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An Analysis of the Channels for Accessing Economic Benefits in the Commons Governance Regime of Space Resources

RESEARCH ARTICLE

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ABSTRACT

On September 22, 2022, the world's first transaction on space resources took place, highlighting the need for an international space mining regime. Although outer space is often considered global commons, there is a concern that the commons governance regime may hinder the commercial use of space resources. The current research does not provide an in-depth analysis of the incentive mechanism under the global commons governance regime, let alone the economic incentive mechanism. This paper explores how to construct the channels for accessing economic benefits in the commons governance regime of space resources. The channels will constitute a critical incentive mechanism for the regime, and they should conform to two principles closely related to the commons and incentives: the common benefit principle contained in international law and the 2B principle proposed by Ostrom. This paper summarizes the basic types of channels and their combinations and finds that the channels and their combinations in previous studies and the latest international instruments do not fully meet the requirements of the two principles. Based on the principles, this paper puts forward a new proposal, which integrates four existing channels and one new channel. Compared with previous research, the proposal suggested in this article has advantages in the following aspects: promoting the realization of the two principles, incentivizing diverse countries to accept commons governance of space resources, and encouraging space cooperation between spacefaring nations and non-spacefaring nations.

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1. INTRODUCTION

On September 22, 2022, ispace EU sold acquired lunar regolith to NASA, completing the world's first transaction for space resources. Nevertheless, the current international treaties have not provided detailed and specific provisions on space resource utilization. The UNCOPOUS, a United Nations body with an overall mandate to improve international space law, plans to take action. The legal subcommittee of the UNCOPUOS decided to establish a working group to study potential legal models for space resource activities (the Legal Subcommittee, 2021). To build such a legal model, the international community cannot ignore the status of outer space and space resources.

Outer space is generally regarded as global commons (e.g., Cross, 2021; Craven, 2019; Patchen, 2018; Steer, 2017), and "most scholars" deem space resources as common-pool resources (Yang et al., 2021). In 2020, however, former US President Donald Trump signed Executive Order 13914, claiming that the United States denies the "global commons" status of outer space and that the United States encourages "international support" for space resource utilization. The executive order aims to enable American entrepreneurs to participate in the competition on space mining (Janssen, 2022). The executive order assumes the status of the global commons as an obstacle to space resource utilization, especially commercial use. However, such a status does not necessarily hinder commercial use. This paper holds that the commons governance regime of space resources can provide various channels for accessing economic benefits, ensuring that all countries, especially spacefaring countries, can obtain economic benefits.

Current research lacks an in-depth and comprehensive analysis of the channels for accessing economic benefits in the commons governance regime of space resources. "The function of commons governance regimes is generally to regulate behaviour" (Vogler, 2012), so these regimes mainly focus on constraints rather than incentives. As to the CPR institution, Ostrom proposes a set of design principles critical to the success of governance (Ostrom, 1990). Some scholars reformulate three design principles (Cox, Arnold, and Villamayor-Tomás, 2009, 234–262), and Ostrom accepts the modifications (Ostrom, 2010). The relevant design principles have been adapted to address global commons issues (Orazgaliyev and Araral, 2019; Garrick, 2018; Stern, 2011) and outer space issues (Lambach and Wesel, 2021; Oz, 2018). Of the above design principles, the 2B principle is most relevant to incentives. It highlights that the distribution of benefits should be proportional to the distribution of inputs (Verrax, 2019; Ostrom, 2010; Cox, Arnold, and Villamayor-Tomás, 2009, 247–248), so this article refers to it as the proportional principle. The relevant research, however, does not specifically analyze how to design the incentive mechanism of global commons governance based on this principle. There is also little literature that comprehensively discusses the economic incentive mechanism in the commons governance regime of space resources. Many commentators have proposed legal models to regulate space mining in the future (e.g., Byrd, 2021; Chouhan, 2020; Koch, 2018; Kim, 2018; Saletta and Rossiter, 2018; Sattler, 2005; Paxson, 1992). Nevertheless, most legal models only provide one or two types of channels for accessing economic benefits.

To fill the research gap, this paper explores how to construct the incentive mechanism under the commons governance regime of space resources through the channels for accessing economic benefits. This paper is helpful to attract more scholars to focus on the incentive mechanism of commons governance and provide references for designing relevant mechanisms from the perspective of economic benefits. It also helps to improve the acceptance of diverse countries to the commons governance regime of space resources.

