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### **Space as a commons: Toward a framework for the allocation of extraterrestrial property rights**

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## Abstract

This research report examines the potential nature of property rights in space and the need for the development of a cogent framework for the allocation of such rights, within the parameters set by the Outer Space Treaty of 1967. This was done in an effort to avoid the dichotomous commons dilemmas of, the tragedy of the commons, as described by Hardin (1968), and the tragedy of the anti-commons, as described by Heller (1998),(2013), whilst endeavouring to encourage the investment in and the development of, space and its resources by private operators.

A review of existing literature across a diverse set of academic fields including economics, space law, and commons dilemmas, led to the development of an *a priori* framework for the allocation of functional property rights in space. The framework was specifically based on the work of Nobel Prize Winner Elinor Ostrom's principles for sustainable governance of common pool resources (CPR), the observations on the nature of the anti-commons, as described by Michael Heller and the theory of the decentralisation of governance structures through the polycentric design of governance frameworks. The validity of the proposed *a priori* framework was tested through in depth interviews with experts in space law, policy development and space related industries.

Through the reviewed literature and evidence gathered by this research, it was evident that the debate around the potential nature of property rights in space is still unresolved. However, a consensus view emerged amongst the respondents, that the bundle of functional property rights and roles proposed in the *a priori* framework were valid and feasibly legal, under the current OST treaty regime, with the exclusion of the polycentric design for the allocation of rights within the framework.

## Keywords

Space; Commons; CPR; Resources; Property Rights

## Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Robert Dario Beney

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## List of abbreviations

CPR	Common Pool Resource
ITU	International Telecommunications Union
OST	Outer Space Treaty of 1967

# 1 Introduction

The existing international legal framework for the governance of Space as a commons does not easily allow for, or encourage the participation of private industry in the development of Outer Space. In fact, according to noted space theorist Everatt Dolman (Dolman, 2002), this has resulted in its under-development. The problem, at its most fundamental level, would appear to be that in declaring Space *res communis*, as opposed to *res nullius*, has resulted in a “tragedy of the anti-commons” (Heller, 1998),(Heller, 2013).

Heller defines an anti-common as a scarce resource with multiple owners. Each owner having the right to exclude other owners, effectively ensuring that no single owner has exclusive rights to the property or resource. Consequently a tragedy of the anti-commons is the underutilisation of a resource or property, as owners effectively exclude each other from access to the resource or property in some form or another. Therefore the perceived business problem, in the case of Space and its resources, is that the current international legal framework enforces a default exclusion of the profit motive.

The Outer Space Treaty of 1967 (OST), which has been widely ratified (see Table 20 in Appendix I for a full list of signatories), serves as the foundation of the international legal framework for the governance of Space. The interpretation of three important articles in the treaty, from a civil law perspective, re-enforces the basis of the exclusion of a profit motive.

Firstly, according to Article I of the OST, Outer Space is the “*province of all mankind*” and “*the exploration and use of outer space ... shall be carried out for the benefit and interests of all countries*” [emphasis added], regardless of a country’s “*degree of economic or scientific development*”. (ST/Space/11, 2002, p. 4 Article I)

Secondly, Article II states that no celestial body is “*subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.*” (ST/Space/11, 2002, p. 4 Article II).

Thirdly, and possibly the most important article to note is Article VI. This article establishes nation states as responsible for all national space activities “*whether carried out by governmental agencies, or by non-governmental agencies*” (ST/Space/11, 2002, p. 4 Article VI).

Essentially, when reading these three articles together, it becomes clear that under a civil law interpretation, no state may appropriate property or resources. Therefore no state can legally confer any rights for development or exploitation on any individual or corporation. Therefore it logically follows, from a civil law perspective, that no individual or corporation may appropriate or claim any form of exclusive rights to property or resources either.

Despite this apparent *de facto* limitation the last decade has seen a significant renewed interest in mankind’s ambition to extend its reach into Space, whether for exploitation of resources (Rosenblum, 2011), exploration (Grillo, 2005), (Valerdi, 2012), or the use of Space as a utility. The increased interest has come from both private and public sectors.

Firstly, there is a growing number of emerging market nations (Å–zalp, 2009),(Giannopapa, 2011),(Ingle, 2011), with space ambitions, who view Space as a strategic imperative for economic growth. Secondly, the industry is experiencing entry of a significant number of private companies, specifically into the space infrastructure sector, led by already successful entrepreneurs such as Richard Branson, Elon Musk (Vance, 2012) and Peter Diamandis (Caulfield, 2012), and with companies such as Virgin Galactic and Space Exploration Technologies (SPACEX). Table 1 is a shortened list of space entrepreneurs and their estimated wealth in 2006; this list has since grown.

**Table 1: List of space entrepreneurs**

Name	Est. wealth	Source	Connection
Paul Allen	\$21B	Microsoft	SpaceShipOne
Jeff Bezos	\$4.1B	Amazon.com	Blue Origin
Richard Branson	\$3.2B	Virgin Corp.	Virgin Galactic
Sergey Brin	\$7.2B	Google	NASA Goddard/ L. Page
Larry Page	\$7.2B	Google	Xprize; SpaceShipOne
Robert Bigelow	NA	Hotel/Real Estate	Bigelow Aerospace
Ellon Musk	\$165M	PayPal	SpaceX
Rick Tumlinson	NA		Space Frontier
John Carmack	NA	Gaming	Armadillo Aerospace
S.Udvar-Hazy	\$2.4B	Lease Finance	Udvar-Hazy Museum

(Mathurin & Peter, 2006, p. 443)

Notably, the primary focus of the majority of these companies has been the development of the space infrastructure sector in the space industry. Space infrastructure is focused on the provisioning of access to Space, such as the development of reusable cargo and crewed transport systems. Currently none of these companies fall strictly into the commons dilemma of appropriating space property or resources, to which rights need to be necessarily apportioned within a *res communis* basis. However, as the privatisation of space infrastructure and launch capabilities advances, so the cost of access will decrease, enabling new space companies such as Planetary Resources and Lunar Express to pursue their aims of extra-terrestrial mining.

Whilst scrapping the OST and re-declaring Space as *res nullius* and opening up the solar system to appropriation through the extension of private property rights, may be a “means to motivate the development of space resources” as suggested by Cooper (2003, p. 117), it would negate the spirit of co-operation surrounding space exploration. Essentially limiting access to a few financially and technologically advanced nations. In However, by not addressing the current regime we run the risk of stifling the continued development of Space and falling back into the tragedy of the anti-commons, as described by Michael Heller (Heller, 1998),(Heller, 2013).

There is a rich history of research and literature describing and investigating the existence and nature of the commons dilemmas, and how to manage them. Commons dilemmas have been described primarily by four models which are discussed in more depth in Chapter Two.

Solutions proposed for avoiding a commons dilemma have traditionally centred on avoiding the commons altogether. Either through the establishment of a Leviathan as defined by Hobbes (1651), (Ophuls, 1973), where normally a government or government institution takes ownership of the resource and manages it; or through the allocation of private property rights, which, arguably under civil law, requires the conferring of property rights by a government to an organisation or individual. Essentially both these proposed solutions negate the commons entirely, by moving the property or resource out of the commons paradigm and into the control of a single entity.

More recently a noted academic and Nobel laureate, Elinor Ostrom has been recognised for her work in identifying and researching a third option: the evolution of the organic growth of institutions for governing the common pool resources (CPR). In her work Ostrom developed an eight point framework, which is discussed in more depth in Chapter two. (Walker, Gardner, Herr, & Ostrom, 2000), (Agrawal & Ostrom, 2001), (Andersson & Ostrom, 2008),

The intention of this paper is to build a theoretical framework for the allocation of bundled functional property rights for the management of a commons, that is able to deal with the paradoxical scenario where avoiding both the “*tragedy of the commons*” (Hardin, 1968) and the “*tragedy of the anti-commons*” (Heller, 1998),(Heller, 2013) is required.

The framework will be built by combining the work of Elinor Ostrom and her many colleagues into existing CPRs and the concept of polycentrism; and the dilemma of the anti-commons and the rights observed by Michael Heller in his work on the anti-commons (Heller, 1998)

The specific context for this paper is to be Outer Space. The changing landscape of space industry has brought to the fore a dire need to understand how to govern in a sustainable manner the diverse interests, not only of nations, but of private companies and individuals, whilst facilitating and encouraging the continued development and investment in a *de facto* commons. The particular focus of this paper will be on property rights as these relate to physical extra-terrestrial land and its resources.

Space can truly be the new frontier of economic growth and investment. But a need for a new governance model for commons has to be addressed. For this reason the intention of this paper is to develop a potential framework of property rights, which provides for sustainable, equitable development and exploitation of space and its resources.

## 2 Literature Review

In the following Chapter the author discusses the two commons dilemmas introduced in Chapter One, the manner in which they manifest or are observed and the additional issues they introduce to the governance models. We then investigate the traditional solutions postulated in literature.

The author then investigates if either of the dilemma models applies to space as a context and whether any of the potential solutions could apply.

Finally the Chapter discusses the development of the framework and frames the propositions that are postulated in Chapter Three.

### 2.1 Commons dilemma models

There are two traditional models focused on describing and highlighting governance issue of commons.

#### 2.1.1 Tragedy of the commons

**“Wealth that is free for all is valued by no one”** (Gordon, 1954, p. 124)

The original commons dilemma, as introduced by Garret Hardin in his seminal paper *“The tragedy of the commons”* (Hardin, 1968), is a well understood and often observed phenomena in economics. The core of the dilemma was explained by Hardin when he sketched the scenario of a grazing ground as a commons. In the scenario a herder who grazes his stock on common ground benefits directly, but incurs a delayed cost from over grazing. Therefore it is of greater immediate benefit for the herder to graze his stock more often than other herders, essentially *“Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited”* (Hardin, 1968, p. 1244). Over time this behaviour results in the over exploitation, degradation and final destruction of the commons, hence the tragedy.

However it must be noted that Hardin was not unique in his observations on the commons. Before him Aristotle explained that *“what is common to the greatest number has the least care bestowed upon it. Everyone thinks chiefly of his own, hardly at all of the common interest”* (Aristotle, 2004).

The basic premise underlying the tragedy of the commons is that man is inherently self-interested and does not cooperate. The tragedy of the commons was formalised by Dawes (1973) in his model of the prisoner’s dilemma (PD).

### **2.1.1.1 The prisoners’ dilemma**

In its simplest form, the prisoners’ dilemma can be understood as a non-cooperative game, in which all the competitors have complete information of the game structure and the potential payoffs that are concomitant to the outcomes. Communication between players is forbidden or not possible. Competitors may, or may not, know the strategies of other competitors, depending on whether strategies are observable. Each player in a game will be said to have a dominant strategy, in that a competitor will always be better off choosing that strategy, regardless of the strategy selected by other competitors. Given the assumptions presented, and expected rational behaviour of competitors, an equilibrium will be achieved in the game that is considered not pareto-optimal, as no competitor has the incentive to change their strategy. A pareto-optimal outcome can be achieved when no outcome is preferred by a competitor that is at least as good for another competitor. In a two competitor game a pareto-inferior equilibrium is reached when both competitors prefer to co-operate, co-operate strategy as opposed to a defect, defect strategy.

Figure 1: Prisoners dilemma

		Player B	
		Cooperate	Defect
Player A	Cooperate	$+1$ $\rightarrow$	$+3$ $\rightarrow$
	Defect	$-1$ $\rightarrow$	$0$ $\rightarrow$

The problem with the prisoners dilemma as a methodology for the analysis of commons dilemmas is that the action based on assumptions, are played out over a limited single round of decision making. The literature is clear that the predictive result in this case is almost always no cooperation.

### 2.1.1.2 The logic of collective action

In 1965 in his work on the logic of collective action, Mancur Olson (Olson, 1965) challenged the long established, accepted group theory that individuals who shared a common interest would voluntarily act in a manner that will further the interests of the group. Instead he posited that once an actor or appropriator cannot be excluded from access to a commons there is little incentive left for that appropriator to continue contributing, voluntarily, to maintaining the common resource, a scenario commonly known as the free-rider problem.

It is important to note that the free-rider problem is predicated on the assumption of the inability of other appropriators to exclude potential appropriators from the commons should they not contribute, or should they exploit beyond the explicit or implicit rules established in the game. Fortunately collective-action theory has matured well beyond the prisoners dilemma and free-rider issues.



## 2.1.2 The tragedy of the anti-commons

*“The tragedy of the anti-commons”* (Heller, 1998) was a term coined by Michael A. Heller to describe a phenomena observed as the anti-thesis of *“the tragedy of the commons”* (Hardin, 1968). An anti-commons, is a resource which has multiple owners with access rights, but most importantly the owners have rights to exclude other owners from access to the resource. Heller contends that *“If too many owners control a single resource, cooperation breaks down, wealth disappears, and everybody loses”* (Heller, 2013, p. 1)

The phenomenon of the anti-commons model has often been used in literature when studying the impact of intellectual property rights on stifling advances in innovation (Murray & Stern, 2007), (Yuan-Chieh & Phil Y, 2008), (Eisenberg, 2008). In his paper Carl Shapiro introduces the concept of a “patent thicket” and asks the very pertinent question *“Is our patent system slowing down the commercialisation of new technologies?”* (Shapiro, 2001, p. 119).

It is in view of this that Heller continues on to say that *“Private property can no longer be seen as the end point of ownership. Privatisation can go too far, to the point where it destroys rather than creates wealth”* (Heller, 2013, p. 11)

## 2.2 The dilemma solutions

In the case of a tragedy of the commons the traditional solutions proposed have revolved around the internalisation of the costly externalities. This can traditionally be achieved by either introducing a *“Leviathan”* (Hobbes, 1651) or through the introduction of private property rights and the privatisation of the common resource.

### 2.2.1 My big brother the Leviathan

A *“Leviathan”*, a term coined by Thomas Hobbes in his book of the same name in 1671, is defined as a necessary all powerful state, or state apparatus, that is required to solve man’s need for social order. Ophuls in his treatise *“Leviathan or oblivion”* argued that

*“even if we avoid the tragedy of the commons it will be by recourse to the tragic necessity of Leviathan”* (1973, p. 229). A view point shared by many researchers including Hardin (1978), Heilbroner (1991), (Lovejoy, 2006).

The basis for the introduction of a Leviathan is the underlying belief *“that those involved in a collective-action problem would not themselves solve it since social dilemmas involve a conflict between rationality and the optimal outcomes for a group”* (Ostrom, 2008, p. 4). Therefore advocates of the Leviathan solution argue that the tragedy can only be averted by enforcing actions of restraint on the involved appropriators. However, De Young and Kaplan (De Young & Kaplan, 2012) argue that a centralized solution, based on coercion will often fail to deal with the innate human phenomenon of resistance against compulsion. In other words, when forced into compliance or involvement in systems without consent, people become motivated to want the forbidden and creatively resist the demanded.

### **2.2.2 Private property**

The second traditional solution to a potential tragedy of the commons, is the introduction of a private property regime, in some form or other. It is clear, from the exhaustive amount of literature available, that the issue of property rights has become central to any investigation into economic theory.

Undoubtedly Coases’ seminal paper *“The Problem of Social Cost”* (Coase, 1960) is considered the founding paper on the economics of property rights and the new institutional economics school of thought. Coase (1960) highlighted the issues arising from the creation of negative externalities and the problems associated with the constraints these externalities created, in the form of transaction costs. Coase argued that for a change in approach to economic policy, in which the transaction costs created by negative externalities could be reduced or mitigated through internalisation.

