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JURISDICTIONAL CHOICE FOR SPACE RESOURCE UTILIZATION PROJECTS: CURRENT SPACE RESOURCE UTILIZATION LAWS

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Francesca Giannoni-Crystal*

ABSTRACT

Space resource utilization is coming. While some legal impediments exist, they are not insurmountable. The ban on the appropriation of resources found in Article II of the Outer Space Treaty ("OST") does not apply to extracted resources, according to the most reasonable interpretation of Article II and the view held by almost all countries and the overwhelming majority of scholars. The Moon Agreement is not a barrier to space resource utilization because it has not been adopted by many countries (and none of the major space-faring ones). By contrast, the Artemis Accords, which have been signed by a significant number of the major space-faring countries (including the US), are supportive of space resource utilization. The growing support for space resource utilization is reflected in the four national laws of the United States, Luxembourg, United Arab Emirates, and Japan. In principle, domestic laws are limited to activities performed in the jurisdiction of the country issuing the law, and space is not subject to the sovereignty of any country. However, the application of domestic law to space mining facilities (without any formal claim of sovereignty) – which is essential to achieving certainty in outer space and avoiding conflicts - is consistent with both the letter of the OST and its underlying purposes. After examining the purposes and the details of the four space resource utilization laws that have been enacted (also in light of the four countries' legal systems), this paper provides a comparison of the four laws and identifies pragmatic considerations that space resource utilization companies should take into account in jurisdictional choices. The paper concludes that the "choice of flag" should be based more on considerations of the business environment, support, and political factors than on differences among the four laws.

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INTRODUCTION

Space mining is coming; it is not a question of "if" but of "when."[1] Space is so rich in natural resources (to be used either in the place of extraction or brought to Earth) that it is only a matter of time before space mining starts.[2] It will probably begin with the Moon,[3] then Mars[4] and the asteroids.[5] As discussed in Part I, several space-faring countries

[1] Controversy exists about when space mining will be technically feasible but late 2020s is a reasonable estimate, at least for the Moon. *See* Leonard David, *Mining Moon Ice, Prospecting Plans Starting to Take Shape*, SPACE.COM (July 13, 2018), available at: https://www.space.com/41164-mining-moon-water-plans-take-shape.html. Leonard David also quotes Dr. Philip Metzger, a planetary scientist at the University of Central Florida:

> I think this confluence of interests makes it likely we will see lunar mining in about a decade. A decade is the fastest lunar mining could possibly begin, [...] when you add up the time needed to characterize and quantify the resources, followed by developing and deploying technologies to mine, it takes about 10 years. *Id*.

[2] *See, e.g*., Scot W. Anderson *et al*., *The Development of Natural Resources in Outer Space*, 51 ENV'T L. REP. 10835 (2021) (hereinafter, "*Nat. Resources in Outer Space*"), available at: https://www.hoganlovells.com/-/media/hogan-lovells/pdf/2021-pdfs/2021_09_28_elr_article_published.pdf.

[3] Initial mining activities are poised to begin on the Moon before expanding to other locations. Extracting ice on the moon will provide essential resources like water, oxygen, and rocket fuel, showing strong potential for economic viability. Utilizing robots and 3-D printers, materials from the moon could construct homes and vehicles. The abundant Helium-3 on the moon will serve as fuel for fusion reactions and holds promise for potential exportation to Earth as a valuable energy source. *Id*. at 10835-36.

[4] Similar to the Moon, Mars harbors ice and potentially liquid water. Beneath its surface lie valuable minerals crucial for sustaining human settlements. Robots could extract resources from asteroids, produce goods in space, and harness asteroid ice as fuel. Asteroids hold the potential to facilitate human exploration of outer space. *Id.* at 10836.

[5] Ramin Skibba, *Things are Looking Up for Asteroid Mining*, WIRED (Oct. 28, 2023), available at https://www.wired.com/story/things-are-looking-up-for-asteroid-mining/(last visited Dec 5, 2023).

(including the United States),[6] and/or their nationals have some space mining plans.[7]

Part II discusses international legal issues regarding contemplated space mining efforts. Current international law presents some uncertainties regarding space mining. Article II of the Outer Space Treaty ("OST")[8] bars national appropriation, but it has no specific provision on space mining.[9] This article discusses how, according to the best scholarly interpretation, which is also the interpretation of the major space-faring countries, Article II does not ban appropriation of the extracted resources but only appropriation of resources when they remain "*in situ*"[10] has a strict regime for resource utilization.[11] The Artemis Accords contemplate that space mining is allowed by Article II OST and provides for "safety zones" to foster safe lunar mining. [12] Still,

[6] This paper uses "space-faring countries" in the sense of "countries with ability to launch space objects" and not as countries that use satellites. In fact, almost all countries "use satellites for communications and weather forecasting, and increasingly for satellite navigation and resource management" but only few – namely the United States, Russia, Japan, China, the European Space Agency (and some European countries), India, Israel, Iran, North Korea – can launch satellites. Spacepolicyonline, *International Space Activities, launching countries*, Spacepolicyonline.com (last edited Nov. 19, 2022), available at: https://spacepolicyonline.com/topics/international-space-activities/ (last visited Feb. 15, 2024).

[7] *See, e.g.,* Jan Osburg & Mary Lee, *Governance in Space: Mining the Moon and Beyond,* RAND (Nov 18, 2022) (hereinafter, "Osburg & Lee, Mining the Moon and Beyond"), available at: https://www.rand.org/blog/2022/11/governance-in-space-mining-the-moon-and-beyond.html(last visited Feb. 15, 2024); Amanda State, *The Global Race to Mine Outer Space,* MINING.COM (May 22, 2022), available at: https://www.mining.com/the-global-race-to-mine-outer-space/ (last visited Feb. 15, 2024).

[8] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 (hereinafter "OST").

[9] "On balance [...] the Outer Space Treaty states general principles and provides a framework that would allow nations and private parties to develop and use natural resources in outer space." *Nat. Resources in Outer Space*, *supra* note 2, at 10840.

[10] The Latin expression "*in situ*" means "in the natural or original position or place." *In situ*, MERRIAM-WEBSTER, available at https://www.merriam-webster.com/dictionary/in%20situ (last visited March 26, 2024).

[11] *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, Dec. 5, 1979, 18 I.L.M. 1434, 1363 U.N.T.S. 3(hereinafter "Moon Agreement").

[12] Katharina Buchholz, *MOON TREATY The Countries That Signed the Moon Treaty,* STATISTICA (Aug. 23, 2023), available at https://www.statista.com/chart/18738/countries-that-are-signatories-or-parties-to-the-1979-moon-treaty/ (last visited Feb. 15, 2024).

they are merely bilateral arrangements among space agencies and not a treaty.

Space mining will have a "geopolitical" significance in the near future, with the "United States … rapidly emerging as a front-runner" but with competition also from China,[13] Luxembourg, and the United Arab Emirates, as well as from "Russia, Japan, India and the European Space Agency, which also harbor space-mining ambitions."[14] Four countries – the United States, Luxembourg, the United Arab Emirates, and Japan - have enacted space resource utilization laws.[15] This article discusses how several OST provisions can be interpreted to justify states' jurisdiction and control over mining facilities and the application of domestic law in outer space.

Part III of the article examines the current national legislative efforts regarding space mining. These laws all have a similar general purpose: to clarify the country's position on international law (mostly in the interest of businesses). Importantly, the four laws – either directly or indirectly - all provide for property rights in extracted resources.[16] After briefly discussing each nation's space background, this article then discusses the four laws, including their purpose and significant provisions.

Part IV compares the four laws, highlighting similarities and differences, while also offering guidance to companies considering which national basis for their space resource utilization projects would be

[13] Connie Lin, *China moon mineral discovery: Here's why Changesite-(Y) could fuel a gold rush for lunar mining*, FAST COMPANY (Sept. 13, 2022) (hereinafter, "Lin, *China moon mineral discovery*"), available at: https://www.fastcompany.com/90789419/china-moon-mineral-discovery-heres-why-changesite-y-could-fuel-a-gold-rush-for-lunar-mining (last visited Feb. 15, 2024).

[14] Alex Gilbert, *Mining in Space is Coming*, MILKEN INST. REV. (Apr. 26, 2021) ("*Mining in Space is Coming*"), available at: https://www.milkenreview.org/articles/mining-in-space-is-coming. (last visited March 26, 2024).

[15] *See* discussion *infra* Part III.

[16] The United States, Luxembourg, the United Arab Emirates, Japan, India, and the European Space Agency all have space mining ambitions. *See* Gilbert, *supra* note 21. Russia and China share aspirations in space mining and have forged a collaborative agreement for joint moon missions. *See* Osburg & Lee*, supra* note 7.

optimal. The discussion includes comments on geopolitical aspects of selecting a flag.

This article concludes that space resource utilization is consistent with the OST and that space resource utilization companies choosing their flag should consider not only the domestic space resource utilization legislation, but also more important geopolitical conditions.

I. CONTEMPLATED PROJECTS FOR SPACE RESOURCE UTILIZATION

Ten years ago, there was an expectation that space mining could happen relatively fast, but then the industry suffered some setbacks. The two main actors of this nascent industry, Planetary Resources and Deep Space Industries (DSI), were overwhelmed by high costs and abandoned their plans.[17]

A second generation of space companies is preparing to initiate projects, including most recently Interlune, a SRU startup, which plans to harvest helium-3 from lunar regolith.[18] Their business models are different from those of the original startups because they want to be economically viable from their inception. Their models envision providing services in Earth orbit while building their space mining business or minimizing cost by hitching a ride as secondary payloads on

[17] Planetary Resources, accepted to be acquired by ConsenSys, a company in the blockchain industry, in 2018 after realizing the impossibility of obtaining further funding. Likewise, Deep Space Industries (DSI), whose plan was to "extract ice from asteroids near Earth and selling it in space as a propellant for other missions," was acquired by Bradford Space, an aeronautics company. The consensus is that these acquisitions are removing the companies from the space business. Some experts are skeptical that "customer base for asteroid mining [will be available] in the next 12 to 15 years." Atossa Araxia Abrahamian, *How the Asteroid-Mining Bubble Burst, a Short History of the Space Industry's failed (for now) gold rush*, MIT TECH. REV. (June 26, 2019), available at https://www.technologyreview.com/2019/06/26/134510/asteroid-mining-bubble-burst-history/ (last visited Dec 5, 2023).

[18] Interlune recently emerged from "stealth mode" with a public announcement on March 13, 2024, unveiling its mission to pioneer sustainable, responsible harvesting of natural resources from space. Founded by two former Blue Origin board members and an Apollo astronaut, the company will initially focus on harvesting Helium-3 from the Moon's regolith. Giancarlo Albertinazzi, *Interlune*: *A New Company will Mine Helium-3 on the Moon*, spacevoyaging.com (Mar. 22, 2024), available at: https://www.spacevoyaging.com/interlune-a-new-company-will-mine-helium-3-on-the-moon/ (last visited March 26, 2024).

a "rocket bus" as SpaceX.[19] These companies have either an *in situ* resource utilization model [20] or a return-to-earth model, the cost of which is higher.[21]

Some companies plan to refuel their landers on the Moon, with water extracted from the Moon itself.[22] An Australian startup, Space Industries Pty Ltd., plans to mine water and helium3 from the Moon.[23] TransAstra, a US based-company [24] funded with a five million grant from the National Aeronautics and Space Administration (NASA) and

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[19] *See* Magdalena Petrova, *The First Crop of Space Mining Companies Didn't Work Out, but a New Generation is Trying Again*, CNBC (Oct. 9, 2022),(interviewing AstroForge on their belief that "there is money to be made in mining asteroids for precious metals"), available at: https://www.cnbc.com/2022/10/09/space-mining-business-still-highly-speculative.html (last visited Dec 5, 2023).

[20] *In situ* resource utilization ("ISRU") describes any equipment or procedure that harnesses and utilizes resources local resources to generate goods and services for both robotic and human exploration, as well as to establish and maintain a sustained presence. Resources comprise both natural elements discovered on celestial bodies like water, implanted volatiles from solar winds (hydrogen, helium, carbon, nitrogen, etc.), extensive metal reserves in mineral rocks and soils, atmospheric components, and also human-produced materials like discarded waste from the crew and hardware that has fulfilled its primary function. The primary aim of ISRU is to significantly cut the direct costs associated with human missions to and from the Moon and Mars to progress towards creating self-sustaining long-term crewed space stations that aid in expanding scientific and exploratory endeavors, and to facilitate the commercialization of space. SPACE EXPL. COORDINATION GRP., IN-SITU RESOURCE UTILIZATION GAP ASSESSMENT REPORT 15 (2021).

[21] The return-to-Earth model involves "extracting materials from various bodies in space and bringing them back to Earth." *See* Michael Dello-Iacovo & Serkan Saydam, *Humans Have Big Plans for Mining in Space - But There Are Many Things Holding Us Back*, THE CONVERSATION (May 15, 2022) (hereinafter "*Humans Have Big Plans for Mining in Space*") (asserting that this is unlikely commercially viable in the near future).

[22] Blue Origin's lunar lander uses propellants composed of liquid hydrogen and liquid oxygen instead of storable hypergolic. The company's founder, Jeff Bezos, declared that "[u]ltimately, we're going to be able to get hydrogen from that water on the moon, and be able to refuel these vehicles on the surface of the moon." Jeff Foust, *Blue Origin Unveils Lunar Lander*, SPACENEWS (May 9, 2019), available at: https://spacenews.com/blue-origin-unveils-lunar-lander/ (last visited Dec. 5, 2023).

[23] This is expected to be obtained through a lunar mining vehicle that will process and return helium-3 to Earth. The byproduct - water - could be used *in-situ* on the Moon for fuel, among other uses. *See* NASA, SBIR/STTR Program, NASA, available at: https://www.nasaitech.org/blog/2019-cycle-2-space-industries-pty-ltd (last visited Dec. 5, 2023). The Moon is the ideal location to start robotic mining because it only has a 2.7 second delay for communications and may be easier to mine remotely. Near-Earth objects also have orbits similar to Earth, and occasionally pass by Earth at distances comparable to the moon. They are ideal candidates to mine as they require little energy to reach and return from. *See also Humans Have Big Plans for Mining in Space*, *supra* note 21.

[24] Petrova, *supra* note 19.

several million from venture capitalists,[25] plans to initially mine water to use as propellant and then mine other materials.[26] Striving for profitability while developing its mining business, TransAstra is designing a vehicle called "Working Bee," which will be used for delivering satellites into Earth orbit and ultimately for space mining.[27] Depending on funding, TransAstra estimates it will be launching a mining mission in five to seven years. California-based startup Astroforge[28] plans to mine asteroids for precious materials, explaining that:

> our mission is to make space resources accessible on Earth. We mine asteroids to extract valuable minerals in space at a lower cost and smaller carbon footprint than the current terrestrial mining methods.[29]

Unlike the first generation of space mining companies, Astroforge intends to keep the costs manageable by using satellite buses like SpaceX to reach outer space.[30] Astroforge is planning to conduct its first mining mission in 2025; the mission will last two years and explore near-Earth asteroids.[31] The Japanese company ispace has plans for extracting water from the Moon to use as propellant and then other

[25]Petrova, *supra* note 19.
[26] TransAstra has already entered into a contract with a publicly traded company. *See* Petrova, *supra* note 19.
[27] Petrova, *supra* note 19.
[28] ASTROFORGE, available at: https://www.astroforge.io (last visited Dec. 30, 2023).
[29] *Id.*
[30] Petrova, *supra* note 19.
[31] *See* Petrova, *supra* note 19. Astroforge is in the process of selecting the asteroid to target, and it expects to bring back to Earth 80 million value of precious metals per mission. Petrova, *supra* note 19. *See also*, Jeff Foust, *Asteroid Mining Startup AstroForge to Launch First Missions This Year,* SPACENEWS (Jan. 30, 2023), available at https://spacenews.com/asteroid-mining-startup-astroforge-to-launch-first-missions-this-year-2/ (last visited Dec. 5, 2023).

resources; it envisions a city of 1000 people on the Moon by 2040 as a result of Moon mining.[32]

Governments are also active in space resource utilization. For example, NASA has plans for scientific experiments of drilling on the Moon[33] and awarded contracts to four companies to extract small amounts of lunar regolith by 2024.[34] Russia,[35] the European Space Agency (ESA),[36] and China[37] are also developing mining projects.

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[32] Ispace describes its vision as follows:

> The Moon's water resources represent untapped potential. Our aspiration is to explore and develop these water resources and spearhead a space-based economy. Water can be broken down into hydrogen and oxygen to produce fuel, so we are mapping lunar resources to accelerate the pace of space development. Imagine the Moon supporting construction, energy, steel procurement, communications, transportation, agriculture, medicine, and tourism [...] We believe that by 2040 the Moon will support a population of 1,000, with 10,000 people visiting every year.

iSpace, *Expand our planet. Expand our future*, ISPACE, available at https://ispace-inc.com (last visited April 18, 2024).

[33] Intuitive Machines, LLC partners with NASA to contribute to the Artemis Program by facilitating the retrieval of lunar scientific data. Intuitive Machines, LLC, *NASA Redirects Intuitive Machines' First Mission to the Lunar South Pole Region*, available at: https://www.intuitivemachines.com/post/nasa-redirects-intuitive-machines-first-mission-to-the-lunar-south-pole-region (last visited Apr. 18, 2024). Steve Altemus (Co-Founder, President and CEO of Intuitive Machines) declared that "the Company is honored to accept the historic and scientific responsibility of bringing the United States to the lunar South Pole Region for the first time ever [...]" *Id*. *See also,* Hillary Smith*, Intuitive Machines Announce Landing Site Location for Lunar Drill*, NASA (Nov. 3, 2021), available at: https://www.nasa.gov/feature/nasa-intuitive-machines-announce-landing-site-location-for-lunar-drill (last visited Apr. 18, 2024).

[34] Press Release, NASA, *NASA Selects Companies to Collect Lunar Resources for Artemis Demonstrations* (Dec. 3, 2020), available at: https://www.nasa.gov/news-release/nasa-selects-companies-to-collect-lunar-resources-for-artemis-demonstrations. (last visited Dec. 5, 2023).

[35] *See* Osburg & Lee, *supra* note 7 (making the point that Russia and China have cultivated aspirations for space mining and have established a collaborative agreement for missions to the Moon).

[36] Russia and the European Space Agency have launched the PROSPECT program to evaluate outer space resource exploration and develop extraction technologies. Meanwhile, the Chinese National Space Administration's Change lunar missions have collected moon samples, assessing the potential for commercial resource exploitation in space. Scott & Kai Adam Luck, *Outer space: The new frontier for restructuring and insolvency*, Norton Rose Fulbright, available at: https://www.nortonrosefulbright.com/en-ca/knowledge/publications/b34b1f80/outer-space-the-new-frontier-for-restructuring-and-insolvency (last visited Dec. 5, 2023).

