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Space mining as an emerging organisational field: An institutional logics perspective

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ABSTRACT

Space mining, or the prospecting for and extraction of minerals and other resources from celestial bodies, has emerged as an integral part of the “New Space” economy and has been extensively debated and researched in the space literature. Responding to recent calls for management and organisation scholars to take greater interest in this economy, this paper advances a theoretical framework that conceptualises space mining as an emerging organisational field. In contrast to much prior research, which has debated what might constitute appropriate governance regimes for this field, this directs our attention to how such regimes may be institutionalised as the field continues to evolve over time. To make sense of such processes of institutionalisation, I mobilise an institutional logics perspective. Three institutional logics, centred on concerns with entrepreneurialism, sustainability and regulation, are identified. I also examine how the interplay between these logics has shaped the field of space mining to date and how they may be expected to affect future trajectories of change. I discuss the implications of my observations for future research on space mining as well as the institutional logics perspective.

1. Introduction

Over the past two decades, the prospects of extracting minerals and other resources from celestial bodies have captured the public imagination and generated a growing body of scholarly work [e.g., [1–6]]. Emerging as an integral part of the burgeoning commercialisation of outer space, epitomised by the notion of “New Space”, such activities have increasingly come to be seen as a solution to the scarcity of equivalent resources on Earth and a prerequisite for future exploration and colonisation of space. While the issue of whether celestial resource extraction will ultimately give rise to anything resembling a large-scale, commercially viable space mining industry is still unknown, the economic [e.g., [7–11]], regulatory [e.g., [2,12–17]] and, increasingly, environmental and social [e.g., [18–24]] implications of such a development have been extensively debated and researched in the space literature. Much of this research has considered the issue of what might constitute appropriate governance regimes that help to balance economic interests with notions of space sustainability in establishing space mining as a viable part of the “New Space” economy. However, less

attention has been paid to the complex social processes whereby such regimes may eventually become institutionalised as a taken-for-granted part of this economy. Addressing this gap is important for deepening our understanding of the circumstances under which emerging governance regimes might be expected to become more firmly established and the consequences this will have for the organisation of space mining activities.

Drawing on insights from management and organisation studies, the present paper responds to this need for greater attention to the institutionalisation of governance regimes by advancing a theoretical framework that conceptualises space mining as an emerging organisational field. In doing so, I build on organisational institutionalism, which has emerged as a dominant perspective within this broader area of scholarship [25,26]. As such, the paper not only aims at furthering our understanding of how the field of space mining might be governed, but also responds to recent calls for management and organisation scholars to take a greater interest in the space sector [27–29]. However, consistent with the focus on field-level processes of institutionalisation, the analysis is not confined to individual organisations but rather seeks to situate

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emerging governance regimes in relation to concerns that are more or less common to a larger population of organisations. The notion of organisational fields facilitates such analyses as it offers a population-based, macro-level perspective as the starting point for examining how organisational practices are institutionalised [30,31].

Following contemporary developments in organisational institutionalism, the paper takes its point of departure in a view of organisational fields as evolving entities that are underpinned by a set of competing or complementary institutional logics [32–34]. Such logics provide normative prescriptions for how to organise economic activities [32,35] and, as such, they fill an important role in the governance of organisational fields [36,37]. Conceptualising organisational fields in this manner allows us to trace emerging governance regimes to a set of partly competing prescriptions that originate at the wider, societal level but that take context-specific form in particular fields. By synthesising extant research on space mining into such a perspective, I identify three distinct logics centred on concerns with entrepreneurialism, sustainability and regulation that have evolved in this field. I also document how these logics interact and how their continued interplay may be expected to shape the development of the field of space mining. I discuss the implications of my observations for future research on space mining as well as the lessons that can be drawn for the development of the institutional logics perspective.

The remainder of the paper is organised as follows. I start by discussing key theoretical points of departure for my analysis in greater detail. I then offer an outline of how space mining has evolved as an organisational field to the present day and conceptualise these developments and discuss what might constitute future change trajectories from an institutional logics perspective. I conclude the paper with a discussion of the implications of my observations for future research and policy development in the field of space mining and the advancement of the institutional logics perspective that may follow from such research.

2. Theoretical points of departure

The notion of organisational fields was initially advanced by DiMaggio and Powell [30] and has since formed a cornerstone of the research tradition that eventually became known as organisational institutionalism [38,39]. DiMaggio and Powell [30, p. 148] conceived of such fields as “those organisations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organisations that produce similar services or products”. A central plank of theirs was that such fields gradually come to be governed by a set of social conventions that bestow legitimacy on organisations and prescribe what constitutes appropriate organisational practices. Such legitimacy emanates from norms, rules and values that become more or less institutionalised, or taken for granted, as they spread across the organisations that make up particular fields and imbue organisational practices with a high degree of stability. The more firmly institutionalised organisational practices are, the stronger the consensus about what constitutes legitimate practices and the lesser the likelihood of them being contested [30,31].

In their original formulation, DiMaggio and Powell [30] argued that processes of institutionalisation such as those described above give rise to strong tendencies towards standardisation of organisational practices. Standardisation was ascribed to the tendency of organisations within the same field to imitate each other as well as the power of professions and regulators to induce compliance with emerging standards. Such processes of standardisation turn organisational fields into relatively homogeneous entities. More recently, however, a view of organisational fields as more heterogeneous, or fragmented, entities where practices do not cohere around a unified and universally accepted set of prescriptions have gained traction in organisational institutionalism [36–38]. This has been accompanied by a view of such fields as contested spheres of institutional life, where practices are not necessarily taken for granted and social conflict is rife, and increasing emphasis on institutional

change [38,40]. Such a view is especially pertinent in emerging organisational fields, where greater attention is required to the mechanisms that give rise to new practices while recognising that such practices may become more firmly institutionalised over time [41–43].

