bringing academic discussion and policy suggestions to a different era of the debate about private sector actors and attitudes in space, namely the early 2000s and Congress' attempt to commercialize the Landsat program. Due to the desire to profit from space activities that existed among private entities and policymakers, and still does today, Johnston and Cordes (2003) recommended that space activities that are well suited for commercialization and privatization should be commercialized/privatized, while those that are not should be left as public goods.

However, there are advocates for a non-government approach to space privatization and the regulation of commercial activities in outer space. Specifically, Chrysaki (2020) argues that the advance of space exploration technology and the private space industry has not prompted an appropriate advance in government space policy. As such, she argues that it falls to the commercial space industry to regulate itself through a voluntary code of conduct based on the principle of "do not harm" (Chrysaki, 2020 p. 10). She even drafts a rough code of conduct as a way to stimulate discussion within the commercial space industry, which outlines the principles that she believes should be used to regulate the space industry and how her idea of private self-regulation would work. This code is very focused on sustainability and encouraging precaution and respect in the companies who decide to abide by it (Chrysaki, 2020).

Another notably non-government focused recommendation comes from Profitiliotis and Loizidou (2019), who were concerned about the potential effects of space activities, especially private space activities, on earth's environment and environmental equity. They focus on the potential of post-reentry activities bringing extraterrestrial biological materials back to Earth and contaminating the areas/communities where those activities are performed, and the anti-space

perceptions that will emerge among the general public if this happens. In order to prevent this, they recommend that “participatory scenario-planning workshops” should be used to include the general public in space mission planning – especially the definition of risks and the distribution of the benefits derived from those missions (Profitiliotis and Loizidou, 2019 p. 6).

All of these papers, while insightful, are focused on a single idea or vague policy recommendation, usually the author’s own. There is no real comparative policy analysis on multiple space privatization schemes, or privatization schemes from other industries that can be applied to outer space. This is a knowledge gap that should be filled, so that policy and decision makers have an understanding of the numerous options available to them and the comparative pros and cons of those options.

3.2 Space Activity Policy Literature Breakdown

The following tables break down the reviewed papers by various aspects of their focus and arguments to provide a better understanding of the literature surrounding this topic. Table 1 contains a breakdown of the reviewed literature by geographic and policy focus where applicable. Most of the reviewed papers are focused on a specific nation and either how space policy impacts that nation or how space privatization could be implemented within it. The United States is the most discussed nation largely due to the SPACE Act, its predecessors and follow up bills – whose existence and policy ideas are discussed at length by Tronchetti, Blount, Robison and Dodge. There are also several authors that discuss the legality of national space policy in the context of previous international law, notably Krolikowski, Elvis, Kelly and Nie. Finally, a few authors take a more international approach to evaluating space policy and private space activities, with unorthodox proposals being raised by Profitiliotis, Loizidou and Chrysaki.

Table 1: Focus Comparison Matrix

Topic: Privatization and Commercialization of Space Activities

Author (Year)	Geographic Focus	Policy Focus
Anderson (2013)	National: U.S.	Public-Private Partnerships
Blount and Robsion (2016)	National: U.S.	U.S. SPACE Act of 2015, Public-Private Partnerships, Property Rights, Legality
Chaben (2020)	National: U.S.	Public-Private Partnerships, Legality
Chrysaki (2020)	International	Deregulation, Private Governance
Dodge (2016)	National: U.S.	U.S. SPACE Act of 2015, Public-Private Partnerships, Property Rights
Handberg (2014)	National: U.S.	Agenda Setting
Hao and Tronchetti (2019)	National: U.S.	American Space Commerce Free Enterprise Act, Property Rights, Legality
Johnston and Cordes (2003)	National: U.S.	Satellite Commercialization, Legality
Kelly (2004)	National: U.S.	Outer Space Treaty, Property Rights, Legality
Krolikowski and Elvis (2019)	International	Future Space Activities, Legality
Mahjoom, Isfahani, Kordnaeij and Hosseini (2019)	National: Iran	National Security, Demilitarization
Nagendra and Basu (2016)	National: India	Need for Space Laws
Nie (2020)	National: China	Demilitarization, Legality
Platt, Jason and Sullivan (2020)	National: U.S.	Private Space Initiatives, Public Support
Profitiliotis and Loizidou (2019)	International	Planetary Protection
Tronchetti (2015)	National: U.S.	U.S. Space Resource Exploration and Utilization Act, Legality

One of the major issues with the scholarship on and debate over space privatization is that there is very little empirical data being used to justify arguments on either side. As Table 2 shows, most papers rely on qualitative discussions of a policy's context and contents to support their opinions rather than empirical data on the merits of a policy or idea. This is a significant knowledge gap in our understanding of space privatization that needs to be filled so that future policy can be based on reality rather people's perception of reality. Notably, Platt et al. was the only reviewed article based on an empirical case study, rather than a qualitative discussion, but

that study was focused on the public perception of space privatization, and as such does not do much to fill this gap.

Table 2: Methods Comparison Matrix

Topic: Research Design

Author (Year)	Method
Anderson (2013)	Historical Analysis, Policy Summarization
Blount and Robsion (2016)	Policy Summarization, Legal Reasoning
Chaben (2020)	Historical Analysis
Chrysaki (2020)	Policy Drafting, Legal Reasoning
Dodge (2016)	Policy Summarization, Legal Reasoning
Handberg (2014)	Historical Analysis
Hao and Tronchetti (2019)	Policy Summarization, Legal Reasoning
Johnston and Cordes (2003)	Historical Analysis
Kelly (2004)	Legal Reasoning
Krolikowski and Elvis (2019)	Legal Reasoning
Mahjoom, Isfahani, Kordnaeij and Hosseini (2019)	Policy Drafting, Legal Reasoning
Nagendra and Basu (2016)	Policy Drafting, Legal Reasoning
Nie (2020)	Policy Drafting, Legal Reasoning
Platt, Jason and Sullivan (2020)	Case Study
Profitiliotis and Loizidou (2019)	Legal Reasoning
Tronchetti (2015)	Policy Summarization

Table 3 contains paraphrased summaries of each paper's primary themes as they relate to privatization, including both assumptions and conclusions. All of the reviewed papers had their own underlying assumptions that were greatly influenced by the focus of the paper, but many of these separate assumptions either come from similar reasoning – usually the inherent benefit or detriment of space privatization – or lead to similar conclusions and policy recommendations. The papers also offer numerous conclusions on the benefits, risks and usefulness of space activities, with many agreeing that space privatization can be beneficial to the nations and corporations that move forward with it, but those benefits come with several caveats. The major one being the difficulty – legal or otherwise – of successful privatization. For instance, despite the desire for space privatization and private property rights among certain actors, it is a violation of international law, which presents several roadblocks for privatization policy. Other papers

argue that privatization is a risky endeavor from a planetary safety point of view, and that the externalities of private actions will be felt worldwide.