[37] Lin, *China moon mineral* discovery, *supra* note 13.

II. INTERNATIONAL LEGAL ISSUES

A. The Outer Space Treaty and the (Non-Insurmountable) Obstacle to Space Mining: The Non-Appropriation Principle of Article II

Neither the OST nor any other of the space treaties that implemented it[38] (with the exception of the unsuccessful Moon Agreement)[39] deal directly with space resource utilization. While the OST presents some issues for space resource utilization,[40] the issues are not insurmountable.[41]

Article II OST provides that "[o]uter space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." This paper does not deal with the issue, which scholars have also debated, of whether Article II also applies to private entities as well as to states [42] and assumes the debate has reached the almost certain conclusion that Article II applies to states and private entities alike.[43]

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[38] *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, Jan. 16, 1968. (hereinafter "Rescue Agreement"), which implemented Article V OST; C*onvention on International Liability for Damage Caused by Space Objects*, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187. ("Liability Convention"), which implemented Article VII OST; *Convention on Registration of Objects Launched into Outer Space*, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15. ("Registration Convention"), which implemented Article VIII OST.

[39] Moon Agreement, *supra* note 11.

[40] *Nat. Resources in Outer Space*, *supra* note 2, *passim*.

[41] "On balance [...] the Outer Space Treaty states general principles and provides a framework that would allow nations and private parties to develop and use natural resources in outer space." *Nat. Resources in Outer Space*, *supra* note 2, at 10840.

[42] The argument in the negative is based on the adjective "national" in the language "national appropriation." *See, e.g.*, Ricky J. Lee, *Article II of the Outer Space Treaty: Prohibition of State Sovereignty, Private Property Rights, or Both*, 11 AUSTL. INT'L L.J. 128 (2004). There is also discussion of the position of some scholars supporting the opposite view. (*e.g.*, Stephen Gorove, *Interpreting Article II of the Outer Space Treaty*, 37 FORDHAM L. REV. 349 (1969)). *See id.*at 136.

[43] Ricky J. Lee concludes that the prohibition must include private entities arguing that because Article VI provides for the relevant State's duty to authorize and oversee private entities' space operations, it is evident that Article II should encompass private acts of national appropriation, not just those directly carried out by the State itself. *Id.* at 129. Within the same paper, however, the author points out that the Chinese language version of the OST – which is one of the authentic languages and therefore important in shaping the content and impact of Article II – supports the argument that Article II does not extend to private parties. In the translation of the same author, it

Article II is ambiguous (and perhaps intentionally so) [44] on the issue of whether appropriation of space resources is possible. Article II has been interpreted by some to preclude the acquisition of property rights in space resources: "Some states and space law experts interpret OST Article II literally to preclude lunar property rights, including ownership of mines."[45]

Von der Dunk notes that this view of Article II [46] is based on several misinterpretations: i) an equation of the language "province of all mankind" in Article I OST as if it would be the same as "common heritage of mankind" used in the Moon Agreement, ii) a broad interpretation of Article II OST and iii) a construction of "exploration and use" in Article I OST as referring only to scientific (noncommercial) use.[47]

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provides, "outer space, including the Moon and other celestial bodies, cannot, through the State by asserting sovereignty, use, occupation or any other means, be appropriated." *Id*. at 130 (citing the author's Chinese translation of Article II).

[44] The OST's diplomatic history suggests that the ambiguity between forbidding the national appropriation of celestial bodies and permitting the use of space resources might have been intentional to secure broader support for the OST. *Nat. Resources in Outer Space*, *supra* note 9, at 10840.

[45] Paul B. Larsen, *Is There a Legal Path to Commercial Mining on the Moon?,* 83 U. PITT. L. REV. 1, 13 (2021) (hereinafter, "Larsen, *Legal Path to Mining the Moon*").

[46] *See, e.g.*, Zachos A. Paliouras, *The Non-Appropriation Principle: The Grundnorm of International Space Law*, 27 LEIDEN J. INT'L L. 37, 50 (2014), arguing that Article II of the Outer Space Treaty precludes appropriation of "any part of outer space […] by private individuals" and that if a country "confers proprietary rights [...] [it] would commit an internationally wrongful act." Even authors that recognize the right to harvest space sources, point out that the lack of agreement on the lawfulness of space mining is likely to create tensions. *See, e.g*., Bryant A. Mishima-Bake, *Moon Wars: Legal in Space and Moon Law*, THE REPORTER 1, 4 (2021) (hereinafter, "Mishima-Bake, *Moon Wars*") indicating that while the use of these resources and lunar sites is acknowledged as permissible under custom and the OST, the complete validation of the right to space resources remains untested as no nation has extracted a significant amount of resources and noting how the moment for this testing is drawing near.

[47] Frans von der Dunk, *The US Space Launch Competitiveness Act of 2015*, JURIST (Nov. 30, 2015) (hereinafter, "Von der Dunk*, US Space Competitive Act*")

> [They] usually argue that (1) celestial bodies as part of the 'province of all mankind' … could only be commercially exploited, if at all, under an international regime to be duly developed, as if it were a 'common heritage of mankind'; and/or (2) that the prohibition of national appropriation, provided for by Article II of the Outer Space Treaty in quite strict and all-inclusive terms, automatically would give rise to a prohibition to apply any national authorization regime regarding such intrusive activities unilaterally; and/or (3) that, following the general context

Behind the misreading of the "province of all mankind" as the "common heritage of mankind" is effectively a desire to see space as a "global commons." However, OST never mentions the concept of global commons.[48] Also, historically, the concept of "commons" applies when a sovereign exists to establish the commons, which is impossible in space because among other reasons, Article II OST prohibits sovereignty. [49] Considering the historical meaning, the use of this term with reference to space is novel and unclear.[50]

Von der Dunk explains why it is wrong to opine that international law prohibits space mining:

1) As a general proposition, freedom in outer space can be limited only by an explicit prohibition, and "there is no explicit prohibition of commercial exploitation to start with." Instead, the OST contains Article VI OST on authorization and supervision, "which … suggests that once that requirement [of authorization] is fulfilled … private space activities

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of the Outer Space Treaty's drafting, the explicit freedom of "exploration and use" and scientific investigation does not refer to commercial use. *Id.*

[48] Henry R. Hertzfeld, *et al., Outer Space: Ungoverned or Lacking Effective Governance? New Approaches to Managing Human Activities in Space*, 36 SAIS REV. INT'L. AFF. 15, 16-7 (2016) (hereinafter, "Hertzfeld, *Outer space ungoverned*") (expressing that, in line with the fundamental principles of space treaties, numerous diplomats, legal experts, and government officials frequently describe outer space as a global commons).

[49] *Id.* at 18 (arguing that in the past, a global commons has typically required a sovereign government to allocate open territory for the benefit of all individuals. Instead, Article II OST prohibits sovereignty in space).

[50] If we were to conclude that space is a global commons, we would be using the term in a different meaning from what we usually intend by "commons". *Id*. "[L]egal concepts of Commons need: (1) a sovereign power to grant the territory to open use [...] [and set the rules] [...]; (2) an area of land or a region with well-defined borders, (3) an economic foundation that requires or facilitates some basic human need." *Id.* at 20. "[A] terrestrial model of a commons is not a model that can easily be applied to outer space." *Id.* at 22. A global commons for space does not even have an economic basis. *Id*. 18-20. Hertzfeld, *Outer space ungoverned* lists practical examples of cooperative solutions to governance problems that could be use analogically to govern outer space: "i) the International Space Station Agreement (Agreement Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil Inter-National Space Station." Hertzfeld, *supra* note 48, at 23. Also, "(ii) the frequency allocation and spectrum management by the International Telecommunication Union (ITU) [and] (iii) "Antarctica, aviation, as well as the high seas." Hertzfeld, *supra* note 48, at 23.

are in principle lawful unless specific other prohibitions or conditions apply."[51]

2) The Moon Agreement's "common heritage of mankind" concept (and the international sharing structure that it entails "before commercial exploitation might be allowed") has been rejected by all the "major spacefaring nations."[52]

3) 1982 United Nations Convention on the Law of the Sea - requiring an international regime to be implemented before exploitation was possible – had to be significantly modified in 1994 to gather more ratifications.[53]

4) The term "use" in the OST has since the sixties consistently been interpreted to include "commercial use" (see e.g., commercial satellites).[54]

Von der Dunk concludes that "[t]he better view is that the unequivocal prohibition of appropriation of celestial bodies as such does not give rise to a prohibition of commercial exploitation."[55] Von der Dunk is certainly not alone in sustaining the lawfulness of space mining, and actually, "the weight of the experts is gathering on the side of permitted use."[56]

A second scholar, Eng Teong See, points out that "[Article II] seem[s] to suggest appropriation of land because of the words 'use or occupation' and 'sovereignty'"[57]; while another scholar opines that "the status of outer space and the celestial bodies is *res extra commercium"* and that "as long as any countries or private enterprises or individuals

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[51] Von der Dunk*, US Space Competitive Act*, *supra* note 47.
[52] Von der Dunk*, US Space Competitive Act*, *supra* note 47.
[53]Von der Dunk, *supra* note 47. The modified regime has been ratified by 168 countries but not by the United States.
[54] Von der Dunk*, supra* note 47.
[55] Von der Dunk*, supra* note 47.
[56] Mark Sundahl, *Don't muddy the message to space mining companies*, SPACENEWS, (June 9, 2016), available at https://spacenews.com/op-ed-dont-muddy-the-message-to-space-mining-companies/#:~:text=Last%20November%2C%20Congress%20passed%20the,interference%20and%20may%20assert%20ownership (last visited Dec 5, 2023).
[57] Eng Teong See, *Commercialization of Space Activities - The Laws and Implications,* 82 J. AIR L. & COM. 145, 159 (2017) (hereinafter, "Eng Teong See*, Commercialization of Space Activities*").

respect the non-appropriation principle of outer space and the celestial bodies, they should be able to use and benefit from it."[58] For "*res extra commercium*" - which he equates to "*res communis* or *terra communis*"[59]- this author intends "a region that exists outside of a national border in which states cannot exercise their sovereignty, but have the freedom of exploration and exploitation."[60] In this region, "no person can own, exclude others or transfer possession of the land."[61] He analogizes the situation to the high seas where vessels can fish but without occupying the sea or excluding other vessels.[62]

In 2015, the International Institute of Space Law (IISL) issued a position paper which concluded that "in view of the absence of a clear prohibition of the taking of resources in the Outer Space Treaty one can conclude that the use of space resources is permitted."[63] In 2019, after three years of work, an international, interagency, and interdisciplinary working group at the Institute of Air and Space Law of the University of Leiden published the "Building Blocks for the Development of an International Framework on Space Resource Activities"[64] ("Building Blocks"), which – as the Artemis Accords – "interpret OST Article II to allow the use of lunar mines without claiming property rights."[65] In conclusion, the overwhelming consensus of scholarly opinion is that Article II of the OST does not prohibit space mining in general and lunar mining in particular. Other provisions of the OST support the conclusion

[58] Han Taek Kim, *Fundamental Principles of Space Resources Exploitation: A Recent Development of Int'l and Municipal Law*, 11 J J.E. ASIA & INT'L L. 35, 51 (2018).
[59] *Id*. at 39.
[60] *Id.*
[61] *Id.*
[62] *Id. at* 39-40.
[63] Board's Opinion, *Position Paper on Space Resource Mining*, INT'L. INST. OF SPACE L., 3 (Dec. 2, 2020) (contending that it remains uncertain if this legal scenario is adequate. The alignment of other states with the United States' interpretation of Article II of the Outer Space Treaty will significantly shape the evolution of the principle of non-appropriation).
[64] *Building Blocks for the Development of an International Framework on Space Resource Activities,* Hague Int'l. Space Resources Governance Working Group, (Nov. 12, 2019), available at https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht--en-ruimterecht/space-resources/final-bb.pdf (last visited Dec 5, 2023).
[65] Larsen, *Legal Path to Mining the Moon*, *supra* note 45, at 14.

that the OST does not prohibit space mining. Article II must be read together with Article I, second paragraph OST:

> Outer space, including the moon and other celestial bodies, shall be free for exploration *and use* by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies. (emphasis added)

The word "use" must imply the possibility of extraction and appropriation of resources. The OST twice refers to "exploration and use," thus indicating that use goes beyond exploration; with a different interpretation, the word 'use' becomes a duplication of 'exploration.[66]

Further, Article II must be interpreted in light of customary international law on treaty interpretation as codified in the Vienna Convention on the Law of Treaties[67] ("Vienna Convention"), Article 31(1) (meaning of the words "in their context and in the light of its object and purpose"): the "non appropriation" principle may have come from a fear that colonization could happen in outer space (on the Moon and other celestial bodies) as it had happened on Earth.[68] Also, "[t]he words seem to suggest appropriation of land because of the words 'use or occupation' and 'sovereignty.'"[69]

Article 31(2) of the Vienna Convention is also relevant: the interpretation of a treaty must consider "any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation."[70] Looking at the declaration of the space-faring countries establishes that their position is that Article II's appropriation ban does not cover extracted resources but only resources

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[66] *Nat. Resources in Outer Space*, *supra* note 2, at 10840 (noting that the Treaty includes the phrase "exploration and use" twice in its terms. The word "use" seems to indicate that the drafters of the OST expressly considered and authorized the development and deployment of space resources).
[67] Vienna Convention on the Law of Treaties, May 23, 1969, 1155 U.N.T.S. 331.
[68] *See* Jack D. Eller, *Space Colonization and Exonationalism: On the Future of Humanity and Anthropology*, 2 Humans 148-160 (2022).
[69] Eng Teong See*, Commercialization of Space Activities, supra* note 57, at 159.
[70] Larsen, *Legal Path to Mining the Moon*, *supra* note 45 at 26.

in situ.[71] For example, the United States has never questioned that the OST allows the extraction and use of space resources.[72] In 2015, a law was passed to recognize property rights in extracted resources.[73] In 2020, NASA signed the Artemis Accords with the space agencies of other space-faring countries, and in the Artemis Accords space mining is a focal point.[74] Of course, after actual mining begins, the absence of an international objection to the practice of space mining would be an even stronger argument than legislation; actual mining would amount to a "subsequent practice" according to the Vienna Convention; the lack of objection by other countries would count as acquiescence.

B. The Moon Agreement

None of the four countries that have passed legislation on space resource utilization are parties to the Moon Agreement.[75] The Moon Agreement is incompatible with unilateral legislative endeavors.[76] As discussed, the Moon Agreement has been unsuccessful [77] and this was mainly[78] due to two controversial provisions that directly touch the topic

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[71] Brian J. Egan, Legal Adviser, State Dep't, *Address at the Galloway Symposium on Critical Issues in Space Law* (Dec. 7, 2016) (explaining how this interpretation of the OST is consistent with the longstanding position of the United States) (archived with author), available at: https://2009-2017.state.gov/s/l/releases/remarks/264963.htm (last visited Dec 5, 2023)

[72] "It has been the State Department's position for several decades that the Treaty's non-appropriation principle applies to space resources only when such resources are 'in place.' This prohibition does not extend to governmental or private ownership of resources once they are removed from the celestial body." *Nat. Resources in Outer Space*, *supra* note 2 at 10841.

[73] *See infra* Part IV(A).

[74] *See infra* Part III(C).

[75] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 18 I.L.M 1434, Dec. 5, 1979, 1363 U.N.T.S. 3.

[76] Larsen, *Legal Path to Mining the Moon, supra* note 45 (stating countries adhering to the 1979 Moon Agreement impose conditions for sharing benefits related to property rights and the commercialization of lunar resources. As a result, there will be varying recognition of property rights concerning lunar mining products among different nations, leading to uncertainty that hampers the marketing of space resources.).

[77] Stefan-Michael Wedenig & Jack Wright Nelson, *The Moon Agreement: Hanging by a Thread?*, MCGILL UNIV. INST. OF AIR AND SPACE L. (Jan. 26, 2023) (hereinafter "*Hanging by a Thread*").

[78] *Id.* At least two scholars suggested that the Moon Agreement (proposed by Argentina, Poland, and France) was essentially a tactic aimed at delaying COPUOS actions that could impede US or

of this paper: 1) the "common heritage of mankind" principle of Article 11.1 and 2) the compulsory international regime that should be established as per Article 11.5. The two points are connected and the second gives substance to the first.

The "common heritage of the mankind" principle refers to the "res communis omnium concept [and] limits use and exploitation by mandating that any exploitation must be conducted according to rules established by the international community as a whole."[79] In fact, Article 11.1 provides: "1. The moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this Agreement, in particular in paragraph 5 of this article."[80] Article 11.5 provides: "States Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible."[81] Article 11.7 clarifies "[t]he main purposes of the international regime," which include "[a]n equitable sharing by all States Parties in the benefits derived from those resources."[82] Article 11.8 specifies that all space resources activities must "be carried out in a manner compatible"

Soviet space endeavors, coinciding with its introduction. There never was an intention of signing the agreement. *See id*.

[79] *Id.*

[80] *See* Moon Agreement, *supra* note 11, art. 11(1).

[81] *See* Moon Agreement, *supra* note 11, art. 11(5). Corollary to Article 11(5) Article 11.6 requires the parties, even before the regime of Article 11.5 is established, to "inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of any natural resources they may discover on the moon," Moon Agreement, *supra* note 11, art. 11(6).

[82] Article 11.7 Moon Agreement:

> The main purposes of the international regime to be established shall include: (a) The orderly and safe development of the natural resources of the moon; (b) The rational management of those resources; (c) The expansion of opportunities in the use of those resources; (d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.

Moon Agreement, *supra* note 11, art. (11.7).

with the said purposes.[83] However, because the Moon Agreement was ratified by only a few countries and because exploitation of resources on the Moon has not occurred. The international regime of Article 11.5 has never been established. [84]

The Moon Agreement has failed to gather international consensus and has become insignificant today (except as a model that the international community rejected) as part of the discussion of governance of space mining.[85] In 2020 President Trump signed an executive order ("*Encouraging International Support for the Recovery and Use of Space Resources*"), definitely rejecting the Moon Agreement and reaffirming that "the United States does not view space as a 'global commons'."[86]

The Moon Agreement's regime is similar to the principles for extracting resources from the High Seas. The regulation of mining of the High Seas was one of the primary objectives of the 1982 United Nations Convention on the Law of the Sea, a treaty that has been quite

[83] *See* Moon Agreement, *supra* note 11, art. (11.8) (referring to Article 6.2, carving out a special regulation for samples collected for scientific purpose, which can be retained by the parties that "which caused them to be collected" but the parties should consider the "desirability of making a portion of such samples available" to other parties and "the international scientific community"). *See* Moon Agreement, *supra* note 11. Article 6.2 specifies that "in the course of scientific investigations" parties can "use mineral and other substances of the moon in quantities appropriate for the support of their missions." Moon Agreement, *supra* note 11, art. 6.2. The fact that the Moon Agreement grants this special leeway for scientific experiments, reaffirmed that – outside of the regime of Article 11.5, – no commercial excavation of the Moon is allowed. *See* Moon Agreement, *supra* note 11.