Notably, Coase never attempted in his paper to address the directly the meaning of property rights as a concept. In an attempt to bridge this gap in understanding property rights, a conceptual framework evolved through the work of new institutional economists such as Alchian(1965), North(1981) and Demsetz(1988), in which property rights were

loosely defined as the exclusive rights over an asset or the attributes of such an asset. Essentially this exclusivity enabled the property to holder to exploit the property without concern or need to quantify the cost of an externalities impact on anyone else (since in theory the externalities are internalised and only affect the property owner).

The mechanism for the emergence of property rights is explained by two seminal papers in new institutional economics, in which Demsetz (1967), and Alchian and Demsetz (1973) postulate, that the notion of private property emerges, as a result of the economic inefficiencies created by common property a position supported by Furubotn and Richter (1998). These perceived economic inefficiencies, stem from the underlying assumptions of the economic model described, as one of a scarcity of the resource in question and the constraints imposed by the negative externalities, that may occur and transaction costs involved. In other words private property emerges because it is more efficient than common property because it believed that common property inherently bears a large social cost and negative externalities. Therefore the more property is privatised the lower the associated transaction costs.

### **2.2.3 Common pool resources – An evolution of institutions for collective action**

Recently empirical work conducted by the eminent and Nobel Laureate Elinor Ostrom has shown multiple scenarios in which institutions that have grown organically have established implicit and explicit rules that govern CPRs. From her work and the contributions of many of her colleagues, Ostrom postulated a framework, not as a solution to all commons dilemmas, but rather as an indicator of whether the governance structure of a CPR is sustainable.

In study of commons dilemmas there are essentially four types of goods: public goods, toll goods, private goods and common-pool resources (E. Ostrom, Gardner, & Walker, 1994) . Figure 2, below gives a simple method of visualizing the differences between these goods

**Figure 2: Four types of Economic goods**

		Subtractability of Use	
		High	Low
Difficulty of Excluding Potential Beneficiaries	High	Common-pool resources: groundwater basins, lakes, irrigation systems, fisheries, forests, etc.	Public goods: peace and security of a community, national defense, knowledge, fire protection, weather forecasts, etc.
	Low	Private goods: food, clothing, automobiles, etc.	Toll goods: theaters, private clubs, daycare centers

Taken from *Beyond markets and states: polycentric governance of complex economic systems* (Elinor Ostrom, 2010, p. 645)

Over more than a decade of empirical research of CPR dilemmas, Ostrom and her colleagues have asserted that “...centralizers and the privatizers frequently advocate oversimplified idealized solutions...” (Ostrom, 1990, p. 22) These solutions tell us nothing about how a central Leviathan is organised or how property rights may be bundled. Ostrom’s extensive research into organic evolution of institutions that govern CPRs, successfully and unsuccessfully, led to the development of a framework for describing the prerequisites for the successful governing CPRs. Her framework of eight points were,

### **2.2.3.1 Clearly defined boundaries.**

CPRs that have organically developed institutions that successfully manage them, have very clearly defined boundaries. According to Ostrom “So long as the boundaries of the resource and/or the specification of individuals who can use the resource remain uncertain, no one knows what is being managed or for whom.” (Ostrom, 1990, p. 91). The primary reason for the clear definition of a boundary is to prevent the collective action problem of free-riding

### **2.2.3.2 Congruence**

Requirement for congruence between the governance structures or rules and the resource context may seem intuitive but more often than not the temptation is to copy rules and structures from CPR that has similar characteristics. A methodology that, if followed, could result in overlooking a unique aspect of a particular CPR.

### **2.2.3.3 Collective choice arrangements**

Collective choice arrangement should allow for the appropriators to participate in decision making processes. According to Ostrom's research CPR institutions which develop operational rules with direct input from appropriators are more likely to endure over time.

### **2.2.3.4 Effective monitoring**

According to Ostrom's research the ability of appropriators to monitor the actions of other appropriators within the context of a common resource pool is essential. Monitoring allows each appropriator to determine for themselves that other appropriators are abiding by the rules. Such monitoring is more effective when performed by the appropriators themselves or by an institution that is accountable to appropriators. There are multiple concerns when one discusses monitoring the actions of appropriators in Space but such concerns are unlikely to be unique in their nature, but as pointed out by Weeden and Chow are more likely to revolve around "*...convincing resource appropriators that such challenges are mainly a function of trust (or lack thereof)*" (Weeden & Chow, 2012, p. 170).

In the context of Space monitoring "*...costs of any proposed CPR rule, cost distribution among resource appropriators, and the relative benefits of any such system to the appropriators*" (Weeden & Chow, 2012, p. 170) will also have to be carefully considered.

### **2.2.3.5 Graduate sanctions**

Ostrom's research found that effective institution for the governance of CPRs had implemented systems of graduate sanction for rule infractions. Minor or infrequent infractions are allowed for in a flexible system of sanctioning and punishment. Weeden and Chow point out that such "*A system of graduated penalties [may] helps circumvent typical regime enforcement issues*" (Weeden & Chow, 2012, p. 170)

### **2.2.3.6 Conflict resolution mechanisms.**

Ostrom found that low-cost mechanisms that were focused on the speedy resolution of dispute are fundamental to any CPR regime governance structure.

### **2.2.3.7 Nested enterprises.**

In the case of larger CPRs, Ostrom's work found that successful management was predicated on governance structures that were embedded in a multi-level format.

Weeden & Chow point out that the OST "*establishes the nation-state as The Outer Space Treaty establishes the nation-state as the primary responsible authority when it comes to space activities.*" (Weeden & Chow, 2012, p. 171), creating the initial impetus for a nested enterprise as nation-states are expected to monitor the actions of their citizens in Space.

## **2.3 The dilemma of dilemma fit**

The question that needs to be asked is which, if any, of the dilemma models described above pertain to the context of space property and its resources. For the purposes of this study we need to consider two aspects. As previously noted Outer Space was legally declared a commons in the OST of 1967. An action deemed by Everett Dolman, a noted space theorist, to be aimed at solving and "*entirely speculative collective action problem*" (Dolman, 2002, p. 138). Subsequently he asserts that this has resulted in space becoming an anti-commons dilemma.

### **2.3.1 A potential tragedy of the commons**

For a potential tragedy of the commons to exist a commons must exist. If we interrogate the traditional models of the "*tragedy of commons*" (Hardin, 1968) it hardly seems logical that the expansion into Outer Space would result in a commons tragedy. In fact, certain commentators have pointed out that Space is far too large to ever pose commons tragedy (Cooper, 2003) and as such should be reverted to a *res nullius* status.

However, Space seems to fit the natural criteria of an open access problem. Even though very few countries currently possess the technological competency required to gain access to Space, the OST has clearly designated Space as open access. Additionally no organisation exists that has the ability to exclude any potential new comers. When considering the individual resource pools within the context of Space itself, the discourse takes a different shape. For example, when discussing the potential for the exploitation of Helium 3 (H3) on the Moon, it becomes clearer that a potential of a resource scarcity exists, revealing therefore that our closest natural match, when discussing the exploitation of celestial bodies, would be described by the definition of Ostrom's CPR (Ostrom, 1990).

A common-pool resource (CPR) is defined by Ostrom as a "*natural or man-made resource system*" (Ostrom, 1990, p. 30) that is characterized by two fundamental problems. Firstly, "*high subtractibility of use*" (Ostrom, 1990, p. 30) , where if an actor or appropriator extracts a resource from the CPR, it subtracts from the ability of another actor or appropriator, to extract that resource from the CPR.

Secondly, the size of the CPR is sufficiently large enough to make it "*difficult, but not impossible to define recognized users*" (Ostrom, 1990, p. 30) or appropriators, "*and exclude other users*" or appropriators "*altogether*". Again it must be pointed out that even though there are very appropriators who currently possess the technology to access existing CPRs in Space, there exists no legislation, nor Leviathan to prevent any appropriators from access once they develop the required technology. For this reason we cannot but accept the assertion, not only from a natural point of view, but also from an international legal standpoint, that the first dilemma we face is one of sustainably governing Space commons comprised of an unknown number of potential CPRs. Conceptualising a governance structure for Space in this manner is consistent with the eighth point of Ostrom's framework or nested enterprises a view supported by Weeden and Chow who point out that "*Although outer space as a whole is a global commons, it is not useful to discuss a single governance model for the entirety of outer space*", rather "*... in the same way that the global commons of the Earth's oceans contains multiple CPRs,*

*each representing individual resource extraction areas ... separate CPRs need to be defined within the global commons of space.” (Weeden & Chow, 2012, p. 168)*

### **2.3.2 A potential tragedy of the anti-commons**

In a similar vein it must also be noted that we potentially face the dilemma of anti-commons as postulated by Heller and asserted by Dolman (Dolman, 2002). For a tragedy of the anti-commons to occur two criteria need to be fulfilled. Firstly the existence of a commons, which we have discussed above, and secondly the existence of global exclusion potential of all other appropriators by a single appropriator, essentially ensuring that resources are not exploited, underexploited or as argued by Buchanan and Yoon “*inefficiently underutilised*” (Buchanan & Yoon, 2000, p. 1). Given the reluctance of space faring nations to share technology used to access Space, it could be argued that there is in effect an ability to exclude emerging nations from access to the commons. In a similar manner the attempt by certain nations to implement the Moon Treaty of 1973, could be seen as an attempt to exclude property rights in Space altogether, or rather seen as a political attempt to exclude space faring nation from exploiting resources in the commons. This analysis would seem to give credence to Dolmans assessment and a tragedy of the anti-commons has occurred and still looms over the development of space and its resources.

## **2.4 Space as a commons**

In an effort to solve a commons dilemma such as the tragedy of the commons and as more recently pointed out a tragedy of the anti-commons, one needs to understand, at a fundamental level, the nature of the dilemma and its context.

Traditionally space exploration has been undertaken by governments who could afford the large capital injections required, without the expectation of significant returns on investment, at least not from a profit point of view. Such large scale investments were



primarily driven by national pride. (Peter, 2008) described four phases of space exploration.

**Table 2: Classification of space exploration**

Exploration phase	Time period	Characteristics
Proto-space Age	Before WWII	Leadership of individuals (and societies) such as Robert H. Goddard, Konstantin Tsiolkovsky, Hermann Oberth, Hermann Potocnik, Robert Esnault-Pelterie, et al. Influenced by Herbert G. Wells, Jules Verne, and other science fiction authors
Space Exploration 1.0	Cold War	Competition between the USA and the USSR with cooperation limited mostly to intra-bloc partnerships driven primarily by political considerations (duopoly situation)
Space Exploration 2.0	1990s – present	Exploration plans with new countries willing to participate, driven primarily by scientific motives (oligopoly situation)
Space Exploration 3.0	Near future	Era of participatory human exploration (nations, industries, universities, and other NGOs) driven primarily by the quest for knowledge (including Arts and Humanities disciplines) as well as economic potential (open-market situation)

Excerpt from *Humans in Outer Space – Interdisciplinary Odysseys*. New York: Springer p. 108

The current legal framework for the management of Space was established during the phase referred to by Peter as Space Exploration 1.0. The environmental context of the time was the cold war, when a significant driver for scientific development and space exploration was national pride and it is widely recognised that the primary aim of the OST was to avoid the militarisation of space. (Ehrenfreund, Peter, Schrogl, & Logsdon, 2010)

Ehrenfreund and Peter assert that regional politics and national pride will still play an important part in space exploration and expansion, especially within the emerging space faring nations. In Asia, emerging market national players such as China, who wish to put a man on the moon by 2017 (Cyranski, 2008);(Solomone, 2005) and India with its proposed missions to Mars (“India steps up space program with big budget, bigger satellites and a leap to Mars,” September 30) compete for regional leadership. However, such regional competitiveness needs to be understood in the context of the transitional nature of the space exploration eras.

Kazuto Suzuki appears to support this view, concluding that in the contest for leadership in East Asia, where he has defined three arenas:

- “*Soft Power*” (defined as competition for prestige)
- “*Hard Power*” (defined as the competition over military capability) and

- *“Economic Power”* (defined as competition for the provisioning of international services or public goods)

Only the third or economic arena can actually be considered to be in contest (Suzuki, 2013).

According to Ehrenfreund and Peter (2009) and Ehrenfreund, Peter, Schrogl, & Logsdon, (2010) we are currently in transition from space exploration 2.0 era to space exploration 3.0: an *“Era of participatory human exploration”* (Ehrenfreund & Peter, 2009, p. 245). One which will span beyond the interests of nation to include various new stakeholders such as non-governmental organisations (NGOs), universities and industries. The organic evolution into this new era will require *“a new organisational structure that acts globally and embraces the interaction of many different stakeholders”* (Ehrenfreund & Peter, 2009, p. 245) as *“new exploration endeavours”* become more *“driven by economics”* (Ehrenfreund & Peter, 2009, p. 245)

Further evidence of the commercialisation of the space economy can be seen in the United States of Americas policy realignment to encourage and facilitate the emergence of private companies as players in the field of space infrastructure development (*“The President’s Remarks on Space Exploration: Revitalizing NASA and Its Mission,”* 2011). The results of which can be seen in the exponential expansion of new commercial space businesses (Pelton, 2012).

The growing number of emerging market nations (Å-zalp, 2009),(Giannopapa, 2011),(Ingle, 2011), with space ambitions and the entrance of a significant amount of private companies, specifically into the space infrastructure sector of the industry, has brought to the fore a dire need to understand how to manage the diverse interests not only of nations, but also of private companies and individuals in space, whilst finding methods to facilitate and encourage private enterprise and investment in this economic field.

### 2.4.1 Space as a (universal) common-pool resource

According to Weeden and Chow space can be defined as a “*global commons*”, which “*refers to large scale resource environments that are inherently international, extremely difficult to own in whole or part, and accessible to anybody.*” (Weeden & Chow, 2012, p. 166). If one were to take this argument to its logical conclusion it must be said that Space is not just a global commons, as its access could never be defined solely as international. But it should rather be defined as a universal commons, as a complete list of potential appropriators could never definitively be drawn up or restricted to the human species.

In their paper “Taking a common pool resource approach to space” Weeden and Chow (2012) propose that the use of Ostrom’s framework of eight principles toward managing Space as commons. They do however, acknowledge that the one caveat to the conceptual framework being that Ostrom’s work was primarily focused on “*small scale, local or regional commons*” (Weeden & Chow, 2012, p. 167) and that “*it is not a foregone conclusion that Ostrom’s principles can be extrapolated to a ‘global commons’*”. However, according to Weeden & Chow (2012) more recent work on the concept of ‘*adaptive governance*’, which states that “*successful commons governance requires that rules evolve*” (Dietz, Ostrom, & Stern, 2003), is “*especially applicable and fitting for the space domain*” (Weeden & Chow, 2012, p. 167).