A key source of inspiration for this re-thinking of organisational fields as changing, contested and possibly fragmented entities is the view of such fields as underpinned by multiple and often competing institutional logics. Tracing its origins to the work of Friedland and Alford [35], the notion of institutional logics has been defined as “the socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, and beliefs, by which individuals and organisations provide meaning to their daily activity, organise time and space, and reproduce their lives and experiences” [32, p. 2]. According to Thornton et al. [32], such logics can be traced to broader, societal-level orders, such as the corporation, the market and the state, that resemble ideal types for organising economic activity but that take concrete, context-specific form as they are institutionalised in particular organisational fields. Institutional logics are thus specific to the fields in which they evolve rather than exact reproductions of the societal-level orders from which they are derived. Individual logics are made up of a set of internally consistent, constitutive elements that reinforce each other and the establishment of particular orders. However, insofar as competing logics made up of different constitutive elements co-exist, this often leads to tensions that need to be managed at different levels of organisational fields [32,33,36]. Different logics entail diverse and potentially conflicting sources of legitimacy and authority that determine the positions and roles of organisations in organisational fields. They also establish competing norms that shape individuals’ identities and the strategies that guide action at different levels of the field. Taken together, this means that diverse logics can provide competing prescriptions for how to organise economic activities and that the practices that evolve in organisational fields will show signs of fragmentation rather than coherence around a unified set of prescriptions [36,37].

The co-existence of competing logics can set various change dynamics in motion that either reduce or preserve the fragmentation of organisational fields. According to Thornton et al. [32], such dynamics tend to follow a path of either replacement, blending or segregation of logics. Logics replacement refers to situations where an emerging logic contests and ultimately replaces an existing one in its totality and often follows from relatively radical change processes that reduce or even eliminate the fragmentation of organisational fields [44–46]. Such change processes are often amplified by institutional jolts, such as economic shocks or crises, that make logics that have historically dominated organisational fields less viable as prescriptions for how to organise economic activities [47]. As a result, organisations have little choice but to follow the emerging logic and an essentially new set of organisational practices will come to dominate organisational fields.

In contrast to such wholesale replacement of logics, logics blending refers to the less contested combination of elements of two or more logics that enables diverse prescriptions for the organisation of economic activities to be at least partly reconciled [48–50]. Such blending facilitates compromises between competing prescriptions and can reduce the fragmentation of organisational fields by creating widely accepted, hybrid practices. However, whether or not the blending of logics will reduce field fragmentation depends on how extensive the blending of their respective, constitutive elements is. Where logics blending is only partial some practices will cohere around blended prescriptions while other practices will remain distinct and cater for competing prescriptions. By contrast, where logics blending is more extensive, the coherence of practices around blended prescriptions will be more complete and fields will tend towards unification around a set of widely accepted prescriptions.

Logics segregation, finally, implies that two or more logics evolve alongside each other and continue to co-exist as relatively distinct orders over extended periods of time [41,51]. Such segregation allows

competing prescriptions for how to organise economic activities to continue to exist in tandem but also perpetuates tendencies towards fragmentation in organisational fields as organisations can preserve a set of relatively distinct and diverging practices. This is, in turn, likely to aggravate social conflicts and reduce the possibilities of reaching compromises in such fields.

While the institutional logics perspective has generated a substantial body of research into change dynamics such as those described above, most of this research has focused on the replacement of one dominant logic with another logic or the blending or segregation of two logics [34]. Research exploring more than two logics is rarer but can yield valuable insights not only into how different logics compete but also how they complement each other and reinforce particular trajectories of change. For instance, as demonstrated by Lee and Lounsbury [52], certain logics can filter, or mediate, two or more other logics by reinforcing their diverging influence on organisational practices and thereby perpetuate a state of logics segregation. As we shall see, similar processes of logics mediation that pull different logics apart and reinforce processes of logics segregation can be found in the field of space mining.

3. Space mining as an organisational field

3.1. Analytical procedures

Determining the boundaries and properties of emerging fields, which are not yet fully structured but still in the making, is challenging [37, 39]. Yet, the institutional logics perspective provides a starting point for doing so as it enables us to trace emerging practices to extant, societal-level orders that are translated into more context-specific prescriptions for how to organise economic activities. Following such an approach, I sought to identify the key institutional logics that are discernible in the field of space mining while reflecting on which change dynamics may be set in motion by their co-existence based on a close reading of extant research and scholarly debates on the evolution of space mining. Relevant literature was identified through a number of keyword-driven searches of databases such as Google Scholar and Scopus and careful examination of the bibliographies of each collected piece of research.² These relatively comprehensive search procedures were complemented with more targeted searches of key academic journals publishing social science research on the space sector, such as *Acta Astronautica*, *Astropolitics*, *New Space* and *Space Policy*, using the same keywords.

Following the view of institutional logics as being made up of a set of internally consistent, constitutive elements that broadly reflect more general, societal-level orders [32], I read the literature on space mining with an eye to how such orders were manifest in recurring themes in this literature. Systematic notes were taken regarding this matter as the reading progressed. However, being cognisant of Lounsbury et al.'s [53] critique of much research on institutional logics for following a toolkit approach that treats societal-level orders as little more than monolithic analytical archetypes, I sought to ground the analysis in the specifics of the field of space mining rather than assuming that the logics that are manifest in this field will be exact representations of such orders. To this end, I took the following categories of constitutive elements, derived from Thornton et al. [32], as the starting point for identifying key institutional logics:

- Economic systems that are favoured by particular logics.
- Root metaphors that capture the overriding symbolic meanings of logics.
- Sources of legitimacy that determine what is appropriate and valued in the field.

- Sources of authority that facilitate governance of the field.
- Sources of identity that determine social actors' position in the field.
- Strategies that guide action in the field.

Using these categories as a basis for mapping the contents of the institutional logics governing the field of space mining, I identified three distinct logics (see Table 1). Following a brief overview of the emergence of space mining as an organisational field, each of these logics is described in greater detail. I then discuss how these logics have interacted in shaping the current state of the field of space mining and how their continued interplay might be expected to influence its evolution.