[84] *See Hanging by a Thread*, *supra* note 77.

[85] Due to limited backing from countries, the Moon Agreement lacks the capacity to effectively oversee the utilization of space resources, prompting states to seek alternative governance mechanisms at both national and international levels. Irmgard Marboe, *What, if any, relevance does the Moon Agreement have to activities in space today?*, THE NEW SPACE AGE: BEYOND GLOBAL ORDER 1, 4 (2021).

[86] Exec. Order No. 13914, 85 Fed. Reg. 20381, sec. 2, (Apr. 10, 2020) (hereinafter, "*Executive Order Recovery and Use of Space Resources*").

> The United States is not a party to the Moon Agreement. Further, the United States does not consider the Moon Agreement to be an effective or necessary instrument to guide nation states regarding the promotion of commercial participation in the long-term exploration, scientific discovery, and use of the Moon, Mars, or other celestial bodies. Accordingly, the Secretary of State shall object to any attempt by any other state or international organization to treat the Moon Agreement as reflecting or otherwise expressing customary international law. *Id*.

successful.[87] Many of its provisions are thought to have become customary international law.[88] The utilization of resources from the "sea bed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction"[89] is subject to the Convention, and the regime is based on the concept of "common heritage of mankind." [90] ("The Area and its resources are the common heritage of mankind.")[91] However, a supplemental agreement to UNCLOS was necessary to overcome the reluctance of States to sign UNCLOS, which was due to the mining of the seabed provisions.[92]

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[87] United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397, (hereinafter, "UNCLOS"). The United States has not ratified UNCLOS. *See, e.g.*, Curtis, Mallet-Prevost, Colt & Mosle LLP, *What is UNCLOS and its function?*, Colt & Mosle LLP, available at: https://www.curtis.com/glossary/public-international-law/unclos#:~:text=UNCLOS%20is%20the%201982%20United,respect%20to%20the%20maritime%20environment. (last visited Mar. 26, 2024).

[88] UNCLOS, *supra* note 87.

[89] UNCLOS, *supra* note 87, art 1.1(1) ("Area").

[90] UNCLOS, *supra* note 87, art. 136 (b) ("Common heritage of mankind").

[91] *See* UNCLOS, *supra* note 87, art. 137 ("Legal status of the Area and its resources").

> 1. No State shall claim or exercise sovereignty or sovereign rights over any part of the Area or its resources, nor shall any State or natural or juridical person appropriate any part thereof. No such claim or exercise of sovereignty or sovereign rights nor such appropriation shall be recognized.
> 2. All rights in the resources of the Area are vested in mankind as a whole, on whose behalf the Authority shall act. These resources are not subject to alienation. The minerals recovered from the Area, however, may only be alienated in accordance with this Part and the rules, regulations and procedures of the Authority.
> 3. No State or natural or juridical person shall claim, acquire or exercise rights with respect to the minerals recovered from the Area except in accordance with this Part. Otherwise, no such claim, acquisition or exercise of such rights shall be recognized.

UNCLOS, *supra* note 87, art. 137.

[92] In 1994, over 100 nations adopted rules for deep seabed mining, applying free market principles and outlining a system that grants mineral rights to the entity extracting resources from the ocean floor. To oversee this process, the agreement establishes the International Seabed Authority (ISA), an autonomous international body separate from the United Nations. UNCLOS DEBATE, *The 1994 Agreement Explicitly Dealt with and Resolved Concerns U.S. had with Ratifying UNCLOS*, available at: https://www.unclosdebate.org/argument/939/1994-agreement-explicitly-dealt-and-resolved-concerns-us-had-ratifying-unclos#:~:text=The%201994%20agreement%20applies%20free,responsibility%20for%20supervising%20this%20process (last visited Apr. 18, 2024).

The failure of the Moon Agreement is indicative of state practice against at least some of its provisions,[93] particularly those in Article 11. Accordingly, the Moon Agreement is not a persuasive basis for claiming that national legislation on space mining is prohibited under international law.

The Artemis Accords[94] are an effort of coordination of the activities in space. In addition, the OST contains some principles that, if developed properly, could help avoid conflicts in space.[95]

C. The Artemis Accords

NASA initiated the Artemis Accords[96] "to establish a common set of principles to ensure missions that fall under the Artemis mission umbrella are undertaken responsibly."[97] The Artemis Accords are bilateral arrangements for cooperation (not a treaty), signed between NASA and other space agencies; the Accords contemplate implementation through bilateral agreements.[98] The Artemis Accords are expressly grounded in the OST.[99] They originated from the "need for clarification" of the framework of space activities.[100]

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[93] Only eighteen countries ratified the Moon Agreement and recently Saudi Arabia notified the United Nations Secretary-General of its withdrawal. C.N.4. 2023.TREATIES-XXIV.2, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Withdrawal, Saudi Arabia, United Nations, New York, available at: https://treaties.un.org/doc/Publication/CN/2023/CN.4.2023-Eng.pdf (Last accessed on May 16, 2023). *See also, Hanging by a Thread, supra* note 77.

[94] *See infra*, Part II(C).

[95] *See infra,* Part II(E).

[96] For further discussion of space agencies making an effort to coordinate activities in space, see the section on the Artemis Accords, *see infra* Part II(C).

[97] Robert Lea, *Artemis Accords: What are they & which countries are involved?*, SPACE.COM, available at: https://www.space.com/artemis-accords-explained (last visited Sept. 15, 2023).

[98] T*he Artemis Accords, Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes*, NASA (Oct. 13, 2020) (hereafter, "Artemis Accords"), available at: https://www.nasa.gov/wp-content/uploads/2022/11/Artemis-Accords-signed-13Oct2020.pdf.

[99] Artemis Accords, *supra* note 98.

[100] Lachlan Blake, *Jurisdiction on the Final Frontier: Facilities, Jurisdiction and Control in International Space Law*, 46 ANNALS AIR & SPACE L. 177, 184 (2021) (hereinafter "Jurisdiction on the Final Frontier").

The Artemis Accords support the thesis of this paper – that space mining is permissible under international law and treaties – because the Accords treat space mining as allowed by Article II OST and provide for "safety zones" to foster safer lunar mining.[101] As Paul Larsen pointed out: "the Accords . . .provide a clear signal as to the trajectory of the understanding and interpretation of international space law by the associated States."[102]

After stating that the "utilization" of space resources is a benefit to humankind,[103] the Accords attempt clarifying existing law on space resources:

> The Signatories affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty, and that contracts and other legal instruments relating to space resources should be consistent with that Treaty.[104]

The Accords also provide that the signers should participate in multilateral efforts to develop both international practices and rules designed to support utilization of space resources along with support for the activities of COPUOS.

[101] Larsen argues that the "safety zones" established by the Artemis Accords might conflict with Article II's language about "use and occupation." Safety zones could potentially be contested by countries not involved in the Artemis Accords, such as China. *See* Larsen, *supra* note 45, at 42. The possible challenges create uncertainty for the commercial operators of lunar mines. Larsen, *supra* note 45, at 42-3.
[102] Jurisdiction on the Final Frontier, *supra* note 100, at 182.
[103] Artemis Accords, *supra* note 98, at § 10.1.
[104] Artemis Accords, *supra* note 98, at §10.2.

Section 11 of the Artemis Accords titled "Deconfliction of Space Activities" provides for safety zones:

> In order to implement their obligations under the Outer Space Treaty, the Signatories intend to provide notification of their activities and commit to coordinating with any relevant actor to avoid harmful interference. The area wherein this notification and coordination will be implemented to avoid harmful interference is referred to as a 'safety zone'. A safety zone should be the area in which nominal operations of a relevant activity, or an anomalous event could reasonably cause harmful interference.[105]

Section 11 details principles that the Signatories "intend to observe" in relation to the "safety zones"[106] including commitments to avoid harmful interference with activities under the Accords, along with prior notification and coordination with others before conducting activities in a safety zone established under the Accords.

The "safety zones" are based on the principle of "due regard" of Article IX OST:

> […] States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty.

In fact, § 11 specifies that "[t]he Signatories acknowledge and reaffirm their commitment to the Outer Space Treaty, including those provisions relating to due regard and harmful interference"[107] and that "consistent with Article IX of the Outer Space Treaty, a Signatory

[105] Artemis Accords, *supra* note 98, at § 11.07.
[106] Artemis Accords, *supra* note 98, at § 11.07 (a-d).
[107] Artemis Accords, *supra* note 98, at § 11.1.

authorizing an activity under these Accords commits to respect the principle of due regard."[108]

Over thirty-five countries have signed the Artemis Accords,[109] including the four countries that passed space resources utilization laws but excluding some major space-faring countries like China and Russia; China and Russia signed a memorandum of understanding,[110] and China National Space Administration is expected to soon create "an organization to oversee and coordinate the China-led International Lunar Research Station."[111] The International Lunar Research Station Cooperation Organization (ILRSCO) organization will be similar to the Artemis Accords.[112]

D. The International Criticism of the National Space Resources Utilization Laws and the Artemis Accords

In 2015 the United States passed Title IV of the Commercial Space Launch Competitiveness Act of 2015 (SPACE),[113] the first domestic law on space resource utilization[114] One commentator on SPACE has remarked "[t]here has been very little official objection to the legislation from countries within the United Nations or

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[108] U.S. Dep't. of State, *Artemis Accords*, *Deconfliction of Activities*, ¶ 9, U.S. Dep't. of State (last visited May 11, 2023).

> Provisions relating to due regard and harmful interference are key obligations of the Outer Space Treaty. Artemis Accords signatories help implement these obligations by providing notification of their activities, including regarding the location and general nature of their operations, and coordinating with any relevant actor to avoid harmful interference. The area covered by the notification and coordination is referred to as a "safety zone." *Id*.

[109] China and Russia have not signed the Artemis Accords and are unlikely to sign. India signed the Artemis Accords in June 2023. NASA, *NASA Welcomes India as 27th Artemis Accords Signatory*, NASA (last visited Aug. 19, 2023).

[110] *See* Osburg & Lee*, supra* note 7.

[111] Andrew Jones, *China to Establish Organization to Coordinate International Moon Base,* SPACENEWS, available at: https://spacenews.com/china-to-establish-organization-to-coordinate-international-moon-base/ (Apr. 28, 2023). (last visited Apr. 18, 2024).

[112] *Id.*

[113] Public Law 114-90, 129 STAT. 70 (2015).

[114] Milton "Skip" Smith, *In review: space law, regulation and policy in USA*, Sherman & Howard LLC (Dec. 9, 2021) available at: https://www.lexology.com/library/detail.aspx?g=563a0add-4c1f-4664-9241-42da197ad1ac (last visited May 16, 2023).

otherwise."[115] However, both Russia and China have expressed concerns about such domestic regulation of space resources.

Russia's position is that space resource utilization should be tackled at an international level.[116] The position of Russia is unsound. As von der Dunk explains, commenting on Title IV of SPACE:

> The United States … by way of the current Act provides for a first step towards compliance with the obligations of authorization and continuing supervision under Article VI of the Outer Space Treaty. This is also where the other substantive clause, Section 51302, comes in: it calls upon the US President to ensure that such authorization and continuing supervision will actually be properly provided for in the near future – that is before such commercial resource harvesting activities will actually take off.[117]

China criticized the US domestic legislation on space resources and the Artemis Accords, especially concerning the "safety zones," [118] which China considered as amounting to "de facto spheres of influence of a state or be subject to national appropriation."[119] While this criticism

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[115] *Id.*

[116] "The matter of regulation of these mining activities is still a very thorny issue," Dmitry Rogozin, director general of Roscosmos, said during a session of the Global Space Exploration Conference 2021 in St. Petersburg. (Russia, June 15, 2021). Jeff Foust, *Japan Passes Space Resources Law*, SPACENEWS, (June 16, 2021), available at: https://spacenews.com/japan-passes-space-resources-law/ (last visited Apr. 18, 2024). Rogozin called for a "system of regulations" to address those issues at an international level, rather than national laws. *Id.* "Russia believes that states mustn't adopt any laws and regulations on a unilateral basis because space is our common heritage and belongs to everyone," he said. *Id.* "We consider the United Nations as a suitable to discuss these issues." *Id.* Russia also criticized President Trump's *Recovery and Use of Space Resources,* comparing "the policy to colonialism and said it "hardly sets the countries to fruitful cooperation."

[117] Von der Dunk, *supra* note 47.

[118] Elliot Ji *et. al*, *What Does China Think About NASA's Artemis Accords? China Views the U.S. Attempt to Enshrine New Principles for Outer Space with some Skepticism*, THE DIPLOMAT (Sept. 17, 2020) (contending that while the announcement of the Artemis Accords did not garner considerable attention in China, it notably provoked an overtly adverse reaction within Chinese news media) available at: https://thediplomat.com/2020/09/what-does-china-think-about-nasas-artemis-accords/ (last visited Dec. 5).

[119] Almudena Azcárate Orteg, *Artemis Accords: A Step Toward International Cooperation or Further Competition?*, LAWFAR (Dec. 15, 2020) (citing Guoyu Wang, Dean of the Academy of

is unsound because the Artemis Accords, including the "safety zones," are consistent with the OST, as a result of unilateral or regional international documents like the Artemis Accords (or the China/Russia ILRSCO agreement discussed above),[120] a risk of fragmentation of space law exists. The essence of the debate is clear: domestic action risks international fragmentation and may lead to claims that are close to sovereignty, but international action is difficult in the current geopolitical environment.

E. The Limitation of the National Approach to Space Mining and a Possible Solution: Limited Control by National States Based on Their Areas of Excavation

The Moon might become the focus of tensions among stakeholders engaged in resource mining.[121] While four countries have passed laws to allow the harvesting of space resources,[122] the license obtained under one of the national resource laws might not be enough to avoid tensions because other countries may question why they should recognize or even give some level of comity to legislation from another country.[123]

Air, Space Policy and Law at the Beijing Institute of Technology in China), available at: https://www.lawfaremedia.org/article/artemis-accords-step-toward-international-cooperation-or-further-competition. (last visited Dec. 5, 2023).

[120] *See* Part II(C).

[121] Mishima-Bake, *Moon Wars, supra* note 46, at 4.

[122] *See infra* Part III.

[123] The problem is relevant because, as discussed in Part II(A), no international consensus on space mining exists. Discussing lunar mining (but the observation is applicable to space mining in general) Larsen noted:

> There are deep legal uncertainties attached to the question of whether a lunar mining issue is or is not within the scope of the OST. The legal authority to issue non-governmental licenses to mine on the Moon may simply rest on the national interpretation of the OST.
>
> Larsen, *Legal Path to Mining the Moon supra* note 45, at 28.

In fact, as von der Dunk commented with reference to Title IV of SPACE:

> [the] recognition of such ownership rights is only applied to the extent of US jurisdiction, essentially meaning US territory and/or US courts, as the US cannot dictate what other states should do or the extent to which non-US citizens outside of the US could be given such rights or be held to corresponding obligations.[124]

This is true for any domestic space resources utilization law and actually it is true in general for every law. However, what differentiates these laws from others is that they focus on outer space, which is not subject to the sovereignty of any state.[125] Domestic laws are generally limited to activities that are performed in the jurisdiction of the country that passes the law, although parties may generally agree through a choice-of-law provision to accept the law of a particular jurisdiction to govern their relationship.

[124] Von der Dunk, *supra* note 47, at 8(noting that lunar mines fall outside the scope of U.S. sovereignty).
[125] Article II of OST, *supra* note 8.

For example, the US General Mining Law of 1872 (as amended)[126] "authorizes and governs the prospecting and mining for economic minerals on federal public lands,"[127] and establishes:

> Except as otherwise provided, all valuable mineral deposits in lands belonging to the United States, both surveyed and unsurveyed, shall be free and open to exploration and purchase, and the lands in which they are found to occupation and purchase, by citizens of the United States and those who have declared their intention to become such […][128]

That law governs land and resources under the sovereignty of the United States, and no foreign citizen or state could reasonably object to harvesting resources in the United States in compliance with the General Mining Law of 1872, as amended.

Conversely, § 51303 of Title IV of SPACE, which establishes the right of US citizens to appropriate space resources, regulates an activity to be performed in a place (outer space) outside the sovereignty of the United States. Therefore, foreign countries and entities could legitimately disregard the right of someone who is mining under Title IV.[129]

If a domestic mining law is to avoid conflict with laws or entities of foreign countries, it is necessary to develop a mechanism to establish "certainty as to control over resources and facilities on celestial bodies and their associated zones of operation."[130] As Lachlan Blake correctly points out, state control over a certain mining facility is necessary to

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[126] General Mining Act of 1872, Act of May 10, 1872 (Mining Law of 1872), *amended by* Public Law 103-66, (enacted August 10, 1993). Codified 30 U.S.C. §§ 21-54. For an overview of mining law in the US, *see* U.S. Dep't of the Interior, *About Mining and Minerals*, U.S. Dep't of the Interior, Bureau of Land Mg'mt. (last accessed Apr. 19, 2024).

[127] Penn State, *Lesson 2.3: the General Mining Law of 1872 (as amended)*, Penn State, John A. Dutton Inst. for Teaching and Learning Excellence, available at: https://www.e-education.psu.edu/geog000/node/8 (last visited Apr. 18, 2024).

[128] 30 U.S.C. § 22 ("Lands open to purchase by citizens").

[129] This is also true for someone who is mining under "the flag" of Luxembourg, the UAE, or Japan.

[130] Jurisdiction on the Final Frontier, *supra* note 100, at 186.

provide certainty, to foster investment,[131] and to avoid conflict,[132] particularly the armed ones, especially with use of weapons of mass destruction in space, the avoidance of which is one of the fundamental aims of the OST. [133] Accordingly, the OST should be interpreted to achieve rather than frustrate this goal. In addition, state control is necessary so that a domestic space resource utilization law can have a practical effect in outer space.

Interpretation of the OST to allow for limited state control over certain areas of space does not violate the prohibition in Article II of the OST against claims of sovereignty in outer space. Control is different from sovereignty; sovereignty is not necessary for a limited state control. By "state control" this paper means that a country must have "the lawful power to make and enforce rules."[134] In other words, a country must have what would be called "jurisdiction" under domestic law, intending "a power to control activity within a particular area."[135]

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[131] Jurisdiction on the Final Frontier, *supra* note 100, at 188-190. Also noting that "[i]f a State or private actor cannot ensure exclusive jurisdiction and control over facilities and the commercial operations conducted within, what would justify the costs of entering the industry?" Jurisdiction on the Final Frontier, *supra* note 100, at 188.