Table 3: Theme Matrix

Topic: Primary Theme of Article

Author (Year)	Primary Theme of Article
Anderson (2013)	SpaceX's recent success demonstrate the potency of private space activities, but public-private partnerships played an incredible role in getting the private space industry this far.
Blount and Robsion (2016)	The SPACE Act was the first policy to recognize commercial property rights in space, which is a valid interpretation of the OST.
Chaben (2020)	Space exploration only captures the attention of the American public if there is something to prove or a competition to be won.
Chrysaki (2020)	Space policy has not advanced at the same rate as space exploration technology has, which means that it cannot protect the wider interests of humanity in space.
Dodge (2016)	Modern space activities in the U.S. are usually public-private partnerships, and as such Congress has an interest in developing the commercial space industry.
Handberg (2014)	The status of human spaceflight on the presidential agenda is dependent on its perceived importance with the president's other priorities, the public and the political community.
Hao and Tronchetti (2019)	American attempts to regulate the space mining industry challenge the traditional interpretation of international space law.
Johnston and Cordes (2003)	OST based regulations around non-discriminatory access make it difficult to profit off space activities, but the modern era is more receptive to privatization than the Cold War era.
Kelly (2004)	The OST provides for freedom of use in outer space through preventing anyone, nations or private entities, from appropriating it.
Krolikowski and Elvis (2019)	"There are many different kinds of asteroid and outer space activities, all of which are best served by different policy regimes specifically tailored to them. Mistakes in outer space can create public bads where the public is the entire globe."
Mahjoom, Isfahani, Kordnaeij and Hosseini (2019)	Iran currently focuses on national security in outer space, but it is logical for the country to commercialize and privatize some of its space activities due to the economic benefits of doing so.
Nagendra and Basu (2016)	Most space policy in India is loosely defined and hinders greater private involvement due to a lack of certainty in or updating of policies.
Nie (2020)	Encouraging private space activates is an important goal, both worldwide and in China, due to the economic and military benefits privatization can bring.
Platt, Jason and Sullivan (2020)	With their limited record and experience in comparison with government space agencies, private space actors such as SpaceX will need the support of the public, government and investors before any largescale private space activities take place.
Profitiliotis and Loizidou (2019)	The actions of private space entities will affect the condition of earth's environment as a whole, as well as public opinion on private space activities.
Tronchetti (2015)	There is no practice or precedent in international or domestic law for non-governmental entities taking space resources on a large scale and profiting off them, but the SPACE Act is an attempt to fill that gap.

Table 4 contains paraphrased summaries of what the outcomes that each paper believes will result from either space policy as it currently stands, would be changed by a specific proposal or by a move towards space privatization. As with Table 2, each paper has a unique viewpoint on the outcomes that are either based off similar assumptions held by multiple authors or will lead to similar policy recommendations. That being said, many papers view the privatization of at least some space activities in a favorable light. There appears to be a broad consensus among the authors that – despite it being forbidden by international law – space privatization is something that is either inevitable or needs to happen, with the only questions being which activities should be left to the public sector and should it be individual nations or the international community who pursue privatization policy. Chrysaki and Kelly are the only major outliers, with Chrysaki advocating for a wholly self-regulated private space industry due to perceived mishandling of space policy by the government and Kelly vehemently supporting the status quo of the OST in the face of a minor legal challenge to it.

Table 4: Outcomes Matrix

Topic: Assumed Sub-Outcomes and Outcomes of Space Privatization/Space Policy

Author	Sub-Outcomes and Outcomes of Privatization/Space Policy
Anderson (2013)	Public-Private partnerships will result in privatization that reduces the role of the government in outer space and reduces the total cost of space activities.
Blount and Robsion (2016)	The U.S. has proposed a new policy scheme that legalizes private space activities despite decades of precedent, and the rest of the world is free to reject or accept it.
Chaben (2020)	Public-private partnerships are the foundation of America's current and future space activities due to the cyclical innovation they generate and the freedom they give NASA.
Chrysaki (2020)	Commercialization and privatization of space should be a primarily private activity. Private self-regulation of activities in outer space.
Dodge (2016)	Long term commercialization and deregulation of U.S. space activities. Creation of a strong commercial space industry heavily supported by the federal government.
Handberg (2014)	Presidential rhetorical support for U.S. space activities often does not mean that their budgetary policies will support those space activities, since they are often too politically insignificant for presidents to risk policy windows on, meaning that major changes to the space policy agenda are unlikely to occur.
Hao and Tronchetti (2019)	American space policy is innovative and will bring change to space law, but also be disruptive to the stability of international space law.
Johnston and Cordes (2003)	Some space activities are perfectly fine as public goods, but there is still a drive among private entities and policymakers to privatize aspects of America's space activities. Other space activities are well suited for privatization, but those that are not need to remain in the public sphere.
Kelly (2004)	Any recognition of private property rights over outer space amounts to national appropriation. The continued lack of recognition of property over outer space will negatively impact the development of space commerce and industry.
Krolikowski and Elvis (2019)	International attempts to serve all of the different possible outer space activities through one treaty or policy create confusion, ambiguity and hold back space activities. Individual nations such as the U.S. will be the lead policy innovators in regards to future space activities.
Mahjoom, Isfahani, Kordnaeij and Hosseini (2019)	Privatization and public-private partnerships in the space industry can improve the welfare and international prestige of a nation.
Nagendra and Basu (2016)	Entrepreneurship with both spin-off technologies and space activities is discouraged by India's policy regime.
Nie (2020)	The creation of the U.S. Space Force and the successful tests of Indian antisatellite weapons could lead to a space arms race that the current international legal framework cannot stop.
Platt, Jason and Sullivan (2020)	Private space initiatives can create both new visions for public space exploration and new public objections to space activities.
Profitiliotis and Loizidou (2019)	Private space endeavors will impact the safety of the earth and its environment, creating the possibility of environmental equity issues.

Tronchetti (2015)	The current ambiguity on how the OST applies to space resources makes laws like the SPACE Act legally questionable within international law. Despite this, the Act does fill a clear policy gap and other nations will follow America's example.
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As shown in Table 5, several authors recommend using a national law to deal with space policy rather than international law which has been the historical norm, which makes sense given that many of these papers were focused on specific nations and their own space policy context. As is normal for longstanding policies such as those that govern space activities, support for the current status quo is very slim. Almost every author recommends some policy changes, which reflects the general desire for privatization that several authors comment on in their articles. However, some of the proposed changes are more extensive than others, with radical authors such as Chrysaki calling for a complete reversal of the *res communis* status quo and the creation of a new privatized order in outer space without the oversight of national governments or international organizations. Other, more moderate, authors such as Tronchetti and Nie call for changes that preserve the current structure of the space policy status quo – namely its international treaty basis and the spirit of global collaboration that those treaties call for – but change the specifics of those treaties and policies to address some of the issues and concerns discussed above. Finally, authors such as Anderson and Chaben advocate for simply embracing the public-private partnerships that have emerged within the status quo framework and building new policies around this proven and currently in use method for advancing space activities. These three broad approaches all have their merits but are very different solutions to different perceptions of the same problem.

Table 5: Policy Recommendations

Topic: Policy Recommendations Regarding Space Privatization

Author (Year)	Policy Recommendations	Extent of Change
Anderson (2013)	National Law Approach, Public-Private Partnerships	Minimal
Blount and Robsion (2016)	Treaty Approach: Reform OST	Medium
Chaben (2020)	National Law Approach, Public-Private Partnerships	Minimal
Chryasaki (2020)	Non-Government Approach, Privatize	Major
Dodge (2016)	National Law Approach, Clarify, Privatize, Public-Private Partnerships, Deregulate	Minimal
Handberg (2014)	None	None
Hao and Tronchetti (2019)	National Law Approach, Privatize, Clarify	Medium
Johnston and Cordes (2003)	National Law Approach, Privatize, Clarify	Medium
Kelly (2004)	Status Quo	None
Krolikowski and Elvis (2019)	National Law Approach, Clarify	Medium
Mahjoom, Isfahani, Kordnaeij and Hosseini (2019)	National Law Approach, Privatize, Public-Private Partnerships	Minimal
Nagendra and Basu (2016)	National Law Approach, Clarify, Privatize, Public-Private Partnerships	Minimal
Nie (2020)	Treaty Approach: New, Privatize, Clarify, Deregulate	Medium
Platt, Jason and Sullivan (2020)	Public-Private Partnerships	Minimal
Profitiliotis and Loizidou (2019)	Civilian Input	Medium
Tronchetti (2015)	Treaty Approach: Reform OST, Privatize	Medium

3.3 Privatization Policy Overview

Another important part of filling the knowledge gap around space privatization is acknowledging that these ideas about space privatization do not exist in a vacuum. Rather, there are entire academic disciplines dedicated to studying privatization theory and history that can be drawn upon to inform space privatization policy. A general review of various relevant articles shows that privatization theorists agree with the general notion that private industries seem to be more effective than their public counterparts, but numerous authors are quick to defend public

industries and give explanations as to the cause of this phenomenon (Perry and Babitsky, 1986; Johnson, Smith and Codling, 2000; Wolf, 2009). The following section is a general review of these arguments, which will be expanded upon and used in the Discussion and Conclusion sections.