3.2. The emergence of space mining as an organisational field: a brief overview

Space mining typically refers to the activities involved in prospecting for and extracting minerals that are, in some cases, in limited supply on Earth and other natural resources that are vital for the furthering of space exploration and colonisation from near-Earth asteroids and the Moon and, in a more distant future, other celestial bodies such as Mars.³ As such, space mining is closely connected to other, existing and future activities such as scientific research [56], space launches [57] and space manufacturing [3] within the broader field of space exploration and commercialisation. While this makes the boundaries of space mining activities somewhat nebulous, the emergence of an increasingly distinct system for governing such activities makes it possible to conceptualise and analyse them as an organisational field in its own right. However, as is generally the case with organisational fields, space mining needs to be seen as nested in adjacent fields and, as such, embedded in a multi-level system of governance extending all the way to the broader, societal level where institutional logics originate [38,39].

As an organisational field, space mining has its origins in the human quest for knowledge accompanying space exploration. Since the beginning of the age of space exploration, human beings have brought back small samples of rocks and other materials from the Moon and other celestial bodies for the purpose of scientific research. While such activities are still an integral part of the growing efforts to realise the prospects of space mining on a larger scale, what has spearheaded growth and investments in this field since the early 2000s is the increasing presence of commercial, private sector interests. This development was pioneered by a small number of mainly US-based, private equity-funded firms developing technological solutions for prospecting for and extracting minerals and other resources from celestial bodies and has been followed by similar ventures in other countries [2,6,10,57, 58].⁴ As a growing number of nation states are expanding their space programmes, exploration and prospecting activities are increasingly undertaken in partnership with national space agencies [17,57,59,60]. As explicated below, an increasing number of states have also enacted legislation aimed at stimulating private sector investments in space mining activities. Yet, the long-term, commercial viability of such activities is still uncertain. Particular concerns have been raised about the economic and technological feasibility of transporting space resources

³ Examples of minerals that might be extracted from asteroids include nickel, cobalt, iron and platinum. The Moon is believed to contain rich reserves of Helium-3, originating from radiation from the Sun, that may be used as a source of nuclear power. Many asteroids as well as the Moon are also expected to contain water [54, 55].

⁴ Notable space mining firms originating in the US include AstroForge, Deep Space Industries, Kepler Energy and Space Engineering, Moon Express, Planetary Resources and Shackleton Energy and have been followed by ventures such as Asteroid Mining Corporation (United Kingdom), Asteromine Corporation (Germany), Canadian Space Mining Corporation (Canada), ispace (Japan), Origin Space Corporation (China) and SES (Luxembourg). However, to date, the rate of attrition has been relatively high with several early ventures terminating operations or being acquired by larger firms [5].

² Key search terms were those of "space mining", "asteroid mining" and "space resources".

Table 1
Overview of institutional logics governing the field of space mining.

	Entrepreneurial logic	Sustainability logic	Regulatory logic
Economic systems	Market capitalism	Cooperative capitalism	State capitalism
Root metaphors	Space as the final economic frontier.	Space as a global common.	Space as a governable sphere of social life.
Sources of legitimacy	Facilitating space exploration and colonisation and enhancing sustainable use of earthly resources.	Conservation and distribution of space resources.	Agreements on the governance of space resources.
Sources of authority	Standing of property rights.	Standing with respect to communal values.	Standing of national and transnational legislative bodies.
Sources of identity	Commitment to entrepreneurial acumen.	Commitment to global space community.	Commitment to values espoused by legislative bodies.
Strategies that guide action	Increasing efficiency and profits.	Enhancing equity and environmental sustainability.	Establishing and enforcing compliance with legislation.

back to Earth for processing and refinement [8,9,57] and the impact the increasing supply of such resources might have on international commodity prices [9,58]. Also, if a viable demand side for space resources cannot be established on Earth, space mining activities critically hinge on the development of other space activities, such as the establishment of more or less permanent space colonies, which, in turn, requires technological solutions for off-Earth processing to be made available. Examples of such processing activities include the extraction of water from the Moon to generate oxygen for sustaining human habitation and hydrogen as a source of rocket fuel. The latter has been seen as a necessity for the use of the Moon as a launch platform for space vehicles exploring more remote celestial bodies [11,54,55].

In recent years, significant steps have been taken towards advancing regulatory frameworks that support the establishment of space mining as a distinct organisational field. A leitmotif of these initiatives has been the efforts to clarify and create a degree of certainty around property rights to stimulate private sector investments and enterprise [6,13,16,17,61]. The need to do so originates in the ambiguous status of such rights in extant, international space agreements, such as the Outer Space Treaty and the Moon Agreement, established under the aegis of the United Nations [2,5,12,54,61]. The Outer Space Treaty from 1967, which has been ratified by all major spacefaring nations, expressly prohibits individual nation states from appropriating celestial bodies while stipulating that the benefits of space exploration belong to all countries. By contrast, the subsequent Moon Agreement from 1979 is arguably somewhat more permissive regarding property rights and recognises that individual states have the right to collect and remove natural resources from celestial bodies although they cannot appropriate such bodies per se by claiming sovereignty over them. However, unlike the Outer Space Treaty, the Moon Agreement has only been ratified by a small number of countries excluding most nations that have historically dominated space exploration and that play a leading role in the emerging field of space mining. Moreover, neither the Outer Space Treaty nor the Moon Agreement expressly prohibit private citizens or corporations from claiming ownership of natural resources extracted from celestial bodies. This has created considerable ambiguity as to who has the right to legitimately appropriate and use such resources and whether nation states can bestow such rights on private citizens and corporations within their jurisdictions. To overcome such barriers to private sector investments, a number of states, starting with the US (in 2015)⁵ and followed by Luxembourg (in 2017), United Arab Emirates (in 2019) and Japan (in 2021), have enacted national space laws granting firms that are registered in their jurisdictions the right to

extract and commercialise the use of natural resources from celestial bodies [5,17,61,66]. However, even though these pieces of national legislation propound to be subject to international space laws, such as the Outer Space Treaty, controversies have arisen as to whether they are truly consistent with the non-appropriation principle of this treaty [17].