[132] Jurisdiction on the Final Frontier, *supra* note 100, at 190-1 (arguing that if States and private entities are "to their own devices" on celestial bodies without defined property rights, it could potentially lead to armed conflicts and hostile actions and suggesting "temporary boundaries" (akin to the safety zones of the Artemis Accords) to deter conflicting claims and mitigate the risk of escalating potential conflict).

[133] Jurisdiction on the Final Frontier, *supra* note 100, at 191, arguing that implementing limited yet exclusive powers of control would align with the goals of the OST (which are fostering regulation and preventing conflicts for the benefits of humanity) and would incentivize sustainable and collaborative practices on celestial bodies. *See* Jurisdiction on the Final Frontier, *supra* note 100, at 191.

[134] Jurisdiction on the Final Frontier, *supra* note 100, at 187 (citing to Frans G. von der Dunk, *Effective Exercise of 'In-Space Jurisdiction': The US Approach and the Problems It Is Facing*, 40 J. SPACE L. 147, 155 (2015)).

[135] Jurisdiction on the Final Frontier, *supra* note 100, at 188. The state that issues the space mining law must have both "jurisfaction" and "jurisaction." Bing Cheng defined "jurisfaction" as "normative power, the internationally recognized competence of a State to enact laws, make judicial pronouncements and adopt other decisions with legally binding force" and "jurisaction" as "the internationally recognized competence of a State concretely to set up machinery to make, implement and enforce, and physically to make, implement and enforce laws, judicial pronouncements and other legally binding decisions; in other words, physically to exercise the functions of a State." Bing Cheng, *Article VI of the 1967 Space Treaty Revisited: "International Responsibility", "National Activities", and "The Appropriate State",* 26 J. SPACE L. 1, 23-24 (1998), available at: https://airandspacelaw.olemiss.edu/pdfs/jsl-26-1.pdf. Bing Cheng states,

Blake, who suggests that state control over a specific mining facility is necessary to provide certainty, also posits that the OST already contains "avenues for lawful exercise of control and jurisdiction over celestial facilities."[136] Blake recognizes that while Article I OST provides that space is "free for exploration and use" (and that must mean "all areas of celestial bodies")[137] and that pursuant to Article II OST no claim of sovereignty is allowed,[138] the OST does contain several provisions that can support a limited form of a state's "jurisdiction and control."[139]

The most evident instance is Article VIII OST, which provides:

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain *jurisdiction and control* over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. […] (Emphasis added)

At least two scholars (Chatzipanagiotis and Rafael Moro-Aguilar) noted that Article VIII establishes a sort of "flag" (quasi-territorial) jurisdiction over the space object that is registered by a state and that "the inclusion in the national registry ... confers jurisdiction

"[e]ffective jurisdiction is when and where a State's jurisaction is not overridden by that of any other State and may actually be exercised." *Id*. at 24.

[136] Jurisdiction on the Final Frontier, *supra* note 100, at 183.

[137] Jurisdiction on the Final Frontier, *supra* note 100, at 186.

[138] Jurisdiction on the Final Frontier, *supra* note 100, at 186.

[139] Blake states that, "[t]he treaty already allows for limited but exclusive powers of control over facilities on celestial bodies, including an ability to limit entry into them and perhaps even providing a lawful basis for the establishment of a surrounding 'safety zone'." Jurisdiction on the Final Frontier, *supra* note 100, at 188.

and control [over the space object]. However, in practice such inclusion entitles the State of registry to exercise its sovereignty over the registered object.[140] Therefore, under Article VIII:

> every satellite, capsule, or any other spacecraft that is registered by a State will be subject to the laws of that State of registry. Likewise, a manned orbital station, or a station placed on the surface of the Moon or another celestial body, will be governed by the jurisdiction of the State that registered such object or objects.[141]

However, Article VIII presents several problems when applied to space resource utilization. First, the Article only applies to an object that is "launched," and therefore it cannot apply to objects constructed in space.[142] Second, space mining for the most part will not happen inside a space object;[143] it will mostly happen in a mining facility on a celestial body.

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[140] Michael Chatzipanagiotis & Rafael Moro-Aguilar, *Criminal Jurisdiction in International Space Law: Future Challenges in view of the ISS IGA*, 57 PROC. INT'L INST. SPACE L. 323, 328 (2014).

> The registry of a space object has the same legal consequences as registering a ship or an aircraft. The only difference is that in Space Law, inclusion in the national registry does not confer nationality *de jure* to the spacecraft, only jurisdiction and control thereon. However, in practice such inclusion entitles the State of registry to exercise its sovereignty over the registered object. This amounts to a quasi-nationality or nationality *de facto* of the space object. *Id.*

[141] *Id.*

[142] Jurisdiction on the Final Frontier, *supra* note 100, at 185. *Building Blocks* § 6 ("Jurisdiction and control over space-made products used in space resource activities") intends to solve exactly this problem, providing that "[t]he international framework should provide that States have jurisdiction and control over any space-made products used in the space resource activities for which they are responsible." *See* Hague Int'l Space Res. Governance Working Group, *Building Blocks for the Development of an International Framework on Space Resource Activities*, *Jurisdiction and Control Over Space-Made Products Used in Space Resource Activities*, § 6, Hague Int'l Space Res. Governance Working Group. The "Space-made product" is defined as "a product made in outer space wholly or partially from space resources." *Id*., § 2.5. *Building Blocks*, n. 4, the *Building Blocks* specify that the understanding was that "this excludes raw mineral and volatile materials, including water, irrespective of form." *Id*. at n.4. However, even if the concept of "Space-made product" were adopted, jurisdiction and control over a mining facility would not exist. *See id.*

[143] Some space mining could happen inside a space object. For example, TransAstra has projects for "capturing" small asteroids inside their space object and perform the extraction this way. *See*

Other provisions of the OST, however, can be applicable to these situations. Article XII provides:

> All stations, installations, equipment and space vehicles on the moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.[144]

While this provision seems only to establish a right of access to another's facility, if the OST did not consider control by a state over a facility, the OST would not have needed to establish a right of access. Also, the right of access is not absolute; the access: i) must happen "on a basis of reciprocity;" ii) is upon "reasonable advance notice;" iii) is subject to optional "appropriate consultations" and possibility of taking "maximum precautions … to assure safety and to avoid interference."[145] Therefore, however indirectly, Article XII stands for the proposition that a state has jurisdiction and control over a mining facility.[146]

Also, Article XII is quite broad; it mentions "stations, installations, equipment and space vehicles on the moon and other celestial bodies"[147] but then it uses the word "facility" at the end of the Article, which as Lachlan Blake correctly pointed out, must function as a more general term than "stations, installations, equipment and space

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Trans Astronautica Corporation, *TransAstra Corporations Queen Bee™ System in action*, *TransAstra (*June 17, 2019), available at: https://transastra.com/ (last visited May 11, 2024).

[144] Article XII of the OST, *supra* note 8.

[145] Jurisdiction on the Final Frontier, *supra* note 100, at 195 (also discussing the meaning of "reciprocity").

[146] Jurisdiction on the Final Frontier, *supra* note 100, at 196 (explaining that Article XII might essentially confer exclusive state jurisdiction on mining or extraction equipment, like drilling rigs that become part of a facility's structure).

[147] Jurisdiction on the Final Frontier, *supra* note 100, at 196-9.

vehicles."[148] Therefore, Article XII refers to any facility "on the moon and other celestial bodies."[149] In addition, the Article mentions "normal operations,"[150] which must refer to facilities that are in operation, as space mining facilities would be.[151] Because the Article mentions both the Moon and other celestial bodies, Article XII covers all space resource utilization facilities, which are expected to be on the Moon, on asteroids,[152] on Mars, and other celestial bodies.

Under Article VIII OST a state's jurisdiction over launched space objects carried on its registry is clear. Jurisdiction and control over facilities under Article XII is not as clear. However, the power to oppose the entrance into a facility pursuant to Article XII is phrased in such vague terms (especially on point of reciprocity) that the difference between the control power under Article VIII and the one under Article XII is not practically significant.

Article IX is another provision in the OST that can be the basis for establishing jurisdiction and control of a state over a mining facility. As Lachlan Blake points out, due regard is an explicit limitation on the concept of free access.[153] In fact, it was the basis for providing "safety zones" in the Artemis Accords.[154]

While this article does not discuss the concept of due regard, as Blake suggests, a parallel exists with the corresponding concept used in

[148] Jurisdiction on the Final Frontier, *supra* note 100, at 198 (discussing whether "facility" is a more general term and "stations, installations, equipment and space vehicles" is a close list).
[149] Jurisdiction on the Final Frontier, *supra* note 100, at 198(discussing whether "facility" is a more general term and that "stations, installations, equipment and space vehicles" is a close list.).
[150] Jurisdiction on the Final Frontier, *supra* note 100, at 199.
[151] Blake contends that personnel in the facility is not required for Article XII to apply. Jurisdiction on the Final Frontier, *supra* note 100, at 199. Therefore, Article XII applies also to a robotic mining facility.
[152] Asteroids are celestial bodies. *See e.g*., European Space Agency, *Hubble Goes Hunting for Small Main-Belt Asteroids*, ESA (Apr. 4, 2018), available at https://www.esa.int/Science_Exploration/Space_Science/Hubble_goes_hunting_for_small_main-belt_asteroids(stating "Asteroids are rocky celestial bodies that orbit the Sun, but do not meet the requirements to be classified as a planet.") (last visited Apr. 18, 2024).
[153] Jurisdiction on the Final Frontier, *supra* note 100, at 201.
[154] Jurisdiction on the Final Frontier, *supra* note 100, at 201.

the United Nations Convention on the Law of the Sea (UNCLOS),[155] which provides for the concept of "due regard" with reference to the exclusive economic zone (EEZ).[156] Unlike territorial sea and like outer space, an EEZ is not subject to the sovereignty of the coastal state;[157] however, coastal states have specific "sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources" and have "jurisdiction as provided for in the relevant provisions of this Convention" with specific reference to certain activities (such as "the establishment and use of artificial islands, installations and structures").[158] The UNCLOS specifies that coastal states must exercise the rights and duties deriving from their EEZ with "due regard to the rights and duties of other States" and "in a manner compatible with the provisions of this Convention."). The UNCLOS' regime of EEZ is a perfect example of an area that is not under the sovereignty of a state on which a state has jurisdiction and control and the exclusive rights to perform economic activities, provided it pays due regard to others. Article IX could be interpreted using the concept of EEZ from UNCLOS as a parallel.

In conclusion, a careful reading of several provisions of the OST (Article VIII, Article XII, and Article IX)–especially if seen through the lens of the general aim of the OST, which is the maintenance of peace

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[155] United Nations, *United Nations Convention on the Law of the Sea*, Dec. 10, 1982, 1833 U.N.T.S. 397, (hereinafter, "UNCLOS, Law of the Sea") available at: https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

[156] The EEZ is "an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States are governed by the relevant provisions of this Convention." *Id*. art. 55.

[157] The Fletcher School of Law and Diplomacy, Tufts University, Law of the Sea, A Policy Primer, *Chapter 2: Maritime Zones* (2017) (hereinafter "*Maritime Zones* ") (last visited Dec 5, 2023).

[158] UNCLOS, Law of the Sea, art. 56, Dec. 10, 1982, 1833 U.N.T.S. 397.

> Within a range of 200 nautical miles from their coastal lines, States can establish an Exclusive Economic Zone (EEZ). This zone grants coastal States exclusive authority to exploit or preserve resources discovered in the water, on the seabed, or beneath its subsoil, spanning living resources (such as fish) and non-living resources (like oil and natural gas). Additionally, States possess exclusive rights to harness offshore energy generated from waves, currents, and wind within their EEZ. *Id*.

and avoidance of conflicts in space–justifies an interpretation of the OST to allow national states to assert a limited control on areas being mined under their domestic laws; this OST-based right of control must be respected by other states.

III. THE FOUR SPACE RESOURCES UTILIZATION LAWS

A. The United States Space Resource Utilization Law

In late 2015, President Obama signed the Commercial Space Launch Competitiveness Act of 2015 (SPACE).[159] The purpose of SPACE was:

> [t]o facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions, and for other purposes.[160]

The most innovative aspect of SPACE is Title IV,[161] which governs space resource utilization.[162] The intent of Title IV is twofold: fostering the growth of the space mining sector and clarifying the US position on international law.[163] Title IV was codified in U.S. Code Title

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[159] Public Law 114 – 90, 124 Stat. 2806 and 2820.
[160] *Id.*
[161] Title IV is referred to as the "Space Resource Exploration and Utilization Act of 2015." At the time, a bill had been introduced to govern the harvesting of space resources from asteroids (*ASTEROIDS Act* (H. R. 5063)) and Title IV contains modified provisions from that bill. Sagi Kfir and Ian Perry*, Title IV of the U.S. Commercial Space Launch Competitiveness Act of 2015: A Critical Step Forward in Facilitating the Development of a Viable Space Infrastructure*. 5:3 New Space 163-9 (Sept. 2017), available at: https://www.liebertpub.com/doi/abs/10.1089/space.2017.0008 (explaining that the U.S. Congress carefully designed Title IV of CSLCA to align with international law and treaties. After input from various agencies and experts, they replaced the ASTEROIDS Act with legislation that explicitly followed the Outer Space Treaty of 1967's Articles II and VI regarding space resource use); *see also* Cody Knipfer, *Congress and commerce in the final frontier (part 2)*, THE SPACE REV. (Dec. 17, 2018), available at: https://www.thespacereview.com/article/3625/1 (last visited Dec 6, 2023).
[162] Von der Dunk*, supra* note 47 (characterizing it as "the most innovative and disputed part of the Act, certainly in an international context").
[163] 51 U.S.C. §51302(a).

51 Ch. 513 ("Space Resource Commercial Exploration and Utilization").[164] In the discussion that follows, this refers to the US space resource utilization provisions either as "Title IV" or "US Space Resource Utilization Law."

Title IV applies to "United States citizens." 51 U.S.C. § 51302 provides that the government shall "facilitate commercial exploration for and commercial recovery of space resources *by United States citizens*", "discourage government barriers" to space resources utilization, and "promote the right of *United States citizens* to engage in commercial exploration for and commercial recovery of space resources free from harmful interference," "in accordance with the international obligations of the United States" and with proper licensing and supervision by the government.[165] (emphasis added).

[164] Rob Sukol, *Positive Law Codification of Space Programs: The Enactment of Title 51, United States Code*, 37 J. SPACE L. 1, 3 (2011) (explaining that the US code stands as the formal compilation of federal statutes).

[165] 51 U.S.C. § 51302

> (a) IN GENERAL.—The President, acting through appropriate Federal agencies, shall (1) facilitate commercial exploration for and commercial recovery of space resources by United States citizens; (2) discourage government barriers to the development in the United States of economically viable, safe, and stable industries for commercial exploration for and commercial recovery of space resources in manners consistent with the international obligations of the United States; and (3) promote the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from harmful interference, in accordance with the international obligations of the United States and subject to authorization and continuing supervision by the Federal Government. *Id*. (emphasis added).

However, 51 U.S.C. § 51301 (Definitions) clarifies that 'United States citizen' has the meaning given to the term in 51 U.S.C. § 50902:

> citizen of the United States" means—
> (A) an individual who is a citizen of the United States;
> (B) an entity organized or existing under the laws of the United States or a State; or
> (C) an entity organized or existing under the laws of a foreign country if the controlling interest (as defined by the Secretary of Transportation) is held by an individual or entity described in subclause (A) or (B) of this clause.

This definition is different from the definition of the same term given in other laws, where the controlling interest in the entity must be owned by US citizens to qualify the entity as a "US citizen."[166] In the case of space mining, the controlling interest can be owned by a foreigner which shows the law was intended to encourage the establishment of space mining companies in the US.

[166] 51 U.S.C. § 51301.

The scope of Title IV is in 51 U.S.C § 51303 ("Asteroid resource and space resource rights"), which establishes the right of United States citizens—including any company formed in the US or formed elsewhere but owned by US citizens—to obtain legal ownership of space resources recovered in space:

> A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter *shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource* obtained in accordance with applicable law, including the international obligations of the United States. (emphasis added)[167]

Property rights are "critical to encourage investment for the long-term development of the space economy"[168] and the government must recognize and enforce them.[169] The section creates property rights in asteroid or space resources; this clarification of property rights ensures

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[167] 51 U.S.C § 51303.