Perry and Babitsky (1986) argue that public organizations are commonly seen as inefficient and unproductive because of the social role assigned to them. Less efficient, productive and profitable operations, such as infrastructure maintenance, often do not survive long in the private sector – and tend to become public operations, especially if they are some form of public good (Perry and Babitsky, 1986). Some authors have applied a reversed version of this idea to space exploration and exploitation, where it started as a public activity because it was incredibly risky and less efficient but is now becoming a private activity due to advancing technology increasing efficiency and lowering risk (Anderson, 2013, Chaben, 2020 and Chrysaki, 2020). This argument can be summed up in the words of the CEO of a NASA contract company; “if it needs to be done once, that’s a government opportunity; if it needs to be done repetitively, that’s a business opportunity” (Anderson, 2013).

This notion of advancing technology influencing the organizational form of an industry has some historical merit as well. In *Power Loss* Hirsh demonstrates that technological development advances faster than governmental regulations dictating organizational forms and can often make the original rationale for those regulation moot (1999). This is most clearly seen in how advances in electricity cogeneration and renewable technology eliminated the natural monopoly nature of electric utilities – a process that eventually resulted in policy change in the form of the Public Utility Regulatory Policies Act of 1978 that removed barriers to entry in the

electricity generation market and gave numerous incentives to non-utility generators in an attempt to encourage the emergence of a freer energy market (Hirsh, 1999).

Meanwhile, Johnson, Smith and Codling examine the apparent differences between public and private organizations from an institutional and psychological perspective, arguing that those differences arise from the different “institutional templates” that workers in each sector follow (2000). Importantly, in cases of institutional change – such as privatization of a specific organization or industry – there is not an immediate change in those institution templates and the old public way of doing things will coexist and compete with the new private way of doing things before being replaced (Johnson, Smith and Codling, 2000). As such, any psychological or organizational advantages of privatization will take time to emerge, and the change between templates will create its own issues that need to be dealt with (Johnson, Smith and Codling, 2000).

Wolf approaches the public-private efficiency divide by arguing that public corporations and agencies have the option to deliberately be more cautious since the public sector’s “planning horizon” is different from the private sector’s (2009). The private sector encourages greater efficiency and production due to free market competition, but public control of commercial activities – or any activity for that matter – allows for slow, deliberate planning and direct state control over activities “too important to be left to the market” (Wolf, 2009). Space exploration and exploitation used to be one of these important activities, and now the industry is taking its first steps away from the cautious public sector to the efficiency and profit driven private sector – which is a potentially monumental change for an industry as dangerous as space exploration, especially human space exploration.

Furthermore, both Wolf and Perry and Babitsky have their own classification schemes for the ownership types of various organizations/systems that are based off the oil and mass transit industries, respectively. Wolf's classification focuses exclusively on how much of an organization is owned by the public sector, ranging from fully state-owned organizations such as Saudi Aramco where the public sector is in full control to fully private organizations such as ExxonMobil where the public sector has no ownership over the organization and can only influence them via regulations and the market (2009). Perry and Babitsky's classifications are more granular; focused on both ownership – usually by a government itself, a special agency of a government or a private organization – and management – usually either publicly or privately, with private management via contract also being an option (1986). Both of these classification schemes will be useful in breaking down the various policy alternatives for space privatization, as they provide rough frames of reference for how a proposed policy will impact the space industry.

Another important consideration when thinking about space privatization policy is that – despite the OST and the generally anti-commercial space stance that most interpretations of it take – there is an aspect of the space industry that has been fully privatized since the 1980s: satellites (Congressional Research Service, 2018). The licensing authority that President Regan gave the Department of Transportation was later transferred to the Federal Aviation Administration (FAA) – which is one of the three federal agencies responsible for the modern commercial satellite launch and use licensing structure alongside the National Oceanic and Atmospheric Administration (NOAA) and the Federal Communications Commission (FCC) (Congressional Research Service, 2018). Each of these overlapping bureaucracies has their own licensing process and responsibilities; with the FAA allocating licenses for launch and reentry

vehicles, NOAA focusing on remote sensing satellites and the FCC regulating the use of radio frequencies by satellites as a part of its pre-spaceflight statutory authority over said frequencies (Congressional Research Service, 2018). The FCC also works with the UN's International Telecommunications Union to assign orbital slots for geosynchronous satellites (Congressional Research Service, 2018). Expanding this licensing structure is another possible space privatization policy alternative in addition to the ones discussed above, but the differences between launching satellites and conducting human space activities is substantial and new ideas and policies are needed to account for that difference.

3.4 Review Summary

Overall, the literature review shows that most researchers believe privatization and commercialization policies such as the SPACE Act are beneficial, that greater clarity and stability is needed at both the national and international level in regard to space policy – especially ownership of space resources – before privatization can begin in earnest and that collaboration, both international and between public and private entities, is needed to achieve success. However, the most important area of interest identified in this matrix is probably the clash between existing international regulation and the desire for privatization and private ownership of space resources. Every author recognized in some capacity that the current status quo is flawed in some way, even Kelly – who supports the continuation of the status quo under the OST – discusses how the current policy regime can discourage future space commerce. This is common, as all policy areas are in a near constant state of flux. However, this is not just a case of a few academics calling for a small policy change. Governments and private actors from around the world want to reverse the current international space policy status quo and privatize some space activities or allow greater freedom for the private space industry because – at least according to Mahjoom (2019), Nie (2020) and Johnston (2003) – they believe that privatization

will bring economic and societal benefits to the nations that allow it and the companies that participate in it.

Additionally, while the matrix focused on the idea of public-private partnerships in space exploration, greater collaboration in general is a major theme of space policy literature. As shown in Table 4, many authors believe that public and private entities should closely cooperate in the realm of space exploration and exploitation to maximize the societal benefits of those activities. What is interesting is that all of the authors who advocate for a more international, treaty based, approach are also calling for similar cooperation, but between nations rather than/in addition to public and private entities.

In fact, this review implies that more international discussion is needed to rework or even replace existing space policy. There are a few specific suggestions in the various articles reviewed, including a Treaty on the Prevention of Placement of Weapons in Outer Space, but overall, the authors generally call for greater clarity on private property rights in space and the greater cooperation between all actors involved mentioned above. This is very interesting, because despite a lot of scholars, governments and private entities pushing for collaborative changes to international space law, for treaty reform, no significant action is being taken on an international level other than debate over the legality of possible actions. As many of the articles point out, it appears that nations such as the U.S. and China are taking the lead in addressing the policy gaps and issues created by existing international law using their own national policy rather than amending the international laws themselves. It is individual nations that are recognizing and pursuing the potential economic benefits of space privatization. It is national policy that is attempting to create the greater clarity and stability that many are calling for. It is individual national space programs that are entering into partnerships with the emerging private space

industry to reap the benefits of that collaboration. All of this is being done despite the main interpretation of international space law effectively not allowing space privatization, because many of the major countries involved in space activities – notably America, Russia and China – do not want their national policy dictated by international treaties for one reason or another. In fact, this preponderance of national space policy making demonstrates the possibility of the National Public-Private Partnership policy directions that will be examined in depth in the Discussion section.