The article is in four parts: first, it argues that the channel is a crucial incentive mechanism in the commons governance regime of space resources, and there are two requirements of commons governance for the channels; second, it summarizes the basic types of channels and their combinations in prior studies and then assesses whether they comply with the two principles; third, it identifies channels in the latest international instruments and discusses whether they comply with the two principles; fourth, it proposes a better proposal for the channels and their combinations.

2. THE CHANNELS UNDER THE COMMONS GOVERNANCE REGIME OF SPACE RESOURCES

This section explains why the channels for accessing economic benefits are critical to the commons governance regime of space resources and what principles the channels should follow.

2.1 THE IMPORTANCE OF INCENTIVE MECHANISM TO THE COMMONS GOVERNANCE

The channels for accessing economic benefits are important for gaining national support for a commons governance regime. After all, states will establish and maintain a commons governance regime only if the perceived benefits outweigh the perceived costs (Hagen and Crombez, 2018). In particular, incentives for spacefaring nations are significant. As of 2022, only eleven countries have the ability

to launch objects with their own launch vehicles, while only three have manned spaceflight technology (Koop, 2022). Thus, space powers are key actors in both exploring and utilizing outer space. According to the norm life cycle model, "norm cascades" require the support of "critical states" (Finnemore and Sikkink, 1998). In addition to spacefaring nations, other countries should also be encouraged to participate in commons governance or space resources. Under Article I of the Outer Space Treaty, exploration and use of space are the "province of all mankind". According to Article 11(1) of the Moon Agreement, "the Moon and its natural resources are the common heritage of mankind"(hereinafter CHM). Although the content of the CHM is controversial and uncertain (Khatwani, 2019), the constituent elements of the CHM are often considered to include international management (e.g., Alsdaifat, 2018; Mirzaee, 2017). Thus, the management of space resources should provide opportunities for all states to participate.

2.2 THE CHANNELS AS CRITICAL INCENTIVE MECHANISMS

As to incentives, the research on the space mining regime mainly realizes the incentive function of the regime by arranging the subjects' rights to space resources, which can be roughly divided into ownership (e.g., Anderson, 2019; Manoli, 2016) and usufruct (e.g., Wrench, 2019; Owolabi, 2013; Buxton, 2004). Usufruct refers to the right to exploit something without owning it. However, the incentive function of rights may be limited. The rights over space resources are not equivalent to attainable benefits, as there are thresholds for exercising the rights. It is difficult for non-spacefaring states to exploit in situ space resources and exercise related rights unless spacefaring nations are willing to cooperate with them. Compared with rights, the channels directly reflect the way and difficulty of obtaining benefits, so the channel can better reflect whether incentives are adequate. Regarding benefits, space resources involve political, military, and economic benefits (Deudney, 2020), and Section 1 of Executive Order 13914 puts special emphasis on commerce, suggesting that an important motivation for actors to participate in space resource utilization is economic benefits. Due to space limitations, this paper focuses on economic benefits.

2.3 THE REQUIREMENTS OF COMMONS GOVERNANCE FOR CHANNELS

The channels should conform to two principles related to commons governance and incentive mechanism: the common benefit principle and the proportional principle.

The common benefit principle requires "all space activities to be carried out for the benefit of all countries" (Yan, 2022), providing both legal and ethical requirements for the channel. As to legal requirements, Article I (1) of the Outer Space Treaty establishes that "the exploration and use of outer space" should be conducted for "the benefit and in the interests of all countries". This clause sets out requirements for utilizing the global commons in space and designing related incentive mechanisms. The Outer Space Treaty has 112 States Parties, including almost all the spacefaring nations. Since States Parties to treaties are legally obliged to abide by them, the common benefit principle in the Outer Space Treaty is legally binding on many countries. The principle is even considered customary international law (Jakhu and Freeland, 2016). In terms of ethical requirements, normative institutionalism can provide references. According to this theory, institutions prescribe what is appropriate behavior (Hysing and Olsson, 2017; March and Olsen, 2004) and have a "logic of appropriateness" that influence their members' behavior (Peters, 2019). The logic of appropriateness means that members' action is driven by appropriate rules or exemplary behavior under institutions. The Outer Space Treaty significantly affects States Parties through the logic of appropriateness, and the common benefit principle establishes an appropriate code of conduct: the exploration and use of outer space should benefit all states. However, the benefits to countries are not unlimited, and they need to comply with the proportional principle.