Unilateral initiatives such as those described above have recently been followed by the so-called Artemis Accords [5,67,68]. Initiated by the US in 2020, the Artemis Accords are a set of non-binding, bilateral agreements with like-minded states aimed at clarifying international space law and laying a foundation for further co-operation in the exploration and exploitation of space. Taking its point of departure in the Outer Space Treaty, the initiative emerged as part of NASA's Artemis Programme of returning human beings to the Moon as a first step towards expanding space exploration to Mars and beyond. Insofar as property rights are concerned, the Artemis Accords affirm that the extraction of space resources does not inherently amount to national appropriation and that any contracts to this end should be consistent with the Outer Space Treaty. According to some commentators, this leaves the question of private property rights to space resources open and effectively subject to national space laws such as those enacted in the recent past [67,68]. However, the Artemis Accords go considerably beyond the regulation of property rights and anticipates the need to preserve space heritage and avoid future conflicts arising from the extraction of natural resources. To the latter end, the Artemis Accords foreshadow the establishment of so-called safety zones around space mining sites to prevent externalities, such as contamination and generation of waste, from interfering with the activities of other signatories [67,69,70]. They also commit signatory states to mitigate other environmental problems arising from space mining and related activities, such as the generation of orbital debris, in an attempt to promote broader objectives of space sustainability [67,68].

As a piece of non-binding, soft space law, the Artemis Accords have gained significant traction in a short space of time. As of July 2025, they have been signed by 55 countries, mainly in the Americas, Asia and Europe. However, the initiative has met opposition from especially Russia and, to a lesser extent, China for representing an overly US-centric approach that by-passes the long-standing efforts of the United Nations to regulate space activities on a multilateral basis [59,67,71]. Following such criticisms, China and Russia have agreed to establish an alternative, bilateral framework entailing the creation of a lunar base to further the prospects of space mining and related activities [5,17]. Criticisms have also been raised that the Artemis Accords are not sufficiently attentive to the interests of developing countries that do not yet have their own space programmes and are thus unable to partake in evolving space exploration activities [71–73]. Crucially, with the exception of the sharing of scientific data, they do not address the issue of benefit-sharing that is arguably implicit in the Outer Space Treaty's stipulation that the benefits of space exploration belong to all countries [11,67,68,74]. Hence, even though the Artemis Accords recognise the need to combine concerns with property rights with wider concerns with sustainability, they fall short of addressing issues related to the equitable

⁵ Key pieces of US legislation include the Commercial Space Launch Competitiveness Act (2015) and the White House Executive Order on Encouraging International Support for the Recovery and Use of Space Resources (2020). See Tronchetti [62,63], Sachdeva [64] Hao and Tronchetti [65] and Tronchetti and Liu [66] for detailed analyses and critiques of these legislative initiatives. See Salmeri [5] and Osada [67] for detailed legal analyses of other national initiatives.

distribution of economic gains from space mining.

Arguably, a key rationale behind the Artemis Accords was a perceived need on the part of the US and other signatory states to avoid the very time-consuming and uncertain process of multilateral legislation in order to accelerate investments and growth in space mining activities [61,67,71]. However, this does not mean that this initiative has evolved in isolation from other initiatives aimed at developing the transnational governance of such activities. Most importantly, as a reaction against the emergence of national space laws such as those enacted by the US and other nation states, the United Nations Committee on the Peaceful Use of Outer Space (UNCOPUOS)⁶ set up the Working Group on Space Resources in 2021 [5,17,59,60]. Originating in an open letter signed by 140 non-governmental experts calling for multilateral actions as an alternative to such legislative initiatives, the working group has been collating submissions from member states of the United Nations and non-governmental organisations as to how space mining activities might evolve in a safe, sustainable and peaceful manner. Its remit does not exclude considerations of property rights but recognises the need to combine this with a regime for international sharing of economic and other benefits. However, several submissions have been openly critical of the relatively one-sided emphasis on property rights pursued by some nation states. The outcome of the work initiated by the Working Group on Space Resources is still uncertain. Its current mandate expires in 2027 and might be extended after that point. However, whether its work will ultimately result in some form of a widely supported, multilateral agreement on the governance of space mining activities is still unknown. Until such an agreement is reached, individual nation states are free to advance their own, unilateral legislations and possibly align such legislations with bilateral agreements such as those drawn up under the Artemis Accords [5,59,60].

Taken together, the above outline of space mining as an emerging organisational field reveals clear tendencies towards fragmentation. In particular, unilateral legislative initiatives emphasising the primacy of property rights only partially overlap with transnational initiatives such as the Artemis Accords and the UNCOPUOS Working Group on Space Resources where broader concerns with space sustainability are more salient. Also, the latter, transnational initiatives do not provide a unified basis for governing such wider concerns. Even though there seems to be some emerging consensus about the need to complement the emphasis on property rights with greater attention to environmental sustainability, concerns with equity such as those epitomised by international benefit-sharing remain contentious. While principles for economic benefit-sharing are notably absent in the Artemis Accords, they have started to feature more prominently in the remit of the UNCOPUOS Working Group on Space Resources. However, as of yet, there is no clarity as to what an international regime for benefit-sharing should entail and how such a regime might be organised [5,74].⁷ In what follows, I extend this discussion of field fragmentation from an institutional logics perspective using the three logics outlined in Table 1 as a starting point.

⁶ The UNCOPUOS was established in 1959 and has a broad remit to safeguard the peaceful and secure development of space activities. Following the end of the Cold War in the early 1990s, this remit has been expanded considerably beyond geo-political and military aspects to also include the safety and sustainable development of commercial space activities.

