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ASTEROID ECONOMIES: CAPITAL, PROPERTY RIGHTS AND THE COMMERCIAL LOGIC OF INTERNATIONAL SPACE LAW

By- **Priyam Pratik**[1]

ABSTRACT

The rapid commercialisation of outer space has placed the question of space resource extraction at the centre of an increasingly contentious international legal debate. While the 1967 Outer Space Treaty establishes that no State may claim sovereignty over celestial bodies, it leaves conspicuously unsettled the question of whether private actors may extract and own the resources found therein. This lacuna has prompted a small but growing cohort of States, led by the United States, Luxembourg, the United Arab Emirates, Japan, and Australia, to enact domestic legislation permitting their nationals to acquire property rights in extracted space resources. The resulting patchwork of national frameworks sits in uneasy tension with the principle of the common heritage of mankind articulated in the 1979 Moon Agreement, which commands the equitable sharing of benefits derived from lunar and celestial resources. Against this backdrop, the article examines the economic incentives driving the space mining industry, which some analysts project will generate revenues exceeding USD 1 trillion by 2040, and assesses how existing and emergent legal architectures respond to those incentives. The article argues that a coherent international regime must reconcile the legitimate commercial

[1]**Faculty of Law, University of Allahabad.**

expectations of investor-States and private enterprises. It further contends that bilateral and mini-lateral instruments, while offering pragmatic short-term solutions, risk entrenching inequality among spacefaring and non-spacefaring nations unless anchored to multilaterally negotiated benchmarks administered through a reformed Committee on the Peaceful Uses of Outer Space.

KEYWORDS: Space Resource Mining; Outer Space Treaty; Common Heritage of Mankind; Artemis Accords; Space Law Economics.

INTRODUCTION:

Few frontiers in contemporary international law have attracted as much commercial excitement and legal uncertainty as the question of who owns what and can do what in outer space. The 1967 Outer Space Treaty (OST), ratified by over 110 States and constituting the foundational charter of international space law, proclaims outer space and celestial bodies to be "the province of all mankind."[2] That resonant phrase, drafted in an era defined by superpower rivalry and the earliest satellite launches, was never designed to grapple with a world in which private corporations seriously plan to extract iron ore from asteroids or mine water ice from the lunar poles.

The commercial space industry is no longer a speculative venture. In 2023, the global space economy was valued at approximately USD 546 billion, with projections from Morgan Stanley and the Space Foundation suggesting that the figure will surpass USD 1 trillion by 2040.[34] A growing segment of this industry is oriented towards in-situ resource utilisation (ISRU) the extraction and use of materials found in space which proponents argue is essential to sustaining long-duration missions, reducing launch costs, and establishing permanent off-Earth settlements. Against this backdrop, the silence of international space law on the property rights of those who

[2]*Outer Space Treaty*, art. II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.

[3]Morgan Stanley, *Space: Investing in the Final Frontier* 4 (2020).

[4]Space Found., *The Space Report 2024: The Authoritative Guide to Global Space Activity* 12 (2024).

extract resources from celestial bodies has become one of the most pressing jurisprudential questions of the age.

What makes this question particularly compelling, and difficult, is the way in which legal ambiguity intersects with immense economic stakes. The gap between what the existing treaty architecture says and what commercial actors need it to say is not merely a technical lacuna to be filled by careful drafting. It reflects a deeper tension between two fundamentally different conceptions of outer space: as a global commons to be managed for the benefit of all humanity, and as an arena for commercially driven exploration in which the rules of property and contract should, over time, come to resemble those that govern any other extractive industry on Earth.[5] That tension has proven resistant to resolution through conventional multilateral diplomacy, and the legal architecture that has emerged in response is notable for its fragmentation as much as for its content.

The article proceeds in the following manner. Section II surveys the existing international legal framework, with particular attention to the interpretive controversy surrounding Article II of the OST and the unratified Moon Agreement. Section III analyses the domestic legislation that major spacefaring States have enacted in the absence of international consensus. Section IV examines the economic architecture of space resource industries, drawing on statistical data pertaining to projected resource values and investment flows. Section V evaluates the Artemis Accords as an emerging mini-lateral instrument and assesses their compatibility with universalist principles of space law. Section VI proposes a framework for reconciling national property rights regimes with international equity obligations. Section VII concludes.

II. THE INTERNATIONAL LEGAL FRAMEWORK: TREATIES, SILENCES, AND CONTESTED PRINCIPLES:

[5]Henry R. Hertzfeld & Frans von der Dunk, *Bringing Space Law and Space Commerce Together*, 6 Chi. J. Int'l L. 203, 210 (2005).

A. The Outer Space Treaty (1967) and the Non-Appropriation Principle:

The OST remains the cornerstone of international space law. Article II provides that outer space, including the Moon and other celestial bodies, is "not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[6] This non-appropriation principle is universally accepted as forming part of customary international law, binding even States that have not formally ratified the Treaty.