The proportional principle not only helps to ensure the success of commons governance but is also closely linked to the incentive mechanism. In the domain of outer space, there should be "a balanced proportion between the users' contribution and benefit" (Tepper, 2021). According to the principle, it can be deduced that the channels should prevent spacefaring countries from monopolizing space resources and prevent non-spacefaring countries from making large profits without input. Thus, the realization of the proportional principle can be seen as addressing the problem of monopoly and free-rider. In particular, when dealing with the free-rider issue, designers of the channels should take specific account of non-spacefaring nations' interests, providing them with appropriate ways to participate in space resource utilization and reasonably identify their contributions. Otherwise, non-spacefaring countries may have no opportunity to contribute and attain benefits, which violates the common benefit principle. This paper argues that the participation of non-spacefaring nations in domestic or international space resource activities through natural resources, labor, capital, technologies, or other appropriate means should be recognized as contributions.

Two principles call for the creation of diversified and differentiated channels. On the one hand, diversified channels help ensure diversity and breadth of beneficiaries,

thereby providing incentives for a wide range of nations. After all, one type of channel may benefit only certain countries. On the other hand, the attainable benefits of different channels should be different. Since channels are likely to differ in the way of participation and the contributions of participants, the benefits proportional to the contribution naturally vary in different channels.

3. THE BASIC TYPES OF THE CHANNELS IN PREVIOUS STUDIES

This section first summarizes the channels for accessing economic benefits and their combinations in previous research and then analyzes whether they meet the requirements of the common benefit principle and the proportional principle.

3.1 FIVE CHANNELS FOR ACCESSING ECONOMIC BENEFITS

Previous research mainly lists five types of channels for accessing economic benefits, which can be considered the basic types of channels. This paper divides these channels into two categories based on whether the channels involve exploitation or not. Three of these channels are exploitation channels, and the other two are non-exploitation channels.

3.1.1 Three Exploitation Channels

Exploitation channels mean that entities acquire economic benefits by exploiting space resources. Almost all space mining models proposed by previous research contain exploitation channels. In previous research, there are three exploitation channels: exploiting the selected area (hereinafter ExSA), exploiting the reserved area (hereinafter ExRA), and exploiting the allocated area (hereinafter ExAA). These distinctions are based on the different ways in which actors obtain rights to mining areas. The selected area is independently selected by the actor; the reserved area is reserved under the space mining regime and is exclusively provided to eligible actors who apply to mine; the allocated area is the mining area divided into equal shares and allocated to all countries.

Among the three Channels, ExSA is frequently mentioned in the literature. Many scholars assume that eligible entities are free to select where to exploit space resources (e.g., Kim, 2018; Sattler, 2005). When exploiters choose this way of gaining economic benefits, subject to appropriate procedures or conditions, they are entitled to select the mining district themselves. ExSA is therefore closely related to the first-come-first-served principle. Therefore, this channel is the most suitable for the interest of spacefaring countries. Their space capabilities will enable them to find and exploit mineral-rich mining areas earlier than other entities, and this will, in turn, stimulate the development of space mining industries. In contrast, if non-spacefaring countries want to attain economic benefits through ExSA, they will have to engage in the mining programs of spacefaring countries or wait until they acquire the necessary technology. Thus, their economic benefits and opportunities to participate are limited. In extreme cases, the first-come-first-served principle may lead to a monopoly on space resources by some spacefaring countries, leaving few minerals to less developed counterparts.

ExRA can effectively reduce the monopoly of space resources. It emphasizes that some mining areas should be reserved for a certain period so entities can exploit them in the future. It is suggested that some lunar resources can be preserved for "future development by less-developed states" (Leib, 2015). The parallel system of seabed mining is a good example, where developing states have the priority to exploit the reserved area within 15 years. The system prescribed by the UNCLOS is regarded as "one of the most valuable lessons for the governance of commercial space" (Koch, 2018). Compared with ExSA, ExRA provides more time for non-spacefaring states to develop space capabilities to utilize space resources, so it is more conducive to the interests of non-spacefaring states. Nevertheless, whether non-spacefaring can acquire economic benefits through this channel also depends on the reservation period and the qualification to apply for mining. If the reservation period is short and there is no priority for developing countries to apply for mining, this channel may produce more benefits for the space powers.