⁷ What seems to be especially contentious is the administration and distribution of future economic gains from space mining. Solutions for the administration of such benefits that have been discussed in the space literature include mandated, international taxes [75], royalties [11,19,20] or other forms of fees [15,21] as well as the establishment of voluntary corporate funds to enhance the legitimacy of private sector space mining to a wider range of constituencies [76]. But whether any of these solutions will be deemed legitimate in the field of space mining and how benefits should be distributed remain unknown.

3.3. Entrepreneurial logic

The first institutional logic that is discernible in the field of space mining is an entrepreneurial one that valorises the role of private sector enterprise and articulates the predominantly economic rationale behind such activities. This logic is similar to that epitomising the increasing prevalence of private sector, for-profit interests in the broader field of space exploration and commercialisation [77–79]. Broadly corresponding to the market logic with its emphasis on competition and the pursuit of economic self-interests as a more general, societal-level order [32], this logic may be seen as favouring an economic system dominated by market capitalism. As noted by several critical observers, the emergence of space mining as an organisational field has often been accompanied by a fundamentally neo-liberal discourse that valorises such economic systems as opposed to the previously dominant role of governments in space exploration [6,80,81]. However, the perception that the entrepreneurs and investors behind space mining firms are mainly concerned with the pursuit of economic self-interests is tempered by the framing of such activities as a driver of a wider economic endeavour that will ultimately benefit the world at large. This broader aspiration is captured by the root metaphor of space as the final economic frontier, where the human, entrepreneurial spirit is harnessed for the greater good, which is reminiscent of earlier frontier tropes of humankind heroically exploring and exploiting the unknown [19,77,80,81].

When translated into a more concrete source of legitimacy, this root metaphor often takes the form of rhetoric suggesting that the economic self-interests of entrepreneurs are merely an enabling factor behind greater goods. Apart from facilitating future space exploration and colonisation, significant weight is attached to how private sectors entrepreneurship can help humanity to overcome problems of resource scarcity on Earth and, as such, reduce the pressures on earthly resources [54,19,80]. For instance, as noted by Fox [80, p. 1], pioneering space mining firms such as Planetary Resources mobilise a public discourse suggesting that the ultimate purpose of the firm is that of “expanding the world’s resource base so that humanity [can] continue to grow and prosper” while construing economic self-interests such as concerns with profit as secondary to this broader purpose. Similar discourse can be found in the UK-based Asteroid Mining Corporation’s public communication, where the company claims to be “redefining the frontiers of mining” as “the Earth’s resources are finite [while] [s]ociety’s demand for them [is] potentially infinite” while, at the same time, admitting that, in order to achieve this objective, their activities need to be profitable [82]. What is noteworthy, however, is that the pursuit of space mining as a means of enhancing the sustainable use of earthly resources is generally discussed without regard for the impact on the space environment or the wider social implications, including the contentious issues of benefit-sharing, that may follow from such activities [54,80,83].⁸

While legitimacy-seeking discourses such as those outlined above may be seen as a means of concealing the economic self-interests behind space mining, such interests are more salient in the importance attached to property rights as a source of authority that facilitates the governance of this field. As we have seen from the previous outline of space mining as an emerging organisational field, the establishment of property rights is increasingly viewed as a pre-requisite for private sector entrepreneurship and investment in such activities. Without such rights, entrepreneurs are unlikely to undertake the very risky and uncertain activities associated with prospecting for and extracting resources from celestial bodies [8,11,12]. Hence, property rights constitute a key source of authority for space mining firms which they are keen to establish and

⁸ This development may reinforce what Wilson and Vasile [84] call the space sustainability paradox, denoting a situation where the utilisation of space to address sustainability challenges on Earth exacerbates problems related to the sustainability of space.

safeguard as a basis for entrenching their market position and attracting investments. Their interest in doing so is not least underlined by the extensive industry lobbying that preceded the unilateral legislation of such rights in the US [64,65,80,83] and elsewhere [58]. It is only after such rights have been established that an economically viable space mining industry might be expected to evolve and attract additional entrepreneurial efforts. At the same time, it is important to bear in mind that the individuals who exert such efforts are likely to nurture identities pivoting on a display of entrepreneurial acumen. As is generally the case where market logics are at play, such acumen, epitomised by an appetite for innovation and risk-taking, might be expected to shape individuals' sense of self and worth [32]. There is some evidence of emerging space mining firms nurturing, or at least wishing to be seen as nurturing, identities that are conducive to such entrepreneurial pursuits and leveraging them for the sake of creating competitive advantage. For instance, in its public communication, the Japanese space mining firm *ispace* proclaims that:

“The time has come for the world to reconsider how to explore and develop space. Until now, governments have taken on the task and risks of space development, and any setbacks reflected on administrations. We feel that this system has led to a slowing of growth in the space industry. Start-ups, such as ours, tend to be more willing to take risks, which equates to better potential to achieve results with more speed.” [85].

Similar to the discourse mobilised by other companies to legitimise space mining activities, statements about espoused identities such as these might lead to the conclusion that entrepreneurial efforts are primarily harnessed to benefit the world at large rather than short-term, economic self-interests. Ultimately, however, the strategies pursued by space mining firms are likely to focus on the primacy of increasing efficiency and profits. The pursuit of efficiency is not least evident in how such firms continuously seek to reduce costs and use this as an argument for why commercial space mining activities should be organised by private sector companies rather than governmental bodies such as national space agencies [5,8,54,59]. As noted above, critics of the increasing privatisation of space activities have also drawn attention to how profit motives are systematically concealed behind rhetoric emphasising the projected benefits of space mining to all of humanity [6, 19,80,81].

