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Commercial Mining of Celestial Bodies: A Legal Framework for Mining Temporarily-Captured Orbiters Regarding the Notion of "*Patria Economicus*"

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Abstract: The purpose of this research paper is to propose a legal framework for mining temporarily-captured orbiters (TCO) as promising candidates for commercial mining and introduce the "*Patria Economicus*" notion as an adaptation to the *Homo Economicus* concept. Legally regulating these mini-moons equates the consideration that space mining laws, such as the Luxembourg Law and the U.S. Commercial Space Launch Competitiveness Act, should guarantee an indubitable commercialization. Primary motivations for extraterrestrial mining include extracting and processing valuable materials for commercial purposes. However, space legislators are facing problematic challenges of bringing space law into the commercial world. Specifically defining which celestial bodies would be most profitable to mine, and how exactly can we regulate that process regarding property rights without sovereignty are the main legal aspects of commercial mining. While space law does not directly subject the commercialization concept, thus aggravating existing space industries, a new dilemma arises: Exploitation or Commercialization? Consequently, the commercial regulation of mining TCO is introduced by comparing essential economic and commercial concepts for creating an appropriate legal regime. Commerce space law must define States' or private mining companies' economic intentions and put them in a legal perspective for regulating the commercialization of TCO minerals and other materials.

Keywords: Property Rights; Extraterrestrial; Space Law; Celestial Resources; Commercialization

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1. Introduction

While one of the main motivations for mining celestial bodies are of commercial reasons, the commercial recovery of space resources represents the exploitation of raw materials from comets, asteroids and other space object, which are usually near planet Earth (Plans for asteroid mining, 2012). Therefore, it is important to simultaneously make a balance, as well as a difference between the notions of commercialization and exploitation, by setting a legal framework for both scenarios according to realistic possibilities. With the sudden popularity of the concept of mining celestial bodies, business leaders operating in the fields of space industry can already feel the impact of space commerce across the economy, as they expect for bottom-line benefits (Space Industry Unites, 2014). It is presumed that space legislators have only partially solved the issue of legalizing asteroid mining with the Luxembourg Law by creating a governing body to supervise the harvesting of asteroids, as well as the U.S. Commercial Space Launch Competitiveness Act. However, when analyzing the rationality about which celestial bodies we can actually mine, we realize that it is not that simple to choose the best option, regardless of whether the act itself already seems legalized. By acknowledging the possibility of mining celestial bodies that legislators and future space miners have not yet considered, it is necessary to examine if currently existing laws can apply to them, how the processes of exploitation and commercialization can be legally regulated regarding the extracted resources, and the nature of the impact they will have upon the national or international market. Since the term asteroid mining includes near-Earth objects, the celestial bodies known as Earth's Temporarily-Captured Natural Satellites also manifest predispositions of valuable target for asteroid miners. In fact, the population of "temporarily captured asteroids" offers attractive candidates for asteroid retrieval missions because once they are naturally captured, they can be easily accessible to our planet, from a couple of months to several years (Urrutxua et al., 2015, p. 2134). Now, it depends on space legislators to appropriately inspect and establish the legal principles of this applicable alternative, regarding its commercial aspects and benefits.

2. Legal Regulation of the Beneficial Commercialization Concept

While celestial body mining manifests commercialization aspects, by implementing extracted space resources within the national and international market, we presume that space legislation will have a national unification effect toward one primary goal – to develop the commercial asteroid resources industry and increase the utilization and exploration of asteroids and other reachable celestial bodies. Still, it is questioned how will the beneficial concept of commercialization be legally regulated?

While the Outer Space Treaty provided the general foundations of space exploration and use, the Luxembourg Law and the U.S. Commercial Space Launch Competitiveness Act regulate activities undertaken by governmental entities, thus disregarding non-governmental companies that manifest serious intentions and predispositions to mine and extract space resources from celestial bodies for commercial uses and purposes (Space Resources, n.d.). These laws are necessary to clear the way for commercial mining activities and confirm that temporarily-captured orbiters have value and can be free of financial encumbrances. Space law expert, Frans von der Dunk, explains how the two abovementioned legislations create a significant division:

"There are two main camps of thought: Those that side with the U.S. and Luxembourg, and those that want to establish an international regime that regulates who can mine what in outer space" (Kaufman, 2017).