Weeden and Chow specifically focus their attention on the application of the framework on near-earth orbit (NEO) application. However, the author feels that the eighth principle of “*Nested enterprises*”, as discussed in section 2.2.3, is a concept which is already catered for in existing international legislative framework, and is eminently suited toward application and extrapolation, not only to “*global commons*” but “*universal commons*”. According to Weeden and Chow “*Nested enterprises are already in place to some extent in the space domain*” (Weeden & Chow, 2012, p. 171)

## 2.4.2 Polycentric design

At the core of the proposed framework design is the concept of polycentric governance of CPRs, as formulated by Vincent Ostrom and Charles Tiebout,. Essentially *“Polycentric’ connotes many centres of decision making that are formally independent of each other.”*(V. Ostrom, Tiebout, & Warren, 1961, p. 831)

There is a rich history in academia of argument for the centralisation of resource control and arguments for the decentralisation of resource governance and the efficacy of both models is hotly contested. However, Andersson and Ostrom, whilst acknowledging that *“All governance institutions are imperfect responses to the challenge of collective action problems”* (Andersson & Ostrom, 2008, p. 73), argue that neither of the prescriptive of full decentralisation or centralisation options are effective. Rather the *“adequacy of a particular governance structure depends on several context specific attributes”* (Andersson & Ostrom, 2008, p. 76). Andersson and Ostrom postulate in their research that the *“key to effective governance arrangements”* is in the relationships among the appropriators *“who have a stake in the governance of the resource.”* (Andersson & Ostrom, 2008, p. 88)

## 2.5 Conclusion

In conclusion it is evident from the literature presented, that Space is considered a global commons, not only from the view of the existing international legal framework as establish by the OST and its supporting treaties. But also from a natural economic definition of a commons. Furthermore, Weeden and Chow (2012) argue that Space should be viewed as a global commons comprised of multiple common resource pools.

The literature also establishes that, as a commons Space and specifically individual CPR within the Space context, are potentially in danger of suffering from a tragedy of the commons as described by Hardin (1968). Additionally Space is already suffering from a tragedy of the anti-commons as described by Heller (1998), (2013), because as pointed

out by Dolman (2002) the OST has become a barrier to private investment in Space by its *de facto* exclusion of a profit motive.

The literature then leads us to the not so simple question of how to govern Space as a commons. The debate has three sides to it. Firstly, there are those, such as Hardin (1978), Heilbroner (1991) and Lovejoy (2006), who advocate for the establishment of a Leviathan. However, such an action would require nation-states to submit their ultimate authority to such a Leviathan. A concept that is not feasible at this point in human history, nor palatable in the realms of geo-political discourse.

Secondly, there are those who view the OST as a barrier to private investment in and the development of Space (Cooper, 2003). Leading them to advocate the abrogation of the OST and declaring Space a *res nullius*, thereby allowing for strict imposition of private property rights in attempts to promote economic efficiencies. A view that would be supported by the new institutional economists such as, Alchian(1965), North(1981) and Demsetz(1988). Wasser and Jobes (2008) argue that because the OST does not explicitly exclude or ban private property rights it must therefore be legal; invoking “*The long-accepted legal doctrine ‘expressio unius est exclusio alterius’ says that, when interpreting statutes, we should presume things not mentioned were excluded by deliberate choice, not inadvertence*” (Wasser & Jobes, 2008, p. 47).

However, some commentators, such as Pop (Pop, 2000), believe that for property rights to exist they need to be defended and therefore must be acknowledged by a nation-state. Pop clearly argues, from a common law perspective, that property rights “*cannot exist outside the sphere of State protection*” (Pop, 2000, p. 277). Regardless of whether such property rights can be considered legal in Pop’s view “*landed private property cannot survive outside the sphere of sovereignty or sovereign rights*” (Pop, 2000, p. 277) making the enforcement of these property rights carry huge transaction costs as individual countries may end up bickering over rights and recognition of sovereignty.

Wasser and Jobes reject this argument by taking a civil law perspective, arguing that under natural law and the principle of *pedis possessio*, “*individuals mix their labour with*

*the soil and create property rights independent of government”* (Wasser & Jobes, 2008, p. 49). Yet acknowledge that the government is required to recognise those rights

The third view and the approach adopted by the author, is to follow in the footsteps of the work conceived by Ostrom and proposed by Weeden and Chow (2012). The author has developed an *a priori* framework, presented in section 2.6, toward the allocation of a set of functional property rights, which could feasibly operate within the existing legal framework established by the OST. The framework is built on the work of Ostrom and Heller in an attempt to address both commons dilemmas.

***Proposition I: It is therefore proposed that, the following a priori framework toward the allocation of functional or quasi property rights, could feasibly be implemented and operate within the existing international legal framework for the governance of space as a common pool resource, as established by the OST.***

## **2.6 Proposed Framework**

The framework needs to address three fundamental structures.

- The nature of property rights in Space
- The roles appropriators might assume in the framework
- The nature of the potential appropriators

Thereafter to complete the framework two mappings are made

- Mapping the roles to the appropriators
- Mapping roles to rights

Given the context of space as a CPR, the current international legal framework and the level of co-operation and collaboration amongst potential appropriators, it follows logically and through the fundamental research findings of

Andersson and Ostrom (2008) that the most effective governance structure for space as a CPR, should have a polycentric flavour to it.

Therefore one of the underlying structural aspects of the framework is an attempt to decentralise the decision making aspect of the framework, this polycentric design is incorporated in the design of the framework in the manner in which the rights are allocated to the differing roles in a non-cumulative manner.

### **2.6.1 The proposed nature of property rights in Space**

As discussed in section 2.2.2 private property rights have, mistakenly, often been confused as a single omnipotent right of alienation, where a single organisation, government or individual, holds the ability to sell all rights of a property, to another party. This form of simple property right is not feasible under the current international legal framework, neither is it acceptable at this point.(Pop, 2000)(Dalton, 2010). Functional property rights however are a possibility.

In an effort *“to think of property-rights systems in regard to bundles of rights”* (Elinor Ostrom, 2008, p. 5), as opposed to a single alienable, omnipotent right, Schalger and Ostrom (1992) built on the insights of Ciriacy-Wantrup and Bishop (1975) and John Commons (1968) and developed a set of five rights from observations made during empirical studies of operational resource systems. These rights were then allocated in a cumulative fashion to a set of five roles that appropriators may play in a CPR scenario. As shown in Table 3 on the following page.

**Table 3: Schlager and Ostrom’s cumulative bundle of rights and roles**

	Authorised Viewer	Authorised User	Claimant	Proprietor	Owner
Access – right to enter defined physical property	X	X	X	X	X
Withdrawal – the right to harvest products or resources		X	X	X	X
Management – the right to determine and regulate use			X	X	X
Exclusion – the right to exclude other appropriators from access				X	X
Alienation – the right to sell or lease any of the above rights					X

Derived from Design principles of robust property-rights institutions: What we have learned (Elinor Ostrom, 2008, pp. 3–5)

The set of rights bundles and roles that assume those rights, along with the bundles of rights observed by Heller (See Appendix II) in his paper on the anti-commons (Heller, 1998, p. 638) form the basis of the *a priori* framework proposed, with some critical exceptions.

Firstly, Heller’s rights of the “*Right to sell*” and the “*Right to receive sale revenue*” are not pertinent, as the current legal framework does not allow for any claims of sovereignty and therefore no sales can legally take place. Additionally, and most importantly, the proposed rights bundles in the *a priori* framework are not cumulative, as in the case of Schlager and Ostrom’s framework, resulting in different roles being accorded, different rights that are very distinct. Table 4 on the following page gives a brief description of rights accorded within the proposed *a priori* framework.



**Table 4: Framework of proposed property rights and duties in space**

<b>Right</b>	<b>Description</b>
Right to access	The right to access property
Right to lease	The right to lease a property to another party
Right to receive revenue	The right to receive lease revenue
Right to occupy	The right to occupy leased property and develop the property
Right to generate revenue	The right to develop, harvest and improve property and to generate revenue from the property and resource on the property
Exclusion	The right to exclude other roles from access and retention of any rights over the property
Right to determine use	The right to determine the nature of property use
Right of alienation	The right to sell or lease obtained rights to a third party who holds the same appropriation role

***Proposition II: It is therefore proposed that the eight rights described in Table 4 above, can effectively act as a bundle of functional or quasi property rights within the existing international legal framework for the governance of space as a common pool resource.***

## **2.6.2 Proposed roles**

From the rights identified in the previous section a set of roles were then developed. The intention was to abstract the direct rights from specific institutions and rather assign roles to institutions in the subsequent sections of the framework. In this manner the framework may be extended and/or possibly extrapolated to other similar commons dilemmas.

There were four roles identified by Ostrom (2008) these roles were adapted and mapped to rights that would be assigned to the specified roles.

### **2.6.2.1 Proprietor**

The role of the proprietor in the framework is to oversee and register requests for access to resource pools. The proprietor does not own any land or resources but rather co-

ordinates requests from authorised users and authorised researcher roles and tries to ensure that there is not competing requests or claims to access.

### **2.6.2.2 Authorised viewer**

The role of the authorised viewer is essentially to act as a check or balance within the framework and as a potential arbitrator should a dispute arise between the proprietors and/or authorised users. The authorised viewer therefore also holds a cumulative registry of granted accesses.

### **2.6.2.3 Authorised researcher**

An Authorised Researcher is essentially a form of Authorised User. He has an interest in Space as for research and exploratory purposes

### **2.6.2.4 Authorised user**

The authorised user in this framework is any corporation or individual who has a desire to access or exploit resource or property in Space. Table 5 below gives a summary of the roles and envisioned institutional appropriators that would perform the roles.

**Table 5: Proposed Roles**

<b>Roles</b>
Proprietor
Authorised Viewer
Authorised Researcher
Authorised User

### 2.6.3 Nature of the appropriators

One of the core pillars of the framework is its polycentric design which requires the consensus of multiple appropriator roles that are theoretically independent and have diverse interests in the resources, before allowing the exploitation of the property or resource. In this manner monitoring is built into the responsibility architecture of specific roles. One of the limitations is an increased risk of transaction cost scaling. However Ostrom argues that when the costs of monitoring for appropriators scales, they are more likely to craft rules that make infractions highly obvious, thus mitigating the costs. (E Ostrom, 1990). The establishment of institutions that would fulfill these roles is outside of the scope of this study. But it is envisioned that the institutions would mirror the four strata of society that best represent mankind's interest in space expansion and the most likely to be considered legitimate appropriators,

- Civil Society Government or State
- Individuals and corporations
- Research institutions and Universities

As representative of each strata of society that are required to coexist in a collective action agreement we assign roles to each representative institution. In this manner each group in society has access to participate in decision making process. Table 6 below lists the institution involved.

**Table 6: Institutions**

<b>Institution</b>
Government
Civil Society
University
Corporation

## **2.6.4 Roles and appropriators**

This section of the framework is to identify the appropriators that might fulfil the roles specified within the common. As discussed above the appropriators that fulfil these roles mirror the four strata of society the best represent man's interest in space.

### **2.6.4.1 Proprietor**

The traditional appropriator of Space has always been government and for the foreseeable future governments will remain the highest form for geopolitical power. Additionally within the framework of the OST the nation state remains responsible for the actions of its citizens in space.

### **2.6.4.2 Authorised viewer**

The role of the authorised viewer is essentially to act as a check or balance within the framework and as a potential arbitrator should a dispute arise between the proprietors and/or authorised users. A role traditionally played, on earth, by civil society groups or on an international geopolitical level, the United Nations (UN). In the case of Space and its resources this role is likely to be effectively filled by UN organisations such as the United Nations Office for Outer Space Affairs or one of its sub-committees, such as the Committee on the Peaceful Uses of Outer Space.

### **2.6.4.3 Authorised researcher**

An Authorised Researcher is essentially a form of Authorised User. It can either be an independent research institution but is more likely to be an institution that would represent the interests of academic research institutions on an international basis.

### **2.6.4.4 Authorised user**

The authorised user in this framework is any corporation or individual who wishes to access or exploit and resource or property in space.

Table 7 below gives a summary of the roles and envisioned institutional appropriators that would perform the roles.

**Table 7: Proposed institutions that may fulfil the roles**

<b>Roles</b>	<b>Institution</b>
Proprietor	Government
Authorised Viewer	Civil Society
Authorised Researcher	University
Authorised User	Corporation

***Proposition III: It is therefore proposed that, the institutions that would most effectively perform the roles described in section 2.6.2 within the existing international legal framework for the governance of space as a common pool resource are shown in Table 7 above.***

## 2.6.5 Rights allocated to roles

The final section of the framework description maps the roles to the rights in the Table 8 and then describes the application of the framework through the discussion of a simple potential scenario. It must be noted here that the manner of allocation of rights, specifically the right to determine exclusion speak to the polycentric nature of the framework.

**Table 8: Final proposed framework**

	Authorised Viewer	Authorised User	Authorised Researcher	Proprietor
Right to access	X	X	X	X
Right to lease				X
Right to receive revenue from lease				X
Right to occupy		X	X	
Right generate revenue		X	X	
Exclusion – the right to determine exclusion	X			X
Right to determine use	X			X
Alienation – the right to sell or lease any rights to institutions of the same category		X		X

***Proposition IV: It is therefore proposed that, the polycentric framework of the allocation of rights to roles as laid out in Table 8 above, represents a valid allocation of rights to the roles and institutions, within the existing international legal framework for the governance of space as a common pool resource.***

## 2.6.6 Scenario

In this final section the author briefly outlines the functioning of the proposed framework and a basic potential scenario.

Company X identifies a resource or piece of land on the moon that it wishes to exploit. Company X would then approach its proprietor (Nation State) and file an application for access to and lease of the property to access the resource. The proprietor (Nation State) who holds the following rights;

- Exclusion
- Right to Lease
- Right to determine use

May either deny the application or if it grants the application dependent on the locally establish national legal framework, it registers the allocation with the authorised viewer.

The authorised viewer who holds the following rights;

- Exclusion
- Right to determine use

May reject the application for registration if there is an existing registration, or the intended use is in conflict with a global interest (e.g. granting the registration may do harm to an existing appropriator or registration such as the Apollo circuit sites). Should the application for registration be accepted then a nominal lease cost is charged for the duration of the lease, is borne by the proprietor and paid to the authorised viewer, for the purposes of maintenance of the registration.

In this scenario Company X now holds the rights to

- Occupy the property – for the purposes identified in its application
- Generate revenue from the property and its resource – in manner identified in its application (i.e. if Company X holds a tourist use right, it may not mine)
- Alienation – the company may sell or lease its rights to the property or resource. However it may only do so to institutions that fulfil the same appropriation role and the determined use remains the same. (i.e. if Company X sells or leases to

Company Y, Company Y is bound by the same application restrictions that would be imposed on Company X)

Notably the framework does not address the processes or laws that a proprietor (Nation State) may establish internally to manage its responsibilities and liabilities.



### 3 Research Propositions

The following Chapter reiterates the propositions that form the constructs of the *a priori* framework for the allocation of extra-terrestrial property rights for the governance of Space as a commons that was developed in Chapter Two.

To answer proposition one sufficiently, all aspects of the framework had to be verified. In other words for proposition one to hold, propositions two, three and four have to hold and are therefore considered sub-propositions.

#### 3.1 Proposition I – Framework legality

Proposition one states that, the *a priori* framework developed in section 2.6, toward the allocation of functional or quasi property rights, could feasibly be implemented and operate within the existing international legal framework for the governance of space as a CPR, as established by the OST.

##### 3.1.1 Proposition II – Potential property rights

Proposition two states that, the eight rights, as described in Table 9 below, can effectively act as a bundle of functional or quasi property rights within the existing international legal framework for the governance for the governance of Space as a CPR.