3.4. Sustainability logic

The second institutional logic that is becoming increasingly salient in the field of space mining is the sustainability logic. In contrast to the entrepreneurial logic, where references to sustainability are mainly mobilised to legitimise space mining as a means of reducing the pressures on earthly resources, this logic is more concerned with the environmental impacts on space and wider social concerns such as benefit-sharing. This logic can, in part, be derived from the broad definition of space sustainability, comprising both environmental issues and the equitable distribution of benefits, that has been endorsed by the UNCOPUOS for the wider field of space exploration and commercialisation [84,86]. This broad definition of sustainability is encapsulated in the notion that “all of humanity can continue to use outer space for peaceful purposes and socio-economic benefit now and in the long term” [86, p. 3] that is inherent in the Outer Space Treaty. As such, the sustainability logic is grounded in a broad sense of communal purpose and resembles what Thornton et al. [32] call community logic as a more general societal-level order. This order entails an emphasis on trust and reciprocity as sources legitimacy and a commitment to communal values that ultimately favour an economic system of cooperative capitalism. In contrast to the market capitalism favoured by the entrepreneurial logic, such systems are characterised by collaboration rather than competition to achieve aims that go beyond narrow, economic self-interests. The emphasis on collaboration is strongly reflected in the consistent appeals

for coordinated, multilateral action to place equity and environmental sustainability concerns centre stage in the field of space mining [e.g., 18, 19, 20, 21, 22, 24, 55]. The root metaphor symbolising such efforts is that of space as a global common that needs to be collectively managed to ensure equitable distribution of benefits while preventing or offsetting any externalities that might emerge from its exploitation [5,13, 16,61].

Similar to the emphasis on trust and reciprocity in community logics [32], the sustainability logic derives its legitimacy from the belief in the need to conserve and distribute space resources in a manner that is consistent with widely ratified, multilateral agreements such as the Outer Space Treaty. Such agreements may be seen as resting on a principle of reciprocity where signatories have committed themselves to preserve space for current and future generations while distributing any benefits emerging from its exploitation on an equitable basis [2,5,24]. However, whether such principles are upheld or not partly depends on the authority of the bodies that are entrusted with ensuring that the governance of space mining complies with communal values. To the present day, the key guarantor that such values are honoured is the United Nations, whose standing as a globally recognized, transnational body has been pivotal for establishing and upholding the legitimacy of international space law [18,24,61]. Similarly, the identification of other social actors with communal values such as those embedded in the sustainability logic depends on the extent to which they are committed to a view of themselves as members of a global space community with concerns that go beyond economic self-interests [19,61]. The fact that this sense of community is still an important source of identity is not least manifest in the widespread mobilisation and support for the work of the UNCOPUOS Working Group on Space Resources from United Nations member states and other actors [24, 59, 60]. As a reaction against the increasing salience of the entrepreneurial logic in the field of space mining, this work seems to have galvanised large parts of the international space community into taking multilateral action to advance broader concerns with equity and environmental sustainability even though the outcomes of these efforts are still uncertain.

Insofar as the sources of legitimacy, authority and identity described above come together and reinforce each other, we may expect a concerted strategy aimed at enhancing equity and environmental sustainability to take shape in the field of space mining. In several respects, such a strategy may counterbalance the emphasis on efficiency and profitability that is inherent in the entrepreneurial logic. Requirements to offset externalities to promote environmental sustainability are likely to add to the costs of space mining [15,59]. Similarly, benefit-sharing regimes promoting equitable distribution of economic gains from the extraction of space resources will reduce the profits of space mining companies and arguably need to be weighed against the incentives required to invest in such activities to avoid hampering growth [5,11,20, 55]. Whether such a scenario will eventually materialise depends on the extent to which the entrepreneurial and sustainability logics, respectively, become more or less influential in the field of space mining. As we shall see later, such processes are also likely to be influenced by the third, regulatory logic and the way it mediates the relationship between the entrepreneurial and sustainability logics.

3.5. Regulatory logic

The third and final logic governing the field of space mining is a regulatory one. This logic underpins the national and transnational efforts to advance legislations for this particular field and the broader field of space exploration and commercialisation in which it is embedded. As such, the regulatory logic corresponds most closely to the state logic and its emphasis on nation states and transnational bodies as democratically governed bureaucracies enacting and enforcing compliance with laws as a more general societal-level order [32]. The economic system favoured by such orders is typically one of state capitalism grounded in a notion of the state as the ultimate arbiter and distributor of rights and liabilities.

The root metaphor capturing the symbolic meanings of the regulatory logic is a view of space as a governable sphere of social life as opposed to the laissez-faire approach relying on voluntary adaptations to emerging realities that has occasionally been promoted by representatives of space mining firms and other commentators [54,76]. According to critics of the increasing salience of the entrepreneurial logic in the field of space mining, such metaphors need to be nurtured to counterbalance metaphors pivoting on space as an economic frontier where unrestricted possibilities of enrichment abound [19].

The regulatory logic derives its legitimacy from the agreements on the governance of space resources that have been reached between and within individual nation states at various points in time. Without such agreements, it is difficult for any state actor to establish and legitimately enforce legislation that binds other actors to particular courses of action. The importance of such agreements is not least illuminated by the differences between the Outer Space Treaty and the Moon Agreement as the basis for subsequent efforts to regulate the field of space mining. Whereas the Outer Space Treaty has consistently formed a reference point for legitimating subsequent initiatives such as the Artemis Accords and the ongoing work of the UNCOPUOS Working Group on Space Resources, the Moon Agreement has been much less consequential due to the lack of broadly based ratification [5,17,59,68]. However, the possibilities of enforcing regulatory agreements also depend on the authority of the legislative bodies sponsoring such agreements and the extent to which other actors identify themselves with the values that are espoused by such bodies. Whereas the Artemis Accords arguably derives much of its authority from the fact that it was initiated and sponsored by the US a major spacefaring nation and framed as a means of furthering international cooperation among like-minded states [67,68], much of the opposition against it has emerged from states that effectively see it as a mere extension of unilateral legislations favouring property rights and that do not identify with such measures [59,71–73]. By contrast, the authority of the UNCOPUOS largely emanates from the member states that make up the United Nations and the extent to which they identify themselves with the need for multilateral legislation [17,59].