Commercial mining will not unify with international legal obstacles, since different national legislations may contradict each other. If nations begin to write individual laws according to their own benefit, opposed regulations would elicit a disrupted international consensus. Another argument that threatens commercialized space mining is the high cost of space access. As long as launching things remain expensive, further commercial exploitation of space will face larger financial hurdles (Regulating Asteroid Mining, 2014). What would the point be of accessing space at a very high financial cost, if the nation or party cannot legally own the extracted resources? This question currently concerns world nations, except the United States due to the U.S. Commercial Space Launch Competitiveness Act. According to section 51302 Legal Framework:

a) Property Rights. – Any resources obtained in outer space from an asteroid are the property of the entity that obtained such resources, which shall be entitled to

all property rights thereto, consistent with applicable provisions of Federal law (U.S. Commercial Space Launch Competitiveness Act, 2015).

Although seemingly violating the Outer Space Treaty, such actions do not preclude States' exercising jurisdiction over objects and persons in space. Hence, there should be a link between the State and a space object or personnel thereof, allowing the former to maintain jurisdiction and control over outer space national activities and comply with its international obligations, as set forth by outer space treaties (Marchisio, 2010, p. 3). If an American mining company brings extracted space resources to Earth, hypothetically speaking, other nations would supposedly have no right to claim them, meaning that such resources will not be considered as *res communis omnium* from the moment they start being mined by the American entity. Accordingly, legal national acts are the main factor for extraterrestrial jurisdiction concerning national law for extracted resources within the national market. When attempting to implement space resources within the international market, jurisdiction also concerns international law as a predisposition for creating a space resource-based monopoly and a tool for commercial dominance. Perhaps, the only method to avoid this, although seemingly science-fictional, would be for extraterrestrial mining to be manufactured in space as a consequential phase of commercialized mining, since the entity's property rights upon the extracted resources are guaranteed. Even so, commercializing extraterrestrial mining is still questioned since space legislators are not fully prepared when it comes to regulating unpredictable situations, as well as presenting space resources and goods on the national and international market. The perfect testing solution for this uncertainty is to bring less profitable or non-profitable extraterrestrial resources.

3. Temporarily-Captured Orbiters – Stepping Stones for Commercialized Space Resources

Commercial extraterrestrial mining is supposedly limited to low-Earth orbit, since regulating celestial bodies out of human reach is equated with rational considerations that appropriate laws should manifest an easily achievable commercialization. Near-Earth asteroids are likely targets for resources to support space industrialization, as they appear to be the least expensive source of required raw materials. Exploitation of asteroids for precious metals and semiconducting elements is a possible environmental friendly remedy for impending terrestrial shortages of these resources (Ross, 2001, p. 1). Temporarily-Captured Orbiters

(TCO), being included as near-Earth objects is one of the options that celestial body miners seriously consider; having different, but positive traits compared with the Moon and difficulty reachable asteroids, thus enhancing the risk of failure or mission malfunction. Space law must analyze their scientific evaluations in order to create specific regulations, leaving no room for any "holes" that may be taken advantage of or misunderstood. Many asteroids of potential interest commercially are too small to be easily spotted from Earth and thus will require the expensive development of space-base detection systems. From a commercial standpoint this may have a bright side however since such systems may be able to produce early cash-flows from the sale of the data they generate to governments interested in tracking asteroids to ensure they pose no collision threat with the Earth (Simpson, 2014, p. 176). This addresses asteroids and celestial bodies that do not orbit near Earth where chances of mining are not very promising due to asteroids distances. Although the small size of a typical temporarily-captured natural Earth satellite would make commercial mining operations unprofitable, studying this population and sending spacecraft to these objects is a natural first step for any project that aims to take advantage of the energy and material resources available in asteroids (Gravnik, 2013, p. 151). Thus, commercialization is achievable through the process of exploitation, where space resources and raw materials may not necessarily be put for market and economic use. Space law, being considered a *lex specialis* of international law, does not imperatively regulate commercialization possibilities faced by space legislators and must be open for developments, changes and reforms to overcome legal obstacles when regulating specific celestial bodies for commercial mining that does not consider a lucrative goal through the national and international market. Non-economic commercialization can be accomplished while simultaneously avoiding the concept of commercial dominance and the legal framework should focus on technological exploitation of space resources. Space legislation must find compromised positions of property rights and the common heritage of mankind principle to determine whether TCO's can be mined by a state or party to extract a modest amount of resources for technological commercialization. Commercial objective attempts undertaken by private mining ventures must be legally regulated for the amount of derived resources to create the realistic global impression that the elements consisted in the mined celestial body, does not violate the notion of it being an object outside of commerce.