[168] Council of Econ. Advisers, Exec. Off. of the President, Economic Report of the President 227, *Ch. 8: Exploring New Frontiers in Space Policy and Property Rights*, (2021) (hereinafter "Economic Report of the President") available at: https://www.govinfo.gov/app/details/ERP-2021/ERP-2021-chapter8 (last visited Apr. 18, 2024). (

[169] "A fundamental role of government in this process is to set rules that create expectations about what the future holds for investors." *Id*. at 227. The Economic Report of the President refers to the "seminal work of Demsetz." Harold Demsetz, *Toward a Theory of Property Rights*, THE AM. ECON. REV., Vol. 57, No. 2, (May 1967) (arguing that establishing property rights provides individuals with clarity when making decisions. This clarity further enables people to anticipate how society will engage with and react to their actions. Clear property rights foster an environment where individuals can confidently invest, knowing which benefits they can expect to receive.) *Id.* at 236. The Economic Report of the President also recommends enforcement of property rights even if "establishing and enforcing property rights impose costs on society;" the individual must have the "expectations" that "the rest of society will comply with the rights specified." *Id.* The Economic Report of the President lists several examples in which the establishment and enforcement of property rights brought economic development (e.g., early oil drilling; mineral rights in Nevada in the 19th century. *Id*. at 236-7) and examples in which the lack of clear property rights brought uncertainty, underdevelopment, and/or depletion of resources (e.g., deforestation in countries where property rights are insecure; fisheries in US and Canada, where no property rights in fisheries are recognized compared to New Zealand, where fishermen have property rights in fisheries. *Id*. at 239-40).

the certainty and predictability necessary to support private investment beyond Earth.[170]

Title IV definition of the property rights includes the right "to possess, own, transport, use, and sell the asteroid resource or space resource."[171] The definition is detailed in comparison to the other space utilization laws that this paper discusses.[172] The reason for this difference is probably that the United States is the only common law country that has passed a space resource utilization law; the other space resource utilization laws have been enacted by civil law countries or hybrid systems. In common law, property is a bundle of sticks; in civil law, property "is seen as inherently undivided."[173] Because a right in a new type of resource was at stake, understandably Title IV spelled out the content of that right. One could wonder about whether "property sticks" that are not mentioned in Title IV are recognized, for example a security interest in space resources. The power to encumber the assets by security interest, lien, or other device should be possible because Title IV includes the power to dispose of the asset ("sell") and the power to encumber an asset is more limited than the power to sell.[174] While Title IV defines in detail property rights in space resources, Title IV only

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[170] *Id*. at 226, 227.
[171] 51 U.S.C. § 51303.
[172] Part III(B)-(D).
[173] Yun-chien Chang & Henry E. Smith, *An Economic Analysis of Civil versus Common Law Property*, 88 NOTRE DAME L. REV. 1, 24 (2012)(hereinafter, "*Economic Analysis of Civil versus Common Law Property*") (arguing that in the common law tradition, particularly in the United States, the prevalent perspective perceives property as a bundle of rights – metaphorically likened to a "bundle of sticks" – binding together right holders and duty bearers regarding an asset. This concept dismisses the idea of an inherent essence or core of property. Instead, it views "property" as a "label" applicable to any assortment of these diverse usage rights pertaining to a resource. In contrast, the civil law theory of property centers on in rem rights, where property, especially ownership, is inherently considered "undivided." The civil law tradition generally disregards the concept of property as a bundle of rights.) *Id.* at 4-5. In civil law, undivided dominion is the central point, and any division represents a "costly departure" with expenses encompassing "information costs of keeping track of the divisions" and the necessity for third parties to handle in rem rights. Legal doctrines like *numerus clausus* aim to limit the emergence of new forms of "lesser property rights." Conversely, the common law of property has its roots in feudalism, emphasizing personal connections and mutual obligations. *Id.* at 9.
[174] In the United States, the power to sell includes the power to encumber because the power to encumber is a form of conditional sale and is less harmful to the remainder interests than an outright sale. *See, e.g.*, *McCarthy v. McCarthy*, 178 N.W.2d 308 (Iowa 1970).

provides a cursory definition of "space resources" ("The term 'space resource" means an abiotic resource in situ in outer space");this is unlike other space mining laws, i.e., the UAE[175] and Japan.[176] As with other space resources utilization laws, the US Space Resources Utilization Law made clear that it had no intent to change international law; in fact, the United States is not asserting sovereignty or "exclusive rights or jurisdiction" on any celestial body.[177]

The US governance of space mining, which started with SPACE, continued with the 2020 Executive Order discussed above in Part II(B), which further encouraged space mining, recognizing "a clear path to off-Earth mining without the need for further international treaty-level agreements."[178] However, the US path for space mining is not complete. In fact, because no license procedure currently exists to perform space mining, additional legislation or agency rulemaking is required to implement Title IV. Moreover, the US has no licensing procedure to perform any activity beyond Earth orbit, except to a limited extent (e.g. frequency assignment) nor does any agency have clear authority to regulate activities beyond Earth orbit.[179] A general "mission

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[175] *See infra* Part III(C).

[176] *See infra* Part III(D).

[177] § 403. DISCLAIMER OF EXTRATERRITORIAL SOVEREIGNTY.

> It is the sense of Congress that by the enactment of this Act, the United States does not thereby assert sovereignty or sovereign or exclusive rights or jurisdiction over, or the ownership of, any celestial body.

U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, § 403, 129 Stat. 704, 720-22 (2015).

[178] Mike Wall, *Trump signs executive order to support moon mining, tap asteroid resources*, SPACE.COM (last updated Apr. 7, 2020), available at https://www.space.com/trump-moon-mining-space-resources-executive-order.html (last visited Dec 6, 2023).

[179] Marcia Smith, *President Signs Law Protecting L\unar Heritage Sites*, SPACEPOLICYONLINE (last Updated Jan. 2, 2021) (contending that currently no US agency possesses explicit authority to grant licenses for activities either on the Moon or in space at large. While companies planning lunar missions or satellite servicing mission—like Moon Express and SpaceLogistics - have gained authorization via makeshift procedures, the question of which agency should oversee licensing for in-space activities remains unsettled). Theresa Hitchens, *White House asks Congress to split 'new space' authority* b*etween Commerce, Transportation*BREAKING DEFENSE. (Nov. 15, 2023) available at: https://breakingdefense.com/2023/11/white-house-asks-congress-to-split-new-space-authority-between-commerce-transportation/ (last visited Dec 6, 2023) (explaining that two competing bills for mission authorization and supervision exist: (1) a bill proposed by Rep. Frank

authorization"[180] similar to the one that the Obama Administration tried to pass[181] could be a solution. While it is irrelevant whether the rulemaking and licensing authority is granted to the Federal Aviation Administration (FAA)[182] or to the Department of Commerce,[183] the failure to grant this authority and the absence of a specific licensing framework at the domestic level creates regulatory uncertainty and unpredictability for space mining companies. Clear authority of an agency is necessary to create a "clear, flexible, predictable regulatory environment to ensure U.S. companies remain a leader globally."[184] A

Lucas and Rep. Brian Babin, which aims to designate the Department of Commerce (DoC) as the singular regulatory body overseeing all private sector space endeavors. It seeks to effectively replace current licensing procedures with a more streamlined certification process that essentially assumes approval; (2) a bill by the White House National Space Council, which would divide regulatory control for emerging forms of commercial space operations between the DoC and the Transportation Department (DoT). In particular, this bill would expand the DoT's oversight, extending its safety jurisdiction to cover not just launch and reentry but also safety in orbit, on commercial space stations, and around celestial bodies. Additionally, it would expand the DoT's licensing authority to include in-space transportation. The proposal would also broaden DoC's licensing for remote sensing satellites to encompass include new space activities—such as assembly, manufacturing, and debris removal—unrelated to human missions or under the DoT's jurisdiction).

[180] The concept of "mission authorization," refers to a new to regulatory authority "for oversight of non-traditional space activities" and "address the 'gap' that currently exists between new commercial space activitie[s] [...]" Theresa Hitchens, *Space firms want White House fix for regulatory tangle, but disagree on how*, BREAKING DEFENSE., (last updated Nov. 22, 2022), available at: https://breakingdefense.com/2022/11/space-firms-want-white-house-fix-for-regulatory-tangle-but-disagree-on-how/ (last visited Dec. 6, 2023).

[181] Letter to Chairman Thune and Chairman Smith, Off. of Sci. and Tech. Policy, Exec. Off. of the President, WHITE HOUSE, (Apr. 4, 2016), available at: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/csla_report_4-4-16_final.pdf (last visited Apr. 18, 2024).

[182] Marcia Smith, *White House Wants Dot in Charge of Commercial Space "Mission Authorization*", SPACEPOLICYONLINE, (last updated Mar. 13, 2017), available at: https://spacepolicyonline.com/news/white-house-wants-dot-in-charge-of-commercial-space-mission-authorization. (last visited Dec. 6, 2023).

[183] Marcia Smith, *Trump Signs Space Policy Directive-2 Initiating Reform of Commercial Space Regulations – Update 2,* SPACEPOLICYONLINE (last updated Jan. 26, 2021), available at: https://spacepolicyonline.com/news/trump-to-sign-space-policy-directive-2-initiating-reform-of-commercial-space-regulations/ (last visited Dec. 6, 2023).

[184] Chirag Parikh, exec. Sec'y of the Nat'l. Space Council, speaking on February 9, 2023, at the FAA Com. Space Transp. Conference. *See e.g.,* Jeff Foust, *White House Reviewing Input on Mission Authorization Concepts*, SPACENEWS, (Feb. 11, 2023), available at: https://spacenews.com/white-house-reviewing-input-on-mission-authorization-concepts.

prompt resolution is necessary to avoid losing competitive edge over other countries.

B. The 2017 Luxembourg Law on Exploration and Use of Space Resources

1. Luxembourg and Its Interest in Space Resource Utilization

The Grand Duchy of Luxembourg, a small European country with around 600,000 inhabitants, slightly smaller than the US state of Rhode Island,[185] is the headquarters of circa 150,000 companies,[186] i.e., 5.49 companies for every 1000 inhabitants, more than double the per capita percentage in the United States.[187] Companies are attracted to Luxembourg because it is a European member state (and therefore a "gateway to Europe");[188] presents a pro-business environment with a combination of friendly regulation, and even friendlier taxation; and operates through "sound macroeconomic foundations [a] stable political environment."[189]

[185] *See Luxembourg,* NationsOnline, (explaining Luxembourg's geography and key characteristics), available at: https://www.nationsonline.org/oneworld/luxembourg.htm (last visited Dec 6, 2023).
[186] Hit Horizons, *Industry Breakdown of Companies in Luxembourg*, HIT HORIZONS, available at https://www.hithorizons.com/eu/analyses/country-statistics/luxembourg (last visited Apr. 18, 2024).
[187] The United States has 2.28 companies for every 1000 inhabitants. *See e.g.*, *Per Capita: COUNTRIES COMPARED*, NationMaster, available at: https://www.nationmaster.com/country-info/stats/Economy/New-businesses-registered/Number/Per-capita(last visited Apr. 18, 2024).
[188] *Why Luxembourg, The Attractiveness of Luxembourg as a Business Hub,* LUXEMBOURG TIMES, (Nov. 2021), available at: https://www.amcham.lu/wp-content/uploads/2021/12/Why-Luxembourg_november-2021-BR.pdf. (last visited Apr. 18, 2024).
[189] *Id.*

The home of SES,[190] in 2016 Luxembourg became interested in space mining.[191] As a sign of its economic commitment to space resource utilization, in June 2016 the government acquired a stake in the business of Planetary Resources.[192] Luxembourg also offered a €200 million line of credit to space companies that would establish their European headquarters in Luxembourg.[193]

In 2017, Luxembourg passed Loi du 20 juillet 2017 ("Luxembourg Space Resource Utilization Law.")[194] Unlike in other countries, the Luxembourg Space Resource Utilization Law predates the enactment of a more general regulation of space (a general law on space activities was passed on December 15, 2020)[195] and even the establishment of the

[190] In 1985 the *Société Européenne des Satellites* SA was founded; it changed its name to "SES SA" in the 2000s. *See* SES, *Annual Report*, *Chairman's Report on Corporate Governance and Internal Control Procedures*, *Organisation Principles*, SES, 1, 20 (2011), available at:https://www.ses.com/sites/default/files/2016-11/SES_AR11_English.pdf (last visited May 16, 2023), SES is the "the world's leading content connectivity provider" and owns "over 70 satellites in different orbits" combining "a vast, intelligent network of satellite and ground infrastructure" offering "video and data solution virtually everywhere on the planet." SES, *Home,* (follow About Us" hyperlink) SES, available at: https://www.ses.com/about-us(last visited Apr. 16, 2024).

[191] Cecilia Jamasmie, *Luxembourg to Set Up Europe Space Mining Centre*, MINING.COM (Nov. 18, 2020), available at: https://www.mining.com/luxembourg-to-create-space-resources-centre/ (last visited Dec. 6, 2023).

[192] *Id*. The government of Luxembourg also "reached an agreement with [...] Deep Space Industries, to send missions to prospect for water and minerals in outer space." *Id.*

[193] *Id.*

[194] Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace. An English translation of the Act (Law of July 20th, 2017, on the Exploration and Use of Space Resources) (hereinafter "Luxembourg Space Resource Utilization Law'') available at: https://space-agency.public.lu/en/agency/legal-framework/law_space_resources_english_translation.html (last visited Mar. 24, 2023). The French version (official version) is available here: https://www.stradalex.lu/fr/slu_src_publ_leg_mema/toc/leg_lu_mema_201707_674/doc/mema_etat-leg-loi-2017-07-20-a674-jo (last visited Feb 22, 2024.)

[195] Loi du 15 décembre 2020 portant sur les activités spatiales. [Law Of December 15th 2020 on Space Activities]. *See* English translation, available at: https://space-agency.public.lu/en/agency/legal-framework/Lawspaceactivities.html#:~:text=(1)%20No%20operator%20can%20exercise,%2C%20hereinafter%20the%20. This applies generally to space activities, except "to missions involving the exploration and use of space resources governed by the Law of 20 July 2017 on the exploration and use of space resources, except for Articles 15 and 16, paragraph 2." *Id*. art. 1(2) (discussing the scope of application and general provisions). Article 15 deals with the registration of space objects and Article 16(2) deals with taxation issues. *Id*. art. 15.

Luxembourg space agency (LSA), which occurred in 2021.[196] The early passage of the Luxembourg Space Resource Utilization Law shows the emphasis Luxembourg places on space resources.[197]

Luxembourg has today a quite comprehensive regulation of space activities[198] but continues to be particularly focused on space resources.[199] In 2020 Luxembourg, in strategic partnership with the European Space Agency, established the European Space Resources Innovation Centre (ESRIC), a center totally dedicated to space resources.[200]

2. General Considerations on Luxembourg Space Resource Utilization Law

Unlike the other three space mining laws discussed in this Part, the Luxembourg law clearly refers to the non-appropriation ban of Article II OST by providing: "*Les ressources de l'espace sont susceptibles d'appropriation.*"[201] While the provision is sometimes translated as "space resources are capable of being owned,"[202] a more faithful

[196] Bob Calmes *et al*., *The Space Law Review: Luxembourg*, ARENDT (Jan. 2023) (last visited Dec.6, 2023).
[197] The Space Activities Law owes much to the groundwork laid by the Space Resources Law, notably by embracing fundamental concepts from the latter and echoing specific wording used in certain articles. *Id.*
[198] The primary legislative frameworks governing the space industry encompass the Electronic Media Law of July 27, 1991, governing satellite system and satellite service transmission, the Frequency Bands Law of May 30, 2005, managing frequency band administration, the Space Resources Law of July 20, 2017, governing space resource exploration and use, and the Space Activities Law of December 15, 2020. *Id.*
[199] *See* Bob Calmes *et al*., *supra* at 196 (arguing that the unique attribute of the domestic space legal structure originates from the principles outlined in the Space Resources Law).
[200] In 2020, the partnership among the Luxembourg Space Agency (LSA), the Luxembourg Institute of Science and Technology (LIST), and the European Space Agency (ESA) resulted in the creation of ESRIC, marking it as the first center in the word exclusively devoted to space resources. ESRIC, *Welcome to the European Space Resources Innovation Centre*, ESRIC available at https://www.esric.lu/ (last visited Apr. 16, 2024) (ESRIC is a research center, "supports commercial initiatives in space resources," share knowledge and "connects people and business, ideas and funding." *Id*. at *Commercialization*.
[201] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 1.
[202] Luxembourg Space Resource Utilization Law (English translation of the Act), *supra* note 194, art 1.

translation is "space resources are susceptible of appropriation," which shows a clear intention to clarify that Luxembourg's position on Article II OST is that the non-appropriation principle does not apply to space resources.[203]

Another interesting aspect of the Luxembourg Space Resource Utilization Law is the absence of a description of the property rights vested in the resources. Luxembourg is a civil law country. In civil law - as discussed above, - property is not a bundle of sticks but rather a unified right.[204] The Luxembourg Space Resource Utilization Law does not need to define the content of space miners' property rights. Once the law recognizes the lawfulness of the activity, the entire regulation of "property" from the Luxembourg Civil Code becomes applicable; Article 544 defines "property" as "the right to enjoy and dispose of things, provided that one does not make a use of them prohibited by the laws or by the regulations…."[205] The definition of "property" as the "right to enjoy and dispose" has a long tradition, coming from the French Civil Code,[206] and the same is true of the limitation regarding the use "prohibited by the laws or by the regulations."[207] Within these

[203] The legislative commentary to Article 1 Luxembourg Space Resource Utilization Law also shows the intent to clarify that the non-appropriation principle does not apply to extracted resources:

> [T]he wording used excludes any possibility of contradicting the provisions of Article 2 of the Outer Space Treaty in that it does not allow the appropriation of asteroids, comets or celestial bodies and it does not allow or does not constitute 'a commencement of a component of sovereignty over a territory above a celestial body or any part whatsoever of outer space and the other celestial bodies.

Bob Calmes *et al*., *supra* note 196.

[204] Yun-chien Chang & Henry E. Smith, *supra* note 173, at 5.

[205] English translation by the author. This is the provision in French:
Art. 544 --- La propriété est le droit de jouir et de disposer des choses, pourvu qu'on n'en fasse pas un usage prohibé par les lois ou par les règlements [...]. *See* Luxembourg Government, *Titre Preliminaire - De la publication, des effets et de l'application de lois en général*, Luxembourg Official Journal, art. 544 (last updated Jan. 2020), available at: https://www.legilux.public.lu/eli/etat/leg/code/civil/20200101.

[206] "La propriété est le droit de jouir et disposer des choses de la manière la plus absolue, pourvu qu'on n'en fasse pas un usage prohibé par les lois ou par les règlements." Code civil [Civil Code] art. 544 (Fr.).

[207] *Id.* (This is the same as in the French Civil Code).

limitations, the right of the owner is the broadest possible[208] and does not need any further definition.

Unlike the other three laws discussed in this paper,[209] the Luxembourg Space Resource Utilization Law does not define "space resources" except that it excludes from its scope "satellite communications, orbital positions or the use of frequency bands;" therefore we know that frequencies, for example, are not resources.

The clear intention of the Luxembourg Space Resource Utilization Law is to attract business. In fact, the law is not limited to and does not even mention Luxembourg citizens.[210] Article 4 clarifies that the permit for space mining can be granted only to *entities* formed in Luxembourg.

The authorization for a space mining mission shall only be granted if the applicant is a public company limited by shares (*société anonyme*) or a corporate partnership limited by shares (*société en commandite par actions*) or a private limited liability company (*société à responsabilité limitée*) under Luxembourg law or a European Company (*société européenne*) having its registered office in Luxembourg.[211] While Article 4 would not seem to require a company formed in Luxembourg to have its headquarters in the country, Article 4 must be read in conjunction with Article 7, which requires headquarters in Luxembourg.[212] The headquarters requirement confirms the Law's intent of attracting business.

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[208] Commenting an analogous provision of the Italian Civil Code (art. 832 "Content of (property) right providing: "The owner has the right to enjoy and dispose of things in a full and exclusive, within the limits and in compliance with the obligations established by the legal system." Maria Francesca Mazzitelli, *La proprietà nel diritto privat*o, ("Property in Private Law"), Simone Blog, (Italian), available at: https://edizioni.simone.it/2022/05/24/proprieta-nel-diritto-privato/ (last visited Apr. 19, 2024) (arguing that the right to enjoy grants authority over the use of a thing, including the right to sell, lease, or establishing rights like servitudes and usufruct. Ownership allows for any lawful use of the property, exclusive control, and the right to exclude others from its enjoyment).