4. Research Questions

Despite the major changes to the national and international context surrounding it since the end of the Cold War, American space policy did not go through any equivalent changes immediately. Space policy still heavily favored NASA and its civilian contractors, and basically made it impossible for any other entities to participate in space activities outside of commercial satellites in LEO (Congressional Research Service, 2018 and Hao and Tronchetti, 2019).

However, change did eventually come to American space policy, in the form of the U.S. SPACE Act of 2015 which began the government facilitation of privatized space activities (Hao and Tronchetti, 2019). Given that many actors - including private interest groups and the federal government - are pushing for their preferred outcomes in regard to space policy, some research should be done on the various possible policy options that can lead to those outcomes, their pros and cons and how they work with or against each other in order to equip future policy and decision makers with a metaphorical menu of possible policy alternatives. As such, this thesis will address the following research questions:

1) “What are the major plausible and realistic space privatization policy alternatives?”

Before you decide on a policy, you need to know what alternative policies and policy directions you have to choose between. Therefore, this thesis will need to define and delineate numerous different policy proposals related to space privatization. Specifically, it will be reviewing theoretically possible policy ideas that are either well developed in the academic literature, based on similar privatization policy from history in comparable industries or further developed through my own research.

2) “What are the outcomes and consequences of each major alternative?”

Furthermore, this thesis will examine the potential outcomes and consequences of each major policy alternative and policy direction. In order to make informed decisions, policymakers need to have an understanding of what each alternative will do to society, and what they may lose by choosing one alternative over another. Describing the outcomes and consequences of each major alternative will equip policymakers to discuss alternatives on their merits, rather than on how flashy or electable those alternatives sound.

3) “How do these policy alternatives interact with each other?”

Once all the possible alternatives are understood on their own, this thesis will investigate which ones can fit together into a distinct policy direction to improve the overall space policy patchwork and which ones are mutually exclusive with each other. Efficient space policy should not work at cross purpose with itself, and as such policy and decision makers need to have an understanding of how the various alternatives available to them work together.

5. Methodology

In order to answer these questions, this thesis will conduct a comparative policy analysis of the various policy recommendations for space privatization as well as similar historical cases of the privatization of a public good. As such, this paper will collate all of the policy alternatives from the literature review, define them in greater depth and group them by their policy recommendations. From there, it will describe the potential tradeoffs associated with each alternative policy recommendation and detail the effects each of them will have on American and global society. Then, it will investigate how each of these alternatives interact with each other to determine which are mutually exclusive and which can be pursued simultaneously. Finally, it will compare the major policy directions and the sets of harmonious alternatives within those directions to generate a policy recommendation and demonstrate how to compare alternatives in the realm of space privatization policy.

While comparing, contrasting and combining these alternatives, this thesis will draw conclusions about the policy context and options it is discussing. The policy recommendation generated will be influenced by those conclusions and its own merit. That recommendation will include a new policy direction of some kind, as the current status quo of space policy has not adequately kept up with the changing technologies and cultures surrounding it and new policy is needed (Chrysaki, 2020). Given the widespread desire for some level of space privatization among commercial interests, academia and various national governments, that policy direction will probably include some element of privatization or legal allowances for private activities in space. However, the menu of policy alternatives will be independent of the recommended policy direction, so that policy and decision makers can benefit from this thesis even if they disagree with the conclusions and recommendations it comes to.

6. Results

There are many possible directions that space policy can be taken in the 21st century, and many of these directions have emerged because of recent changes in the political, technological and economic contexts surrounding outer space and space activities (Anderson, 2013; Tronchetti, 2015 and Chrysaki, 2020). These contextual changes have created a policy window – an opportunity for national space agencies, legislative bodies and the international community to change the direction of space policy away from the status quo or reaffirm their commitment to said status quo. In order to take advantage of this policy window, we must understand what the space policy status quo is, how context changes allow for new policy directions and what the major alternative directions are.

For the purposes of this paper, a space policy direction is defined as the combination of the following policy aspects: source of regulation, level of regulation, clarity of regulation and stance on private activity. The source of space activity regulations is an important part of a policy direction because it determines which policymakers are responsible for setting the new space policy direction and which policymakers need to relinquish actual or claimed political and legislative authority over space policy. The level of space activity regulation determines how much authority the source of regulations has over the space industry as a whole and individual actors within it. The clarity of space activity regulations determines how easy it is – relative to the status quo – for actors to understand space policy and space activity regulations. Finally, the direction's stance on private activity is based on both Wolf's (2009) and Perry and Babitsky's (1986) ownership classification schemes and details if the activities are publicly or privately managed, and which sector owns the infrastructure, resources and other assets needed to conduct space activities.

6.1 The Status Quo

Using the policy direction framework, the space policy status quo can be defined as a policy direction where regulation comes from the international community via treaties, space activities are highly regulated by obscure or unclear policies and all space activities are publicly managed, and most infrastructure is publicly owned (Outer Space Treaty, 1967; Kelly, 2004 and Blount and Robison, 2016). This policy regime – which is embodied by the OST and its most common interpretations – emerged from the Cold War era context that it was drafted in and is wedded to the political ideas, technological capabilities and economic context of that time period. It has not kept up with the many changes to the political and technological contexts that have occurred in the post-Cold War era – and as such many argue that it needs to be reformed or replaced (Tronchetti, 2015 and Chrysaki, 2020).

6.2 The Self-Regulation Model

Despite widespread calls for change to the space policy status quo, there are numerous disagreements about what it should be turned into or replaced with, disagreements that can be summarized into three different policy directions: the Self-Regulation Model, the New International Treaty Model and the Public-Private Partnership Model. The Self-Regulation Model is rooted in the idea that the lack of appropriate advances in space policy as its context changes is unacceptable, that the Status Quo is unacceptable, and that it now falls to the private space industry to regulate itself before it is too late for regulation to meaningfully protect “the interests of humankind” (Chrysaki, 2020). This regulation would come from a clearly defined code of conduct that private entities may voluntarily subscribe and hold themselves to (Chrysaki, 2020). The code of conduct would be written by those private entities that agree to abide by its regulations, and the primary space activities encouraged by this policy direction would be privately managed activities conducted with privately owned resources (Chrysaki, 2020).

While this proposed policy direction is a major diversion from the status quo, changes from a publicly run and regulated system to a privately run and regulated system have precedence in privatization theory. It has long been argued that inefficient, unproductive and less profitable activities tend to become public operations because no private entity can benefit from them (Perry and Babitsky, 1986). This idea is a simple explanation for why space activities started out as a public operation; they are incredibly risky, inefficient and difficult to extract profit from. However, the corollary to this idea is that activities that are efficient, productive and profitable will tend to become private operations – and that if a previously public operation, such as space activities, becomes more efficient and less risky then it could successfully be turned into a private operation (Anderson, 2013 and Chaben, 2020). Thus, given Chrysaki’s arguments about the changing technological context of space activities, and the lack of reciprocal change in space policy, it seems that the Self-Regulation Model has merit insofar as it calls for changes in regulation to keep up with changes in technology.

Furthermore, history has also demonstrated the validity of a change in technology prompting a change in system organization and policy, most notably in the case of electric utilities in the United States. According to Richard Hirsh in his book *Power Loss: The Origins of Deregulation and Restructuring in the American Electric Utility System* (1999), the start of the 20th century saw the electric ‘utility consensus’ earn the designation of a natural monopoly and use it to accrue economic and political power – only for the consensus to be replaced by a highly competitive free market for electricity by the end of the century. This change in organizational form was brought about by changes to the economic, political and technological context of electric utilities; primarily, the 1970s energy crisis, the Public Utility Regulatory Policies Act of 1978 and the technological advances that it encouraged (Hirsh, 1999).