Compared to the other two exploitation channels, ExAA best serves the interests of non-spacefaring nations. This channel divides celestial bodies like the moon into "distinct geographic portions", so each country can get a share equally and exploit it (Heim, 1990). Once non-spacefaring countries are assigned a particular share of the mining district, they need not worry that there will be no valuable space resource left to them in the future. In contrast, the space powers' interests are limited. They will not be able to use technology to occupy as much of the mining area as possible.

3.1.2 Two Non-exploitation Channels

In contrast to exploitation channels, non-exploitation channels enable qualified entities to attain economic benefits in ways other than exploiting space resources. Therefore, it benefits countries that cannot participate in space activities. Summing up previous studies, there are two non-exploitation channels: allocation of funds (hereinafter AoF) and transfer of rights (hereinafter ToR).

If the space mining models contain AoF, exploiters will be charged, and the money will be allocated to various states according to specific procedures and principles (Chouhan, 2020; Gawronski, 2018; Pershing, 2019; Saletta and Rossiter, 2018). Although the specific methods of charging and allocation vary, they both establish that those who do not carry out mining activities will be able to gain economic benefits through the allocation of revenue derived from space resource utilization. However, if the charge amount is low and conditions of allocation are strict, the actual allocated benefits may be greatly limited.

ToR is another non-exploitation channel. In this situation, states are granted exclusive rights over celestial bodies, and they can earn income by transferring rights so they don't have to engage in exploitation. One example is the credit trading system (Paxson, 1992). In the system, the credits allocated to each country allow the holder to mine a certain amount of resources, and the credit can be traded. Compared with AoF, ToR does not require any condition of allocation. Besides, the source of economic benefits is the exclusive rights that belong to all states, meaning there is no need to rely on a distribution mechanism and the unwilling exploiters. ToR is therefore better for the interests of non-spacefaring countries than AoF. The interests of spacefaring countries are limited to a greater extent. The scope of each state's exclusive right is limited, so space powers are unable to take advantage of their advanced technology to occupy and exploit the space mining area to the greatest possible extent.

3.2 FOUR COMBINATIONS OF CHANNELS

After identifying the basic types of channels, it is possible to summarize the combinations of the channels. In previous studies, commentators' preferences for combining the channels are not very diverse, and the combinations can be roughly divided into four basic types. The first combination consists of only ExSA, which has been proposed by many scholars (e.g., Tennen, 2015; Hofmann and Blount, 2018). This combination provides only one channel, and only those participating in space mining programs can attain economic benefits. The second combination, including ExSA and AoF, is also popular with many scholars (e.g., Pershing, 2019; Saletta and Rossiter, 2018). The third combination is much less popular and comprises ExSA, ExRA, and AoF(e.g., Leib, 2015; Koch, 2018). The last type of combination involves ExAA (Raclin, 1985) or ToR (Paxson, 1992). This combination's main feature is that it will grant exclusive exploitation rights, such as ownership or usufruct to space resources, to all states in advance. This mechanism is so marginal that it has been rarely mentioned in recent years.

3.3 A BRIEF ANALYSIS OF THE CHANNELS AND THE COMBINATIONS IN PREVIOUS STUDIES

The channels and the combinations in previous research do not fully conform to the common benefit principle and the proportional principle.

Many proposals are not conducive to the realization of the common benefit principle. First, most combinations are more favorable to spacefaring countries. Most combinations involve ExSA, the most beneficial channel for spacefaring countries. In contrast, the two most beneficial channels for non-spacefaring countries, ExAA and ToR, are seldom mentioned in the literature. Besides, channels that prevent actors from occupying excess mining areas, such as ExRA and ExAA, are less likely to be included in the previous combinations, which is not conducive to preserving space resources for future exploitation by non-spacefaring nations. Third, most combinations of channels combine less than two types of channels, failing to meet the diversified requirements mentioned in Section 2.3. The limited variety of channels will reduce the types of beneficiaries. The feature of differentiation is based on the feature of diversification, so the lack of diversification makes it difficult to achieve differentiation.

Some studies do not conform to the requirement of the proportional principle. On the one hand, some studies lack reasonable restrictions on the mining area and mining time of ExSA, and spacefaring nations may take advantage of technological advantages to monopolize space resources. On the one hand, some studies containing ExSA do not reasonably restrict the size of the mining area and the length of the mining period, which could lead to a monopoly on space resources. On the other hand, some studies containing AoF do not specify the allocation criteria, allowing some countries to obtain economic benefits without making any investment. The reason for not meeting the proportional principle is mainly the lack of reasonable restrictions. This lack allows actors to get excessive benefits through channels.