[209] *See* Part III(A), (C) & (D).

[210] The operator seeking authorization is not required to be exclusively owned by Luxembourg companies or citizens. Bob Calmes, *et al.*, *supra* note 196.

[211] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 4.

[212] "The authorisation shall be subject to the production of evidence showing the existence in Luxembourg of the central administration and of the registered office, including the administrative

3. Space Mining Authorization

Unlike the US Space Resource Utilization Law, which establishes general principles and requires additional legislation and/or agency rulemaking,[213] the Luxembourg Space Resource Utilization Law is largely complete.

The law requires space mining companies to file for "a written mission authorisation from the minister or ministers in charge of the economy and space activities."[214] The authorization is for a "mission of exploration and use of space resources for commercial purposes."[215] The identity of the applicant of the authorization is important. In fact, the law provides that the mining activities cannot be performed through third parties[216] and the "authorisation is personal and non-assignable."[217] The activities must be performed "in accordance with the conditions of the authorisation and the international obligations of Luxembourg."[218] The information the applicant must deliver is extensive; the application must contain "all such information as may be useful for the assessment thereof as well as by a mission program."[219] The applicant must also provide "a risk assessment of the mission … [specifying] the coverage of these risks by personal financial means, by an insurance policy of an insurance undertaking not belonging to the same group than the operator to be authorised or by a guarantee of a credit institution not belonging to the same group than the operator to be authorised." [220]

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and accounting structures of the operator to be authorised." Luxembourg Space Resource Utilization Law, *supra* note 194, art. 7(1).

[213] *See* Part III(A).

[214] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 2(1).

[215] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 3.

[216] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 2(2).

[217] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 5.

[218] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 2(3).

[219] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 6.

[220] Luxembourg Space Resource Utilization Law *supra* note 194, art. 10(2) ("The authorisation shall be conditional upon the existence of financial bases that are appropriate to the risks associated with the mission.").

The law requires the space mining business to be solid; in fact, the applicant must show (1) a "robust scheme of financial, technical and statutory procedures and arrangements" which must include "commercialisation of space resources;"[221] (2) "a robust internal governance scheme, which includes in particular a clear organisational structure" that is able to manage the risks and presents "adequate internal control mechanisms" both from the administrative/accounting perspective as well as for the technical part;[222] (3) "arrangements, processes, procedures and mechanisms" which must "be comprehensive and proportionate to the nature, scale and complexity of the risks inherent to the business model … as well as to the mission."[223]

Concern for soundness of the business extends beyond license approval. For example, the financial statements of operators must be audited every year.[224] Intense scrutiny of the business does not stop with the entity itself; shareholders or members must also meet legal requirements. First, in order for the authorization to be issued, the identity of the shareholders or members ("direct or indirect, natural or legal persons") controlling a least 10% of the entity must be disclosed, and if nobody reaches that threshold "the identity of the twenty largest shareholders or members."[225] Second, the authorization is not granted if the shareholders or members are not suitable for "a sound and prudent operation."[226] To evaluate whether the operation is "sound and

[221] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 7(2).
[222] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 7(2).
[223] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 7(3).
[224] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 11.

> (1) The authorisation shall be conditional on the operator to be authorised having its annual accounts audited by one or more réviseurs d'entreprises agréés who can show that they possess adequate professional experience.
> (2) Any change in the réviseurs d'entreprises agréés must be authorised in advance by the ministers.
> (3) The rules in respect of commissaires, which may form a supervisory board as laid down in the Law of 10 August 1915 on commercial companies, as amended, only apply to operators where the Law on commercial companies mandatorily prescribes it even if there is a réviseur d'entreprise.).

Luxembourg Space Resource Utilization Law, *supra* note 194, art. 11.
[225] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 8(1).
[226] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 8(1).

prudent," the licensing authority examines the good reputation of the operators and of the shareholders/members, the knowledge and skill of managers and shareholders/members, the financial soundness of shareholders/members, and whether there is any ground to suspect money laundering or terrorism.[227] The "management body" must possess "good repute" and "sufficient knowledge, skills and experience" during the entire time of the authorization;[228] "guarantee of irreproachable conduct" is also required.[229]

The Law goes into the details of the management of the business requiring that "[a]t least two persons must be responsible for the management of the operator," that these persons must be given effective power, and that they must have had prior experience at a high level in the space industry or a related sector. [230] Changes in the management must be communicated in advance to the ministers so that they can make appropriate inquiries into the qualifications of the new operators and refuse to authorize the change for the reasons indicated in the law.[231] The Law also requires applicants to communicate any changes in the information on which the authorization was based.[232]

The application for authorization has some required content (i.e., description of how the operator "fulfills the conditions of Articles 6 to 11, paragraph 1 and 2") and some optional content.[233] Fees for processing an application can range from EUR 5.000 to EUR 500.000 depending on

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[227] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 8(2).
[228] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 9(1).
[229] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 9(1).
[230] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 9(2).
[231] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 9(3) (specifying that the change is not approved if "if these persons are not of adequate professional repute or do not have sufficient professional experience or where there are objective and demonstrable grounds for believing that the proposed change would pose a threat to the sound and prudent management of the operation.").
[232] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 9.4.
[233] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 12.
This optional content includes:

> a) the activities to be carried on within the territory of the Grand Duchy or from such territory; b) the limits that could be associated with the mission; c) the modalities for the supervision of the mission; d) the conditions for ensuring compliance by the operator to be authorised with its obligations.

Luxembourg Space Resource Utilization Law, *supra* note 194, art. 12.

the complexity of the application.[234] Article 18 provides for criminal penalties if an operator performs space resource utilization activities without a permit and for other violations of the Luxembourg Space Resource Utilization Law.[235]

4. Concluding Considerations About Luxembourg

Luxembourg is focused on space mining: its space agency has been formed with that specific purpose in mind. Similar to the banking sector, Luxembourg wants to present itself as the place to be for a space mining business.[236] In addition to passing a domestic law, Luxembourg has been seeking international cooperation to establish a global regulatory framework for space resource utilization.[237] Luxembourg signed memoranda of cooperation with both China,[238] and the United

[234] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 13 The Law delegates to a "grand-Ducal regulation" the determination of the "the procedure applicable to the collection of such fee." Luxembourg Space Resource Utilization Law, *supra* note 194, art. 13.2.
[235] Luxembourg Space Resource Utilization Law, *supra* note 194, art. 18.
[236] Cecilia Jamasmie, *Luxembourg's Mining-Focused Space Agency Ready to Lift Off*, MINING.COM (last accessed Nov. 7, 2023) (contending that Luxembourg aims to establish itself as Europe's central hub for space mining. In contrast to NASA, the Luxembourg Space Agency (LSA) does not engage in research or launches. As Paul Zenners, a government counselor, highlighted in an emailed statement, LSA focuses on fostering collaborations among leaders in the space sector, investors, and various partners).
[237] Jeff Foust, *Luxembourg adopts space resources law*, SPACENEWS (July 17, 2017) (reporting Etienne Schneider's statement, Luxembourg's First Deputy Prime Ministry from 2013-2020, at the time of the enactment of the Space Resource Act).
[238] Luxembourg Space Agency, *The National Space Science Center of the Chinese Academy of Sciences to Establish a Research Laboratory in Luxembourg,* LUX. SPACE AGENCY (Jan. 17, 2018).

State.[239] Luxembourg is an early signatory of the Artemis Accords,[240] and positions itself as a "middle power."[241]

In addition, Luxembourg offers a very favorable tax environment for business, which is beneficial to space companies as to any other business.[242] In summary, the legal and other initiatives adopted by Luxembourg make it a very favorable location for companies seeking to engage in the space resource mining business.

C. The United Arab Emirates' Regulation of Space Resource Utilization

1. The UAE and its Interest in Space

A federation of seven Emirates,[243] situated in the Arabian Peninsula[244] with a population of almost 10 million,[245] the UAE is an economic force with a varied economy, stable politics, robust capital

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[239] Press release, U.S. Embassy in Luxembourg, *The United States and Luxembourg Sign Memorandum On Space Co-Operation On May 10, 2019* (May 10, 2019), available at: https://lu.usembassy.gov/the-united-states-and-luxembourg-sign-memorandum-on-space-co-operation-on-may-10-2019/. (last visited March 26, 2024.).

[240] Press release, The Luxembourg Government, Luxembourg, *NASA and several other partner countries are among the first signatories of the Artemis Accords*, (Oct. 14, 2020), available at: https://gouvernement.lu/en/actualites/toutes_actualites/communiques/2020/10-octobre/14-luxembourg-nasa-artemis.html (last visited March 26, 2024).

[241] Namrata Goswami, *The Second Space Race: Democratic Outcomes for the Future of Space,* GEO. J. OF INT'L AFF. (Jan. 25, 2022), available at: https://gjia.georgetown.edu/2022/01/25/the-second-space-race-democratic-outcomes-for-the-future-of-space/ (last visited Dec 5, 2023) (contending that Luxembourg positions itself as a middle power, with relationship with both United States and China).

[242]Ruud De Mooij *et al., International Taxation and Luxembourg's Economy*, INT'L MONETARY FUND, (IMF Working Paper No. 2020/264) (Nov. 25, 2020).

[243] Australian Government, *United Arab Emirates country brief*, Austl. Gov't Dep't. of Foreign Affs. and Trade, available at https://www.dfat.gov.au/geo/united-arab-emirates/united-arab-emirates-country-brief#:~:text=The%20United%20Arab%20Emirates%20(UAE,joined%20the%20federation%20in%201972. (last visited April 20, 2024).

[244] *United Arab Emirates*, available at: https://www.nationsonline.org/oneworld/arab_emirates.htm (last visited May 16, 2023).

[245]Ovarian, *Why do business in the UAE?,* OVARIAN, (Oct. 23, 2018) available at: https://www.ocorian.com/insights/why-do-business-uae (last visited Apr. 16, 2024).

flow, advantageous tax settings, and open trade policies.[246] From a legal perspective, the UAE's legal system is a hybrid system in which constitutional and federal law coexist with sharia law, customs and practice, which are all sources of law. The law is mostly based on Egyptian and French law.[247] Considering the latter, not surprisingly the UAE has a Civil Code.[248]

The UAE has a strong interest in space, which started with telecommunication.[249] The UAE has been actively seeking "to establish itself as a regional hub for civil and commercial space activities." [250] In 2006, the UAE established the Mohammed bin Rashid Space Centre (MBRSC), a governmental organization which is the "home to the UAE National Space Programme"[251] and in 2014 the UAE space agency (UAESA).[252]

Besides the obvious interest in attracting business, which permeates the UAE economy,[253] space is a driver to build knowledge, to

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[246] *Id.*

[247] El Ameir Noor *et al*, *Legal Systems in the United Arab Emirates: Overview*, Thomson Reuters, Practical L., (last visited Apr., 2024) (arguing that the UAE's legal system blends constitutional law, the UAE Civil Code (Federal Law No. (5) of 1985), Sharia principles, and various sources like the Constitution, federal and local laws, Sharia law, customs, and French and Egyptian civil legislation, governing civil matters).

[248] United Arab Emirates Civil Code (UAE Civil Code) of 1985. For an English translation, *See* https://lexemiratidotnet.files.wordpress.com/2011/07/uae-civil-code-_english-translation_.pdf. Translated from Arabic into English by James Whelan MA (Cantab), Cert. Ed. (London) Resident Manager, Clifford Chance, Sharjah Marjorie J Hall BA, PhD. (last visited Apr. 20, 2024).

[249] Deema AlQaisieh, *Why is the UAE Interested in Developing Outer Space Programs?*, InterRegional for Strategic Analysis, (Aug. 4, 2022) available at: https://www.interregional.com/article/Lift-Off:/1735/En (last visited Dec 6, 2023) (contending that the UAE's venture into space initially stemmed from aspirations to advance the communications sector.).

[250] Matt Kerster, *AAA Air Support Is International – Aerospace Industry United Arab Emirates*, AAA Air Support, available at: https://www.aaaairsupport.com/aaa-air-support-is-international-aerospace-industry-united-arab-emirates. (last visited Dec. 5, 2023).

[251] Mohammed bin Rashid Space Centre, *About Mohammed bin Rashid Space Centre* (MBRSC), Mohammed Bin Rashid Space Centre (last visited Apr. 16, 2024).

[252] Kayaan Unwalla *et al*., *Global Outer Space Guide: United Arab Emirates (UAE),* Norton Rose Fulbright (Sept. 2023), available at: https://www.nortonrosefulbright.com/en/knowledge/publications/e2a4dae0/global-outer-space-guide-uae (last visited Dec 5, 2023).

[253] Alexander Cornwell, *United Arab Emirates cuts red tape to attract businesses*, REUTERS, (July 6, 2022), available at: https://www.reuters.com/world/middle-east/united-arab-emirates-cuts-red-tape-attract-businesses-2022-07-06/ (last visited Dec 5, 2023).

foster development, to train and inspire new generations,[254] and to increase the UAE's international reputation.[255] In addition, harvesting celestial resources is among the UAE's motivations for its interest in space.

2. The UAE General Space Law

In December 2019, the UAE issued Federal Law No. (12) of 2019,[256] a comprehensive space law ("UAE General Space Law"), which also contains provisions specifically governing space resource utilization ("UAE Space Resource Utilization Provisions"), becoming the third country (after the US and Luxembourg) to enact specific legislation dealing with space resource utilization.[257]

The purposes of the UAE General Space Law are listed in Article 2 (*Objectives of the Law*); fostering investment is the first objective. The UAE General Space Law establishes a "legislative framework" for space activities to stimulate investment, to promote safety and sustainability of space activities, and to show both transparency and State commitment to international conventions and treaties dealing with space.[258]

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[254] Times Higher Educ., *The UAE turns to space to fuel development and build its knowledge economy*, Times Higher Educ., available at https://www.timeshighereducation.com/hub/united-arab-emirates-university/p/uae-turns-space-fuel-development-and-build-its-knowledge (last visited May 16, 2023) (arguing that Khaled Al Hashmi, director of the UAE's National Space Science and Technology Center, emphasizes that space programs are more than just reaching a destination; they aim to inspire, build industries, and boost Earth's economy).

[255] The UAE's interest in space aims to strengthen its global role and image, recognizing space as a means to elevate a country's reputation. *Id.* Dr. Al Hashmi highlights that space serves as a gateway to multiple sciences, drawing students into scientific pursuits through missions to celestial bodies and satellite launches. *Id.*

[256] Law No. (12) of 2019 (On the Regulation of the Space Sector), 19 Dec. 2023 (UAE).

[257] P.J. Blount & Mohamed Amara, *SPARC Brief, United Arab Emirates*, Univ. of Washington, Space Pol'y and Research Ctr., (Aug. 2020), available at: https://orbilu.uni.lu/handle/10993/44626 (last visited Dec 5, 2023).

[258] *See* Law No. (12) of 2019, *supra* note 256, art. 2. This Law aims to establish a legislative framework regulating the Space Sector so as to create an appropriate regulatory environment to achieve the objectives of the State's national space policy, including the following purposes:

> 1- Stimulating investment and encouraging private and academic sector participation in the Space Sector and related activities.

The UAE General Space Law applies to

> Space Activities and other Space Sector-related activities that are carried out as follows: 1. In the State's Territory or the State's establishments outside the State's Territory. 2. From ships or aircraft registered with the State or Space Objects registered by the State. 3. By persons who hold the nationality of the State, or companies that have a headquarters in the State.[259]

Therefore, the UAE Space Resource Utilization Provisions, along with other provisions of the UAE General Space Law, apply to activities performed in the UAE and in its "establishments," as well as to activities under the flag of the UAE. In addition, the UAE General Space Law applies to UAE nationals and to entities headquartered in the UAE. It contains no limitations about foreign ownership of a company, so non-UAE citizens and non-UAE companies can perform space resource utilizations under the UAE Law, provided they are headquartered in the country. [260]

The scope of the UAE General Space Law is defined with reference to "Space Activities," which are those activities that target the "Specified Area," defined as "[a]ny area above eighty kilometers or more than the average sea level."[261] Article 4 ("Regulated Activities") contains

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> 2- Supporting the implementation of the necessary safety, security and environmental measures to enhance the long-term stability and sustainability of Space Activities and related activities.
> 3- Supporting the principle of transparency and the commitment of the State to implement the provisions of international conventions and treaties related to Outer Space and to which the State is a party.

Law No. (12) of 2019, *supra* note 256, art. 2.

[259] *See* Law No. (12) of 2019 *supra* note 256, art. 3.

[260] However, per Article 3, citizens of the United Arab Emirates who perform their activities under the flag of another country are still subject to the General Space Law. Law No. (12) of 2019 *supra* note 256, art. 3.

[261] These definitions are in Article 1 General Space Law – ("Definitions"). *See* Law No. (12) of 2019 *supra* note 256, art. 1. The UAE law uses a spatial concept of outer space, at least for the purpose of defining "Space Activities" but places the limit below the traditional Kármán line of 100 kilometers. *See* Daisy Dobrijevic & Andrew May, *The Kármán Line: Where does space begin?,* SPACE.COM (Nov. 14, 2022), available at: https://www.space.com/karman-line-where-does-space-begin (last visited Dec. 5, 2023).

a list of "Space Activities" for the purpose of this Law. As for space mining, it lists "… (i) Space Resources exploration or extraction activities … (j) Activities for the exploitation and use of Space Resources for scientific, commercial or other purposes."[262] The 80-kilometer threshold should be immaterial for space resource utilization, as it is unlikely that mining will happen in low-Earth orbit; however some accessory activities, such as the processing of space resources, could occur in that region and may be regulated by other laws. [263]

3. The UAE Space Resource Utilization Provisions - Interaction with the Civil Code

The UAE Space Resource Utilization Provisions are limited to the definition of "Space Resources" in Article 1 and to Article 18, requiring a permit for the "exploration, exploitation and use of Space Resources, including their acquisition, purchase, sale, trade, transportation, storage."[264]

"Space Resources" are defined as "[a]ny non-living resources present in outer space, including minerals and water."[265] Therefore, space resources available for harvesting are confined to non-living elements, which implies that organic compounds like oil can potentially be collected because "non-living" and "organic" are not interchangeable terms. However, it remains uncertain whether bacteria fall within the permissible resources for extraction.[266] As this paper discusses in the

[262] Article 4(1) General Space Law ("Regulated Activities"). *See* Law No. (12) of 2019*, supra n*ote 256, art. 4(1) & 4(2). Article 4(2) gives a non-exhausting list of "Other Space Sector-related activities;" they include "Space Supporting Flights and High-Altitude Activities and "Space Data management activities." *See* Law No. (12) of 2019*, supra n*ote 256, art. 4(2).
[263] An example of accessory activity that could happen in low-Earth orbit is the use of minerals excavated from asteroids or the Moon as "in-orbit propellant replenishers." Annette Froehlich, *Space Resource Utilization: A View from an Emerging Space Faring Nation*, European Space Policy Institute (ESPI) (Springer, 1st ed. 2018).
[264] *See* Law No. (12) of 2019, *supra* note 256, art. 18.
[265] *See* Law No. (12) of 2019, *supra* note 256, art. 1.
[266] "Non-living" and organic are not the same. *See* John D. Morris, *Does Organic Mean Living?*, Inst. for Creation Rsch., (May 16, 2023), available at: https://www.icr.org/article/does-organic-mean-living (last visited Dec. 5, 2023) (discussing how "to a non-specialist the term 'organic

next section, Japanese law is open to the possibility of harvesting living-resources in space.[267]

The UAE Space Resource Utilization Provisions do not define property rights in the resources; the issue must be analyzed in light of the UAE Civil Code and especially Part 4 ("Things and property").[268] As seen for Luxembourg, the UAE law neither needs a definition of property rights in space resources nor a recognition that space resources can be owned: once the law clarifies space mining is permitted (subject to a license), then general property provisions from the UAE Civil Code elucidate the content of property rights in space resources.