A possible extrapolation of Chrysaki's arguments would involve all public institutions that currently regulate and manage space activities – most notably the UN and various national governments – passing policies that completely deregulate outer space and divest themselves from control over the space economy. From there, it would fall to private companies with an interest in outer space to begin drafting their own rules for in-house space activities, and eventually the most up to date, efficient and profitable rules would be adopted by most if not all private space actors as a unified code of conduct due to the demands of the market. This is a strong version of the Self-Regulation Model, where the governments of the world explicitly deregulate space, and is arguably the best-case scenario for the proponents of the Self-Regulation Model, but in many ways it seems unlikely. While not complete self-regulation, a more possible approach would be to gradually remove national and international regulations through policy action, as the private space industry continues to grow until there is an equilibrium between private economic freedom in outer space and public consumer and planetary protection. Another possible path to something approaching the Self-Regulation Model would be the continuation of the current space policy deadlock – which could result in a situation where the governments of the world cannot or will not enforce the regulations that do exist, which would give private space companies the opportunity and desire to self-regulate.

If this model, in any of its forms, was implemented, political and economic power in space would belong to the companies that can act under, edit and enforce the code of conduct. Without any non-market way for the public or public servants to regulate private space activities, private companies would have free reign to do as they see fit. The proponents of the Self-Regulation Model view this as a good thing, because private companies are heavily incentivized by competition to make changes to their space activities and practices to keep up with its

changing economic and technological contexts. However, this freedom could worry members of the public, especially in the case of a focusing event such as a particular company abusing that freedom or a major space disaster, who could then call for government intervention and regulations. This is where the code of conduct and some form of cooperative enforcement would come in – to avoid the need for government regulation by preventing such focusing events from happening. Like all forms of self-monitoring and self-regulation, the possibility of major consequences due to lax self-regulation or outright negligence is always present, and disastrous events in space do not discriminate between public and private actors.

That all being said, immediate change in a longstanding institution, such as public space agencies, is rare – and it often takes time for context changes to impact the way that organizations and people interact with and use new systems (Johnson, Smith and Codling, 2000). In a sense, space industry actors as a whole - and space policymakers in particular - could still be adjusting their templates in response to changes in political, economic and technological contexts. Furthermore, when institutional change does happen, it does not have to be as sweeping and all-encompassing as the Self-Regulation Model advocates for. There are authors who disagree with Chrysaki over the extent of the change in the space policy context, who argue that the main change is a widening of the policy gaps in the OST; primarily, in regards to private space activities, use and ownership of space resources and weapons in outer space (Tronchetti, 2015; Blount and Robison, 2016; Hao and Tronchetti, 2019 and Nie, 2020).

6.3 The New International Treaty Model

Authors that focus on the widening policy gaps within the status quo recommend filling those gaps by reforming and clarifying existing international space treaties, drafting and signing new international space treaties, and aligning national laws to these treaties (Tronchetti, 2015;

Blount and Robison, 2016; Hao and Tronchetti, 2019 and Nie, 2020). Their arguments inform what I call the New International Treaty Model, where regulation comes from national laws informed by clarified, reformed and new international treaties (Tronchetti, 2015 and Hao and Tronchetti, 2019). This would include moderate regulations on privately owned and managed space activities, which would coexist alongside continued public owned and managed activities, and strict regulations on the militarization of outer space by any actor (Blount and Robison, 2016 and Nie, 2020).

In the strictest version of this model, new international treaty would have to be drafted by the UN and its member governments and agreed to by all major spacefaring nations – most notably the US, Russia, China, the EU, Japan and India. In order to actually remedy the gaps in current treaties; this new treaty would have to clarify the rights and responsibilities of both private and public actors in outer space. It would have to create a system to grant property rights over space resources, define who is responsible for keeping both sectors accountable to space law and change outer space from a *res communis* that only governments can legally access to a true *res communis* where all can legally participate. Signatory nations would then have to implement their interpretation of the treaty into their own national law and then enforce it in such a way as to further the goals set out in the treaty. However, this level of international agreement and cooperation is rare these days, and as such a weaker version of the New International Treaty Model where the major spacefaring nations all adopt similar national laws or practices governing private space activities is more likely. In fact, the adoption of similar private space activity laws has already begun in the U.S., UAE and Luxemburg, who have all created policies that grant private property rights to materials extracted from outer space bodies.

Despite this model's focus on international treaties, it would give power to the major spacefaring nations that sign onto the treaty or join the implicit regulation reform wave, as it will be their responsibility to interpret the treaty and create national laws that dictate how their citizens can act in space. While there will – in theory – be minimums and limitations on what these nations can do in regards to regulating space activities, the power is in their hands to do as they see fit. In some ways, this makes sense as it has been governments who have been managing and directing space activities for most of humanity's history in outer space. National governments have the knowledge, experience and infrastructure needed to create and enforce new regulations and distribute new responsibilities. However, it is national governments backed by international treaties who have brought space activities and space policies to the deadlock we see today – and there is always the chance that this will continue if they continue to hold power over space policy. Furthermore, every national government has its own agenda and priorities, which could result in differing approaches to regulating private space activities – which could result in anything from an international race to the bottom in regards to space activity regulation all the way to the destruction of private space activities due to the sheer volume of conflicting regulations in outer space.

Ultimately, the New International Treaty Model is based on the idea that the changes in space policy's political, economic and technological contexts give new actors the opportunity to participate in and expand upon existing space activities and systems – rather than mandating that those actors replace existing activities and systems. It uses the same logic as the Self-Regulation Model but does accept the conclusion that the failure of previous government space regulations gives the private sector the right to be solely self-regulated. However, unlike the Self-Regulation Model it calls for complicated legal reforms to international and national space policy – which

means that the New International Treaty Model will have to deal with international negotiations and space industry template changes that could hamper its effectiveness (Johnson, Smith and Codling, 2000 and Tronchetti 2015).

6.4 The Expanded Public-Private Partnership Model

There is one possible policy direction that would not have to deal with international treaties and changes in psychological templates – the Expanded Public-Private Partnership Model. This model originates from several authors who note that the main change in space policy's economic context since the Cold War is the emergence and proliferation of private space companies such as SpaceX, Boeing and so on (Anderson, 2013; Dodge, 2016 and Chaben, 2020). They argue that this economic change has already brought about a change in policy direction from the status quo in the form of space activity public-private partnerships between these private companies and national governments (Anderson, 2013 and Chaben, 2020).

This public-private partnership policy direction derives its regulations from clearly written national laws – with space companies working with, while also being regulated by, the nation in which they are incorporated (Anderson, 2013; Dodge, 2016; Nagendra and Basu, 2016; Mahjoom et al., 2019; Chaben, 2020 and Platt, Jason and Sullivan, 2020). Currently, this takes the form of a highly regulated space industry where space activities are owned by special authorities – including both state-owned national space agencies and fully private partnered space companies – and managed by the contracts between those authorities (Perry and Babitsky, 1986 and Wolf, 2009).

Authors such as Anderson, Chaben, Mahjoom and Nagendra do not see any issues with this public-private partnership focused de facto status quo – and advocate for it to be expanded and embraced by all spacefaring nations. This would involve the major spacefaring nations

changing existing international law – or outright disregarding it in an implicit approach – to allow for the creation of their own public-private partnership focused national space laws, contracts and economies based off America’s current approach to space activities. In their view, changes in the technological, economic and political context of space activities have already created a new and viable implicit alternative policy direction underneath the status quo that just needs to be embraced – explicitly or implicitly – by individual nations rather than internationally debated (Anderson, 2013 and Chaben, 2020). This approach is somewhat of a middle ground between the New International Treaty and Self-Regulation Models, as it would split power over space activities between national governments and their private space companies who choose to become contractors. It would also divide the burden of space activities between these two stakeholder groups and allow each to access the strengths of the other to further the goals of the partnership. However, partnerships would make space activities dependent on both the public and private sector, meaning that there will be a generous amount of discussions and negotiations involved in all future space activities, which could delay or derail said activities depending on how those conversations go. That being said, this policy direction would just be an expansion and clarification of the existing context of American space activities, and as such there would be no change in America’s industry template slowing down progress and other nations would have an example to look to for best practices as they go through the template change (Johnson, Smith and Codling, 2000).