4. THE CHANNELS IN THE LATEST INTERNATIONAL INSTRUMENTS

In 2020, the Building Blocks for the Development of an International Framework on space resource activities (hereinafter the Building Blocks) was submitted to COPUOS. In the same year, eight founding member nations concluded the Artemis Accords (hereinafter the Accords), which contains provisions concerning space resource utilization. By April 17, 2023, there are 23 signatories to the Accords.

4.1 THE CHANNELS AND THE COMBINATION IN THE BUILDING BLOCKS

The Building Blocks proposes two channels, ExSA and AoF, so it adopts the second type of combination listed in Section 3.2. The Building Blocks has a number of provisions related to ExSA. Article 7 on priority rights shows that the Building Blocks supports space resource utilization on a first-come-first-served basis. Paragraph e of Article 14 suggests the mining area is freely selected by the operator and then registered and notified. Article 8 affirms the legitimacy of resource rights, guaranteeing the economic benefits derived from ExSA. Article 8.1 stipulates that the resource rights for minerals and related products can be legally acquired. Article 8.2 further ensures the mutual recognition of resource rights between countries. In contrast to ExSA, AoF is only mentioned indirectly and briefly in Article 13. Paragraph g of Article 13.1 states that benefits can be shared by establishing an international fund. But Article 13.2 highlights that the benefit-sharing mechanism should not be compulsory.

4.2 THE CHANNEL AND THE COMBINATION IN THE ARTEMIS ACCORDS

Based on the provisions of the Accords, it can be inferred that the Accords only involve ExSA and that the chosen combination is the first type of combination listed in Section 3.2.

At first, ExRA and ExAA are not involved in the Accords. The establishment of these two areas must be based on specific institutional arrangements, such as the reservation, division, and allocation of mining areas. The Accords, however, do not specifically mention the reservation or allocation of mining areas. Besides, Section 10(4) provides that the signatories intend to contribute to international practices and rules regarding space resource utilization based on the Accords, so the signatories believe the Accords can provide sufficient guidance and legal basis for space resource utilization. If the signatories had intended to select ExRA and ExAA, they would not have considered that the Accords had laid sufficient groundwork but would have concluded a supplementary agreement to add indispensable institutional arrangements.

In addition, the Accords does not place specific restrictions on space resource utilization, so actors have the freedom to select and exploit the mining area. Under Section 10(2), the Signatories affirm that "the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty." Article II of the Outer Space Treaty establishes the well-known non-appropriation principle, which stipulates that outer space is not subject to national appropriation by any means. Section 10(2) emphasizes that Article II does not prohibit space mining, ensuring the legitimacy of space resource utilization. Such interpretation helps reduce the illegal risk of ExSA. NASA intends to justify Section 10(2) through practice in the future, and it plans to purchase extracted lunar resources from providers so as to establish a precedent for extracting and purchasing lunar resources (NASA, 2020).

4.3 A BRIEF ANALYSIS OF THE CHANNELS AND THE COMBINATIONS IN THE TWO INSTRUMENTS

Based on Section 4.1 and Section 4.2, neither instrument contains diversified and differentiated channels. The Accords adopts the first type of combination in Section 3.2, and the Building Blocks uses the second type of combination in Section 3.2. While the two instruments reflect a willingness to adhere to the common benefit principle and the proportional principle, they do not focus on the design of the channels, and the channels do not adequately meet the requirements of both principles.

The channels in both documents are not conducive to realizing the common benefit principle. While Article 1.1 of the Building Blocks and preface of the Accords reflect the spirit of the common benefit principle, like many proposals mentioned in Section 2, these two instruments do not pay sufficient attention to how to design diversified channels. The Building Blocks contains two channels, and the Accords includes only one. As analyzed in Section 2.3 and Section 3.3, the lack of diversity is not conducive to realizing the common benefit principle.

According to both instruments, their arrangement of ExSA will not violate the proportional principle, but more detailed provisions are needed to prevent monopoly. Article 7 of the Building Blocks implies that there are maximum limits on the mining area and the mining period. Although the Accords do not mention the limit in these two aspects, Section 10(2) and Section 10(3) commit to compliance with the Outer Space Treaty, demonstrating the willingness of signatories to abide by the non-appropriation principle. The above provisions show that both instruments oppose the monopoly on space resources. Nevertheless, specific provisions are needed. If there is no clear limit on the period and area of exploitation, some nations may occupy a large number of space resources for a long time, forming a *de facto* monopoly.