The central interpretive controversy concerns whether the prohibition on "national appropriation" extends to the appropriation of resources extracted from celestial bodies. Two principal schools of thought have emerged. The first, favoured by the United States, Luxembourg, and a number of commercial actors, contends that resource extraction is analytically distinct from territorial sovereignty: one may own coal extracted from a mine without owning the earth in which the mine sits.[7] The second, advanced by scholars critical of the dominant commercial narrative, argues that permitting unrestricted private extraction effectively accomplishes what Article II prohibits, since the entity that controls and exploits the resources of a territory exercises a form of de facto sovereignty over it.[8]

There is, it should be said, a certain logical force on both sides of this debate. The analogy to terrestrial mining is not frivolous: international law has long recognised that the right to extract does not necessarily entail the right to territorial control. The deep seabed regime under UNCLOS, for example, separates the exploitation of manganese nodules from any claim of sovereignty over the seabed itself.[9] Yet the analogy is imperfect in ways that matter. The deep seabed regime created a specific

[6] *Outer Space Treaty* art. II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.
[7] Sagi Kfir, *Space Resources and the Challenge of International Law*, 104 Cornell L. Rev. Online 166, 170 (2019).
[8] Frans von der Dunk, *Space Resources and the International Law Framework*, in *Space Resources: The Legal Framework* 48, 51 (Fabio Tronchetti ed., 2019); Fabio Tronchetti, *The Exploitation of Natural Resources of the Moon and Other Celestial Bodies* 112 (2009).
[9] Convention on the Law of the Sea, art. 136, Dec. 10, 1982, 1833 U.N.T.S. 3.

multilateral authority, the International Seabed Authority, to manage exploitation and distribute benefits. No equivalent institution governs celestial resources, and the unilateral recognition of resource property rights by individual States has proceeded without any such institutional framework.

Article VI further complicates matters. It imposes on States the obligation to authorise and continuously supervise the activities of their nationals in outer space, making States internationally responsible for the activities of private actors.[10] This supervisory obligation implies that States must exercise regulatory control over their nationals' space resource activities -- a conclusion that has shaped the structure of every domestic resource rights statute enacted to date.[11] Article III reinforces this by requiring that activities in outer space be conducted in accordance with international law, including the UN Charter.[12] Together, these provisions suggest that the OST does not leave outer space as a regulatory void; rather, it distributes regulatory authority among States, which are then individually responsible for ensuring that their nationals' activities conform to the Treaty's broader purposes.

B. The Moon Agreement (1979) and the Common Heritage Principle:

The 1979 Moon Agreement represents the most direct, and the most politically marginalised, effort to regulate space resource extraction.[13] Article 11 declares the Moon and its natural resources to be "the common heritage of mankind" and mandates the establishment of an international regime governing their exploitation. The Agreement further specifies that this regime shall ensure equitable sharing of benefits derived from those resources, with particular regard for the interests of developing countries.

[10]*Outer Space Treaty*, supra note 1, art. VI.

[11]Frans von der Dunk, Asteroid Mining: International and National Legal Aspects, 26 Mich. St. Int'l L. Rev. 83, 91 (2017).

[12]*Outer Space Treaty*, supra note 1, art. III.

[13]Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

The practical significance of the Moon Agreement is, however, severely limited by its near-complete lack of ratification among major spacefaring States. As of 2026, the Agreement has attracted only eighteen ratifications and eight signatories, none of which operates a significant space programme.[14] The United States, Russia, China, Japan, and the members of the European Space Agency have declined to ratify, rendering the common heritage principle, in its binding treaty form, largely inoperative as applied to resource extraction.[15]

The concept of the common heritage of mankind was not invented for the Moon Agreement. It was developed in the context of the deep seabed under UNCLOS[16] and carries with it a cluster of related ideas: that the relevant domain is res communis rather than res nullius, that no State or entity may appropriate it, that its exploitation must be conducted for the benefit of all, and that an international authority must manage it.[17] The Moon Agreement sought to import this entire package into the space context. Its failure to attract ratification does not necessarily extinguish the underlying principle, but it does mean that the principle operates, if at all, through the less certain mechanisms of customary international law rather than through binding treaty obligation.

The relationship between the OST's "province of all mankind" language in Article I[18] and the Moon Agreement's "common heritage of mankind" formulation has generated considerable doctrinal controversy. Whereas the former is commonly interpreted as expressing a principle of freedom of access rather than one of equitable distribution, the latter carries the redistributive and managerial

[14]Michael Listner, *The Moon Treaty: It's Not Dead Yet*, Space Rev. (Oct. 24, 2011), https://www.thespacereview.com/article/1957/1.

[15]Steven Freeland, *Fly Me to the Moon: How Will International Law Cope with Commercial Space Tourism?*, 11 Melb. J. Int'l L. 90, 93 (2010).

[16] United Nations Convention on the Law of the Sea art. 136, Dec. 10, 1982, 1833 U.N.T.S. 3.

[17]Brian Israel, *The Common Heritage of Mankind as a Resource Allocation Mechanism*, 61 Va. J. Int'l L. 305, 315 (2021).