**Table 9: Proposition II – Final non-cumulative property rights in space**

Right	Description
Right to access	The right to access property
Right to lease	The right to lease a property to another party
Right to receive revenue	The right to receive lease revenue
Right to occupy	The right to occupy leased property and develop the property
Right to generate revenue	The right to develop, harvest and improve property and to generate revenue from the property and resource on the property
Exclusion	The right to exclude others from access and retention of any rights over the property
Right to determine use	The right to determine the nature of property use
Right of alienation	The right to sell or lease obtained rights to a third party who holds the same appropriation role

### 3.1.2 Proposition III – Legitimate appropriators

Proposition three states that, the institutions the institutions that would most effectively perform the roles described in section 2.6.2 within the existing international legal framework for the governance of space as a CPR are shown in Table 10 below.

**Table 10: Proposition III – Final roles and institutions**

<b>Roles</b>	<b>Institution</b>
Proprietor	Government
Authorised Viewer	Civil Society
Authorised Researcher	University
Authorised User	Corporation

### 3.1.3 Proposition IV – Rights allocation

Proposition four states that, the polycentric framework of the allocation of rights to roles as laid out in Table 11 below represents a valid allocation of rights to the roles and institutions, within the existing international legal framework for the governance of space as a CPR.

**Table 11:** Proposition IV - Final rights allocation framework

	Authorised Viewer	Authorised User	Authorised Researcher	Proprietor
<b>Right to access</b>	X	X	X	X
<b>Right to lease</b>				X
<b>Right to receive revenue from lease</b>	X			
<b>Right to occupy</b>		X	X	
<b>Right generate revenue</b>		X	X	
<b>Exclusion – the right to determine exclusion</b>	X		X	X
<b>Right to determine use</b>	X			X
<b>Alienation – the right to sell or lease any rights to institutions of the same category</b>		X	X	X

## 4 Research methodology

The following Chapter presents the chosen methodology used to gather and analyse the data. In addition this Chapter discusses the limitation of the research method used.

The study was focused on the development of a framework for the allocation of property rights in a commons environment that would encourage the investment in and development of such a commons. A prototype or *a priori* framework was developed through the literature review in Chapter Two which yielded four propositions that were presented in Chapter Three. The objective of the research was to test the validity of the propositions, thereby validating the framework and adjusting accordingly, should new potential variables be uncovered.

### 4.1 Research Method and Rationale

As the *a priori* framework developed in Chapter Two drew on multiple fields of study, such as economics, international relations, politics, policy and law, it became evident that the study required an in depth understanding of a broad range of subjects. Subsequently the chosen research design was qualitative and exploratory in nature.

According to Saunders & Lewis (Saunders, Lewis, & Thornhill, 2011), exploratory research can be considered useful in trying to clarify the nature of a problem. Additionally, Robson describes exploratory research as being valuable when the researcher is searching for new insights or looking to evaluate phenomena in a new light (Robson, 2002).

The context of the study was set in the re-emergent economic sector of space exploration and development. It was primarily focused on a perceived problem of a lack of private property rights in Space as a cause for the *de facto* exclusion of the profit motive.

The use of exploratory research was further motivated by discoveries made during the literature review process that interpretations of the international legal framework still generate debate as to whether Space is a commons or not.

Cooper and Schindler (Bloomberg, Cooper, & Schindler, 2008) noted that exploratory research, although associated with subjectivity, non-representativeness and non-systematic design, should not be slighted as it is useful in covering areas that are new or vague, in which the researcher needs to do an exploration to learn something about the issues being researched and possibly uncover future research tasks.

#### **4.1.1 Population and sampling**

##### **4.1.1.1 Population**

The nature of the research questions indicated that the universe from which a sample could be derived was quite narrow. Even though this encompassed interested parties from nation states to individual entrepreneurs as potential appropriators of space and its resources, very few individual are active in the arena or were deemed to have specialised enough insight to make meaningful contributions to the study. Therefore the population comprised representatives of nation states, non-governmental organisations, think tanks and private enterprises that were or are directly involved in the research or development of Space, space policy, space infrastructure or the space economy as a whole.

##### **4.1.1.2 Sampling method**

Although it would theoretically be possible to employ a probability sampling methodology, as a complete list of potential appropriators could be drawn up, such a list would be extensive, making the research impractical. Additionally, due to the nature of the subject, gaining access to the respondents as representatives of the listed potential appropriators was not simple. For this reason a non-probability sampling method was employed. The sampling methodology, in this case, was a mixture of purposive, snowballing and to a lesser extent convenience sampling.

###### **4.1.1.2.1 Purposive Sampling**

According to Saunders & Lewis purposive sampling is a *“type of non-probability sampling in which the researchers’ judgement is used to select the sample members based on a range of possible reasons and premises”* (Saunders et al., 2011, p. 138)

In this research the primary sampling unit was the individual expert. A purposive sampling methodology was used. The criterion for selecting Individual respondents was based on various factors dependent on the sector in which the individual was involved. For example respondents chosen from government organisations were selected on the basis of their influence in driving national and/or international strategic agendas on the involvement of states or private enterprises in the development of space infrastructure capabilities.

From private enterprises, individuals were selected based on their seniority and influence within their organisations and industrial sectors that were currently actively involved in the development of infrastructure and corporate strategy where possible. From non-governmental organisation, individuals who are well respected and considered thought leaders were identified and approached for input.

Notably, as the industry context is still small and specialised, respondents often had prior experience in government and were now employed in private organisations or represented the interests of organisations within government.

#### **4.1.1.2.2 Snowball sampling**

Access to the types of organisations identified and at the required levels of seniority of respondents needed to ensure richness in the collected data for this research was by no means simple and became significant limitation in the overall research process. For this reason the referral technique of snowballing technique was employed in conjunction with the purposive sampling. Snowball sampling is defined by Saunders & Lewis as *“a type of non-probability sampling in which, after the first sample member subsequent sample members are identified by earlier sample members”* (Saunders et al., 2011, p. 139)

Notably the snowball sampling methodology introduced bias, as respondents were generally only able to refer the researcher to additional respondents from the same nation state, who shared the same basic fundamental economic ideology. However, the author was able to partially mitigate this by using purposive sampling, as the researcher

was able to purposely select respondents to encourage varying view points and therefore better data variance.

### **4.1.2 Sample Size**

According to Leedy and Omrod (2001), when conducting qualitative research with in-depth interviews, a sample size of between five and twenty five respondents is sufficient. The original aim was to interview between eight and twelve respondents spread across the four potential institutional appropriators identified in the framework in section 3.3 table 12. In addition, due to varying interpretation of existing international legal framework, a greater variety in national representivity would have been preferred. However, due to access issues only six interviews could be finalised. Even though this was below the upper bound of the target, it was still within the target range and therefore deemed to be valid amount of respondents. Additionally when considering the nature of the topic and limited number of experts in the field it was considered sufficient.

## **4.2 Data collection method**

As the research method was to be qualitative and exploratory, the proposed collection method was in-depth interviews. Qualitative research is by definition aimed at gaining depth of information through the interview process. In this manner new themes can be uncovered or identified. According to Marshall and Rossman *“in-depth interviews are more like conversations than formal events”* (Marshall & Rossman, 2010, p. 101) during which the respondents views, or emic perspective, of the phenomena in question are revealed and investigated, as opposed to the researchers views, or etic perspective.

### **4.2.1 Data collection tools**

Given that the context of the research, respondents were specifically selected to represent potentially opposing viewpoints of differing organisations within in the space industry, a standardised set of interview questions would not aid in the probative nature of process. Therefore only a basic interview guideline was used (See Appendix III), covering the thematic content of the framework proposed and envisaged problem.

According to Saunders and Lewis (2012) pilot interviews are important in ensuring that the content of interviews are appropriate, in order to ensure that any issues can be addressed before engaging directly with the targeted sample. Unfortunately due to the limited availability of experts in the field of study a pilot interview could not be conducted. However, the interview guide was adjusted (See Appendix IV) to include or probe emerging themes from one interview to another.

Additionally, due to the specialist nature of the respondents, all respondents were located overseas requiring the interviews to be conducted via recorded Skype sessions. Unfortunately due to technical difficulties experienced during the interview of respondent two (R2), the recording software failed. Resulting in the researcher having to make do with the notes he manually captured during the discussion.

### **4.3 Data Analysis**

The recorded interviews were transcribed into rich text format documents. According to Denscombe (2010) transcription of audio recordings can be difficult as meaning and intonation may become lost, for this reason the task was entrusted to a professional transcription service. To ensure that the transcription were consistent with the recorded data, the research reviewed the transcriptions whilst listening to the recorded audio. The transcriptions were then imported in a qualitative statistical tool, Atlas.ti, for coding.

A dual approach of content and thematic analysis was used to analyse the data. The deductive approach was used to validate the framework and inductive approach assisted in uncovering new themes.

#### **4.3.1 Coding methodology**

First a set of codes were pre-built based on the *a priori* framework built in Chapter Two and coding of the transcripts were approached from a deductive content analysis point of view. A second run of coding was performed using an inductive approach, building a new



set of codes for a thematic analysis to uncover existing themes and new phenomena or themes not previously considered.

#### **4.4 Research Ethics**

All respondents were provided with an informed consent letter which included a concise description of the purpose and scope of the proposed research. Respondents were informed in the letter that they may, at any time, terminate the interview or refuse to answer any question posed at any time without a need to explain. Anonymity and confidentiality of all respondents were guaranteed (Saunders & Lewis, 2012, p. 224). For this reason, no individual has been identified in the research report.

#### **4.5 Research Limitations**

As discussed in section 4.1.2 due to the nature of the study and the expert nature of the respondents, sought access was a significant limitation. Unfortunately only a limited number of respondents, six in all, were able to take part. A further limitation was the use of snowball sampling as a method. Snowball sampling often leads to limiting the variance of data collected as respondents often refer the researcher to respondents who hold similar opinions.

The experience of the researcher in the practice of research was another limitation. In particular the researcher's inexperience in compiling interview guides and the researcher's ability to successfully conduct qualitative interviews and guide the respondents in order to achieve optimal feedback in addressing the research questions.

## 5 Results

The following Chapter presents the results of the research and data analysis as described in Chapter Four. Firstly, the Chapter briefly reviews the demographics of the respondents, providing a context to the results. Secondly the Chapter presents and discusses the research results, based on broad themes in relation to underlying assumptions and discourse driving the debate of which governance model would provide the best solution to Space as a commons dilemma.

Then the results for validating the concepts within the *a priori* framework are discussed.

### 5.1 Respondents in brief

As previously highlighted, the context of Space and the debate around its governance and related issues of resource and property rights, is so specialised that very few individuals can be considered experts in the field. In addition to this, the senior level of the required respondents made access very difficult to secure. Hence, only six interviews were conducted. The majority of the respondents were senior academics and/or lawyers specialising in space policy and law.

A number of the respondents were, or have been, involved in advising international governments and private operators, with regards to space policy and law. Unfortunately, due to the methodology of snowball sampling, all but one of the respondents was American. This skewed some of the results toward the American view point of property and resource rights in space. The American view point was slightly mitigated by the responses received from the lone European respondent. As indicated in section 4.5 on research limitations. The study would have been better served with a greater variance in respondent demographics.

## 5.2 Space, a commons or not?

One of the primary assumptions of the *a priori* model developed in Chapter two, was that Space should be considered a global commons from natural and legal point of view; an assumption that appears to be debatable in the view of some of the respondents.

Respondent two (R2) was quite emphatic on the point of Space being a commons;

*"No it's not" (R2),*

going on to explain that the concept of space as a commons needs to be agreed too.

*"First fundamental problem is the definition of 'global commons,' is one where international parties agree that is a 'commons.'" (R2)*

*"Space ... may become a global commons if agreed to. But it is not yet a global commons" (R2)*

This view point was supported by respondent five (R5);

*"I would say the overwhelming majority opinion is that the Outer Space treaty does not create a commons" (R5)*

What is evident is that the view seems to primarily describe the United States of America (USA) perspective as pointed out by respondent two:

*"If you go over to our lawyers in the State Department who are responsible for interpreting what international law is at least from the U.S. perspective, they will be quite clear in telling you that Space is not a 'commons' " (R2)*

However, it is not a view point that was universal in its appeal, according to respondent six (R6), the only non-American respondent, was clear in his assessment that Space was a commons. Or at least it was always intended to be recognised as one.

*"Outer Space treaty, article no. 1, it tells you that Outer Space is the province of all mankind" (R6)*

,and therefore,

*"Outer Space was intended to be as a global common" (R6)*

It would seem that the concern from the US perspective is that, in allowing Space to be considered a commons it would imply that all resource in space would be considered a commons too.

*“The language in the Outer Space Treaty is not the same as the common heritage of mankind concept in the Moon Treaty.” (R5)*

*“Outer Space Treaty does not create a commons in terms of all nations that are party to the treaty do not own minerals in common” (R5)*

It would appear that the debate continues as to whether Space is a commons or not, which is the root of the problem when considering potential governance models.

## **5.2.1 Potential dilemma solutions**

With the finding that Space is not universally considered a commons the validity of the *a priori* framework was brought into question. Therefore the researcher felt it necessary to probe the respondents further to find evidence in support of the assertions made in Chapter Two.

### **5.2.1.1 Leviathan to the rescue?**

When discussing solutions to managing Space, regardless of the whether they believed Space to be a commons or not, the general consensus across all the respondents was that the governance solution does not lie in the establishment of an overarching controlling body.

The impetus for refuting the establishment of a Leviathan organisation, is founded in three primary reasons. Firstly, international geo-politics is founded on the simple concept of the nation-states sovereignty and that a nation-state is the highest legislative power.

*“... they are not subject to being told what to do by some other higher power because by definition the original higher power is that of the sovereign state” (R2)*

*“The challenge of course is that challenging the sovereignty of a nation-state is kind of a big deal. Because the entire international, governance, economic, political framework rests, in the final analysis in the nation-state. That is everything. For all purposes the reality is constructed around that idea.” (R1)*

A concept that was carried through into the OST in its liability provisions, in which it holds the nation-states responsible for the actions of its citizens in space. When discussing the

potential need for the establishment of an international controlling body, respondent two answered;

*“I would think not because the nation-state would ultimately responsible.”  
(R2)*

Even though a group of nations may decide to do this in the future, it is highly unlikely, especially when considering the major space-faring nations, that they would delegate away their control.

*“The nation-states could decide to give the power to a transnational organization to do this on their behalf. ... But I think relatively few countries would really want to turn over that kind of power to a transnational organization. I certainly cannot imagine the Russians, the Chinese or the Americans doing that.” (R2)*

Secondly, there is a concern regarding the escalation of transaction costs.

*“I would recommend against that: my own personal philosophy and general approach is to avoid bureaucracy and expense wherever possible” (R5)*

*“It’s a pretty significant overhead and burden to do that. There always be people that are going to worry about the creating a massive international organization” (R1)*

And finally the economic impact that this would have on the development of Space.

*“I would oppose any international organization that would govern resource appropriation. I think that discourages economic activity that we need.” (R5)*

The reality is summed up quite well by respondent six (R6), who commented on the complexities of transnational Leviathan structures such as the ITU:

*“it is slow and states can try and go around the rules, ... , if you want to establish a new organization that is going to cost time and money, so when you have to think of allowing a corporation into, you have to think of how to do it in practice, how to save money, how not to take too much time, you know” (R6)*

Respondent one also indicated that the need for a new organisation is not necessary.