5. A NEW PROPOSAL FOR THE CHANNELS AND THE COMBINATIONS

The channels in previous studies and the latest international instruments do not fully meet the requirements of the common benefit principle and the proportional principle.

Based on these principles, this section presents a new proposal on channels and combinations.

The proposal aims to ensure that different states have the opportunity to benefit from space resource utilization through different channels, so it can be seen as an attempt to materialize the common benefit principle in Article 1 of the Outer Space Treaty. To realize the principle, obligatory cooperation, financial transfer, and other institutional arrangements are needed (Hafner, 2012). Thus, the arrangements proposed in this paper, such as allocation schemes, remain within the limits outlined in the Outer Space Treaty.

5.1 SELECTION OF THE CHANNELS

According to Section 3.1, the previous research mainly referred to five channels. Based on the common benefit principle and the proportional principle, this section analyzes whether these five channels should be selected and how they should be specially arranged.

To realize the proportional principle, channels should ensure that the economic benefits received by actors are proportional to their contributions. As analyzed in Section 2.3, the key to adhering to this principle is to deal with two problems: monopoly and free-rider. To prevent monopoly, it is necessary to arrange ExSA rationally. Section 3.1.1 shows that this channel is based on a first-come, first-served basis, which risks leading to a monopoly on space resources. Nonetheless, this channel should be included because many spacefaring nations favor it. Without this channel, it would be difficult to obtain spacefaring nations' support. Therefore, the regime should not exclude this channel but adopt reasonable arrangements to prevent monopoly. On the one hand, reasonable restrictions should be imposed on the time and area of ExSA. On the other hand, the regime needs to contain channels with the function of preventing monopoly, such as ExRA.

As to the free-rider problem, it is necessary to prevent non-spacefaring countries from using some channels to obtain disproportional benefits without any contribution. First, if ExRA is contained, it should not only ensure that non-spacefaring countries have opportunities to utilize space resources in the future but also prevents a situation where these countries only occupy the area but do not utilize it. Thus, it is necessary to reasonably arrange the prerequisites for application and the latest time to start actual utilization. According to the "use it or lose it" policy applied in countries such as the United States, Canada, Australia, and Zimbabwe, miners should extract the resource or risk losing mineral rights (Gwata, 2019). Second, ExAA should be excluded. This channel cannot coexist with ExSA. The allocation of a fixed share of mining area to each country is contrary to the practice of allowing each country to select an unlimited share of the mining area. More importantly, the channel enables non-spacefaring countries to gain access to benefits without any contribution, violating the proportional principle. According to Locke, it is labor that gives a right of property (Locke, 1689). Third, regarding AoF, there is a need to rationalize the conditions under which funds are allocated and the amount of allocated funds, ensuring that beneficiaries have made contributions within their capacity and that the benefits are proportional to their contributions. Fourth, the institutional arrangements for ToR should prevent non-spacefaring countries from acquiring transferable rights without investing in space resource utilization by setting conditions for the acquisition and ToR. Fifth, participants in space resource activities contribute more than those that do not, so the available benefits of non-exploitation channels should be smaller than those of exploitation channels, which can encourage actors to make greater contributions.

To ensure that the channel is in line with the common benefit principle, the commons governance regime should contain different types of channels to ensure that it can benefit countries at different levels of development. According to the previous analysis, ExAA should be excluded. The combination of other channels is beneficial to diverse nations. Based on Section 3.1, ExSA is most beneficial to spacefaring nations, and the other three channels, ExRA, AoF, and ToR, are conducive to non-spacefaring countries to obtain economic benefits. Besides, space cooperation between spacefaring nations and non-spacefaring countries needs to be encouraged, so the channels should provide more economic incentives for such collaboration.

It is worth adding that the channels may not be limited to the above listed in this paper. To improve the alignment of the channels with the two principles, commentators may envision new channels. This article proposes a new channel, which is described in detail in Section 5.2.4.

5.2 COMBINATIONS OF THE CHANNELS

After the channels are selected, it is necessary to consider how they can be reasonably integrated. This section first introduces the institutional arrangements required for the channels. Then, it separately expounds on the specific arrangements for each channel, including how they meet the requirements of the two principles and how they relate to each other.

Some involved details related to the channels, such as the size of the area, the duration of time, the participation criteria, and the amount of funding, can be adjusted in the future in light of the actual situation and technical level.