4. Balance between Exploitation and Commercialization

The next step toward commercializing TCO-extracted resources and raw materials is to consider whether the process should be identified as exploitation, thus highlighting that outcomes will not have a direct appearance and economic value regarding commerce. Announcements of space mining companies in these recent years have displayed their objectives. For instance, Deep Space Industries has announced its own ambitions to quarry space based materials for uses both on Earth and beyond (Simpson, 2014, p. 177). Space legislators are obliged to determine who would own the extracted materials which indicates that they are not a common benefit for all nations, however further development can produce the opposite effect. Although it is argued that TCO-extracted resources and their value belong to mankind, the concept only applies to commercial extraterrestrial mining. Regarding research-purpose utilization with future commercialization attempts, the legal concept changes as there is no commercial value during the beginning process of TCO mining. Article I of the Luxembourg Law states: *"Space resources are capable of being appropriated"* (Foust, 2017).

The term "appropriate" may be viewed from various legal perspectives. For one, it could mean taking a property right in a celestial body whether by a private mining company or the government. However, if the government or the private company extracts raw materials without enforcing a legal claim upon the TCO, no legal violation is considered. Hence, it is unnecessary to claim a formal legal property right upon TCO's. Any derived space resource, in compliance with section 51302 Legal Framework from the U.S. Commercial Space Launch Competitiveness Act, may temporarily achieve the status that samples and moon rocks have when taken from Russian or U.S. missions, as they have not been economically exploited. It is relevant what space legislators mean by the term "commercialization" and its non-economic application. Namely, commercialization represents the process of introducing a new product into commerce, thus making it available on the national and international market. Since TCO's aren't very large, their entry into the mass market is unlikely. However, the notion of commercialization also includes a transfer from the laboratory into commerce, even though such commerce could be limited, meaning that if the derived space resources are eventually commercialized, not only will the commercialization be unprofitable due to the small amount, but will also be of limited commerce, if directly moved from the research laboratory to the national or international market, thus not making them necessarily practical for commercial use. On the other hand, we can create a clear concept about

exploitation being put within the frames of commercial use. Legal regulations must focus on creating sufficient dispute settlements to adequately solve future attempts of commercializing extracted TCO resources which are not primarily owned by property rights. Results of such settlements and mechanisms must provide a balanced legal framework in order to enforce rules without the intention of creating an environment that is litigious as it would be for direct commerce purposes.

While current space access is not very affordable, the distance and cost of the mining missions significantly contribute in the process of commercializing extraterrestrial mining. The ability to conduct low-cost missions to objects that share Earth's orbit will also be of interest to the burgeoning asteroid mining industry (Williams, 2018), meaning that extending a space mining mission negatively impacts the desirability of the mining operation. On the other hand, longer mining seasons allow a greater return of mineral resources. General accessibility of celestial bodies for mining operations is defined based on energy requirements for the trajectories employed by the mission, expressed in terms of required velocity to move a mass from one orbit to another. Near-Earth Asteroids have relatively low energy requirements to reach them and return mineral resources from them to low Earth orbit (Ricky, 2012, p. 73). Considering TCO's as near-Earth objects, shorter and cheaper missions are a guaranteed trait. The most immediate reason would be to realize the cost savings inherent in the use of materials from space in the manufacture of products whose use will also be in space. The cost of lifting similar materials from Earth could be reduced by obtaining the materials directly from the asteroids. (Baca, 1993, p. 1044) Costs including transport of extracted resources and between TCO's and Earth will not be considered an offset for their attempted commercialization, which makes TCO commercial mining take a short-term development.