*“I don’t necessarily think that it’s going to be a requirement to establish an organization to do that. I think it’s perfectly feasible for all to work within the framework of the Outer Space Treaty and just have countries access that” (R1)*

Therefore the evidence suggests that the governance solution does not lie in the establishment of a Leviathan. So what then of the other traditional solution proposed what of real property rights?

### 5.2.1.2 Real property rights

When discussing the potential of implementing real property rights in Space, it was again very clear from the respondents that moving away from the OST and declaring space *terra nullis*, or tearing up the OST and allowing nation to claim sovereignty is not feasible.

*“In dealing with property rights I find the no sovereignty issue is pretty clear therefore under a common law system like in the U.S. I don’t think we could ever see to have simple property rights.” (R2)*

*“I don’t think we should withdraw from the OST, as some people might argue, and that we should not get rid of the no sovereignty claim.” (R2)*

*“I don’t think it is foreseeable or feasible to tear up the Outer Space Treaty and start all over again. The question is going to be: modification, additions. One of the big questions is for private actors, you know, private companies, private entities they are moving around and operating at the moment, they are still totally within a government, nation-state framework.” (R1)*

Respondent two was able to summarise the overall impetus going forward

*“So both those old paradigms: planting the flag or declaring Space to be some sort of commonly owned entity subject to some U.N. bureaucracy. Both of those would get axed” (R2)*

So the in conclusion, if the Leviathan is not the answer and simple property rights are not the answer, where to from here? Respondent one had this to say.

*“I think it’s perfectly feasible for all to work within the framework of the Outer Space Treaty and just have countries access that and say: look you can go off and do that but I am going to provide the ongoing supervision” (R1)*

Respondent two felt that a bundle of functional property rights based on a lease or license system would be feasible.

*“I think we should have functional property rights... But with functional property rights I think you can get the vast bulk of economic benefit from long term leases.” (R2)*

A position supported by respondent six

*“But what you can have is like some rules of the road, that is possible, because that is what they are doing in space right now; they start with guidelines and then with practice they become stronger and stronger from a legal point of view, becoming eventually law as such. So that is always a possibility, you know, involve states and relevant companies and try to get together and develop some framework really – even a non-binding framework but some kind of rules.” (R6)*

### **5.2.2 Finding**

The evidence therefore supports the assertions made in Chapter two, that neither the Leviathan nor the abrogation of the OST and the introduction of a real property rights regime would be acceptable. Rather, a framework based on functional or quasi-property rights, that can function within the existing legal framework as established by the OST of 1969 would be preferred.

### **5.3 The OST an impediment to investment - The red herring**

Another of the underlying discourse driving the debate surrounding the best solution for the governance of Space, is the assertion that the Outer Space Treaty is itself an impediment to private investment.

The general opinion across all respondents was that the OST did not remove the profit motive entirely.

*“I don’t see the Outer Space Treaty as being a significant barrier to that.”  
(R5)*

Profits could still be made even if it were through government awarded contracts.

*"I don't think there is a no profit motive. I think that there is less. Obviously somebody is going to find a way make money. Even if it is a government contract." (R1)*

Rather the problem would appear to be that the OST and other existing treaties, have not explicitly dealt with property rights or resource appropriation for the purposes of commercial exploitation. On this matter it was felt that the

*"treaties are really vague" (R6)*

and that the fact that OST and its supporting treaties did not deal directly with the issues of private appropriation of land or resource, has resulted in the creation of *legal lacunae* (Gaps in the law). An uncertainty has emerged of how the international community, nation states and companies deal with property, resources and resource extraction from a commercial point of view.

*"Outer Space Treaty ... doesn't solve the end problem; it is open to interpretation, ... , it doesn't say anything about the resources as such" (R6)*

*"I think the problem at the moment is **not** [emphasis added] that companies are prohibited from making profits in space, that's not the case. The problem is that's unclear, uncertain and it's in that uncertainty that companies have a hard time defining risk and therefore have a hard time making a business case." (R1)*

A view point supported by respondent two and respondent six:

*"So the question becomes if you are a private person trying to invest you just want to know what the rules are. You just want something that is predictable ..." (R2)*

*"... law as such is unclear whether or not you can remove the resources and appropriate the resources and sell them and get profits" (R6)*

*"If I have a company that goes off to the moon or an asteroid and I find something valuable, bring it back and I sell it it's to make a profit. I think the answer is yes. But I don't know for a fact the answer is yes" (R1)*

Respondent four felt that, not only is there significant uncertainty, but that better guidelines on the current framework should be provided. Clarity on risk would make it significantly easier for "new space" companies to raise investment capital.



*“... a more granular definition of the current framework with regards to the property right in a manner that removes uncertainty for new space companies. Allowing to feel more comfortable in taking on more risk.” (R4)*

Therefore the evidence shows that this legal uncertainty is what inhibits large scale private investment, rather than the very existence of the OST, or any explicit wording in it:

*“I don’t see the Outer Space Treaty as being a significant barrier to that.” (R5)*

Therefore it is clear that even though the OST does not directly impose an exclusion of the profit motive, it does, through an un-intended consequence, impede the development of Space by creating *legal lacunae* and uncertainty. This uncertainty can and should be addressed:

*“... then the regulatory uncertainty, by lack of definition of property rights, is a further problem. And that is something that I think it can and should be fixed.” (R2)*

The evidence therefore suggested that the OST was not the explicit barrier to investment. An additional common thread throughout the discussions with respondents was that none felt that abrogating the OST and replacing it with a new treaty regime was necessary or a desirable the solution.

*“I don’t think it is foreseeable or feasible to tear up the Outer Space Treaty and start all over again.” (R1)*

*“You know new treaties as such, nobody now wants new international treaties in space, it is not feasible as an option really at the moment” (R6)*

*“We are interested in carrying out our existing responsibilities to international regulations, but we recognize there are areas where our national regulation probably is not sufficient to address many of the new interesting new hypothetical ideas that are springing up almost every day.” (R2)*

*“We are not interested in, when I say we I am pretty certain of what the U.S. position is, we are not interested in creating some treaty regime” (R2)*

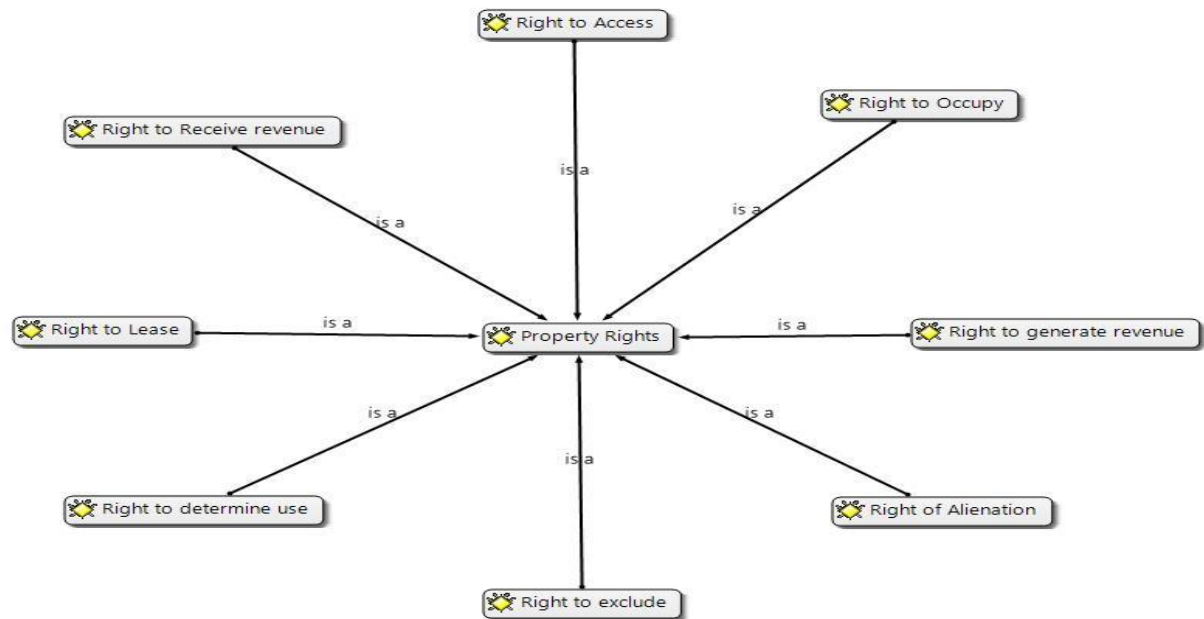
### 5.3.1 Finding

In conclusion, the researcher found no direct evidence to support the belief that the OST is a direct impediment to private investment in Space. However, there is evidence to suggest that the indirect, unintended consequence of creating an uncertain investment environment, by not directly addressing the nature of property right created *legal lacunae*. Furthermore no new treaties are needed or desired, rather national laws based on a functional property right regime and recognised with reciprocity are needed to address the *legal lacunae*.

## 5.4 Nature of potential property rights in Space

The debate of Space as commons has become more critical of late as more “new space” companies and nation-states express their intentions to exploit resource for commercial purposes. The *a priori* framework defined in Chapter two proposed eight non-cumulative, potential property rights, as shown in Figure 3 on the following page, which could legitimately be recognised without being considered in breach of the existing international legal framework.

Figure 3: Property rights and duties



### 5.4.1 Right to access

The right to access is very well defined within the OST. Therefore, as expected, the universal view of all respondents was that access to space is open to all: a concept that is clearly summarised by respondent six

*“... the rule is that in theory outer space is free, there is free access in outer space for states, and implicitly also to private operators, so nobody could be denied access to space – that’s the theory you know” (R6)*

However, there does seem to be an implicit caveat to this when one looks at section 5.4.6 and the implicit right of nation-states to exclude its citizens and private operators. Therefore evidence was found that the right to access is a right that is clearly consistent with the existing legal framework established by the OST.

### 5.4.2 Right to lease

When it comes to the question of granting rights to appropriators that want access to property or resource for the purposes of commercial exploitation, the right to lease appears in the view of the respondents to be overwhelmingly popular as a solution.

Respondent five explained how a nation-state would be able to establish a national law in which it could lease property or grant access to resource via a licensing mechanism whilst not finding itself in breach of the OST.

*“If a nation wanted to pass mining laws that would operate in that manner, it would be legal, they would have to say there that our licensing activities are to have an official record, an official authorization for activities in a specific area; but the law should always say to be clear, that these licenses do not in any way establish any claim of territorial sovereignty in that area” (R5)*

Respondent six clearly agreed with this assertion, however he did elaborate that the passing of such a law at a national level may result in international friction:

*“if a government would ever give this type of license there would be nobody who could stop a state to do that you know, nobody can prohibit a state to do that, but you know, you can expect big complaining and problems about that” (R6)*

Respondent two went a step further, in the discussion indicating that such a licensing or leasing framework, would be feasible within the parameters of the international legal framework. To avoid international complaints such a framework or similar frameworks should be implemented across multiple nation-states who would recognise, through reciprocity agreements of international law, the other states framework.

*“... if a state starts giving license, based on what, because there is no sovereignty so if you don't own that territory you cannot give a license. So if it is a group of states then it is different, and maybe if you take all the relevant space actors, the most relevant involved in lunar activity, then they together decide to allow this, and then there is a legal basis to do that.” (R2)*

According to respondent five a precedent on this type of framework for the reciprocity of the recognition of licenses to extract resource already exists in the seabed mining laws passed by multiple countries.

*“Mining Law for Outer Space, I would like to see space faring nations follow the model that was used in the Law of the Sea, whereby the countries that were anticipating that they would engage in deep sea bed mining, each of a number of nations during a one and a half year period passed laws that would govern their own citizens mining activities on the deep sea bed, and each of those laws had a reciprocity provision, that said that they would recognize the claims of other nations.” (R5)*

A view supported by respondent one

*“I think you can frame as: let’s look at the existing rights responsibilities norms that have already been established by the existing treaties and we are going basically create a national licensing framework to let private companies to operate under that regime. I think it’s perfectly feasible.” (R1)*

In conclusion the evidence suggested that the right to lease or grant a license to access, to an appropriator, whether that appropriator is a private operator or other. Would feasibly be allowed within the current international legal framework. However, such lease or licensing agreements would have to:

- Clearly indicate that this does not imply any claim of national sovereignty
- Could be contentious unless multiple nation-states co-ordinate the implementation of such laws and include reciprocity agreement for the purposes of recognising claims.
- 

### **5.4.3 Right to receive revenue from lease**

No direct evidence was found during the interviews to support the existence of this right. However, a precedent exists for this concept in the form of the International Telecommunications Union (ITU). The ITU is an international body independently operating under the auspices of the United Nations.

The ITU oversees the allocation of frequencies and orbits for satellites.

*“... it’s in the United Nations system, not really part of the United Nations. It basically gets fees. Everytime you file paperwork it charges fees. It gets its money through the filing of documents, procedures and stuff and it is supported by nation-states. For the most part countries are bearing the weight of that overhead cost.” (R1)*

The major concern when discussing the concept of lease revenue was the need to avoid escalating transaction costs. Transaction costs were particularly prevalent as concern when discussing the potential establishment of an overarching Leviathan organisation. Given the finding in section 5.2.1.1 where it is was clear that a Leviathan is not considered

a solution, such a right to receive revenue from a lease would likely sit at the nation state level. Additionally the right to receive revenue from a lease is implied and directly linked to the right to lease or license.

#### 5.4.4 Right to occupy

The right to occupy is a distinctly different right than the right to access. The right to access is defined in the OST and is accepted as a universal to all appropriators. The right to occupy regards the right to establish a presence whether for a limited or unlimited period of time and to be allowed to make changes to the property. What came through very strongly in discussions was that this right is almost self-evident and universal to appropriators.

Especially a government or nation-state;

*“They are going to go wherever they want to go, whenever they want to go”  
(R2)*

A point re-iterated by respondent six

*“It is the right of a state to go into space, you can’t deny it as such.” (R6)*

Who takes this a step further alluding to a lease or a license allowing another appropriator the right to occupy, but under certain lease conditions;

*“It is another story where if you get the license to go there, mine and then if you don’t comply with the license, then the license can be withdrawn and the activities stopped. But that is another story.” (R6)*

Respondent five alluded to the existence of similar lease conditions including time restrictions

*“... when the company ceases mining activities in that area the license will terminate and they will have no further rights to do any work in that area, and you would probably want to say, if they abandon their work for a certain period of time, then the license automatically terminates.” (R5)*

Therefore even though there does not appear to be any direct reference to a right to occupy, other than in reference to nation-states it is implied as existing in the discussions.