5.2.1 The Institutional Arrangements Necessary for the Combination

If the mechanism constituted by channels is to operate normally, some necessary arrangements should be established.

Above all, an International Space Authority (hereinafter the Authority) needs to be established to provide necessary organizational and institutional support. Without an international governing body, it will be challenging to achieve specific functions of the mechanism, such as allocating funds and setting up reserved areas. Some scholars suggest the International Seabed Authority may provide an appropriate point of reference (Pershing, 2019; Morris, 2016). For example, the organs of the Authority could be arranged with reference to International Seabed Authority, with the Assembly as the supreme body. In the Assembly, each member state shall have one representative, and decisions should be taken by representatives present and voting. Limited by length, this paper does not delve into voting power and voting rule. As to powers, the Authority only needs to maintain the operation of channels and does not need to be empowered to exercise comprehensive regulation like International Seabed Authority. As long as space activities do not violate international obligations, the Authority shall avoid interfering in the relevant activities.

Besides, it is necessary to draft a list of vulnerable nations, which records countries requiring special treatment from the channels due to economic and technical disadvantages. The reason for making this list is that the category of 'developing countries' or 'non-spacefaring countries' is hardly representative of countries that need policy assistance. Some developing countries may have relatively advanced space technology and can participate in space activities. Some non-space countries may be economically strong and can master space technology in a short period of time. Therefore, the Authority needs to identify which countries fall into the category of vulnerable nations and which entities can represent these vulnerable countries' interests. For ease of expression, the vulnerable countries described in the following paragraphs include all entities that can represent their interests.

5.2.2 Exploiting the Selected Area

Applicants who plan to gain economic benefits through this channel should first select the mining area and then submit an application to the Authority. The application operates on a first-come-first-served basis, and it must be approved if it does not violate the international obligations of existing international treaties. Thus, the freedom to select mining areas will not be unduly restricted. Approval produces exclusive mining rights in the selected area. Unlike the parallel system in the UNCLOS, applicants are not obligated to select similar areas as reserved areas when choosing selected areas. Selecting reserved areas is freedom rather than obligation, as detailed in Section 5.2.3.

The size of this area must not exceed the limit of the applicant's actual mining capacity, which must be proven in the application materials. Once the Authority approves, the area becomes the applicant's exclusive mining area. To prevent the exclusive mining area from being left idle, the actual utilization should begin within five years. Once the mining activity becomes profitable, the Authority levies a space mining tax on the exploiter. The exclusive exploitation period is 15 years, which is calculated from the date of actual exploitation. Before this period expires, the original exploiter can apply to continue mining the selected area in advance. If the exploiter does not apply to continue the exploitation, the Authority will disclose the information on these mining areas, enabling other potential miners to apply for mining.

If the applicant's mining plan involves the participation of vulnerable countries and their participation meets the minimum participation criteria, the applicant will be eligible to enjoy the following preferential policies. First, the Authority can increase the size of the applicant's exclusive mining area. The greater the number of vulnerable nations that meet the mining plan's minimum participation criteria, the larger the exclusive mining area will be. But the final size of the exclusive mining area must not exceed three times the original size. Second, the Authority can extend the exclusive exploitation period of the applicant. Similarly, when more vulnerable countries meet the plan's minimum participation criteria, the extension period will be longer. The period should not exceed 45 years. Thirdly, the tax rate for the space mining tax can be appropriately lowered. However, the preferential policies will be canceled if the participation of vulnerable countries does not meet the minimum participation criteria in practice.

5.2.3 Exploiting the Reserved Area

When applicants apply for the selected area, they can choose the second mining area as part of the reserved area. The size of the reserved area should be the same as the selected area, and proved mineral reserves per square kilometer of these two mining areas should be similar. In particular, if the Authority expands the applicant's selected area, the reserved area should be the same size as the expanded area. Once the reserved area is determined, the Administration will disclose the information about the reserved area. Unlike the parallel system, the selection of reserved areas by applicants is voluntary rather than obligatory, which increases the freedom of applicants and reduces their cost of exploration. To incentivize applicants to provide reserved areas to the Authority, applicants who

select reserved areas shall receive bonus areas as rewards, as detailed in Section 5.2.4.