Public-private partnerships have been used extensively in other industries since their first modern implementation in the United Kingdom’s Private Finance Initiative (PFI) in the 1990s, which means that policymakers have a lot of data to draw on when debating the pros and cons of the Expanded Public-Private Partnership Model (Hodge et al., 2017). During the early 2000s,

many countries saw public-private partnerships as the best - and only – way to build and modernize infrastructure such as roads, hospitals and schools (Hodge et al., 2017). This international confidence in public-private partnerships was not unwarranted, as PFI programs saved the UK anywhere from 10-60% of the traditional costs associated with public infrastructure procurement (Zhang, 2005). However, the Great Recession of 2007-2009 demonstrated some of the risks inherent in public-private partnerships, such as the loss of competition due to the emergence of a favored government partner, the complete nationalization of project risk and privatization of project benefit and the potential for a lack of citizen control over the project (Hodge et al., 2017). Even though policymakers have learned from the recession and recent public-private partnerships have been designed to mitigate these issues, legislators must carefully consider if the possibility of non-competition, unequal risk distribution and lack of citizen control are worth the cost saving and strength sharing benefits of public-private partnerships.

6.5 Other Policy Suggestions

The Status Quo, Self-Regulation, New International Treaty and Expanded Public-Private Partnership Models are the four main competing possible directions for future space policy. They are – for the most part – mutually exclusive with each other due to their disagreements about the importance of international law and the role of the government in space activities. However, the context changes that the latter three point out – space technology and policy not advancing at the same rate, the growing need to fill the international policy gap around private space activities and the ascendance of public-private partnerships in outer space – are all important aspects of the modern space context that need to be considered when making new space policy. In fact, these three changes in context have given rise to other policy suggestions that – while present in the models discussed above – are independent of the four main directions and can be mixed and

matched with each other in the policymaking process to modify policy directions or create new ones.

The most notable of the policy suggestions is for the UN or the major spacefaring nations to clarify existing space law by defining and better communicating the goals and meanings of international or national space policy and regulations (Johnston and Cordes, 2003; Tronchetti, 2015; Dodge, 2016; Hao and Tronchetti, 2019; Krolikowski and Elvis, 2019 and Mahjoom et al., 2019). This suggestion is compatible with all four of the major policy directions – and is inherent in all of them except for the Status Quo Model. It is also compatible with all of the other policy suggestions, as clearly written and communicated policy is easier for actors to understand, follow and iterate on.

Another major policy suggestion is to privatize space activities by introducing more free-market elements to the space industry (Johnston and Cordes, 2003; Tronchetti, 2015; Dodge, 2016; Nagendra and Basu, 2016; Hao and Tronchetti, 2019; Krolikowski and Elvis, 2019; Mahjoom et al., 2019; Chrysaki, 2020 and Nie, 2020). These free-market elements can range from the major spacefaring nations simply allowing private actors more autonomy and rights in outer space all the way to the total self-removal of both international and national government interference and activities in the industry. This suggestion is compatible with the Self-Regulation, New International Treaty and Expanded Public-Private Partnership Models – and is inherent in all three of them. Privatization is also compatible with all of the other policy suggestions due to the clamor for private space activities.

A more specific version of privatization is the deregulation of the space industry in order to spur private activity (Dodge, 2016; Chrysaki, 2020 and Nie, 2020). Again, this policy ranges from a moderate governmental removal of the most egregious international or national

regulations all the way to a complete deregulation of the sector as in the Self-Regulation Model. This policy is most compatible with the Self-Regulation Model – as the Status Quo is built on existing regulations and the New International Treaty and Expanded Public-Private Partnership Models assume either new regulations or no major legal changes at the national level. Deregulation is compatible with any policy suggestion that does not add new rules and regulations to the space industry.

Finally, Profitiliotis and Loizidou (2019) suggest an interesting international policy that would legally mandate all actors involved in space activities to consult with all actors impacted by those activities. This would add another layer of accountability – and bureaucracy – to space activity planning and provide a direct forum for the public to have their say on space activities. Consultation is compatible with all four of the major policy directions and is also compatible with all of the policy suggestions except for deregulation.

6.6 Political Feasibility

Another important factor that policymakers ought to take into account when deliberating on the various directions space policy can take is the directions' political feasibility.

Understanding the political feasibility of a policy direction is important because a policy can be perfect on paper and still be unsuccessful if it is not feasible for one reason or another. As such, this thesis will use government sources from the United States, Russia, China, the European Union, Japan, India and Iran to estimate the political feasibility of each major direction in each of those countries. This will be done by offering a rough assessment of how those nations view the policy aspects that characterize those policy directions to determine which – if any – of the major directions each nation would support.

6.6.1 The United States

The United States has been a major player in space policy since the 1950s, and the passage of the SPACE Act of 2015 by Congress restarted the policy debate over the status quo. Given the goals and sentiments of the SPACE Act - especially its focus on the de facto status quo, deregulation and private property rights in space - it is clear that the United States favors clear laws and moderate regulations that allow for private activity in outer space (H.R. 2262, 2015). However, given the “the United States does not thereby assert sovereignty... over... any celestial body” wording of Title IV Sec. 403 of the SPACE Act, it also appears that the U.S. cares about being consistent with the existing international treaty framework – even as it tries to change it (H.R. 2262, 2015). Furthermore, while the Act focuses primarily on improving the ability of private actors to engage in space activity through redefining, deregulation and clarification, it does not neglect the U.S.’s ongoing public space activities and ensures that the public and private sectors will work together to spur the growth of the American private space industry (H.R. 2262, 2015). Overall, the U.S. would be most supportive of either the New International Treaties Model or the Expanded Public-Private Partnership Model – given the country’s noted disagreement with the Status Quo Model and its support for continued public involvement in and regulation of space activities.

6.6.2 The Russian Federation

Russia, as the successor state to the Soviet Union, is the original space power, and the continuation of their space activities through ROSCOSMOS makes them an important actor in modern space policy. Similar to the United States, Russia has a positive view of some forms of private space activities and is working to leverage the economic potential of space activities – partially by transferring the responsibility of “space technology products” to Russian businesses (Roscosmos, 2016). Furthermore, they favor highly regulated space activities and are more than

willing to engage in international cooperation and treaties in order to better regulate and capture the benefits of those activities – as shown by their numerous intergovernmental agreements with other nations in the field of space activities and their willingness to introduce new international space treaties such as the Treaty on the Prevention of the Placement of Weapons in Outer Space (Roscosmos, n.d.). Based on these aspects, Russia would be supportive of the New International Treaties Model and perhaps the Expanded Public-Private Partnership Model, and most likely would prefer to avoid a continuation of the status quo or the advent of the Self-Regulation Model.

6.6.3 The People's Republic of China

China was the third and currently final nation to achieve human spaceflight capabilities and is arguably in the middle of its own era of focused space exploration. This, alongside the nation's willingness to engage in international diplomacy and treaty drafting, make them another important actor in determining the future of space policy. Between the Chinese government's clearly expressed willingness to engage in “mutually beneficial international exchanges and cooperation” in outer space - and their partnership with Russia in the above-mentioned Treaty on the Prevention of the Placement of Weapons in Outer Space – it is clear that China would be ok with a treaty-based approach to space law (PRC Information Office, 2016, Ch 1, Sec. 2 and NTI, n.d.). Furthermore, China is actively studying existing international space law as part of an effort to formulate its own “national law to govern the space industry” that focus on granting permits for various space and space related activities while also building up the Chinese space industry (PRC Information Office, 2016, Ch 4, Sec. 5). This suggests that China favors clear laws that heavily regulate the space industry, while at the same time allowing for some measure of private activity so long as it tows the state's line. Given all of this, China would be in favor of the New International Treaties Model – partly because of their involvement in the development of new

international treaties and partly because the remaining models do not fit with their vision of China's law and economy.