#### 5.4.5 Right to generate revenue

As indicated in section 5.2 the crux of the commons debate revolves around the resource in Space and in section 5.3 we see that the issue of lack of investment revolves around the uncertainty regarding an appropriators' legal ability to exploit resources for commercial gain. In short the debate is fundamentally based on the right of an appropriator to generate revenue from the exploitation of a resource in Space, whether that be "in situ" or through extraction. From the discussions held with respondents;

*"... there is nothing really prohibiting private sector hunters as long as they are under ongoing supervision by a nation-state." (R1)*

which respondent one re-iterated

*"But resource extraction? There is nothing to prevent that from happening. And when it comes back down there is nothing that prevents me from using it. There are interpretations, there are people who have said we don't want that to happen but it's nothing hard and fast at all" (R1)*

Respondent five agreed that the under current legislation it would be hard to argue against the extraction of resources for commercial gain because of the uncertainty:

*"if one of the prospective space mining companies ... were to capture an asteroid and begin mining it, and upon the first commercial sale of materials from that asteroid there might be someone ... would question 'is this legal?' But I think that international lawyers would be hard pressed to say that it is illegal because they wouldn't be able to point to any international agreement or any rule of international law that says that you can't do that." (R5)*

Respondent six, though not totally adversarial to the concept, pointed out that there would could be legal contest on this point, precisely because of the uncertainty:

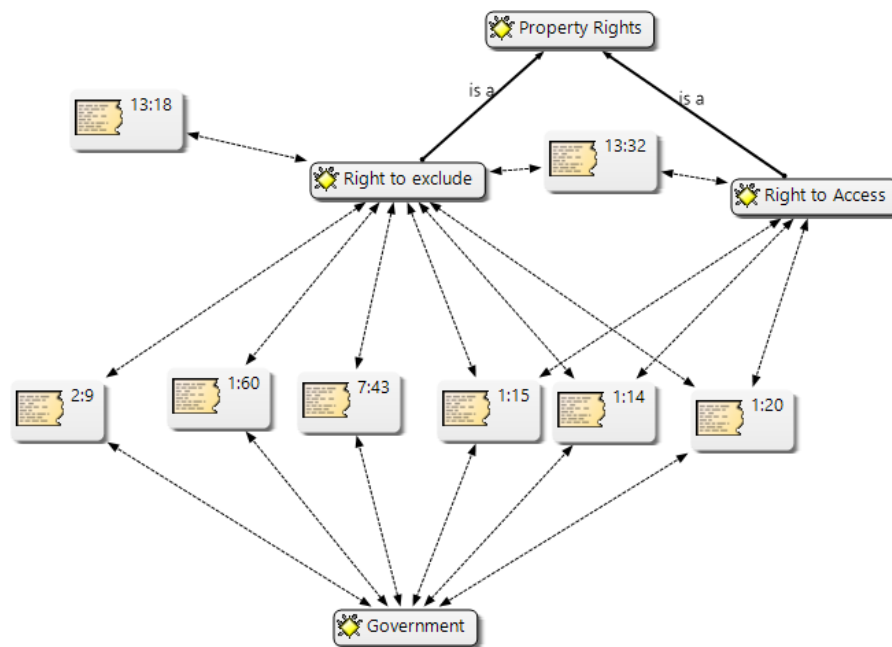
*"... big problem because the law as such is unclear whether or not you can remove the resources and appropriate the resources and sell them and get profits." (R6)*

In conclusion evidence was found to support the existence of this right. The uncertainty created by the OST not dealing explicitly with property rights makes it an adversarial point. However the right must, by design, be included and dealt with or the very concept of a governance model to encourage investment is moot.

## 5.4.6 Right to exclude

The OST very clearly defines that it is the nation-states that are held liable for the actions of their citizens in space. This in turn leads to the implicit contradiction that even though access to Space is open to all, such access is and will always be controlled by nation-states. A concept that was clearly visible when developing the network map that related the rights of access, the rights to exclude and government as an appropriator.

Figure 4: The right to exclude belongs to nation-states



And supported by the opinions of multiple respondents:

*“The only reason they get to exist in space is because some nation-state gives them permission to do so and has ongoing supervision of them.” (R1)*

*“... means that they have to get a “may I” permission from the nation-state at this stage. I don’t think it is ever going to go away” (R1)*

The very foundation of the right to access Space is inextricably linked to the OST provision that the nation-states are liable for the actions of its private or corporate citizens in Space. Therefore the right to exclude an appropriator explicitly cannot exist, however implicitly at a national regulation level, it must and does exist.



#### 5.4.7 Right to determine use

Evidence to support the right to determine use was slight, not explicit in its nature and primarily slanted toward a function of nation-state.

*“Nations should I think know what companies plan to do in advance, and a licensing process is a good way to subject that to review prior to the activity taking place.” (R5)*

*“under international space law the state which has licensed the private operator is responsible for what the private operator” (R6)*

*“That’s all for the nation-state. The Outer Space Treaty says that all persons and entities of a country, that includes organizations, NGOs, non-profit companies, individual citizens, their behaviour is the responsibility of that country” (R1)*

The evidence suggested that the concept of use determination is strongly linked to the nation-states liability for the actions of their citizens in Space. Implicitly it therefore follows that the nation-state would want to have some form of mechanism to determine the use of property under a license or leasing system.

#### 5.4.8 Right of alienation

The right of alienation, or the right to sell your rights to another appropriator, is important in creating a secondary market to capture economic value of Space. Again no explicit evidence to support this was found. However, precedent exists for the transfer of frequency rights within the ITU structure.

Additionally one of the respondents who did significant work in this arena has already considered and proposed a conceptual mechanism in this regard.

*“ I have recommended that national registries of space objects be in place, where nations would register their mining licenses, and then I have also recommended that nations either enact their own laws in coordination with reciprocity provisions, or that join in a treaty, that they approach the UN office of outer space affairs, and ask that the UN registry of space objects, or just the international registry of space objects, that they add an additional column to their registry to include a description of mining sites that nations have*

*authorized under their mining laws – whether that takes... it would probably take the form of a license” (R5)*

Therefore although no specific evidence was found for this right, it is clear that it does exist and would not breach the current framework of the OST.

### 5.4.9 Proposition II: Finding

The supporting evidence for the proposed property rights in Space is mixed. Table 12 below outlines these results per proposed right and highlighted with comments.

**Table 12: Summary of findings for proposition II**

Proposed Right	Direct Evidence	Implied Evidence	Comments
Right to access	Yes	Yes	A general acknowledgement that the OST provides for access
Right to lease	Yes	Yes	Evidence supports a functional property right where a lease or license given to an appropriator by an entity
Right to receive revenue for lease	No	Yes	No explicit evidence supports the potential existence of this right. However, implicitly if the right to lease exists there is an expectation that a lease cost is incurred. Hence this right is likely to exist. Additionally precedent exists in the existence of the ITU.
Right to occupy	No	Yes	Again no explicit evidence supports this however implicitly this right must exist if a lease is given.
Right to generate revenue	Yes	Yes	Evidence exists in support of this right. This right is the CRUX of the entire resources debate.
Right to exclude	Yes	Yes	There is strong evidence of a right to exclude that would reside with the nation-state but only at a national level.
Right to determine use	No	Yes	Strong evidence exists but it is clearly linked to the issues of liability residing with the nation-state
Right of alienation	No	Yes	The implied evidence is strongly supported by the existence of other recommendations made by proponents in this field.

## 5.5 Appropriators in space

Proposition III stated that, that institutions that would most effectively perform the roles described in section 2.6.2 within, the existing international legal framework for the governance of space as a CPR are shown in Table 14 in section 5.5.1 below.

To address this proposition evidence of the nature of the appropriators in Space had to be established. Evidence was found by running a code co-concurrency table in the qualitative analysis software. Table 13 below indicates that number of instances where an institution was spoken about in the context of appropriation or referred to as an appropriator.

**Table 13: Evidence of appropriators**

	Appropriation	Appropriator
Government	2	12
NGO	n/a	2
Private Operator	n/a	9
University	n/a	3

Additional direct evidence was found for legitimising the status of some of these institutions and the roles they already play in Space.

Universities are already present in Space, functioning in collaboration with governments in efforts to perform research.

*“First of all there are tons of universities and organizations that are already involved. I am on the board of a group called USRA, Universities Space Research Association. We have something like 105 research universities some of which are overseas, Germany, UK and Hong Kong who are operating in space” (R2)*

Private operators are starting to become prevalent in their involvement.

*“... there are actual private companies and international organizations that are all taking part in the space. But the governance mechanisms are still nation-state dominated. That is a bit of an issue.” (R1)*

Interestingly respondent two made a distinction between private operators and commercial operators using the source of primary funding as a distinguisher. Where private operators are funded through government contracts, commercial companies are funded through commercial sales and non-government contracts.

*“You have always had private operators; you have not always had commercial” (R2)*

NGOs and civil society are growing in involvement but governments seem to still be the most prevalent appropriator and will be for the foreseeable future.

*“You have the civil society concept which is non-profit NGOs, private citizens, you can think like churches, religions but we are talking governments for the most part” (R1)*

### **5.5.1 Proposition III – Finding**

A significant amount of evidence was found supporting the existence, or possible existence, of what would be considered legitimate appropriators involved in space. Clearly governments, being the traditional appropriator, was prevalent in throughout all the discussions. Universities were identified as already being very active in the role of research. Private operators were identified as becoming a lot more active. However, the lack of evidence suggested that civil society is not currently recognised as an active participant but more of an observer. Table 14, on the following page, indicates the number of times the appropriator was referred to in conjunction with a possible role.

**Table 14: Appropriators and potential roles**

	Government	NGO	Private Operator	University
Authorised Researcher	n/a	n/a	n/a	1
Authorised User	n/a	n/a	1	1
Authorised Viewer	n/a	n/a	n/a	1
Proprietor	6	n/a	2	n/a

## 5.6 Rights allocation

Throughout earlier discussions and evidence presented in section 5.4 on the nature of property rights in Space, the evidence for the allocation of rights to specific institutions has been dealt with. The evidence was supported and easily visualised when looking at the code co-occurrence table extracted from the data shown in the Table 15 below

**Table 15: Evidence of rights allocation to specific institution types**

	Government	NGO	Private Operator	University
Right to Access	6	n/a	2	1
Right to determine use	9	n/a	3	n/a
Right to exclude	6	n/a	2	n/a
Right to generate revenue	n/a	n/a	1	n/a
Right to Lease	11	n/a	2	n/a
Right to Occupy	3	n/a	1	1
Right to Receive revenue	1	n/a	n/a	n/a

### 5.6.1 Proposition IV – Finding

From this data analysis became manifest that nation-states or government currently an almost a carte blanche on the frameworks proposed rights. It was difficult to assess the roles of NGO's in the matter as the concept of civil society in this case is considered to diffuse. What was also clear from the findings was that the right to exclude is fundamentally in the hands of a nation-state and only exercisable on a national level.

This finding had significant implications for the validity of the *a priori* framework, as it removes the polycentric design from the structural allocation of rights. It would appear that devolution of power and sharing of decision making in a polycentric manner, though feasible at a national level, is not considered by nation-states at this point to be palatable.

## 6 Discussion

Chapter Six discusses the results presented in Chapter Five in direct relation to literature and the aspects of the *a priori* framework developed in Chapter Two and the propositions presented in Chapter Three. Where gaps in the framework are identified these are addressed and the framework is modified accordingly.

### 6.1 The commons debate revisited

The framework developed in Chapter two was based on a number of fundamental assumptions. During the interviews conducted and the subsequent analysis of those interviews it became evident that some of the assumptions had to be addressed.

The first set of assumptions were premised on the understanding that Space is a global commons. As shown in section 5.2 there were varying views as to whether this statement was valid, the majority emphatically refuted the assertion entirely. These varying views appear to be based primarily in ideological backgrounds or legal tradition. The argument against Space being a commons, seemed to originate primarily from a capitalist perspective.

In Chapters One and Two, an argument was developed for Space as a commons in its totality. The argument was grounded in two aspects.

The first aspect, was whether Space was legally declared a commons by the ratification of the OST of 1967.

An analysis of the OST showed that, according to Article I, outer space is the “*province of all mankind*” and “*the exploration and use of outer space ... shall be carried out for the benefit and interests of **all countries***” [emphasis added]. (ST/Space/11, 2002, p. 4 Article I). It was also shown that Article II stated that no celestial body is “*subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.*” (ST/Space/11, 2002, p. 4 Article II).

According to Dalton the “*the thrust of these provisions is to firmly establish a community interest in the use of outer space and celestial bodies.*” (Dalton, 2010, p. 7)

In addition, even though the prevailing view of the respondents was the assertion that space was not a commons, respondent six was of the opinion that it was the intention of the OST to establish space as one.

The argument against Space as a commons would appear to be grounded in the context of commercial access to and use of resources and was more focused on a rejection of the perceived socialist stigma created by the use of the term “common heritage of mankind”, in the Moon Agreement of 1979. The Moon Agreement is widely accepted as being a failed treaty with very few countries having signed or ratified it. The term more suited when referring to Space as a commons is *terra communis*. A term used primarily to describe a commons to which there is free and open access “*there is no room for exclusive property rights*” (Dalton, 2010, p. 9). Dalton successfully argues that the principle of the OST, “*of space benefitting all mankind suggests that terra communis controls*” (Dalton, 2010, p. 10)

The second aspect pertained to the definition of a natural economic commons from academic point of view. According to Ostrom (Ostrom et al., 1994),(Ostrom, 2010) a common good is one that is characterised by two aspects. Firstly a high subtractability in use, which essentially means that an appropriator’s use of a common detracts from the ability of another appropriator to use that common. The general argument by those claiming this means Space is not a commons is based on the unknown. The claim is simply Space is so unknowingly large and the resources available, so limitless that to call Space a commons is a fallacious argument.

*“In my view the resources of space for all intents and purposes are unlimited”*  
(R5)

A seemingly valid argument. However, this argument appears to contradict the very underlying assumptions of the models used in the advocacy of the emergence of private property rights regimes by new institutional economists such as Demsetz (1967) and Alchian and Demsetz (1973). As discussed in section 2.3.2 the foundational premise is of



the scarcity of resources in question and the constraints imposed by the negative externalities that may occur. Neither of these appear to exist in the context of Space. Firstly the argument of respondent five, is that the resources are abundant beyond measure and secondly the nature of the externalities are fundamentally different in Space. Issues around social cost when discussing potential negative externalities, such as air pollution and noise pollution no longer apply. Rather it would appear that attempts to impose traditional forms of private property rights are mired in “Terrestrial Chauvinism”. A term coined by Isaac Asimov to denote the concept of needing to apply terrestrial models to extra-terrestrial issues.

The second aspect is possibly more important when considering Space in its entirety. That aspect, is the open access problem and the right to access. When we consider Space in its entirety, controlling access to it is a technical improbability. The respondents were also clear that the OST provides for open access as a right that cannot be denied.

At least it cannot be denied to any Nation State. Rather it is likely that within a nested enterprise environment, a Nation State that carries the responsibility of the actions of its citizens in Space will hold the right to exclude its citizens or private operators.

According to respondent four, enforcement of exclusion is an issue that would have to involve governments, and a right to be held by government only. A view corroborated by respondent one who, when asked which appropriator could or should retain the right of exclusion, clearly indicated that though this might evolve or change over time, but it must for now reside with government.

In conclusion, if by legal definition in the OST, Space is considered the province of all mankind and free to access and this access cannot be denied or controlled, it must be a commons, at least by the definition of *terra communis*.

However, when considering the issue of property and resources whether for commercial exploitation or not, given the unknown size of outer space and the resources it possesses and coupled with the uncertainty created by the absence of specific parameters in the

OST, regarding the handling of resource extraction, exploiting individual resource bodies and property, such as an asteroid or the Moon as commons, becomes fundamentally more problematic.

## 6.2 Which solution – Framework justification

The solution to the governance of Space is by no means a simple or easy discussion. Section 2.2 discussed three potential solutions toward governing Space as a commons. The first potential solution of the establishment of a Leviathan was found, in the discussion of the literature review and in the evidence presented in section 5.2.1.1 to be unacceptable.