Vulnerable countries were the only ones who were allowed to apply to mine the reserved area. They determine the location and size of the reserved area based on the estimated mining capacity. After the Authority approves the application, the reserved area can be reserved for the vulnerable country for 15 years. The actual exploitation activities in the reserved area should start within the 15-year period that follows approval. The exclusive exploitation period for vulnerable countries is 15 years. Before the exclusive exploitation period expires, vulnerable countries are permitted to apply to continue mining the reserved area in advance.

The vulnerable country can cooperate with other countries, but cooperation projects require the Authority's approval. In cooperation projects of this kind, the vulnerable country should be dominant position in the cooperation and should meet the maximum participation criteria, which considerably exceeds the minimum participation criteria in ExSA. The exploitation activities in the reserved area are not taxed. Vulnerable countries can transfer the exclusive exploitation right of the reserved area to other countries through ToR (Section 5.2.6 describes it in further detail).

If no state applies for the reserved area, or if the exploiter does not apply to continue exploitation, the reserved area will be kept by the Authority. The Authority will disclose the information on these reserved areas and encourage other vulnerable countries to apply for mining.

5.2.4 Exploiting the Bonus Area

Exploiting the bonus area is a new channel introduced in this paper. The bonus area is an award given by the Authority to an applicant for selecting a reserved area.

If applicants submit a reserved area when applying for mining in the selected area, they can select another area as the bonus area. The predicted mineral reserves and size of the bonus area should resemble the selected area and reserved area. In particular, the economic benefits derived from the bonus area are not taxable. Exploiters have exclusive exploitation right in the bonus area. They should not exploit the bonus area after the exclusive exploitation period for their selected area expires. The exclusive exploitation period is 15 years, and exploiters can apply to continue mining the bonus area in advance. If exploiters do not apply to continue to exploit the bonus area, the Authority will disclose information on relevant areas to potential applicants and attract diverse entities to apply for utilizing relevant areas.

5.2.5 Allocation of Funds

The International Sponsorship Fund will be established to allocate the funds. The primary funding sources are donations, the space mining tax, and other taxes. The tax rate and taxation conditions of the space mining tax will be negotiated and determined by diverse nations. They should be flexible, as this will help to ensure the balance between reducing mining costs and ensuring funding sources. Eligible applicants for the funds should be vulnerable nations with programs to participate in space resource activities. Their application should outline the input, required funding, and the use of funding. Once their applications are approved, they can receive long-term financial aid. Once vulnerable countries receive financial aid, they should regularly disclose information on the use of funds. Specifically, the amount of funding should not only be proportional to applicants' contribution but also less than the obtainable gains they could receive through the exploitation channels.

5.2.6 Transfer of Rights

ToR is closely related to all types of exploitation channels. In the selected area and bonus area, exploiters can freely transfer their exclusive mining rights. In the reserved area, ToR should be restricted because the reserved area is mainly established to prevent monopolies and encourage vulnerable countries to exploit space resources. If vulnerable countries want to transfer exclusive rights over the reserved area, they should submit an application to the Authority, stating the reasons for the transfer and the use of the related income. The use of income should be related to space resource activities. ToR can only occur after the Authority provides its approval. The Authority taxes the income to ensure that the available benefits of ToR are lower than those of the exploitation channels. The related tax revenue, like the space mining tax, constitutes the funding sources of AoF. After the transfer, the vulnerable country cannot apply for another reserved area until the transferee's exclusive exploitation period for the reserved area expires. In particular, the Authority should take measures to facilitate transfers and prevent coercion, such as providing templates for transfer contracts, improving transparency of information on ToR, providing the latest mineral prices and historical transaction prices of ToR as a reference, and establishing an open auction platform.

6. CONCLUSION

The current study does not provide an in-depth analysis of the incentive mechanism of global commons governance, nor does it comprehensively discuss the economic incentive mechanism under the space mining regime. This paper argues that the incentive mechanism is essential to the commons governance regime of space resources and that the channels for accessing economic benefits would constitute a crucial incentive mechanism. Under the regime, the channels should conform to the common benefit principle and the

proportional principle. This paper summarizes the basic types of channels and their combinations. Nevertheless, the channels and their combination in previous studies and the latest international instruments do not fully conform to those two principles. Based on those principles, this paper put forward a new proposal containing four existing channels and a new channel. The advantages of these channels and the combinations lie in the higher level of diversification and differentiation, which can better realize those two principles. Specifically, the new proposal is conducive to incentivizing diverse countries to accept commons governance of space resources and encouraging space cooperation between different countries.

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