[18]*Outer Space Treaty, supra note 1, art. I.*

connotations developed in the context of the deep seabed regime under UNCLOS.[19] Whether the common heritage principle has crystallised into customary international law applicable to space resources, independently of the Moon Agreement, remains a genuinely contested question. What seems clearer is that the distributive aspiration embedded in both instruments has not disappeared simply because one instrument lacks ratification and the other is widely interpreted in a minimalist fashion. It resurfaces, with some regularity, in debates about the Artemis Accords and in the statements of developing-country delegations at COPUOS.

C. The Broader Treaty Ecosystem: Rescue, Registration, and Liability:

Any comprehensive account of the international legal framework must look beyond the OST and the Moon Agreement to the broader ecosystem of space law instruments. The 1967 Rescue Agreement[20] establishes obligations to assist and return astronauts in distress, but its relevance to resource extraction is tangential. The 1972 Liability Convention[21] and the 1974 Registration Convention[22] are more directly pertinent, and both present significant challenges in the context of commercial resource extraction.

The Liability Convention imposes absolute liability on launching States for damage caused by space objects on the surface of the Earth, and fault-based liability for damage in outer space.[23] This framework was designed with governmental space operations in mind and rests on the assumption that the launching State is both the operator and the entity capable of bearing legal responsibility. Where a private mining company operates under a licence from one State, launches from the territory

[19] *Outer Space Treaty*, supra note X, art. I.

[20]Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 U.N.T.S. 119 [hereinafter Rescue Agreement].

[21]Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 961 U.N.T.S. 187 [hereinafter Liability Convention].

[22]Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1974, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

[23] *Liability Convention*, supra note 21, arts. II–III.

of a second, and causes damage to the equipment of a third-State operator in lunar orbit, the attribution of liability under the Convention becomes genuinely uncertain.[24] The Convention' s definition of a "space object" may or may not encompass extraction equipment, robotic vehicles, or resource caches, and its dispute resolution mechanism, a Claims Commission, has never been tested in the context of commercial operations.

The Registration Convention requires States to maintain national registries of space objects and to furnish information to a United Nations register, but it provides no mechanism for registering claims to space resources as distinct from the objects used to extract them. This distinction matters because the commercial value of a space mining operation lies primarily in the resources extracted, not in the hardware used to extract them. A mining company that successfully extracts and transports a cargo of water ice or platinum has acquired something of significant value that no existing instrument gives it a clear legal title to hold, transfer, or use as collateral for financing.[25] The absence of a registration or titling mechanism for extracted resources is one of the most concrete and commercially significant gaps in the current framework.

Table 1: Major Spacefaring States and Treaty Participation

State	OST (1967)	Moon Agmt (1979)	Liability Conv. (1972)	Artemis Accords Signatory
United States	Yes	No	Yes	Yes (2020)
Russia	Yes	No	Yes	No
China	Yes	No	Yes	No
Luxembourg	Yes	No	Yes	Yes (2020)
Japan	Yes	No	Yes	Yes (2020)

[24]Gary D. Payne, *The Governance of Commercial Space Activities: An Institutional Analysis*, 15 Minn. J. Int'l L. 75, 88 (2006).

[25]Nathan Johnson, *Private Property Rights in Space: A Proposal for the Future*, 32 Wis. Int'l L.J. 234, 241 (2014).

State	OST (1967)	Moon Agmt (1979)	Liability Conv. (1972)	Artemis Accords Signatory
India	Yes	No	Yes	Yes (2023)
UAE	Yes	No	Yes	Yes (2020)
Australia	Yes	No	Yes	Yes (2020)

Source: UNOOSA Treaty Database; Artemis Accords Secretariat (2026)

III. NATIONAL LEGISLATION AND THE FRAGMENTATION OF SPACE RESOURCE LAW:

Frustrated by the deadlock in multilateral negotiations, a number of States have resolved the interpretive ambiguity of the OST through unilateral domestic legislation. The United States took the first decisive step with the Commercial Space Launch Competitiveness Act of 2015 (CSLCA), Section 51303 of which provides that a US citizen engaged in commercial recovery of a space resource "is entitled to any space resource obtained, including to possess, own, transport, use, and sell the space resource."[26] The Act was careful to include a disclaimer that it does not assert US sovereignty, sovereign rights, or jurisdiction over, or the ownership of, any celestial body, a drafting choice plainly designed to maintain formal consistency with the non-appropriation principle.

Luxembourg enacted its own legislation in July 2017, going one step further than the CSLCA by permitting any operator to acquire property rights in extracted space resources, provided they operate under a Luxembourg licence.[27] This approach was deliberately designed to attract international space mining companies to incorporate in Luxembourg, positioning the Grand Duchy as a European hub for the nascent industry. Subsequent enactments by the UAE,[28] Japan,[29] and Australia[30] followed

[26] *U.S. Commercial Space Launch Competitiveness Act of 2015*, Pub. L. No. 114-90, 129 Stat. 704 (2015).

[27] *Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace*, Mém. 2017, 674 (Lux.); *Loi du 20 juillet 2017*, supra note 4, art. 1.

[28] *Federal Law No. 12 of 2019 Concerning the Regulation of the Space Sector* (U.A.E.).

[29] *Japan Space Resources Act*, Act No. 83 of 2021 (Japan).