The evidence presented in section 5.2.1.2 for the introduction of real property rights also revealed that the desire for this type of solution was lacking amongst the respondents of this research project as many felt that it would be in breach of the provisions of the OST framework. However, there are proponents who have argued for their countries to exit the OST. Dalton (2010) argues that even exiting the treaty may be irrelevant as *“even non-parties to the Outer Space Treaty are bound by the principles that have passed into customary international law, One of which being Article II”* (Dalton, 2010, p. 26).

Wasser and Jobes (2008) argue that the current OST regime, when viewed from a civil law perspective, allows for the establishment real property rights that would only need to be recognised but governments. A view rejected by Pop (2000) who, from a common law perspective, maintains that the very fact that a nation recognises a real property claim results in that nation establishing *de facto* sovereignty over that property.

As an alternative Dalton advocates for the establishment of new multi-lateral treaty regime to *“guarantee property rights to private actors”* (Dalton, 2010, p. 26)

The evidence, however, also argues against the need or a desire for a new international treaty regime and rather that a series of limited functional property rights are permitted under the current regime. Oddly this is acknowledge by Dalton in the conclusion of his

paper where he notes that “*A limited form of private property rights in celestial territory, namely functional rights, are probably permissible under the current regime*” (Dalton, 2010, p. 29)

In conclusion, it would appear the solution of a Leviathan is not acceptable. The issue of real property rights, is still a hotly debated topic based on legal traditions and would therefore be difficult to reach consensus on. Furthermore a new treaty regime is unpalatable and consensus would be difficult to reach.

What is left, is the view that a limited set of functional property rights may be permissible, and the logical conclusion would be for nation-states, particularly those that are space-faring to adopt a common framework within which they can enact national laws for the recognition of functional property rights.

### **6.3 The red herring**

The evidence presented in section 5.3 above found that there was no direct evidence to support the assertion by some commentators that the OST is a direct impediment to private investment in Space. Rather, the evidence suggested that an uncertain investment environment had been created through the indirect and unintended consequence of *legal lacunae* (legal gaps) surrounding the issue of property and resource rights in Space.

The general opinion across all respondents was that the OST did not remove the profit motive entirely. Profits could still be made even if it were through government awarded contracts. Rather the problem would appear to be that the OST and other supporting treaties, have not explicitly dealt with property rights or resource appropriation for the purposes of commercial exploitation. Resulting in the creation of *legal lacunae* and therefore creating an uncertain investment environment.

Dalton concurs with this finding arguing, that it is this very ambiguity or uncertainty “*regarding the status of property rights ... is a major barrier to commercial development*” (Dalton, 2010, p. 4). Hertzfeld and von der Dunk (2005), also maintain that they do not

currently, or in the foreseeable future, see a particular problem where the lack of sovereignty plays a significant role.

Therefore it is evident that it is not the OST and the international legal framework it establishes that presents an impediment to investment and the development of Space. But rather it is the lack of certainty it creates, since *“commercial development requires large amounts of financing and the ambiguities prevent effective financing and deprives private operators of assurance that their investments will be protected”* (Dalton, 2010, p. 4)

#### **6.4 Proposition I - Discussion on the framework and the validity of its sub propositions**

As shown in section 5.4, supporting evidence for the eight proposed property rights in Space are mixed. The rights proposed in the *a priori* framework were adapted partially from Schlager & Ostrom (1992). Additional rights added to the framework were adopted from Heller (1998). Finally to build onto the rights model proposed by Ostrom, the framework was adjusted to allow for the rights to be non-cumulative and for certain decision orientated rights to be held by multiple appropriators, thus introducing a polycentric design to the framework.

The results indicated that direct evidence was found supporting five of the eight proposed rights. The three remaining rights were not validated by direct evidence, but rather implicit evidence, through their association with other rights; justifying their existence.

Table 16 on the following page outlines these results per proposed right and highlights some comments.

**Table 16: Summary of findings for proposition II**

Proposed Right	Direct Evidence	Implied Evidence	Comments
Right to access	Yes	Yes	Evidence supports that there is a general acknowledgement that the OST provides for access to all
Right to lease	Yes	Yes	Evidence supports a functional property right where a lease or license can be allocated to an appropriator by an entity. Evidence supports that entity is government.
Right to receive revenue for lease	No	Yes	No explicit evidence supports the potential existence of this right. However, implicitly if the right to lease exists there is an expectation that a lease cost is incurred. Hence this right is likely to exist. Additionally precedent exists in the existence of the ITU.
Right to occupy	No	Yes	Again no explicit evidence supports this. However implicitly this right must exist if a lease is given.
Right to generate revenue	Yes	Yes	Evidence exists in support of this right. This right is the CRUX of the entire resources debate.
Right to exclude	Yes	Yes	There is strong evidence of a right to exclude that would reside with the nation-state but only at a national level.
Right to determine use	No	Yes	Strong evidence exists but it is clearly linked to the issues of liability residing with the nation-state
Right of alienation	Yes	Yes	Evidence and precedent for the right of alienation exists

The right to access is a basic fundamental right of any common or common resource pool. When discussed in the context of Space and the provisions of the OST it becomes a moot point. A more complicated discussion, which is tightly linked to the right to access, is that of the right to exclude.

Ostrom (2008), through many decades of empirical investigation into operational resource systems in the field, identifies the right to exclude as one of the five rights, that are important in long-lived commons governance models. Ostrom maintains that a collective-action group develops rules through trust and reciprocity; that enables appropriators to jointly exclude potentially untrustworthy appropriators. Exclusion in this manner, at a global scale may not be legally enforceable because of the provisions of the OST, and technically difficult. However, if the framework proposed were considered at a national level, nation-states could consider passing national legislation to exclude its citizens based on its own criteria. The evidence again strongly supports the right to exclude, as being a right of nation-states.

The allocation to governments of the right to exclude is supported in the evidence by the acknowledgement of the provisions of Article VII of the OST, which imposes the international liability of the actions of its citizens onto the nation-state.

There is also strong supportive evidence that the right to lease, as functional property right, would not be in breach of the current international framework, providing that it is clearly indicated in any lease or license allocated that said lease or license did not extend any form of sovereignty claim, a position supported by Dalton (2010). Pop (2000) argues that *“States are free to regulate the conduct of their nationals in relation to resources located beyond the limits of their territorial jurisdiction, but cannot regulate in respect of the resources themselves”* (Pop, 2000, p. 279). Essentially this translates into nation-states may be able to grant leases to harvest resources, but may not grant exclusive rights to a portion of a celestial body. Therefore a functional lease may be permissible within the parameters established by the current regime, so long as it is clear that no claim of sovereignty is made. Pop however, does clearly state that he believes that even though the *“appropriation of land can exist outside the sphere of sovereignty, but its survival depends upon the endorsement from a sovereign entity”* (Pop, 2000, p. 281). But, functional property rights specifically make no claim of appropriation of land. Therefore, under certain circumstances, a right to grant a lease should be permissible. The right to receive revenue from a lease would fundamentally be tied to the appropriator who holds the right to grant such a lease. Strong evidence exists that the role of proprietor is the government and therefore the right to receive revenue implicitly must exist in and be allocated to a nation-state.

The evidence presented in Chapter Five further supports the right of alienation, but primarily for the purposes of developing a secondary market for property rights. Ostrom (2008) points out that the right of alienation has not been a key defining right *“for those who have been responsible for design and adapting common-property systems in the field”* (Ostrom, 2009, p. 4). However, the stated purpose of the framework is to encourage the development of space by spurring investment through involvement of private operators. Therefore right of alienation, though not key to the governance of a

commons, is key in encouraging investment. The right of alienation would be key in generating a secondary market, allowing appropriators to sub-contract resource extraction and development. A secondary market of such a nature would also allow for the involvement of nation-states who do not currently possess the technology to take part in the space expansion. However, the development of such a secondary market would have to be cautiously observed in order to avoid issues that may arise, in particular around nation-states becoming “flags of convenience”.

Given the discussion above proposition two and proposition three can be accepted as valid; with caveats listed.

Unfortunately the evidence, particularly when discussing the allocation of the rights, diverges strongly from the *a priori* framework proposed. The divergence is specific to the polycentric approach built into the *a priori* framework. Andersson and Ostrom (2008) indicate that previous research suggests that one of the largest constraints to implementing a decentralised decision making framework, is that central governments rarely give up enough power: a view point clearly strongly supported by the findings in Chapter Five. Again the argument made is simply that, as the OST imposes the liability of the actions of its citizens on the nation-state, then those rights which can dictate exclusion and determine use should be exclusive to the nation-state. However, as the liability for actions starts devolving away from nation-states toward direct liability of the appropriator, this may change. Therefore proposition four cannot be accepted.

In conclusion the *a priori* framework could not be validated and its implementation as is would not be feasible. Rather adjustments, specific to the polycentric nature of the rights allocation, to the framework need to be made. Therefore according to the finding we must reject Proposition One

## 6.5 Revised Framework

Building a revised framework based on the findings of the research discussed (see Table 18 and Table 17 on the following page for a comparison). We find that, firstly as described previously, the construct of polycentrism needs removed and the traditional underlying model as proposed by Ostrom (2008) of cumulative rights emerges, alluding to the nature of Space as a commons which appears to be developing within the context of Ostrom's CPR framework.

The revised framework would still maintain a role of authorised viewer, which would be fulfilled by a civil society institution in some manner. The rights allocated to this role, as shown by the evidence, would primarily by a right to access.

However, the role of the authorised viewer and or civil society will need to grow and develop in its involvement and influence. Even though building trust and reciprocity is considered crucial to constructing the social capital required to develop functional property rights within a common environment (Ostrom, 1998) (Ahn & Ostrom, 2008), *"few long-surviving resource regimes rely only on those"* (Ostrom, 2008, p. 8) to limit rule-breaking.

Rather, according to Ostrom's framework (2008), the best form of monitoring is monitoring that is established by active participants in the commons, or at least where the monitors are selected and beholden to the authorised users. Notably the role of the authorised viewer is not to act as arbitrator, but rather as an informant to disclose infringements of appropriators to all appropriators.



**Table 17: Original proposed framework**

	Authorised Viewer	Authorised User	Authorised Researcher	Proprietor
<b>Right to access</b>	X	X	X	X
<b>Right to lease</b>				X
<b>Right to receive revenue from lease</b>				X
<b>Right to occupy</b>		X	X	
<b>Right generate revenue</b>		X	X	
<b>Exclusion – the right to determine exclusion</b>	X		X	X
<b>Right to determine use</b>	X			X
<b>Alienation – the right to sell or lease any rights to institutions of the same category</b>		X	X	X

**Table 18: Revised framework**

	Authorised Viewer	Authorised User	Authorised Researcher	Proprietor
<b>Right to access</b>	X	X	X	X
<b>Right to lease</b>				X
<b>Right to receive revenue from lease</b>				X
<b>Right to occupy</b>		X	X	X
<b>Right generate revenue</b>		X	X	
<b>Exclusion – the right to determine exclusion</b>				X
<b>Right to determine use</b>				X
<b>Alienation – the right to sell or lease any rights to institutions of the same category</b>		X	X	X

The final observation on the revised framework is the level of implementation. The original objective to the research report was aimed at developing a framework for the allocation of extra-terrestrial property rights, as viewed from an international legal perspective. The evidence presented in Chapter Five and subsequent discussion in Chapter Six, have shown that the appetite for a new treaty regime or a new international legal framework may not be particularly palatable to the international community and consensus on its form would be difficult to obtain. Therefore it may be more appropriate to redirect the focus of the proposed framework toward national governments as a proposed framework from which they could draw, in constructing national laws to fill the *legal lacunae* left by the OST. Thereby encouraging their private operators look to investing in and developing Space. Should enough nations approach their regulatory frameworks in such manner, then an international legal structure could develop overtime that establishes recognition through reciprocity.

## 7 Conclusion

Chapter Six discussed the research findings in the context of existing literature in Space law, the development of CPRs, and polycentric designs for decentralised governance models. Chapter seven will provide a brief review of the background to the research problem and the objectives outlined at the outset of the research. The Chapter will present an overview of the key findings and recommendations to appropriators, whether these be private operators, governments, NGOs or universities. Limitations of the research will be outlined and implications for future research presented

### 7.1 Research Background and Objectives

The original premise of the research was based on the view that by declaring Space a *de facto* commons, the OST had created a hostile investment environment from a private investment perspective, effectively removing the profit motive. The research presented in this paper had multiple objectives. Firstly to test the underlying assumption that Space had been declared a commons by the OST; secondly to test the premise that the OST itself was a barrier to private investment in Space and thirdly to validate the feasibility of an *a priori* framework for the governance of Space as a commons. The *a priori* framework was developed from the analysis of a rich history of economic literature, which discusses the governance issues present in commons dilemmas and the analysis literature focusing on the current debate amongst lawyers and policy makers specialising in Space law.

### 7.2 Main Findings

The primary finding of the research was that disagreement still exists within the Space law community as to whether Space is a commons or not. However, the evidence and literature clearly supported the assertion that, if not from a legal stand point, then at least from a natural economic definition Space is a *terra communis*, if not an outright commons as explained by Dalton (2010).

The confusion spurring the debate appears to centre on whether the resources in Space are subject to being treated as a commons or whether they can be exploited for commercial gain. This has led some potential appropriators and commentators to erroneously draw the conclusion that the OST is a barrier to private investment. However, the research findings suggests that the OST and its provisions should not be viewed as an explicit barrier to investment. Rather the issue at hand is that the OST does not define or specifically deal with the nature of private property rights and resources. Therefore it has created uncertainty and it is this uncertainty about the nature of property rights and resources in Space that continues to fuel the debate on potential governance models.

Despite this continued debate, it was clear from the research that neither side felt that the OST and its supporting treaties should be abrogated or replaced. Therefore the final objective of testing the viability of the *a priori* framework of basic functional property rights remained a justifiable objective.

Both explicit and implicit evidence was found in the research and in current literature to support the proposition that a modified version of the *a priori* framework of functional rights was not only feasible, but would be consistent with the current international legal framework. However, the modified framework would necessarily have to exclude the polycentric notion of decentralised governance at the international level, at least until such time as nation-states are not held responsible for the action of their citizens in Space. Given the exclusion of polycentrism for the *a priori* framework a revised framework in Table 19 on the following page, was proposed and explained in section 6.5.

**Table 19: Revised framework for the allocation of functional extra-terrestrial property rights**

	Authorised Viewer	Authorised User	Authorised Researcher	Proprietor
<b>Right to access</b>	X	X	X	X
<b>Right to lease</b>				X
<b>Right to receive revenue from lease</b>				X
<b>Right to occupy</b>		X	X	X
<b>Right generate revenue</b>		X	X	
<b>Exclusion – the right to determine exclusion</b>				X
<b>Right to determine use</b>				X
<b>Alienation – the right to sell or lease any rights to institutions of the same category</b>		X	X	X

The most important conclusion the researcher came to was that the proposed framework, which was originally aimed at addressing the uncertainty and *legal lacunae* introduced by the OST at an international level, would better serve the development of Space if aimed at the national level. In other words, if multiple nation-states passed laws using such a framework, with acknowledgement that no sovereignty claims in Outer Space are recognised, but that through reciprocity with other nation-states, they would recognise the functional property rights allowed by other states.