It is currently unclear which of these initiatives will ultimately come to dominate the field of space mining and how it will shape the strategies for establishing and enforcing legislation that are necessary for the regulatory logic to gain traction. While the Artemis Accords have become influential in a relatively short space of time, the work of the UNCOPUOS Working Group on Space Resources constitutes a potentially important counterbalance to the former given its wider remit and the way that it appeals to the broader, international space community. In particular, the explicit mandate to take concerns with equity, such as those manifest in the demands for benefit-sharing, into account may become an important source of momentum given its appeal to a broad spectrum of nation states that are not yet actively involved in space mining. Also, the standing of the UNCOPUOS as a branch of the United Nations bestows it with greater formal authority to enforce emerging, multilateral legislations regulating the field of space mining. However, since such legislations require broadly based consensus to be enacted and enforceable, the risks of this failing to materialise are significant [5,74]. As explicated next, the outcome of legislative processes in the field of space mining also depends on a complex interplay between the entrepreneurial, sustainability and regulatory logics.

3.6. Extant and future trajectories of institutional change

By considering how the three institutional logics governing the field of space mining have evolved and how they interact we may advance a theoretically informed explanation of why this field shows tendencies towards fragmentation and contemplate how it might be organised in the future. The emergence of the entrepreneurial logic can be seen as a possible source of logics replacement in the sense that it has at least partly been mobilised in opposition to the extant institutional order of space exploration as a government-dominated field by actors with

vested interests in reaping economic gains from space resources. However, this shift is still incomplete. The entrepreneurial logic has not replaced the regulatory logic, which may be seen as the key exponent of the government-dominated order. Rather than forming a new, dominant order promoting the pursuit of private enterprise, the entrepreneurial logic has evolved alongside another, emerging order, namely the sustainability logic, that has, in large part, evolved as a reaction against the increasing salience of the former. This has created a situation where there are at least two distinct logics offering competing prescriptions for how to organise economic activities in the field of space mining while the regulatory logic can be said to have mediated both albeit in different ways. The entrepreneurial logic has gained momentum largely as a result of national legislations clarifying and creating a degree of certainty around property rights as part of a broader effort to legitimise private enterprise. By contrast, the sustainability logic has mainly been mediated into what may eventually evolve into some form of multilateral agreement through the work of the UNCOPUOS Working Group on Space Resources. This mediation of the entrepreneurial and sustainability logics through diverse fora has largely kept them apart and produced what is best described as logics segregation reinforcing the state of field fragmentation.

The lack of more forceful shifts in favour of the entrepreneurial logic can partly be explained by the lack of notable institutional jolts in the form of economic shocks or crises that outweigh the uncertainty surrounding the economic and technological viability of space mining and set radical change dynamics in motion [47]. Even though the legitimacy of the entrepreneurial logic is partly rooted in a depiction of earthly resources as finite and in need of more sustainable use, such resource scarcity has not yet become a sufficiently acute concern to create forceful pressures for change. However, given the momentum that has recently been added to the entrepreneurial logic through legislative initiatives of unilateral and bilateral origin, there is a risk of it becoming an increasingly dominant order that contributes to the marginalisation of wider concerns with sustainability. This risk is imminent given the relative inertia and uncertainty surrounding multilateral legislation supporting the sustainability logic [5,74]. Such a development is likely to result in a lack of balance and compromises between competing imperatives and raises critical questions as to who will benefit from the development of space mining as an organisational field. As we have seen, there are particular concerns about how the emphasis on property rights, that is a key, constitutive element of the entrepreneurial logic, might be reconciled with the need for an international regime for benefit-sharing that underpins the sustainability logic. However, as we shall see below, resolving such conflicts may not be sufficient for fostering a deeper sense of compromise between these logics and a reduction of field fragmentation.

Contemplating how a sense of compromise might be institutionalised, it is difficult to see how this might be accomplished without a greater degree of logics blending than is currently the case in the field of space mining. The current state of logics segregation is likely to perpetuate field fragmentation and conflicts between the entrepreneurial and sustainability logics and make the negotiation of compromises between these logics difficult. This may, in turn, enable space mining firms to mainly follow the entrepreneurial logic while regulators are tasked with the responsibility of ensuring that the sustainability logic is not further marginalised. By contrast, a scenario where these logics are blended is likely to compel such firms to reconcile at least some of the elements of these logics and pursue more balanced strategies. One way in which this may be accomplished is if space mining firms were to voluntarily allocate parts of their profits to funds for benefit-sharing to gain legitimacy from the wider international space community and protect themselves from regulatory incursions that put mandatory and perhaps more onerous systems for benefit-sharing in place [76]. This would be akin to what some authors have described as selective coupling of institutional logics and may prove to be a relatively robust strategy for deflecting more far-reaching pressures for change

[87]. However, this is likely to preserve a degree of field fragmentation as other prescriptions for how to organise economic activities associated with the entrepreneurial and sustainability logics will remain intact and enable the pursuit of diverging courses of action. Without more extensive blending of these logics that reinforces the commitment of key actors to both, the sense of compromise is likely to be rather superficial and not permeating the field of space mining in any deeper sense.

For a deeper sense of compromise to emerge, a combined emphasis on property rights and benefit-sharing will need to be accompanied by wider changes that make the identities associated with the entrepreneurial and sustainability logics more compatible and translate this into sources of legitimacy that appeal to space mining firms as well as the broader, international space community. Insofar as such identities and sources of legitimacy are espoused by various actors, this may gradually lead to the institutionalisation of economic systems combining elements of market capitalism and cooperative capitalism and strategies that reconcile the profit imperative with wider concerns with sustainability. This is likely to reduce the degree of field fragmentation as practices will start to cohere around a more unified set of prescriptions. However, more extensive forms of logics blending are perhaps unlikely to emerge on a purely voluntary basis. Such blending may also need to be mediated by a regulatory logic that compels space mining firms to take the entrepreneurial as well as the sustainability logics to heart in a more comprehensive manner. Hence, an important avenue for further research and policy development is to consider how firm-initiated and regulatory changes interact and how this affects the governance of the field of space mining.