Article 95 of the UAE Civil Code provides that "Property ("*mal*" in Arabic) is any thing (sic) or right having a material value in dealing."[269] It is expected that space resources have a material value, and therefore they are "property" under Article 95.[270] Article 97 provides

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compound,' connotes life and living, yet [organic compound] [...] merely [...][mean] a carbon-based molecule."). So, for example, even if there is disagreement regarding the origin of petroleum, with some arguing for the organic origin and some for the inorganic, petroleum is certainly not a "living resource." *See* John Bluemle & Lorraine Manz, *The Origin of Oil*, N.D. Geologic Survey (May 16, 2023), available at: https://www.dmr.nd.gov/ndgs/documents/newsletter/NL04S/PDF/origin.pdf (last visited Dec. 5, 2023). For a discussion about viruses, see Luis P. Villarreal, *Are Viruses Alive?*, SCIENTIFIC AM. (May 16, 2023). As a comparison, the *Building Blocks* §2.1 defines "space resource" as "an extractable and/or recoverable abiotic resource *in situ* in outer space." *See Building Blocks*, Hague Int'l Space Res. Governance Working Group, at §2.1.

[267] *See infra* Part III(D).

[268] 1 Code Civil [Civil Code] art. 95-103 (UAE) (hereinafter, "UAE Civil Code").

[269] UAE Civil Code. "Ain", translated as "thing", covers both land and possessions, representing all property broadly under English law, except for intangible rights. Throughout, "property" translates "mal" in the text. *See* UAE Civil Code *supra* note 268.

[270] UAE Civil Code supra note 268, art. 96 (distinguishing between property that is 'mutaqawwim' and property that is 'non-mutaqawwim' and specifies that "[m]utaqawwim property is that which it is permissible for a Muslim lawfully to enjoy, and non-mutaqawwim property is that which it is not permissible for a Muslim lawfully to enjoy"). *See also Mal Ghayr Mutaqawwim*, Fincyclopedia (Sept. 12, 2021) (last visited Apr. 19, 2024) (defining Mal Ghayr Mutaqawwim). On Islamic property, *see* Ahmed Akgunduz, *Private Law: Islamic Law in Theory and Practice*, IUR Press, (2017). To be valuable (mutaqawwim) and therefore to be the object of property rights, "things" must have two characteristics the asset is considered must have been acquired, known as muhraz. *Id.* Therefore, fish not yet caught, or game not yet hunted are not categorized as mutaqawwim. *Id.* The status of assets can change over time; for instance, solar energy was previously not recognized as property because it could not be acquired, but it is now considered property due to being controllable. *Id. Mutaqawwim* property necessitates both these qualities. *Id*. Only such property can be involved in legal transactions and is eligible for compensation in case

that to be the "proper object of property rights," things must be "possessed whether physically or constructively," must be "lawfully enjoyed," and must not "by its nature or by operation of law fall outside the scope of dealing (transactions)."[271] Space resources can be the object of transactions; in fact, they can be the object of "acquisition, purchase, sale, trade, transportation, storage;"[272] the list is not exclusive. Because space resources are "property", the other articles of the UAE Civil Code governing property also apply.

Article 109 defines a property right as "a direct power over a particular thing, given by law to a particular person,"[273] and Article 110 distinguishes between "[o]riginal property rights" and "[c]onsequential property rights;" "[o]riginal property rights are rights of ownership, disposal, usufruct, use, residence or shared occupation, rights of easement, waqfs, and rights which the law provides shall be deemed to be such," while "[c]onsequential property rights are mortgages for security, possessory mortgages, and liens."[274] Both types of rights are possible for space resources; for example, a lender could take a lien on extracted space resources to secure a mortgage because the resources are recognized as property. [275]

4. Permit for Space Resource Utilization Activities

Because the UAE Space Resource Utilization Provisions are part of the more general UAE General Space Law, the general rules of the

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of loss. *Id.* However, this criterion applies exclusively to Muslims. For non-Muslims, the presence of the second feature is not mandatory to ensure protection of property rights. Ahmed Akgunduz, *Private Law: Islamic Law in Theory and Practice*, IUR PRESS, (2017).

[271] UAE Civil Code *supra* note 268, art. 97. Article 98 defines which are the "things which are by their nature outside the scope of dealing." UAE Civil Code *supra* note 268, art. 98. These are "those which no person may possess exclusively, and things which are outside the scope of dealing by operation of law are those which the law does not permit to be the subject of property rights." UAE Civil Code *supra* note 268, art. 98.

[272] Law No. (12) of 2019, *supra* note 256, art. 18.

[273] UAE Civil Code *supra* note 268, art. 109(1) & (2).

[274] UAE Civil Code *supra* note 268, art. 110.

[275] Therefore, space resources can be bought and sold. *See* Law No. (12) of 2019, *supra* note 256, art. 18. (defining "acquisition, purchase, sale, trade."). Space resources can also be the object of usufruct and use, a security right, or a lien. *See* Law No. (12) of 2019, *supra* note 256, art. 18.

UAE General Space Law apply to space resource utilization. For example, Article 18 (referring to "conditions and controls related to Permits exploration, exploitation and use of Space Resources") remands to the general provision for permits for space activities, which is Article 14.[276] Pursuant to Article 14, [277] a permit from the Agency is required to own a Space Object, engage in Space Activities, or use facilities.[278] In addition, Article 14 discusses conditions, controls, and procedures for permits (including "granting, renewal, amendment, cancellation, suspension and assignment") and defers to decisions of the Council of Ministers (or its delegate) for detailed regulations. [279]

Article 14 (3) provides the possibility of a waiver for single operators;[280] Article 14(4) imposes on the Space Agency an obligation to "ensure that the application for the Permit meets the terms and conditions prescribed for its granting;"[281] Article 14(5) specifies that the permit can be suspended or canceled, but even if this happens, the operator is not exonerated from "any liability, administrative penalty, punishment or any other obligation, unless otherwise stated in this Permit."[282] The same is true in the case of assignment of the permit, with reference to "any obligation or liability established prior to the date of the assignment;"[283] Article 14(7) requires approval of the Space Agency for any prospective assignment.[284] Criminal penalties exist for

[276] "Subject to the provisions of Article (14) of this Law […]" Law No. (12) of 2019, *supra* note 256, art. 18.
[277] Article 14 applies to space resource utilization activities with two caveats that will be discussed *infra* in this Part III(C) as special rules for space mining. Even in the absence of a specific reference, the general provisions of Article 14 would have applied.
[278] Law No. (12) of 2019, *supra* note 256, art. 18.
[279] Law No. (12) of 2019, *supra* note 256, art.14.2.
[280] Law No. (12) of 2019, *supra* note 256, art. 14.3: "[a]s an exception to the provision of clause (1) of this Article, the Chairman of the Board of Directors may form an interim committee to exempt any specific Space Operator or Activities from obtaining a Permit, or from any special conditions, controls or procedures."
[281] Law No. (12) of 2019, *supra* note 256, art. 14.4.
[282] Law No. (12) of 2019, *supra* note 256, art. 14.5.
[283] Law No. (12) of 2019, *supra* note 256, art. 14.6.
[284] Law No. (12) of 2019, *supra* note 256, art. 14.7.

violations, and "the liability shall be joint between the assignee and the assignor in case of violation thereof."[285]

As for any space activities that can cause damage, the operator of space resource utilization activities must show that it obtained insurance coverage from an insurance approved by the Space Agency (or "provide any other guarantees approved by the Agency")[286] and is responsible for reimbursing the government for damage "resulting in international claims against the State."[287]

The permit for space resource utilization differs from the other permits in two aspects: (1) Article 18 provides that the special "conditions controls" relating to space mining activities will be determined by "a decision issued by the Council of Ministers or whomever it delegates" (therefore the decisions differ from the Council of Ministers' decisions provided in Article 14); (2) Unlike the other permits, the permits for space mining "shall be granted by a decision of the Board of Directors upon the proposal of the Director General"[288] and not generally the "Agency" as in Article 14.1.[289]

[285] Law No. (12) of 2019, *supra* note 256, art. 15.7.
[286] Law No. (12) of 2019, *supra* note 256, art. 25.
[287] Law No. (12) of 2019, *supra* note 256, art. 26. The responsibility is limited to certain amount - as calculated according to Article 24 ("Estimating the Limitation of Compensation for Liability") - but "[i]f the Operator is not authorised or is in breach of the terms of his Permit, the compensation shall be absolute for those claims and for the losses or damages incurred by the State in this regard.") Law No. (12) of 2019, *supra* note 256, art. 24 & 26.2.
[288] Law No. (12) of 2019, *supra* note 256, art. 18.
[289] Because the "Board of Directors" referred to in this provision is the Board of Directors of the Space Agency, the distinction might not be meaningful, but the applicants should be aware of this peculiarity. Law No. (12) of 2019, *supra* note 256, art. 14.1.

D. Japan's Act on Promotion of Business Activities Related to the Exploration and Development of Space Resources

1. Japan as a Technology Leader and a Space Power

Japan is a leader in technology and most of all robotics. Earlier than other countries, Japan realized how technology can benefit society and began to invest in technology innovation.[290] Today technology is omnipresent in Japan.[291] Robotics is very advanced, important to solve the aging problem of the Japanese population,[292] and one of the strongest components of Japanese production. [293]

Japan has had a strong interest in space for decades, leveraging its leadership in technology to advance in space.[294] Fifty years ago, Japan began substantial investment in space exploration, achieving considerable success, including the development of "a launch vehicle using only domestic technology."[295] In 1994 Japan succeeded in launching the H-II, its first domestic rocket.[296] Besides the development of launch vehicles, Japan has been successful in space exploration. For example, the Japan Aerospace Exploration Agency (JAXA) Hayabusa

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[290] News on Japan, *Here's how Japan has Become a Leading Technological Power*, NEWSONJAPAN.COM (Mar. 22, 2023).
[291] Fast infrastructure (e.g., the bullet-train Shinkansen was inaugurated in 1964), workforce automation (as a remedy for the ongoing scarcity of labor"), technological advancements to solve environmental problems (such as electric vehicles and hybrid vehicles). *Id.*
[292] Uptin Saiidi, *Here's Why Japan is Obsessed with Robots*, CNBC (Mar. 9, 2017) (stating that, given Japan's status with the world's most rapid decline in its total population, economists argue that the nation must decide between welcoming more immigrants or harnessing robotic technology within its workforce). *Id.*
[293] Press Release, *Japan is World's number one Robot Maker*, Int'l Fed'n of Robotics (Mar. 10, 2022) (arguing that Japan leads as the top industrial robot producer globally, contributing 45% to the total supply).
[294] Anupama Vijayakumar, *To Infinity and Beyond: Japan's Rise as a Space Power*, THE DIPLOMAT (Jan. 25, 2020) available at: https://thediplomat.com/2020/01/to-infinity-and-beyond-japans-rise-as-a-space-power. (last visited Dec 6, 223) (arguing that in recent decades, Japan has risen as a prominent nation in space exploration. Renowned for its advancements in high technology, the country has utilized its expertise in fields like robotics to solidify its position among the top-tier space-exploring nations).
[295] Hiroko Yotsumoto, *The Space Law Review: Japan*, THE L. REV. (Jan. 5, 2023) (hereinafter, "*The Space Law Review: Japan*").
[296] *Id.*

Project, in 2010, and the Hayabusa2 Project, in 2020, completed missions of asteroid sampling. The IKAROS Project demonstrated a revolutionary solar electric sail technique for spacecrafts.[297]

2. The Japanese Space Resource Utilization Act and its Purpose

Because space resource utilization lies at the intersection of space capability and robotics (because space mining will be done primarily by robots), it seems only natural for Japan to become interested in space mining. Even before the enactment of a specific law on resource utilization, the Japanese government invested in space mining projects,[298] demonstrating Japan's commitment to the field.[299] In June 2021, Japan passed its space resources utilization law, known as the Act on the Promotion of Business Activities for the Exploration and Development of Space Resources[300] ("Japanese Space Resource Utilization Act"). The Japanese company ispace obtained the first license for space mining in November 2022.[301]

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[297] *Id.*

[298] Taijiro Suzuki, *Japan: Legal issues in space business in Japan - Volume 2,* BAKER MCKENZIE (Jul. 9, 2021), available at: https://insightplus.bakermckenzie.com/bm/real-estate_1/japan-legal-issues-in-space-business-in-japan-volume-2 (explaining that the Japanese government made an investment in ispace, inc., a Japanese space venture company dedicated to space mining, via the Development Bank of Japan) (last visited Dec. 6, 2023) (hereinafter: "*Legal issues in space business in Japan"*).

[299] *See Legal issues in space business in Japan, supra* note 298.

[300] [Space Resource Act] Law No. 83 of Dec. 23, 2021 (*宇宙資源の探査及び開発に関する事業活動の促進に関する法律(令和三年法律第八十三号*). A translation is available on website of Cabinet Office, Government of Japan at https://www8.cao.go.jp/space/english/resource/documents/act83_2021.pdf (last visited May 15, 2024). The Japanese version (official version) is available here: https://elaws.e-gov.go.jp/document?lawid=503AC0000000083 (last visited May 15, 2024).

[301] *See also* ISPACE WEBSITE*, ispace Receives License to Conduct Business Activity on the Moon from Japanese Government*, ISPACE, available at: https://ispace-inc.com/news-en/?p=3829 (last visited Dec 5, 2023) (announcing in 2022 to have received "a license from the Japanese government to conduct business activity on the moon as part of its first lunar mission").

Article 1 describes the purpose of the Act:

> to ensure the accurate and smooth implementation of [the international conventions] … and to promote business activities for the exploration and development of space resources by private business operators, by establishing special provisions for license under the provisions of the Space Activities Act, … as well as specifying the rules for the acquisition of ownership of space resources and other necessary matters concerning such activities […][302]

The purpose is twofold: (i) clarification of the law and (ii) promotion of the commercial sector. Japan had issued the Basic Space Law,[303] the Space Activities Act,[304] and the Remote Sensing Act.[305] But, before the Japanese Space Resource Utilization Act, there was "no clarity regarding the commercial exploitation of space resources." [306]

The Japanese Space Resource Act clarifies the law, expressly requiring "permission to prospect for, extract and use various space resources."[307] The Japanese Space Resource Act refers to and must be read in conjunction with the Space Activities Act. However, attention should be paid to Article 3(5) Japanese Space Resource Act, which modifies the Space Activities Act with reference to space mining activities.[308]

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[302] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 1.
[303] [Basic Space Law] Law No. 43 of May 21, 2008.
[304] [Space Activities Act] Law No. 76 of 2016. The Space Activities Act provides for a set of special liability rules for damage suffered by third parties caused by falls, collisions, and the explosion of rockets after commencement of the launch operation. *See* Yotsumoto, *supra* note 295.
[305] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300.
[306] Suzuki, *supra* note 298.
[307] Jeff Foust, *Japan Passes State Resources Law*, SPACENEWS (Jun. 17, 2021), available at: https://spacenews.com/japan-passes-space-resources-law/ (last visited Dec.5, 2023); *see also* Library of Congress, *Japan: Space Resources Act Enacted*, LIBRARY OF CONGRESS, available at: https://www.loc.gov/item/global-legal-monitor/2021-09-15/japan-space-resources-act-enacted/ (last visited May 15, 2024).
[308] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3(5).

3. License for the Exploration and Development of Space Resources

Space resource utilization is subject to a permit (which Article 3 calls "License for the Exploration and Development of Space Resources"), whose application must contain a detailed "activity plan;"[309] the plan must be "in compliance with the basic principles of the Basic Space Act and is not likely to cause any adverse effect on the accurate and smooth implementation of the conventions on development and use of outer space and the ensuring of public safety."[310] The applicant must be the person in "control of spacecraft … for the purpose of the exploration and development of space resources."[311] The licenses are granted by the Prime Minister of Japan after consultation "with the Minister of Economy, Trade and Industry."[312]

With a unique provision not found in the other space resource utilization laws, Article 4 provides that - when the Prime Minister grants a License for the Exploration and Development of Space Resources - the Prime Minister will make a public announcement,[313] "without delay via the Internet or by other appropriate means."[314] The purpose of the announcement is to foster international cooperation and to avoid disputes regarding space resources.[315] The Prime Minister will make no public announcement (or depending on the case, will limit the

[309] The Space Resource Act - in addition to the requirements of the Space Activities Act-, mandates a detailed activity plan for mining permits.[Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3. . The government assesses the plan to ensure that the proposed activity complies with Japan's Space Basic Act, space treaties, and national security, and to confirm the capability of the applicant to carry out the intended mining operations. *See* Suzuki, *supra* note 298.
[310] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3.2(i).
[311] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3.
[312] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3(4).
[313] Upon granting a permit for an individual to engage in space resources mining in accordance with the Space Activity Act and Space Resources Mining Act, the government will publicly disclose the recipient's name, their activity plan, and any other necessary details as per the applicable regulations. Suzuki, *supra* note 298.
[314] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 4.
[315] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3.5.

information provided) if the "business activities … are likely to be unjustly harmed by said public notice."[316]

Proceedings to obtain a space resource mining license are governed by Article 3, which refers to the proceeding of Article 20(1) of the Space Activities Act but adds some requirements:

> [the applicant] must state [in addition to what provided by Article 20(2) of Space Activities Act] … a plan in which the following matters are specified (hereinafter referred to as a 'business activity plan') as provided in the provisions of Cabinet Office Order:
> (i) the purpose of business activities for the exploration and development of space resources […]
> (ii) the period of business activities for the exploration and development of space resources;
> (iii) the place where the exploration and development of space resources […] are to be conducted;
> (iv) the methods of exploration and development of space resources[...]
> (v) […] the contents of business activities for the exploration and development of space resources; and
> (vi) other matters specified by Cabinet Office Order.[317]

As discussed above for Luxembourg, the government requires details of the operations, which is reasonable considering that Japan will be responsible (under Article VI OST) for the mining activities of its commercial entities.