Following this recognition a system of functional property rights may be able to pass into customary international law, thereby creating investment certainty and encouraging the investment into and development of Space, by private operators and commercially orientated organisations. This would effectively enable and encourage the development of a long-term collaborative governance structure for Space as a commons that is populated by multiple CPRs.

### 7.3 Recommendations and implications for investment in Space

Encouraging investment from private operators and commercial entities, requires investment environment certainty and a route to profits; something that is not feasible within a common heritage of mankind regime, with absolutely no form of property rights.

The research presented in this paper showed that, the continuing debate amongst commentators as to whether Space should be considered a commons is misplaced. The research showed that Space is, if not legally, then at least by natural economic definition, a commons. What is unclear is how access to and the use of CPRs found in Space should be governed.

The continued debate distracts from the simple imperative that the human race must invest in and develop technologies that reduce the cost of access to the resources in Space. Therefore, in an effort to find clarity within the debate of Space as a commons, the author proposes that when conceptualising Space, it should be viewed as a commons or *terra communis* made up of many distinct CPRs as defined by Ostrom (Ostrom, 1990); and that the focus of the debate shift from the governance of Space as a whole, to a discussion on how these distinct CPRs should be governed.

The evidence presented was clear. There is overwhelming support for the implementation of a framework of functional or quasi property rights, which will bring certainty and stability to the Space as an investment environment. The evidence suggested that the underlying structure of such a framework would closely mimic the findings of Ostrom's work into CPRs and that the implementation of such a framework is feasible at a national level and would operate with the parameters of the OST.

What this suggests is that in moving forward greater urgency amongst nation-states is needed in the development of national legal frameworks that will establish the recognition of property and resource rights for its citizen in Space.

## 7.4 Recommendation for further research

Further research could revisit the *a priori* framework at a national level to investigate the role of polycentrism in encouraging the engagement of national civil society organisations in Space.

Further aspects that could be researched include the potential role an international civil society group could play as an authorised viewer in monitoring and reporting on the behaviour of appropriators.

The nature of the structures for the governance of the evolving nested enterprise within the international space community needs to be reviewed with the specific aim of encouraging the cheap and efficient resolution of disputes.

## 7.5 Limitations of the Research

The research findings reveal some very important trends in the development of space policy and law; making some valuable recommendation toward a framework for the governance of Space as commons. The research findings also alluded to adopting a different view of Space as a large commons that is comprised of multiple CPRs that in turn need to be governed themselves.

Although the original research methodology proposed depth interviews of eight to twelve expert respondents, across verticals within the space industry and national backgrounds, access was an issue. As a result the respondent base was limited to six experts mainly based in the United States. This resulted a definitive bias in the evidence. The bias was evident as the only non-American respondent had clear differences of opinion to his American counterparts. Therefore the original methodological design may have yield different results.

Additionally the limited knowledge of the researcher in the fields of law and economics also limited the possible depth and richness of the discussion.

## 7.6 Conclusion

The reality is that space-faring nations will be forging the new rules of engagement.

When dealing with the establishment of a foundation for property and resource rights in Space, space-faring nations will proceed with caution and respect, not acting unilaterally, but as they were the ones taking the risk their opinions in the matter should carry more weight a view succinctly expressed by respondent two.

*“So, the rules are made by the people who show up not by the people who stay behind. There has to be obviously some respect for international opinion, there has to be involvement, input from all states but the weight has to be on those who are taking the risks and the burdens.” (R2)*

*“I don’t think the decision can and should be unilateral. I think to have predictability in the environment one needs to have international agreement. But first I would want to international agreement from those other countries that are also operating in Space.” (R2)*

Space as a frontier is being drawn closer by the ever advancing and accelerating technological discoveries. Private operators such as Space Exploration Technologies and Orbital Sciences are driving down the costs of launches and making access to Space more affordable and achievable. Nation-states who wish to participate in Space no longer require their own launch vehicles. The same can be said for commercial enterprises. Mining companies are not restricted in any form, from commencing private prospecting projects. To steal a phrase *there is helium 3 in them there hills*.

Space is open for business; just remember you do not and cannot own a piece of it yourself, but that does not preclude you from making a profit.



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# Appendices

## Appendix I – List of signatories to the Outer Space Treaty of 1967

Table 20: List of signatories to the Outer Space Treaty of 1967

Country	Date <sup>1</sup> of Signature	Date of Deposit <sup>1</sup> of Ratification	Date of Deposit <sup>1</sup> of Accession
Afghanistan	01/27/67	03/21/88	
Antigua and Barbuda			01/01/81
Argentina	01/27/67	03/26/69	
Australia	01/27/67	10/10/67	
Austria	02/20/67	02/26/68	
Bahamas, The			08/11/76
Bangladesh			01/17/86
Barbados			09/12/68
Belgium	01/27/67	03/30/73	
Benin			06/19/86
Bolivia	01/27/67		
Botswana	01/27/67		
Brazil	01/30/67	03/05/69	
Brunei			01/18/84
Bulgaria	01/27/67		03/28/67
Burkina Faso	03/03/67	06/18/68	
Burma	05/22/67	03/18/70	
Burundi	01/27/67		
Byelorussian S.S.R. <sup>2</sup>	02/10/67	10/31/67	
Cameroon	01/27/67		
Canada	01/27/67	10/10/67	
Central African Republic	01/27/67		
Chile	01/27/67	10/08/81	
China, People's Republic of			12/30/83
China (Taiwan) <sup>4</sup>	01/27/67	07/24/70	
Colombia	01/27/67		
Cuba			06/03/77
Cyprus	01/27/67	07/05/72	
Czechoslovakia	01/27/67	05/11/67	

Denmark	01/27/67	10/10/67	
Dominica			11/08/78
Dominican Republic	01/27/67	11/21/68	
Ecuador	01/27/67	03/07/69	
Egypt	01/27/67	10/10/67	
El Salvador	01/27/67	01/15/69	
Ethiopia	01/27/67		
Fiji			07/14/72
Finland	01/27/67	07/12/67	
France	09/25/67	08/05/70	
Gambia, The	06/02/67		
German Democratic Republic	01/27/67	02/02/67	
Germany, Federal Republic of	01/27/67	02/10/71	
Ghana	01/27/67		
Greece	01/27/67	01/19/71	
Grenada			02/07/74
Guinea-Bissau			08/20/76
Guyana	02/03/67		
Haiti	01/27/67		
Holy See	04/05/67		
Honduras	01/27/67		
Hungary	01/27/67	06/26/67	
Iceland	01/27/67	02/05/68	
India	03/03/67	01/18/82	
Indonesia	01/27/67		
Iran	01/27/67		
Iraq	02/27/67	12/04/68	
Ireland	01/27/67	07/17/68	
Israel	01/27/67	02/18/77	
Italy	01/27/67	05/04/72	
Jamaica	06/29/67	08/06/70	
Japan	01/27/67	10/10/67	
Jordan	02/02/67		
Kenya			01/19/84
Korea, Republic of	01/27/67	10/13/67	
Kuwait			06/07/72
Laos	01/27/67	11/27/72	

Lebanon	02/23/67	03/31/69	
Lesotho	01/27/67		
Libya			7/03/68
Luxembourg	01/27/67		
Madagascar			08/22/68
Malaysia	02/20/67		
Mali			06/11/68
Mauritius			04/07/69
Mexico	01/27/67	01/31/68	
Mongolia	01/27/67	10/10/67	
Morocco			12/21/67
Nepal	02/03/67	10/10/67	
Netherlands	02/10/67	10/10/69	
New Zealand	01/27/67	05/31/68	
Nicaragua	01/27/67		
Niger	02/01/67	04/17/67	
Nigeria			11/14/67
Norway	02/03/67	07/01/69	
Pakistan	09/12/67	04/08/68	
Panama	01/27/67		
Papua New Guinea			10/27/80
Peru	06/30/67	02/28/79	
Philippines	01/27/67		
Poland	01/27/67	01/30/68	
Romania	01/27/67	04/09/68	
Rwanda	01/27/67		
Saint Christopher-Nevis			09/19/83
Saint Lucia			02/22/79
San Marino	04/21/67	10/29/68	
Saudi Arabia			12/17/76
Seychelles			01/05/78
Sierra Leone	01/27/67	07/13/67	
Singapore			09/10/76
Solomon Islands			07/07/78
Somalia	02/02/67		
South Africa	03/01/67	09/30/68	
Spain			11/27/68

Sri Lanka	03/10/69	11/18/86	
Swaziland			10/22/68
Sweden	01/27/67	10/11/67	
Switzerland	01/27/67	12/18/69	
Syria			11/19/68
Thailand	01/27/67	09/05/68	
Togo	01/27/67		
Tonga			06/22/71
Trinidad and Tobago	07/24/67		
Tunisia	01/27/67	03/28/68	
Turkey	01/27/67	03/27/68	
Uganda			04/24/68
Ukrainian S.S.R. <sup>2</sup>	02/10/67	10/31/67	
Union of Soviet Socialist Republics	01/27/67	10/10/67	
United Kingdom	01/27/67	10/10/67	
United States	01/27/67	10/10/67	
Uruguay	01/27/67	08/31/70	
Venezuela	01/27/67	03/03/70	
Vietnam			06/20/80
Yemen, People's Democratic Republic of (Aden)			06/01/79
Yugoslavia	01/27/67		
Zaire	01/27/67		
Zambia			08/20/73
<b>Total</b> <sup>3</sup>	<b>91</b>	<b>62</b>	<b>36</b>

1 Dates given are the earliest dates on which countries signed the agreements or deposited their ratifications or accessions -- whether in Washington, London, Moscow, or New York. In the case of a country that was a dependent territory which became a party through succession, the date given is the date on which the country gave notice that it would continue to be bound by the terms of the agreement.

2 The United States regards the signature and ratification by the Byelorussian S.S.R. and the Ukrainian S.S.R. as already included under the signature and ratification of the Union of Soviet Socialist Republics.

3 This total does not include actions by the Byelorussian S.S.R. and the Ukrainian S.S.R. (See footnote 2.)

4 Effective January 1, 1979, the United States recognized the Government of the People's Republic of China as the sole government of China.

Retrieved from <http://www.state.gov/t/isn/5181.htm#signatory> at 19h36 7<sup>th</sup> August 2013



Appendix II – Property Rights (M. A. Heller)

<b>PROPERTY RIGHT</b>	<b>OWNER</b>
<b>Right to sell</b>	Local administration Property committee Committee for Architecture and Historical Preservation State enterprise or institute (as balance-sheet holder) Budget organization Relevant council
<b>Right to receive sale revenue</b>	Federal government Oblast administration Local administration Property committee Committee for Architecture and Historical Preservation
<b>Right to lease</b>	Property committee State enterprise or institute Maintenance organization
<b>Right to receive lease revenue<sup>88</sup></b>	Relevant administration Property committee Committee for Architecture and Historical Preservation State enterprise or institute Maintenance organization
<b>Right to determine use<sup>89</sup></b>	Planning committee Property committee Balance-sheet holder
<b>Right to occupy</b>	Workers' collective

Taken from (Heller, 1998, p. 638)

## Appendix III - Respondents

**Table 21: Table of respondents**

<b>Respondent Number</b>	<b>Organisation</b>	<b>Sector</b>	<b>Experience</b>	<b>Current Role(S)</b>
R1	NGO 1	NGO	Researcher into Space Policy and Governance	Technical advisor
R2	University 1	University	Advisor to US Presidents on Space Policy; Previous NASA Executive	Professor at Major US university specialising in international affairs; Director of an Institute focused on Space Policy
R3	Individual 1	Private	Active in multiple Space and Space Policy interest groups; Senior Member of the L5 society (instrumental in convincing US government to not ratify the Moon Treaty)	Private engineering consultant specialising in space solar based energy
R4	Company 1	Defence & Space	Astronaut; Strategic Planning; Governance; Space Policy	Vice President of strategy and business development for a “New Space” Company
R5	Law Firm 1	Law	Attorney and Space Law consultant in US; Twenty plus years as a specialist in Space Law	Attorney and Space Law consultant in US
R6	University 2	University	European Specialist in Space Law; Author	Professor at Asian University specialising in Space Law

## Appendix IV – Interview Guide Version I

Question 1: Please could you tell me a little about yourself and the organisation you work for and its relation to space?

Question 2: The UN outer space treaty of 1967 established space as a commons, would you agree with this assertion? Why?

*Question 3: Do you agree that celestial bodies, such as the moon, asteroids and Mars could in suffer from over exploitation in the future? Do you believe that these could and should be exploited?*

Section 2:

Question 5: Do you believe the current international legal framework for the oversight of space activities is still relevant? Why? What would you change or improve on?

Question 6: Do you see any impediments to private investment in the development of space?

Question 7: Do you believe that individuals and organisations should be held responsible for their action in space. At what level do you believe this should happen? international community or at a national level? Why?

### **Appropriators:**

Question 8: What groups, in your opinion, do you see as legitimate users of space and its resources?

### **Rights:**

Question 9: With regards to your groups you have mentioned, what rights do you foresee as being appropriate and what if any obligations should be attached to such rights?

- Should rights be unbundled?
- Should certain groups be granted the rights to exclude other groups?

### **Roles:**

Question 10: Looking back at the groups you identified what roles do you believe they would play in decision making of the use of a specific space resource?

Question 11: Do you believe differing roles could or should be accorded different rights.

## Appendix V – Interview Guide Version II

### **Basic Interview Structure**

#### **Introduction**

- Could you please give a brief overview of yourself and your current involvement in the development of space and space policy?

#### **OST and the commons**

- The UN outer space treaty of 1967 established space as a commons, would you agree with this assertion? Why?
- Do you believe the current international legal framework for the oversight of space activities is still relevant? Why? What would you change or improve on?
- Do you believe the current international legal framework presents an impediment to private investment in the development of space?

#### **Appropriators**

- Who do you foresee as potential legitimate representatives of appropriators of property in space?

#### **Rights to property:**

- Do you believe that property rights should be based on a civil law or common law basis?
- Do you foresee an opportunity to unbundle property rights?
- What form do you believe unbundled property right could take?

#### **Roles:**

- Referring to potential appropriators you identified earlier. Do you believe that any of these should have the rights to exclude access to any of the others?
- Do you believe differing roles could be accorded differing rights? If so how would you allocate these rights?

## Appendix VI – Informed Consent Letter

Dear Sir/Madam

Firstly, I would like to thank you for acceding to my request of an interview.

As a partial fulfilment of my Masters in Business Administration (MBA) at the Gordon Institute of Business Science, I am conducting research on private property rights in space. I will be exploring whether the current international legal framework governing activities in space, impede or facilitate private and corporate investment into development and expansion into space. Our interview is expected to last about an hour, and will help us understand whether the current or a proposed framework is better suited to continued development of this industry.

Please note that your participation is entirely voluntary and you can refuse to answer any specific questions asked or withdraw from the interview entirely, at any time. All personnel data will be kept confidential. If you have any concerns, please contact me or my supervisor. Our details are provided below. All interviews will be digitally recorded and transcribed for research purposes, if you do not wish for the interview be recorded or at any point would like any specific responses to be “off the record” please indicate this to the interviewer.

Researcher : Robert Beney

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Phone: +27 (0) 82 333 9853

Phone: +27 (0) 82 495 1283

Signature of participant: \_\_\_\_\_

Date: \_\_\_\_\_

Signature of researcher: \_\_\_\_\_  \_\_\_\_\_

Date: \_\_\_30/07/2013\_\_\_\_\_