[30] *Space (Launches and Returns) Act 2018* (Cth) (Austl.).

broadly similar structures, each asserting that their nationals or licensed operators may own extracted resources while scrupulously avoiding any claim of sovereignty over celestial territory.

The proliferation of national resource rights laws has attracted sharp criticism from international law scholars.[31] Some argue that unilateral recognition of space resource property rights is legally impermissible under the OST, regardless of the sovereignty disclaimer.[32] Others contend that such laws are legally valid but politically problematic, since they allow wealthy spacefaring States to lock in first-mover advantages in a domain that the OST commits to the benefit of all nations.[33] The absence of any multilateral instrument to coordinate these national regimes means that disputes about competing claims to extracted resources, licensing conflicts, or environmental damage to celestial bodies would fall into a significant legal vacuum.

What is particularly notable about this legislative trend is the speed with which it has proceeded in the absence of any international consensus. Within a decade of the CSLCA, at least five States had enacted resource rights statutes, and several others -- including South Korea, the Netherlands, and Saudi Arabia -- were reported to be in various stages of legislative deliberation.[34] This pattern of competitive norm-setting, in which each State enacts its own framework in ways that reflect its particular commercial interests and legal traditions, is a familiar feature of international regulatory dynamics in emerging industries. What makes the space resource context distinctive is the explicit international law dimension: unlike regulatory competition in, say, financial services or environmental standards, unilateral space resource

[31]Matthew Schaefer, *The Inadequacy of Consensualist Grounding for the UNCLOS and the Need for New Approaches to Space Resource Law*, 12 J. Int'l & Comp. L. 177, 183 (2019).

[32]SA'ID MOSTESHAR, *SPACE MINING: LAW AND REGULATION* 17 (Springer 2021).

[33]Rosanna Sattler, *Transporting a Legal System for Property Rights: From the Earth to the Stars*, 6 Chi. J. Int'l L. 23, 31 (2005).

[34]U.N. Comm. on the Peaceful Uses of Outer Space, Legal Subcomm., *Nat'l Legislation Relevant to the Peaceful Exploration and Use of Outer Space*, U.N. Doc. A/AC.105/C.2/2024/CRP.5 (2024).

legislation operates directly against the backdrop of a treaty regime that commits the entire domain to the "province of all mankind."[35]

The China dimension deserves particular attention. China has not enacted dedicated space resource legislation, though its state-controlled space programme operates under a general framework that concentrates authority over space activities in government agencies. China's lunar ambitions are substantial: the Chang'e programme has already achieved far-side lunar landings and sample-return missions, and China has announced plans for a permanent lunar research station by the mid-2030s in collaboration with Russia.[36] The absence of domestic resource rights legislation from China does not imply that China's state-controlled actors will not engage in de facto resource utilisation; it means, rather, that such activities would occur under a governmental framework that bypasses the domestic licensing regimes that other States have created. Whether this state-centric approach is more or less compatible with international space law than the private-licensing approaches adopted by the US and Luxembourg is a question that the existing framework is ill-equipped to answer.

Table 2: National Space Resource Legislation (2015-2025)

Jurisdiction	Legislation	Year Enacted	Key Provision on Resource Rights
United States	CSLCA 2015	2015	US nationals may own resources extracted from asteroids/Moon
Luxembourg	Space Resources Law 2017	2017	Operators (any nationality) may own extracted space resources
UAE	Federal Law No. 12/2019	2019	Regulates space sector; recognises resource extraction licences

[35]Andrea Harrington, *The Outer Space Treaty at 50: Revisiting Its Relevance in the Current Space Environment*, 43 Annals Air & Space L. 1, 14 (2018).

[36]Krista Langeland & Dmitry Gorenburg, *Challenges and Opportunities for International Cooperation in Space*, RAND Corp. Research Rep. RR-A869-1, at 22 (2021).

Jurisdiction	Legislation	Year Enacted	Key Provision on Resource Rights
Japan	Space Resources Act 2021	2021	Nationals may acquire ownership of extracted space resources
Australia	Space (Launches & Returns) Act 2018	2018	Provides licensing framework enabling resource-related activities
China	No dedicated statute (2026)	Pending	Draft regulations under review; state-controlled exploration assumed

Source: UNOOSA National Legislation Reports 2024

IV. THE ECONOMICS OF SPACE RESOURCE EXTRACTION:

A. Resource Potential and Market Projections:

The economic case for space resource mining rests on three pillars: the extraordinary abundance of targeted materials in the near-Earth asteroid population, the potential for water ice to serve as rocket propellant (thus dramatically reducing the cost of deep space missions), and the possibility of accessing rare or strategic materials whose terrestrial supply is geopolitically constrained.