6.6.4 The European Union

While not capable of independent human spaceflight in its own right, the European Space Agency is a key actor in exploring the solar system and developing advanced technologies for use in outer space – and as such any space policy regime benefits from being approved by the ESA and its European Union partners (Bieńkowska & Woerner, 2016). The ESA – itself a product of international cooperation – is open to international collaboration and treaties that benefit European citizens (ESA, 2021). Additionally, as other nations such as China, the U.S., Japan and India revolutionize and commercialize space activities, the ESA has become more and more open to private space activities and the creation of a “vibrant commercial space sector to serve its own... needs and priorities” (ESA, 2021, p. 6). The ESA has also begun streamlining their internal processes to clarify, speed up and simplify the procurement and decision-making processes – suggesting an approach that favors clearly written laws and policies with medium amounts of regulation (ESA, 2021). These attributes indicated that the ESA would favor either the New International Treaties Model or perhaps the Expanded Public-Private Partnerships Model depending on how the European space industry is commercialized. The ESA recognizes that various other major space powers are moving away from the Status Quo – and is following their lead – while the Private Self-Regulation Model does not fit the ESA's focus on national cooperation at both a European and global level.

6.6.5 Japan

Japan is another nation that has a long history of space activities but no current human spaceflight capabilities, and JAXA is currently focusing on promoting space utilization in “fields of critical importance to the industry and human life” – making Japan another potentially

important actor in the future of space law (Strategic Headquarters for Space Policy, 2013, p. 5). As a part of this goal to expand space utilization, Japan is open to both international collaboration and private space activities (Strategic Headquarters for Space Policy, 2013). Japan has repeatedly rewritten and improved upon its space law and has recently emphasized the clarity and integration of their regulations and bureaucracy (Strategic Headquarters for Space Policy, 2013). These factors indicate that Japan would support the New International Treaties Model, as none of the other three models would allow for the efficient utilization of outer space in Japan's current conditions.

6.6.6 The Republic of India

India is a rising space power that – like China – is currently going through its own era of focused space exploration. Since its first steps into the space industry in the 1960s India has recognized that “space has a dimension beyond national considerations” and that international cooperation in outer space is necessary (ISRO, n.d.). As a part of that international cooperation, India is “refining space policies and defining international frameworks for exploitation and utilization of outer space for peaceful purposes” – indicating that they are both in favor of international treaties and clear space laws (ISRO, n.d.). India has also begun to encourage “private companies to make launch vehicle and satellite related components” as part of an effort to create a space industry in the country (ISRO, 2016). While this is not support for full blown private space activity, it does indicate a willingness on the part of the Indian Space Research Organization and India's government to make private enterprise a part of the space industry. Given their focus on international collaboration, India would very likely support the New International Treaties Model over the other three.

6.6.7 The Islamic Republic of Iran

Iran is an internationally controversial nation that – nevertheless – has been at the forefront of international space policy since Sputnik, making it an important nation to consider when discussing space policy (Mahjoom et al., 2019). Iran was an early signer of many major international space treaties and is eager to participate in international collaboration so as to maximize the utilization of outer space (Iranian Space Agency, 2008 and Mahjoom et al., 2019). Furthermore, as per Article 3 Sections c and e of the Iranian Space Agency's Articles of Association, Iran favors clear laws and extensive regulations that promote space activities by both the government and the private sector (Iranian Space Agency, 2008). This puts Iran firmly in favor of the New International Treaties Model as the direction of future space policy.

6.7 Comparing the Directions and Suggestions

In order to better understand how the possible space policy directions compare with each other, Table 6 summarizes each of the directions based on the four policy aspects used to define them, as well as which countries would be favorable to the direction. While all three of the new directions are different, they have some key similarities that set them apart from and make them mutually exclusive with the Status Quo – namely the fact that they advocate for clearly written space policy and that they all accept and allow for private space activity in some way. While the Expanded Public-Private Partnership Model currently exists unofficially within the status quo, it is limited to three nations and lacks widespread international support due to adherence to the status quo, making it incompatible with the Status Quo Model in the long term. Of the three new models, the Self-Regulation Model is the largest outsider, given its calls for voluntary regulation and the complete abandonment of public intervention in space activities (Chrysaki, 2020). This makes it mutually exclusive with the other three models, which all call for some level of government regulation of the private space industry. This leaves the New International Treaty

and Expanded Public-Private Partnership Models as the only major policy directions that can potentially synergize with each other. At first, they seem somewhat contradictory, given the New International Treaty Model's focus on changing the international space policy status quo and the Expanded Public-Private Partnership Model's disregard for said status quo (Tronchetti, 2015; Anderson, 2013 and Chaben, 2020). However, there is the potential within the New Internationally Treaty approach for interested nations to create or expand public-private partnerships depending on how new treaties are written and interpreted, and it would also be possible for a treaty to explicitly support and encourage the use of Americanesque public-private partnerships by its signatory nations. Both of these approaches would satisfy advocates of both models to varying degrees, but it would result in a situation where the approach of one model is used to achieve the desired results of another – which could introduce complications and disagreements to the treaty negotiation, ratification and implementation process.

Table 6: Policy Direction Comparison Matrix

Topic: Policy Directions

Direction	Source of Regulation	Clarity	Level of Space Activity Regulation	Stance on Private Activity	Nations Favorable to Direction
Status Quo	International Treaties	Unclear	Highly Regulated	No Private Activity	None
Self-Regulation	Private Self-Regulation	Clear	Voluntarily Regulated	Primarily Private Activity	None
New International Treaties	International Treaties and National Law	Clear	Moderately Regulated	Mix of Independent Public and Private Activity	U.S., Russia, China, EU, Japan, India, Iran
Expanded Public-Private Partnerships	National Law	Clear	Highly Regulated	Public and Private Activity Working Together	U.S., Russia, EU (potentially)

Table 7 lists the four independent policy suggestions, summarizes them and notes which of the policy directions and other suggestions that they are compatible with. Clarification and privatization are built into all of the proposed new policy directions simply because of the complex, confusing and anti-private state of current space policy – which are aspects of the status quo that most authors argue needs to be changed (Johnston and Cordes, 2003; Tronchetti, 2015; Dodge, 2016; Nagendra and Basu, 2016; Hao and Tronchetti, 2019; Krolikowski and Elvis, 2019; Mahjoom et al., 2019; Chrysaki, 2020 and Nie, 2020). Deregulation is a trickier suggestion, as only the Self-Regulation Model fully embraces it due to the calls for regulatory reform in the New International Treaties and Expanded Public-Private Partnership Models – both of which would introduce new regulations or swap existing regulations for contractual obligations respectively (Hao and Tronchetti, 2019; Anderson, 2013 and Chaben, 2020). Consultation is a relatively outside of the box suggestion that in theory fits within any of the

policy directions, even the Status Quo, as it approaches the issue of space activities from a scientific rather than political or economic view (Profitiliotis and Loizidou, 2019). The Self-Regulation Model might have a slight conflict with Consolation being legally mandated, but the idea could be worked into a code of conduct or set of best practices with little issue.