[316] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 4.
[317] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3.1.

In fact, Article 3(2) specifies that "the Prime Minister must not grant a license … unless the Prime Minister determines" that:

> (i) the business activity plan is in compliance with the basic principles of the Basic Space Act and is not likely to cause any adverse effect on the accurate and smooth implementation of the conventions on development and use of outer space and the ensuring of public safety; and
> (ii) the applicant … has sufficient ability to execute the business activity plan.[318]

Lastly, Article 3(4) deals with the conversion of a license obtained under Article 20(1) of the Space Activities Act into a License for the Exploration and Development of Space Resources: the conversion is possible provided that the applicant complies with the same requirements for a new license.[319]

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[318] [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 3(2). Article 3(2) provides that the application must also complies with the provisions of Article 22 of the Space Activities Act, which requires the following:

> (i) the purposes and methods of use of the spacecraft are in compliance with the basic principles and are not likely to cause any adverse effect on the accurate and smooth implementation of the conventions … and the ensuring of public safety.
> (ii) the configuration of the spacecraft, a mechanism for the prevention of dispersion of its components and parts has been implemented, or that the configuration of the spacecraft otherwise complies with the standard specified by Cabinet Office Order as being those that are not likely to cause an adverse effect on the prevention of the harmful contamination of outer space [...]
> (iii) the control plan requires the implementation of measures to avoid collision with other spacecraft or other measures specified by Cabinet Office Order … for the prevention of harmful contamination … as well as termination measures, and the applicant … has sufficient ability to execute the control plan;(iv) [Specific measures concerning end of mission].

[Space Activities Act] Act No. 83 of Dec. 23, 2021, *supra* note 300, art. 22.

[319] Article 3(4) Japanese Space Resource Act provides that

> [a] person who intends to obtain a license under Article 23, paragraph (1) of the Space Activities Act to make the exploration and development of space resources a purpose of using the spacecraft by changing the purpose of using the spacecraft pertaining to the license under Article 20, paragraph (1) of the Space Activities Act.

[Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300.

4. Intertwinement With the Japanese Civil Code: Definition of Space Resources

Unequivocally, the Japanese Space Resource Utilization Act grants property rights in the extracted resources. Article 5 provides:

> A person who conducts business activities related to the exploration and development of space resources shall *acquire the ownership of space resources* that have been mined, etc. in accordance with the business activity plan pertaining to the license, etc. for the exploration and development of space resources, by possessing said space resources with the intention to own. (Emphasis added). [320]

Early commentators have pointed out that because the Japanese Space Resource Utilization Act does not specifically provide for transfer, lease, or security over space resources, the general provisions of the Japanese Civil Code apply. [321] Japan is a hybrid system in which elements of civil law and (more recently) elements of common law coexist.[322] Because of the Civil Code background, the Japanese Space Resource Utilization Act does not need to specify the content of the ownership rights in space resources. Article 206 of the 1896 Civil Code[323] object to the restrictions prescribed by laws and regulation." Typically,

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[320] *See also,* Suzuki, *supra* note 298.

[321] Suzuki, *supra* note 298 (contending that, until the Japanese government introduces specific regulations to govern space resource transactions, the Civil Code of Japan will apply to them. According to the Civil Code, transferors and transferees can agree on terms verbally or in writing, and could provide, for example, that the transaction is completed by transferring possession, either physically or constructively.).

[322] Univ. of Cal. San Francisco, *Japanese Law Research Guide: Legal System & Statistics*, U.C. L. San Francisco (last visited May 15, 2023), available at: https://libguides.uchastings.edu/japan-law/legal-system-stats (arguing that the modern Japanese legal system, rooted in the civil law system influenced by 19th Century European models like Germany and France, was established during the Meiji Restoration in 1868. Post-World War II, the 1947 Constitution, crafted under American influence during the Allied Occupation, reshaped the legal landscape. Presently, Japan's legal system is a blend of continental and American law, weaving together Civil Law concepts, Common Law influences, and traditional Japanese values).

[323] Japanese Civ. Code, Act No. 89 of April 27, 1896 (last visited May 15, 2024). A translation of the Japanese Civil Code is available at: https://www.moj.go.jp/content/000056024.pdf.

in the civil law systems, the content of the ownership right is broad and includes the rights of use, disposition, and profitability, subject to the restriction provided by law (which in the case of resource utilization, consists in obtaining a license for the activity).[324]

Unlikely the other space mining laws, the Japanese Space Resource Utilization Act defines "space resources" as "water, minerals and other natural resources that exist in outer space, including the Moon and other celestial bodies."[325] At least one commentator has argued that because "the Act does not define the term 'natural resources'" and because "the term is widely understood to include fauna and flora that is useful to humans," the Japanese Space Resource Utilization Act would "allow potentially a broader exploitation and ownership of space resources compared to the US law since, at least in theory, a person could exploit and acquire ownership of animate matter as well as inanimate matter in outer space." [326]

[324] An interesting provision of the Japanese Civil Code is Article 239 ("Ownership in Ownerless Thing") providing that "[o]wnership of movables without an owner shall be acquired by possessing the same with the intention to own." Japanese Civ. Code, *supra* note 324, art. 239. This is exactly the situation of space resources.

[325] [Act on the Promotion of Business Activities for the Exploration and Development of Space Resources], Act No. 83 of 2021, art. 2(i).

[326] Suzuki, *supra* note 298.

However, Article 2(i) needs to be read in conjunction with Article 2(ii), which defines "exploration and development of space resources" as

> any activities listed in any of the following subitems (excluding those conducted exclusively as scientific research or for the purpose of scientific research): (a) examination of the existence of space resources that contribute to the mining, extraction and other similar activities *specified by Cabinet Office Order* …; and (b) mining, etc. of space resources and related processing, storage and other acts specified by Cabinet Office Order." (Emphasis added)[327]

For now, uncertainty exists on whether biota[328] is a legitimate mining target under Japanese law, and resolution of the issue must wait for issuance of a specific Cabinet Office Order.

IV. CONSIDERATIONS FOR LOCATION OF A SPACE RESOURCE UTILIZATION PROJECT

Space vehicles, like naval vessels, must operate under the laws, or "flag," of a particular country. "The process of flagging occurs when a company incorporates itself in a country or launches from that country."[329] Among the four countries that have enacted laws regarding space resource utilization.

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[327] [Act on the Promotion of Business Activities for the Exploration and Development of Space Resources] *supra* note 326, art. 2(ii).

[328] This paper uses the term "biota" as used by NASA's *Planetary Protection Independent Review Board* ("*PPIRB)*, *Glossary of Terms*, §2 NASA, in its final report to NASA

> [a] generic term for all life forms, microorganisms, viruses, and prions that have the ability to take in energy from the environment and transform it for growth and reproduction. For the purposes of planetary protection, this is assumed to include all putative forms of exobiology, regardless of their composition or form."

Id. See generally Thomas H. Zurbuchen, NASA, *NASA Response to Planetary Protection Independent Review Board Recommendation*s 1,10 (2019).

[329] Rachel Slobodien*, Council of Economic Advisers,* Economic Report of the President, 245 (2021), available at: https://www.govinfo.gov/content/pkg/ERP-2021/pdf/ERP-2021.pdf

A. Similarities and Differences Among the Four Laws

Should the differences among the four laws matter for the jurisdictional choice of a space mining business?

The four space resources utilization laws are similar in the sense of clarifying the right to harvest space resources and granting property rights in the resources that have been harvested but as discussed in Part III, differences exist. Some are obvious and some are more subtle, but none is substantial enough to dictate a choice of one jurisdiction over the others.

A first and most obvious difference is that Luxembourg, the UAE, and Japan have instituted a licensing procedure for space mining (with the Luxembourg law being the most detailed about this), while the United States still has not. This difference, however, is probably immaterial at this time for a business considering where to headquarter itself: (1) The situation in the US is only temporary and likely to find a solution before any space mining would practically start;[330] (2) A company that wishes to obtain an authorization before a license procedure is instituted, may still be able to obtain a private bill from Congress.[331] Because only a few companies would be in need of such an authorization at this time, the avenue of the private bill is not impractical.

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[330] Part III(A).

[331] *See* United States Senate*, Types of Legislation, Bills* (May 15, 2023), available at: https://www.senate.gov/legislative/common/briefing/leg_laws_acts.htm (last visited Dec 6, 2023)

> A private bill provides benefits to specified individuals (including corporate bodies). Individuals sometimes request relief through private legislation when administrative or legal remedies are exhausted. Many private bills deal with immigration–granting citizenship or permanent residency. Private bills may also be introduced for individuals who have claims against the government, veterans' benefits claims, claims for military decorations, or taxation problems. The title of a private bill usually begins with the phrase, "For the relief of [...]" if a private bill is passed in identical form by both houses of Congress and is signed by the president, it becomes a private law. When bills are passed in identical form by both Chambers of Congress and signed by the president (or repassed by Congress over a presidential veto), they become laws. *Id.*

A second difference is in the way in which the four laws clarify their position *vis-a-vis* the non-appropriation ban of Article II OST; only Luxembourg takes a strong position in the text of the law itself: by using the same word that Article II OST uses,[332] Luxembourg stands firmly for the proposition that the non-appropriation ban of the OST does not apply to space resources. The other laws only imply that their position *vis-à-vis* Article II OST is the same as Luxembourg's by authorizing the activities and granting property rights in the obtained resources (either directly in the law or through the application of their civil code). This difference, however, is insignificant for a company considering where to flag.

A third difference among the four laws is the level of completeness of the regulation, with the Luxembourg law being the most complete and not requiring any implementation and the US law being largely a statement of principles and general rules that require full implementation, with the other two laws occupying a middle ground between the two opposites. This difference could have some bearing on a company's choice of where to locate its business because operating under a legal framework with complete regulation offers more certainty. On the other hand, because the development of space resource utilization is still in its early stages, it is probably the case that this difference is still not important enough to tip the scale in favor of a State such as Luxembourg because when significant activity starts, it is likely that all the laws will be fully implemented.

A fourth possible difference is in the beneficiaries of the four laws. This paper discussed how the US law is apparently reserved for US citizens,[333] but the definition of US citizens is broad -- encompassing US nationals; entities organized or existing under US law belonging to US nationals or foreigners; and foreign entities owned by US nationals-- so in practice, non-US citizens may flag with the United States through a US entity. This is similar to the UAE, whose provisions apply to "persons

[332] Luxembourg Space Resource Law, supra note 194, art. 1 (providing "*Les ressources de l'espace sont susceptibles d'appropriation*").
[333] U.S. Code Title § 51301 *et seq.*

who hold the nationality of the State, or companies that have a headquarters in the State."[334] On the other hand, this paper discussed how Luxembourg law does not seem to be limited to Luxembourg citizens because it does not even mention Luxembourg citizens, but it reserves licenses to entities and those entities must be headquartered in Luxembourg.[335] The Japanese law does not contain limitations on the nationality of applicants. However, the law makes clear that it applies to operations connected to Japan. This encompasses scenarios where Japan has jurisdiction over spacecraft control facilities located in Japan, or there is a Japanese-registered spacecraft, and other cases identified by Cabinet Office Order.[336]

However, another factor related to the beneficiaries of the laws needs to be considered. Under the four laws as they currently exist, wherever applicants decide to flag their resource activities, they might still be subject to their national law. A fifth difference among the four space resource utilization laws lies in the authority responsible for granting the license or permit.[337] Of course, as for the US, it remains to be determined which agency will have rulemaking and licensing authority with respect to space mining operations.[338] In Luxembourg, the license is granted by a government-level official (the minister for economy and space activities)[339]; in the UAE, the license is granted by the space agency;[340] while in Japan, the Prime Minister has the authority to grant licenses.[341] The number of applications for licenses for space resource activities is quite low at this time, so this difference

[334] Law No. (12) of 2019, *supra* note 256, art. 3.3.
[335] Luxembourg Space Resource Utilization Law, *supra* note 300, art. 7.
[336] Article 5 Japanese Space Resource Utilization Act refers to Article 20(1) Space Activities Act ("License") and provides that language in the article in question is modified from "spacecraft control facility located in Japan" to "spacecraft control facility located in Japan, or onboard a ship or aircraft registered in Japan or onboard spacecraft prescribed in Cabinet Office Order as those over which Japan has jurisdiction." [Space Resource Act] Law No. 83 of Dec. 23, 2021, *supra* note 300, art. 5.
[337] See Part III(A)-(D).
[338] See Part III(A).
[339] Part III(B).
[340] Part III(C).
[341] Part III (D).

among the jurisdictions regarding who grants authority should not be a significant element for now in the choice of jurisdiction.

Sixth, the four laws also differ in whether they define "space resources" and, if they do, in the way in which they define the terms.[342] Luxembourg law does not define "space resources;" the US law gives a cursory definition of the concept; while the UAE and the Japanese laws provide a detailed definition.[343] As discussed above, the Japanese definition is particularly broad because it arguably encompasses living resources;[344] the UAE's definition of "space resources" by reference to "non-living resources" clearly excludes living resources, but not necessarily organic compounds.[345] While the countries that do not currently define space resources or give a cursory definition of the same arguably allow for the broadest leeway for space mining, the situation in those countries is uncertain until the license-granting authority issues a regulation or decides on the application. A country that provides a definition offers more certainty, but if the definition excludes certain material as a space resource, as in the case of the UAE, the benefit of certainty comes at the cost of a possible loss of opportunity.

A seventh distinction among the laws is in the level of detail that must be provided when applying for a license.[346] The Luxembourg law requires applicants to provide a substantial amount of information.[347] However, because the U.S. law still needs implementation, and the UAE and the Japanese law refer to additional authorities outside of the law, it would probably be misleading to think that the Luxembourg law is the most demanding.[348] While the Luxembourg law is more detailed, this is actually an advantage because it avoids uncertainty.

An eight apparent difference is represented by the definition of property rights that are spelled out in the US law and not precisely

[342] *See* Part III(A)-(D).
[343] *See* Part III(B); Part III(A); Part III(C); Part III(D).
[344] *See* Part III(D).
[345] *See* Part III(C).
[346] *See* Part III(A)-(D).
[347] *See* Part III(B).
[348] *See* Part III(A); Part III(C); Part III(D).

defined in the other three laws.[349] This paper discusses, however, how the background of the Civil Code in Luxembourg, the UAE, and Japan takes the place of a definition in the space resource utilization law.[350] Therefore, this is not a difference that should be significant for a business deciding where to locate.

In conclusion, the differences in the laws discussed above are not determinative factors for a company to choose one law over the other. There are, of course, other differences among the four laws (and many more may emerge from the practicalities of filing for a license). However, this paper argues that the fundamental reason for choosing to flag with one country over another should not reside in those differences but rather in general considerations of business environment, governmental support, and political factors.

B. Additional Considerations on the Flag of Choice

All four countries have demonstrated an interest in fostering space resource utilization, although the enthusiasm shown by Luxembourg is remarkable.[351] This paper discussed the nurturing environment that Luxembourg has been creating for space mining through the space resource dedicated ESRIC, through specific benefits, including a line of credit; in addition to favorable taxation. [352] However, while there might good reasons to opt for a "middle power" as Luxembourg, there are also compelling reasons to choose a "space power" like the US to flag a space resource utilization business.

While it is true that the US law needs implementation, and the US has not demonstrated the degree of attention that Luxembourg has shown towards space mining utilization, it remains true that the US has the most mature environment for space activities; also the government supports its commercial entities with a wide variety of instruments,

[349] *See* Part III(A)-(D).
[350] Part III(B); Part III(C); Part III(D).
[351] *See* Part III(B).
[352] *Id.*

including public procurement, and other ways of interaction with and benefits to the commercial sector.[353] In addition, considerations of "domestic infrastructure and international support needed to spur investment while mitigating risk,"[354] along with the availability to commercial entities of "national support in international disputes" stand in favor of the US as the flag of choice.[355] As discussed previously, space mining could cause conflicts (especially in the cislunar and lunar region);[356] as a result, space mining companies should consider the importance of flagging with a country that is available to assert self-defense in space of its national activities, as the United States seems prepared to do.[357]

CONCLUSION

Space mining has had a slow start as discussed in Part I. The original actors of this nascent industry were hampered by high costs and abandoned their plans. However, a second generation of space companies are developing projects. In addition, governments are also active in space resource utilization.

As discussed in Part II, some legal impediments to the development of the space mining industry exist, but these difficulties are not insurmountable. Article II of the Outer Space Treaty contains a ban on the appropriation of "[o]uter space by claim of sovereignty, by means of use and occupation, or by any other means" however, the majority view – both scholarly and governmental -- is that the appropriation ban of Article II does not cover extracted resources but only resources *in situ*.

The Moon Agreement, discussed in Part II, would be a significant impediment to space mining, but the Agreement has not been adopted

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[353] Jack R. McCaffrey, *NASA's Space Act Agreements: Efficient and Effective Acquisition in Exploring the Final Frontier*, 51 PUB. CONT. L.J. 111 (2021).
[354] Slobodien*, supra* note 329.
[355] Slobodien*, supra* note 329.
[356] Mishima-Bake, *Moon wars*, *supra* note 46.
[357] *U.S. Space Force, Space Capstone Publication; Spacepower Doctrine for Space Forces*, U.S. Space Force (June 2020).

by many countries (and none of the major space-faring countries), so effectively it is not a barrier to space resource utilization. By contrast, the Artemis Accords, which have been adopted by a number of major space-faring countries including the US, support space resource utilization.[358]

The growing support for space resources utilization is reflected in the four national laws of the United States, Luxembourg, United Arab Emirates, and Japan, but in principle, domestic laws are limited to activities performed in the jurisdiction of the country that issues the law and space is outside that jurisdiction. Developing an approach that other authors have recommended, Part II argues that state control over space mining facilities (without any formal claim of sovereignty) is essential to achieving certainty in outer space, promoting investment, avoiding conflict, and benefiting humanity in general. In addition, Part II develops the idea that state control over space mining facilities is consistent with the letter of the OST and its underlying purposes.

Part III examined the purposes and the details of the four space resource utilization laws that have been enacted, in light of the four countries' legal systems. Part IV provided a comparison of the four laws and identified pragmatic considerations that space resource utilization companies should consider when deciding where to flag. The choice must be based to some extent on the space resource utilization law of the relevant jurisdiction but much more on considerations of business environment, government's support, and political factors.

[358] See Part II(C)