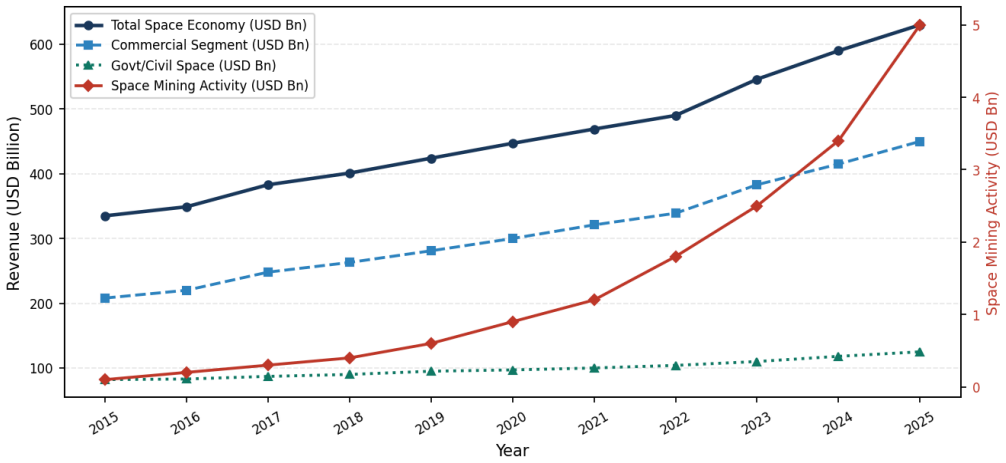
Near-Earth asteroids are estimated to contain water, iron, nickel, cobalt, and platinum group metals in quantities that vastly exceed known terrestrial reserves. The asteroid 16 Psyche, which NASA is currently visiting, is estimated to contain iron-nickel deposits with a nominal value exceeding USD 10 quintillion, a figure that, if realised, would collapse global iron markets and illustrates the macroeconomic complexity inherent in large-scale space extraction.

The water economy of cislunar space is regarded by many analysts as the most plausible near-term commercial proposition. Water extracted from lunar poles can be electrolysed into liquid hydrogen and liquid oxygen, the standard components of chemical rocket propellant. A robust cislunar propellant depot system could reduce

the cost of lunar surface missions by an estimated 40-50 percent by eliminating the need to launch fuel from Earth. The European Space Agency's 2025 space economy report estimates the in-space propellant market alone could be worth USD 20-30 billion annually by 2040.[37]

It is worth noting, however, that headline asteroid valuations are somewhat misleading as guides to commercial viability. The nominal value of a metallic asteroid's iron-nickel content reflects terrestrial commodity prices, which would themselves be devastated if such quantities were ever brought to market. The economically meaningful question is not what space resources would be worth at current terrestrial prices but what they would be worth in an in-space market, where the relevant comparison is the cost of launching equivalent materials from Earth. On this basis, the economics of water ice and of certain specialty materials look considerably more attractive than those of bulk metals, which is why the near-term commercial focus has shifted towards propellant production and in-space manufacturing rather than terrestrial commodity supply.[38]

Figure 1: Global Space Economy Revenue Trends (2015-2025)



Source: Space Foundation, The Space Report 2024; Morgan Stanley Space Economy Report (2020)

[37]EUR. SPACE AGENCY, *REPORT ON THE SPACE ECONOMY 2025* 22 (2025).

[38]Mosteshar, supra note 33, at 34.

B. Cost Structures and Investment Flows:

Despite the extraordinary projected resource values, the commercial viability of space mining remains critically dependent on bringing launch and in-space operational costs within economically rational parameters. The historic cost of launching one kilogram of payload to low Earth orbit stood at approximately USD 54,500 during the Space Shuttle era. As of 2025, SpaceX's Falcon 9 has reduced this figure to approximately USD 2,720 per kilogram, and the Starship system is expected to bring it below USD 100 per kilogram in a mature operational phase.[39] This trajectory in launch economics is the most significant enabling factor for space resource industries and has attracted billions of dollars in private investment over the past decade.

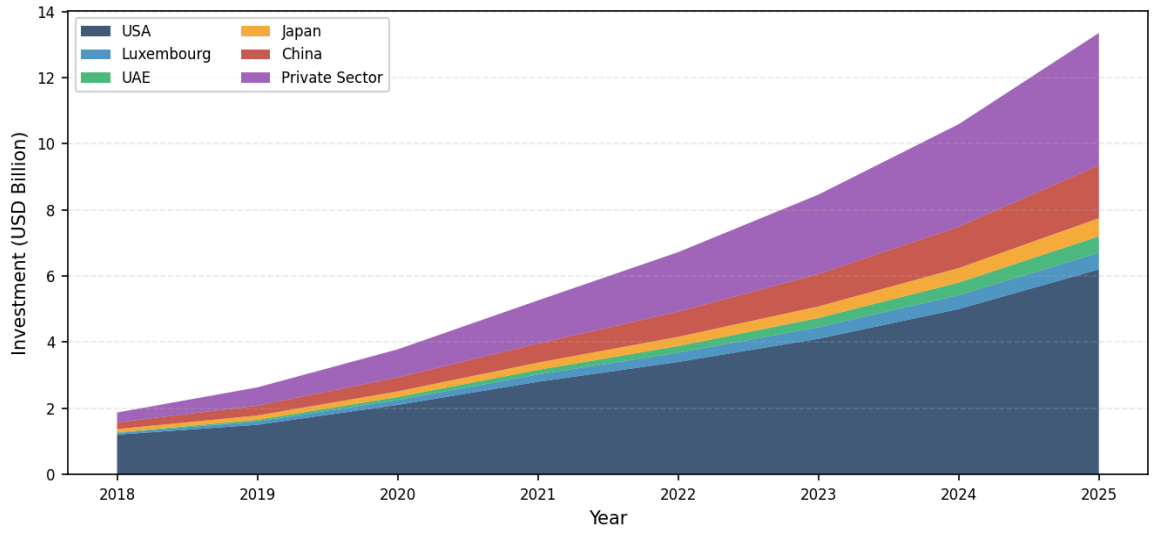
Investment in space resource activities, broadly defined to include prospecting missions, technology development, and regulatory lobbying, has grown substantially since 2018. The United States accounts for the largest share of this investment, driven by NASA's Artemis programme, which includes a stated objective of demonstrating ISRU technologies on the lunar surface.[40] Private sector investment, channelled through venture capital funds and direct corporate spending by companies such as AstroForge, TransAstra, and Astrobotic, is also growing rapidly, though reliable aggregate figures remain difficult to ascertain given the absence of standardised reporting requirements.