4. Conclusions

Mobilising an institutional logics perspective, this paper has offered a conceptualisation of space mining as an emerging organisational field that may be used as a starting point for further empirical research exploring how this field will evolve and inform related policy discussions. This perspective helps to explain how the current state of field fragmentation has emerged by drawing attention to how two distinct logics, centred on concerns with entrepreneurialism and sustainability, have been mediated by a third, regulatory logic and how this process of mediation has resulted in logics segregation. I have also discussed how this state of logics segregation can be overcome such that a deeper sense of compromise between the entrepreneurial and sustainability logics is institutionalised. I have argued that this requires a greater degree of logics blending to emerge and be supported by key actors in the field of space mining including the space mining firms that populate this field. Also, while a degree of logics blending may emerge on a voluntary basis as space mining firms take measures to gain legitimacy in relation to the wider, international space community, it will in all likelihood need to be reinforced by the regulatory logic. Hence, I have emphasised the importance of continued, but more unified forms of logics mediation and the centrality of the regulatory logic as a mechanism facilitating logics blending. Future empirical research in the field of space mining can build on these conjectures to shed light on how the governance of this field will evolve.

In the current regulatory environment, it is difficult to see how continued logics mediation, fostering more extensive logics blending and a deeper sense of compromise, can emerge without some form of multilateral agreement such as the one potentially evolving through the work of the UNCOPUOS Working Group on Space Resources. While the entrepreneurial logic has gained traction through unilateral and bilateral initiatives, it is mainly through the work of this group that a more comprehensive conception of space sustainability resembling the sustainability logic has started to emerge. As such, I sympathise with those who have called for greater emphasis on multilateralism as a basis for the governance of space mining [e.g., 5, 14, 68, 71, 74]. However, it remains to be seen whether this will ultimately result in a greater degree of blending of the entrepreneurial and sustainability logics. For this to

materialise, there may need to be broader policy discussions focused on how multilateral forms of regulation might be reconciled with unilateral or bilateral regulations. Without such reconciliation, the regulatory logic is likely to continue to mediate the entrepreneurial and sustainability logics into diverging paths of development and perpetuate the current state of logics segregation. Interestingly, the UNCOPUOS has recently sought to facilitate deliberations on how multilateral and unilateral regulations of space mining might be reconciled [5]. The institutional logics perspective can inform such policy discussions by providing a theoretical rationale for exploring the circumstances under which more or less extensive logics blending may be expected to materialise. This perspective may extend such discussions beyond the technicalities related to regulatory processes to consider the complex social processes whereby compromises become institutionalised, or taken for granted, as an integral part of the governance of the field of space mining.

In addition to advancing our understanding of the governance of space mining and related policy discussions, future empirical research in this field can make important contributions to the literature on institutional logics. As we have already noted, such research offers an opportunity to explore the under-researched issue of how more than two logics interact in shaping the evolution of organisational fields and how particular logics can mediate the development of other logics. While the discussion in this paper has generated some initial insights into how such logics mediation has unfolded in the field of space mining, future empirical research can deepen this research focus and examine how this mediation evolves over time and whether this perpetuates or reduces the degree of field fragmentation. Such research provides an opportunity to nuance the view that field cohesiveness and fragmentation are a direct result of whether one logic comes to dominate organisational fields or, alternatively, whether two or more competing logics co-exist, that has dominated the literature on institutional logics [32,34]. Instead, it is possible that field fragmentation is amplified or reduced by logics that reinforce or weaken the influence of other logics and that such logics mediation can also facilitate logics blending and the emergence of compromises between competing logics. Studies of how particular logics mediate other logics can thus answer calls for further research into the circumstances under which diverse logics not only compete but also complement each other [33].

Another promising avenue for future research is to explore how individual space mining firms respond to the prevalence of multiple logics and how such responses interact with those of other actors. As indicated in the foregoing, such interactions may entail an intricate interplay between voluntary change initiatives aimed at logics blending and regulatory initiatives reinforcing such blending. There is currently a dearth of in-depth empirical research into how individual space mining firms respond to the three logics identified in this paper. However, taking their responses as a starting point, researchers may gain valuable, micro-level insights into how the three logics are reproduced and transformed as they are translated into specific organisational practices [32,53]. Such research would complement the macro-level perspective that has dominated research on institutional logics [53,88]. By extending research to examine how firm-level responses trigger actions by other actors that make up the wider, international space community and how the interplay between multiple actors evolves over time, researchers may also advance longitudinal, cross-level analyses. Such analyses have repeatedly been called for [32,33,88] but are still relatively rare in the literature on institutional logics [34].

Finally, further empirical research into how the field of space mining evolves over time offers a valuable opportunity to examine an emerging organisational field that is still in the making. Such research is relatively rare in the literature on institutional logics. Much of this research is of a retrospective, historically informed nature, exploring how relatively well-established institutional orders have evolved over time, which has led to calls for researchers to engage with institutional processes as they unfold in real time through in-depth ethnographic research [53,88].

Exploring emerging organisational fields is not without challenges. As noted in the foregoing, such fields may be difficult to clearly delineate due to the absence of well-established field boundaries although the identification of nascent institutional logics such as those emerging from my analysis is a promising avenue to this end. Another challenge is the risk of long-term field formation failing to materialise and that this might deter researchers from investing time and effort in exploring emerging fields in real time. The risk of something similar happening in the field of space mining is high given the current uncertainty about its economic and technological viability. However, as noted by Zietsma et al. [39], even though failed field formation is an under-researched topic in organisational institutionalism, much can be learnt from such failures. Such research may be used as a valuable contrast to the more extensively researched topic of successful field formation to further systematic theory development as to which mechanisms and processes reinforce one or the other outcome and the roles that institutional logics play in this regard.

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