Table 7: Policy Suggestion Comparison Matrix

Topic: Policy Suggestions

Suggestion	Summary	Compatibility
Clarification	Defining and better communicating the goals and meanings of current and future space policy, laws and regulations.	Status Quo, Self-Regulation, New International Treaties, Expanded Public-Private Partnerships, Privatization, Deregulation, Consultation
Privatization	Shifting to a free market-based approach to space activities, either through the total removal of government interference or through greater private autonomy and rights in a regulated space economy.	Self-Regulation, New International Treaties, Expanded Public-Private Partnerships, Clarification, Deregulation, Consultation
Deregulation	Removing existing regulations to spur private space activities.	Self-Regulation, Clarification, Privatization
Consultation	Creating legally mandated meetings between space actors and all groups who have a stake in the outcome of their space activities, including civilians who would be impacted by a failed mission.	Status Quo, Self-Regulation, New International Treaties, Expanded Public-Private Partnerships, Clarification, Privatization, Deregulation, Consultation

Based on these comparisons, it is theoretically possible to create a policy that mixes the New International Treaty and Expanded Public-Private Partnership Models with all of the policy suggestions. This would create a treaty based but national law focused approach to space policy that clarifies the rules and regulations surrounding space activities, allows for a relatively unregulated private space industry that is in constant consultation with all of its stakeholders to align its activities with the needs and desires of those stakeholders. However, just because many of these options can be combined doesn't mean that they should be, and each direction and suggestion should be considered on both its own merits and how it interacts with or replaces existing policy and practice before being enacted.

Additionally, all of these directions advocate for some kind of regulation of space activity alongside the privatization of those activities, even though the source and level of that regulation

differ from direction to direction. It is important to point out that privatization of any kind transfers the remaining risks inherent in space activities from being wholly on the public sector to now applying in some way to the private sector, and there is no way to regulate these risks away completely. Space activities are dangerous to both the people participating in them, the organizations funding them and potentially the world itself. Space activities that pose a large amount of danger to a large population – such as towing asteroids to earth orbit for easier access – would most likely be forbidden in all four directions. Meanwhile, many of the other risks such as those to the astronauts going on these missions or to the financial standing of the companies that participate in private space activities, would be handled differently or not addressed at all depending on a direction's source and level of regulation. For instance, the Status Quo doesn't need to create regulations about the risks to private astronauts because it doesn't allow for private space activities, while the New International Treaties and Expanded Public-Private Partnership models would likely see national governments using existing or modified labor laws to lower the risks that companies can legally put their employee astronauts in.

Finally, in terms of passing and implementing any of these alternatives, policymakers have two broad choices for how quickly to embrace change: either take a large and immediate step towards a new direction with all of the discussion and consideration happening before hand or muddling through the issue by gradual multiple passing small changes and measuring their impacts as the system slowly advances towards the new direction. Both approaches are valid and come with their own pros and cons but like with the policy directions a concrete and well-informed decision must be made soon in order to start the process of regulating private space activities. Taking a larger step would match the problem with a comprehensive perceived solution without any trial and error – allowing for a complete and clean transition from the Status

Quo to the new direction – and demonstrate that the public sector is willing to address issues surrounding space policy in a firm and decisive manner. However, any such policy would be limited by the lack of practical knowledge of its effects and the extent to which it was debated and considered beforehand, which might result in new space policy issues that would need to be discovered, debated and solved through another policy process. Furthermore, conducting all of the debate and consideration of the policy responses before passing any policy could result in any government response being delayed or outright stopped by disagreement and gridlock. On the other hand, muddling through the issue would allow governments to pass smaller space privatization measures – such as granting private property rights over space materials – gradually and build up to whatever policy direction policymakers are aiming for. This would allow for trial-and-error learning, as policymakers would be able to see the early impacts of their initial policies while they are working on the next set of policies and react accordingly and make the public sector response to space privatization more flexible and responsive to change overall. That being said, muddling through takes time, and there will be periods where space policy is a mix of old Status Quo laws and new direction laws – which could complicate matters for the private space industry. Furthermore, the more spread out these gradual changes are, the greater the possibility that shifts in the policymaking landscape could prevent additional policy changes from happening, leaving space policy in a halfway state between one direction and another.

7. Conclusion

As space exploration and exploitation technology advances, the policy gaps and disagreements in international space law will only grow larger and more important. Uncertainties and disputes over Cold War era space policy that originally prompted a frivolous lawsuit against NASA now enabled multiple billionaires to build and launch their own personal spaceships with little care to the nominal illegality of doing so. Even if private space activities are beneficial on the whole – as many people argue they are – they should not be conducted in isolation and a state of questionable legality. The OST set a precedent of space being a global commons, a *res communis*, from which every nation ought to be able to benefit and work together to investigate. The fractured and disputed nature of space policy that surrounds otherwise promising advancements in space exploration capabilities goes against that precedent – and an agreement on truly modern space policy needs be made before all of humanity can fully benefit from these new capabilities and efforts.

7.1 Recommendation

Like electricity before it, the political, technological and economic contexts of space activities have changed and there are many directions that policymakers can take to update space policy to reflect these changes, from reinforcing the anti-private status quo to embracing a fully privatized space economy, from new international agreements and cooperation to multiple national and corporate ventures working separately or in concert. Given the success of private ventures such as SpaceX, Virgin Galactic and Blue Origin – and the opportunities presented by public-private partnerships for numerous space activities – the international community should seriously consider the merits of the U.S. SPACE Act of 2015, view it as valid state interpretation of the OST and gradually adopt the Expanded Public-Private Partnership Model as the new space policy standard. The major advancements in space technology and activities that have been

brought about by American public-private partnerships indicate that greater inter-sector cooperation will drive humanity into the future of space exploration, and that a legal framework that allows for such cooperation will benefit the nations that adopt it. Public-private partnerships create opportunity and distribute risk, they can maximize the benefits of space activities while better sharing the costs involved. They free public space agencies to focus on exploration and science while allowing private space companies to bring the untapped benefits of the stars down to earth. Furthermore, the Expanded Public-Private Partnership Model requires little to no international debate or treaty making, as it focuses on a nation's relationship with its own private space sector rather than the international community's consensus on space activities. This makes the model the most responsive to the constantly changing nature and context of the modern space economy and prevents it from falling behind the times as the Status Quo Model has. While there are calls for new international space treaties, reaching a new consensus while private space activities are already moving forward will be difficult – and it will be better for the emerging space economy, and the nations who are participating in it to create a way to regulate and reap the benefits of private space activities now and hammer out an international consensus and further gradual reforms on the matter later.

That being said, there is value in considering the other three models, as well as the various independent policy suggestions, and using aspects of them in the creation of new space policy. Good policy requires good information and understanding the menu of possible policies presented here will help policymakers create better space policies than the ones we have now. Furthermore, no matter what form it takes, tight regulation of the private space industry will be needed for the foreseeable future and beyond. Even though advancing technology has reduced the risks and costs associated with space activities, they will always be an inherently risky

endeavor for both those who undertake it and the world as a whole no matter how routine they become. As pointed out by Platt et al., and Profitiliotis and Loizidou, space activities are dangerous, and no amount of technology or regulation can change that. Space companies are naturally risk tolerant and need to be regulated in such a way that the most disastrous externalities, such as damage to our communication infrastructure or the planet itself, are avoided.

7.2 Limitations

This paper is a comparative policy analysis of ideas drawn from previously written papers on the very extensive and complicated subject of space law and space privatization. As such, it is limited by the research and arguments that it analyzes, as well as the bounds of the topic. The models and suggestions discussed here are based on pre-existing research and discussion and may not represent the totality of options available to policymakers as the march of technological and political progress continues. Non-space related factors, such as climate change or economic issues, not considered or given little attention in this paper may play larger roles in the creation and implementation of future space policy than these models and suggestions assume. Furthermore, this paper's research, conclusion and recommendation are not externally valid and are solely applicable to the matters of space law and space privatization.

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