The relationship between public investment and private investment in this sector is worth examining more carefully. NASA's Artemis programme is, at its core, a publicly funded initiative that creates infrastructure launch systems, lunar gateways, surface access capabilities on which private resource extraction will ultimately depend. The pattern is not unlike that of the early aviation or telecommunications

[39] *Space Launch Market Competition, WIKIPEDIA, https://en.wikipedia.org/wiki/Space_launch_market_competition (last visited June 14, 2026); Starship, SpaceX, https://www.spacex.com/vehicles/starship/ (last visited June 14, 2026).*
[40] *Space Foundation,* supra note 6, at 18.

industries, where public investment in infrastructure and regulatory frameworks preceded and enabled private commercial development.[41] The critical difference is that in those industries, the infrastructure was terrestrial and the applicable property law was well-established. In the space context, the infrastructure is extraterrestrial and the property law is not merely unsettled but actively contested at the international level. Private investors must therefore factor legal risk, the risk that the property rights their governments have granted will be challenged under international law, into their commercial calculations.

Figure 2: Space Resource Investment by Nation/Sector (2018-2025)



Source: ESA Space Economy Report 2025; UNOOSA National Legislation Reports 2024

V. THE ARTEMIS ACCORDS: A MINILATERAL SOLUTION AND ITS DISCONTENTS:

Recognising the deadlock in COPUOS and the inadequacy of the existing treaty framework, the United States launched the Artemis Accords in October 2020 as a bilateral-turned-multilateral instrument intended to establish norms for responsible

[41]Mike Hoversten, *U.S. National Security and Government Regulation of Commercial Remote Sensing from Outer Space*, 50 A.F. L. Rev. 253, 278 (2001).

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behaviour in civil space exploration.[42] The Accords have since attracted over thirty signatories, including key allies such as Japan, Australia, Canada, the United Kingdom, and India.

Section 10 of the Artemis Accords addresses space resources directly, asserting that the extraction and utilisation of space resources does not inherently constitute national appropriation under Article II of the OST and that signatories commit to supporting the establishment of operational notifications and "Safety Zones" around extraction operations.[43] This position aligns closely with the US-centric interpretation articulated in the CSLCA and represents a significant effort to build a coalition of States committed to a permissive reading of international space property law.

The Accords also address several other dimensions of responsible space behaviour that are relevant, even if not directly connected, to the resource extraction question. These provisions are broadly consistent with existing international obligations and have been characterised by some commentators as a useful codification of best practices. It is the resource provisions, however, that have generated the most controversy, both because they address the most legally contested aspect of space activity and because they do so through a mechanism that excludes the most significant non-Western space powers.

Critics of the Artemis Accords have raised both substantive and procedural objections. Substantively, it has been argued that the Accords constitute, in effect, a collective decision by technologically advanced States to interpret international law in a manner that advantages their commercial interests, without any meaningful participation by developing nations that lack space programmes.[44] Russia and China, both of which possess substantial space capabilities and have their own lunar

[42]Lincoln Hines & Emile Vrijdaghs, *The Artemis Accords: Implications for the Law of Outer Space*, 47 J. Space L. 1, 8 (2022).

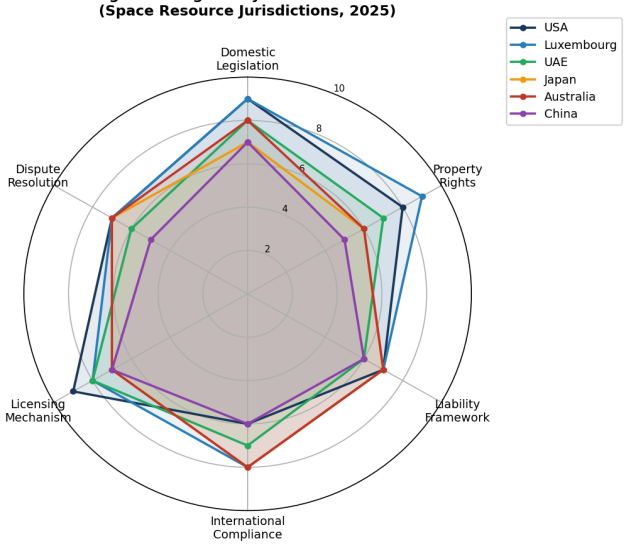
[43]*Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes* § 10 (2020).