5. "*Patria Economicus*"

While commercializing TCO's resources predicts market and economic use only, their exploitation is reserved for scientific research, with a subtle attempt for future commercialization. Yet, their consideration as objects out of commerce is arguable by previously representing a common heritage to mankind. Hence, it is questioned whether TCO-extracted materials considered as *res communis onmium* are open for transfer and being considered as *res extra commercium*?

The answer lies in the field of economy and commerce, by associating notions that allow space legislators to specifically regulate the development of commercialized celestial mining. Adam Smith within his book *"An Inquiry into the Nature and Causes of Wealth of Nations"* claims that if the individual aims towards his own interest, it can contribute for a general benefit:

"It is not the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but if their advantages" (Smith, 1776, p. 27).

Smith's concept argues that self-interested actions are what make the economy and commerce function on a global level. Reflecting such concept with commercial celestial body mining, associates humans' self-interest upon those of world states. Hence, states and private mining companies are given the traits of *"homo economicus"* as an individual that acts so as to maximize his well-being given the constraints he faces. *Homo economicus* is the prevalent model of human behavior among economists (Rodriguez-Sickert, 2009, p. 223). Being described as a rational human being, coining the term "*Patria Economicus*" would simultaneously represent and portray States and private mining companies as rational entities. Commercializing space resources would be unnecessary if Earth is already well provided with minerals, metals, and other valuable elements. No State or private mining company would emphasize the need to mine celestial bodies, where the purpose for this action (or lack of action) is derived by States' subjective economical wellbeing. Additionally, if States and private mining companies recognize a big and profitable demand and have available mechanisms to supply that demand, again it does not necessarily originate from their own needs. Considering its legal framework, we question whether such rationality is derived from personal benefit or from the sense of common benefit. These two assumptions are compared with the abovementioned doctrines. On one hand, *res communis omnium* refers that the small amounts of derived TCO resources are originally considered as a common heritage of mankind by equating general benefits. However, this status only applies before entities begin mining the celestial body. On the other hand, *res extra commercium* refers that already mined space resources would be considered as objects outside of commerce. Certain scholars define outer space as a *res extra commercium*, in order to emphasize that outer space must be considered an area outside commerce and, therefore, not subject to national appropriation and open to all. (Tronchetti, 2009, p. 13) This context refers to an

area beyond national border, which includes TCO's: *"These regions are subject to a common freedom of exploitation without exercising national sovereignty"* (Baslar, 1998, p. 42).

Since commercial celestial mining represents the extraction of space resources as exploitation without the necessary obligation to claim TCO's as national sovereignty, they can be considered as objects outside of commerce. However, this status should only apply while the derived resources and materials are in their raw form, no matter if they are even brought to Earth.

6. Conclusions

Space legislators should consider that the commercial mining of TCO's can be perceived and regulated not from a directly commercialized point of view, but rather as a primarily exploitation process along with the attempt for future commercialization. Processes that are characteristic to be performed in stages tend to be less problematic for space law and property rights, since it does not necessarily require a formal legal claim of sovereignty. The consequence is that in order to ensure a safe, rational, peaceful and orderly exploitation of the resources of other celestial bodies a legal regime containing rules establishing how this exploitation has to be organized and carried out must be established (Tronchetti, 2009, p. 4) Additionally, a beneficial commercialization concept must be provided to the regulations of space law, combined with a legal balance made between exploitation and commercialization of celestial body resources. Furthermore, the commercial aspect concerning the legal framework that regulates celestial body mining of temporarily-captured should be introduced with the comparison of economical and commercial concepts that are vital for creating a legal regime for this approach to commercial extra-terrestrial resources extracted from TCO's. From the concept of *Homo Economicus* to the coining of the notion of *"Patria Economicus",* commercial space law should define the economic intentions of a State or private mining company and put them in a legal perspective in order to regulate the direction of the potential commercialization of minerals and other materials from TCO's, only after being brought to Earth.

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