[44]Christopher Johnson, *The Artemis Accords: Repeating or Departing from the Past?*, 47 J. Space L. 45, 48 (2022).

ambitions, have declined to sign, citing concerns about what they characterise as an attempt by the United States to replace multilateral space governance with a US-led order.

Procedurally, the Accords were negotiated outside COPUOS, the principal UN body responsible for developing space law.[45] This decision has been criticised as deliberately circumventing the inclusive processes of multilateral treaty-making in favour of an instrument that reflects the interests of established spacefaring powers.[46] The result is a bifurcation of the international community into Artemis signatories and non-signatories, with potentially divergent norms governing space resource extraction for each group. Historically, the development of customary international law has benefited from near-universal State practice and opinio juris; an instrument accepted by thirty-odd States, opposed or ignored by several major powers, and silent on the positions of over a hundred non-spacefaring nations is an uncertain foundation for a new customary norm.[47]

Figure 3: Regulatory Readiness Radar (Space Resource Jurisdictions, 2025)



[45]United Nations Office for Outer Space Affairs, *Committee on the Peaceful Uses of Outer Space: Membership*, https://www.unoosa.org/oosa/en/ourwork/copuos/members/index.html (last visited June 14, 2026).

[46]Ram S. Jakhu & Joseph N. Pelton, *Global Space Governance: An International Study* (Springer 2017).

[47]Andrea Harrington, *The Outer Space Treaty at 50: Revisiting Its Relevance in the Current Space Environment*, 43 Annals Air & Space L. 1 (2018).

Source: Based on UNOOSA National Reports 2024; scores reflect domestic readiness on a scale of 1-10

VI. TOWARDS A COHERENT INTERNATIONAL FRAMEWORK:

A. The Case for Multilateral Regulation:

The proliferation of national space resource legislation and mini-lateral instruments like the Artemis Accords represents a pragmatic response to genuine regulatory uncertainty, but it falls short of the kind of stable, predictable, and equitable framework that a nascent industry of this magnitude and potential consequence requires. Several considerations point towards the continued necessity of multilateral engagement.

First, the environmental integrity of celestial bodies is a genuinely global concern. The OST contains an obligation under Article IX for States to conduct activities with due regard to the interests of other States and to avoid harmful contamination of outer space.[48] Large-scale extraction activities could alter the physical properties of the Moon or asteroids in ways that affect scientific research, cultural heritage, and the interests of future generations. Only a multilateral regime can establish enforceable environmental standards with universal application.

Second, the liability and registration frameworks under the 1972 Liability Convention[49] and the 1975 Registration Convention[50] were designed for governmental space activities and are poorly adapted to private commercial operations involving resource extraction. The Liability Convention's fault-based standard for damage in outer space and absolute liability standard for damage on Earth's surface may be inadequate for accidents involving extraction machinery or debris generated by mining operations. Updating these conventions through

[48] *Outer Space Treaty*, supra note 1, art. IX.
[49] Liability Convention, supra note 21.
[50] Registration Convention, supra note 22.

multilateral negotiation is preferable to relying on domestic tort law regimes that will produce inconsistent outcomes across jurisdictions.

Third, the equity dimension cannot be responsibly ignored. The space resource industry, if it develops as projected, will generate enormous wealth. The question of how that wealth is distributed between spacefaring and non-spacefaring States, between present and future generations, between the public and private sectors is fundamentally a question of international distributive justice that market mechanisms alone are incapable of resolving.[51]

Fourth, and perhaps most practically, the absence of a multilateral framework creates conditions in which geopolitical competition is likely to intensify rather than moderate. If China, Russia, and the United States each pursue their respective lunar and asteroid programmes under incompatible national frameworks, with no agreed mechanism for resolving competing claims or preventing interference with one another's operations, the risk of conflict whether diplomatic or, in extreme scenarios, physical is non-trivial.[52] The history of international resource regimes, from the deep seabed to Antarctic minerals, suggests that multilateral frameworks are considerably more effective at managing competitive pressures than the absence of any framework at all, even where those frameworks are imperfect.

B. Proposed Elements of a Reformed Framework:

Several scholars and policy advocates have proposed elements of a reformed multilateral framework for space resource governance.[53] Drawing on these proposals and on the preceding analysis, the present article suggests the following elements as necessary components of any durable regime.

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[51]Kfir, supra note 7, at 178.

[52]JAMES CLAY MOLTZ, *THE POLITICS OF SPACE SECURITY: STRATEGIC RESTRAINT AND THE PURSUIT OF NATIONAL INTERESTS* 88 (3d ed., Stanford Univ. Press 2019).

[53]Frans von der Dunk, *Towards a Comprehensive International Regime Governing Space Resources*, in *PROCEEDINGS OF THE INTERNATIONAL INSTITUTE OF SPACE LAW* 312, 318 (2020).

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The first element is a multilateral instrument, negotiated within or under the auspices of COPUOS, that explicitly addresses the property status of extracted space resources without purporting to alter the non-appropriation principle of Article II. Such an instrument should confirm that extraction does not constitute appropriation while imposing substantive conditions, including environmental impact assessments, safety zone notifications, and benefit-sharing contributions, as prerequisites for the exercise of property rights.

The second element is a reformed international regulatory body with the technical capacity to issue extraction licences, monitor compliance, and adjudicate disputes. The existing COPUOS structure is ill-suited to this role: it operates by consensus, lack enforcement powers, and is principally a deliberative rather than a regulatory body. An International Space Resources Agency, modelled loosely on the International Seabed Authority established under UNCLOS, would provide a more appropriate institutional architecture, though significant political challenges would attend its creation.

The third element is a benefit-sharing mechanism. The precise contours of such a mechanism are legitimately contested: the sharing of financial revenues, technological knowledge transfers, preferential access to data, and capacity-building assistance for developing countries are all plausible modalities.[54] What is not plausibly contested is the principle that an industry benefiting from the common heritage of outer space has some obligation to distribute a portion of its gains to those who have contributed to, and been excluded from, the development of space technology. A modest levy on the assessed value of extracted resources perhaps two to three percent, directed to a fund administered through COPUOS, would represent a meaningful, if modest, recognition of this principle without imposing prohibitive costs on commercial operators.

[54]Schaefer, supra note 31, at 190.

The fourth element is the harmonisation of national regulatory frameworks. States that have enacted space resource laws should be encouraged, through the multilateral instrument, to align their domestic regimes on core issues: minimum environmental standards, data-sharing obligations, liability allocation, and the terms on which extraction licences may be transferred or revoked.[55] Harmonisation would reduce the incentives for regulatory arbitrage, the "race to the bottom" in standards that Luxembourg's open licensing approach already hints at, while preserving the ability of States to tailor their regimes to domestic conditions.

The fifth element, and perhaps the most politically sensitive, is a mechanism for addressing the interests of non-spacefaring States. Developing countries that have no near-term prospect of participating in space resource activities nonetheless have a legitimate stake in how those activities are governed, both because of the general principle that outer space belongs to all mankind and because developments in the space economy are likely to have downstream effects -- on commodity markets, on the geopolitical balance between space-capable and non-space-capable States, and on the norms of international governance more broadly.[56] Ensuring that these States have a meaningful voice in the development of space resource norms, not merely a formal seat at the table, but a genuine capacity to shape outcomes, is both a matter of fairness and a precondition for the broad acceptance that any durable regime requires.[57]

VII. CONCLUSION:

Space resource mining occupies a paradoxical position at the intersection of frontier economics and settled international law. The question is not whether space resources

[55]von der Dunk, supra note 7, at 60.

[56]David Tan, *Towards a New Regime for the Protection of Outer Space as the Province of All Mankind*, 25 Yale J. Int'l L. 145, 162 (2000).

[57]von der Dunk, supra note 7, at 322.

will be extracted but under what conditions, by whom, subject to what obligations, and with what distribution of the resulting benefits.

The existing framework does not provide adequate answers to any of these questions. The Artemis Accords represent a sincere attempt to fill the vacuum, but their value is limited by their exclusivity: an instrument that divides the world's space actors into signatories and non-signatories cannot provide the universal norms that a global industry requires.[58]

What this survey reveals is that the challenge of space resource law is not, at its core, a technical one. The legal tools, treaties, protocols, institutional frameworks, dispute resolution mechanisms, are well understood and have precedents in the deep seabed regime, Antarctic governance, and international telecommunications regulation. The challenge is political: it requires major spacefaring States to accept constraints on their commercial freedom in exchange for the legitimacy and stability that only a multilateral framework can confer. That is a bargain that has proven difficult to strike in the past, and there is no guarantee that the accelerating pace of commercial space activity will make it easier.[59]

The path forward requires patient, sustained multilateral engagement through COPUOS, supplemented by the political will of major spacefaring States to accept that the immense wealth of outer space cannot be managed as a purely private or national domain. The common heritage principle, shorn of its more impractical collectivist implications, offers a workable foundation for a reformed regime, one that acknowledges the legitimate commercial expectations of investors while ensuring that the broader community of nations retains a meaningful stake in humanity's most ambitious economic frontier.

[58]JAMES CLAY MOLTZ, *THE POLITICS OF SPACE SECURITY: STRATEGIC RESTRAINT AND THE PURSUIT OF NATIONAL INTERESTS* (3d ed., Stanford Univ. Press 2019).

[59]Fabio Tronchetti, *The Exploitation of Natural Resources of the Moon and Other Celestial Bodies: A Proposal for a Legal Regime* 128 (Martinus Nijhoff Publishers 2009).

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The economics of international space law, in the final analysis, are not merely the economics of a new industry. They are the economics of a new relationship between national interest and global governance, a relationship whose terms remain urgently, and consequentially, to be negotiated. The decades ahead will reveal whether the international community is capable of the institutional imagination that moment demands, or whether the legal frameworks governing outer space will simply ossify into a reflection of the power asymmetries that characterise the early twenty-first century order on Earth.