# Research on Asteroid Mineral Distribution Strategy Based on Global Fair Model

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**Abstract:** With the development of space exploration technology, more and more countries take the equity of asteroid mining into account. In order to make the asteroid mining industry truly benefit mankind, this paper focuses on the establishment of a global equity model. It takes the indicators including scientific and technological development in aerospace and other fields, carbon dioxide emissions, poverty eradication, hunger eradication, health and well-being, quality education, gender equality, climate action, marine environment, terrestrial ecology, and institutional justice as a reference to realize the evaluation of equity. First, what we need to do is to measure the concept of fairness. Equity refers to matching what a country gets with what it deserves rather than the same indicators assigned to everyone. Therefore, we need to quantify this allocation coefficient. The larger the coefficient is, the more resources it is worth. The first is to establish the distribution coefficient model. When constructing the index system, we consider many aspects such as population, economy, development, and region. Here, we need to use TOPSIS to solve the index's weight. At the same time, we need to consider the gap between the positive and negative of the index, rank, and calculate. The higher the score, the fairer. Then, we used the "wage distribution" model, which is how to distribute money (minerals), that is, the "whole planet." Here, in addition to considering the situation of each country, we also added the concept of "investment and income." Scientific and technological factors (number of universities or talents) and market consumption (consumption of minerals) are added to influence what asteroid mining might look like in the future. Finally, we believe that the core of the policy is the data behind it. Therefore, we will change the perspective of analyzing problems to maximize the benefits of all mankind, and shift the core of thinking from "fairness" to changing goals. To take a simple example, countries with advanced science and technology need more resources, which has nothing to do with their population, GDP, and other factors. Finally, we compare the benefit value after target transformation.

## 1. Introduction

With the increasing shortage of resources on earth, many countries have invested a lot of manpower and funds to develop space exploration to take the lead. The development of space science and technology has enabled mankind to break through the diaphragm of the atmosphere and rush to the universe.[1] The philosophical significance of space exploration lies in that it expands human cognitive objects and improves cognitive ability and changes human thinking mode and scientific research methods, and further confirms the knowability of the world and the nonlinearity of things' development. However, while space exploration brings new development opportunities to mankind, it may also bring new ethical problems to mankind.[2] For example, the military utilization and peaceful purpose of space resources, the common human ownership and "first boarding and first occupation" of space resources, the sharing of space exploration data and intellectual property rights, the conflict between astronauts defending national interests and serving the interests of all mankind, and the conflict between commercial interests of the space industry and public social welfare. The first way to solve the problem is to establish new ethics of coordinating national interests and human interests, and the second is to standardize the subject of space exploration and utilization practice.[3]

By discussing the philosophical significance and ethical issues of space exploration and the proposal of solutions, it aims to deepen the understanding of space exploration further, avoid vicious competition and predatory development, and guide the rational, orderly, and sustainable development of space exploration.[4]

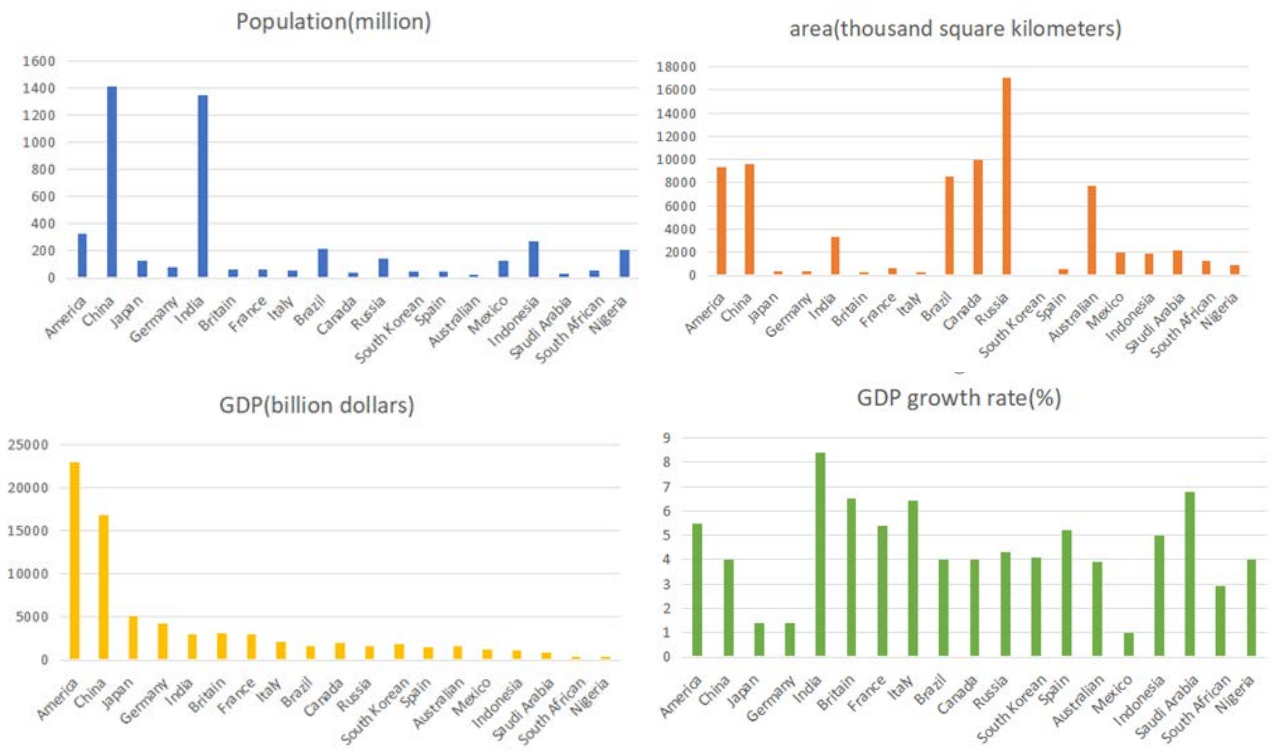
The outer space treaty and the moon agreement are the leading international treaties regulating the development of space resources.[5] They stipulate the development and utilization of space resources. They are of positive significance in regulating the development of space resources, but they also have deficiencies. Recently, the development of space resources involves a series of legal issues that need to be adequately solved, including the legal status of the moon and other celestial bodies, the legal nature and ownership of space resources, etc. The moon agreement has laid the foundation for the future space resource development system.[6] However, the international community urgently needs to reach a consensus on the future space resource development system.

## 2. Global Fair Evaluation Model Based on THE TOPSIS

We selected a total of 19 countries, namely the United States, China, Japan, Germany, India, the United Kingdom, France, Italy, Brazil, Canada, Russia, South Korea, Spain, Australia, Mexico, Indonesia, Saudi Arabia, South Africa, and Nigeria. These countries are distributed on six continents, including developed and developing countries. It has two-thirds of the world's population and four-fifths of GDP.

Global equity is a comprehensive issue, considering it from many aspects. At the same time, fairness is a relative concept. It is not equal to the absolute fairness between regions and individuals, but to allocate limited resources to people worldwide under a suitable distribution mechanism.

We selected six populations, area, GDP, GDP growth rate, human development level index, and life expectancy of the above 19 countries for comprehensive analysis. These indicators can comprehensively reflect a country's space occupation, economic vitality, and social development.[7]



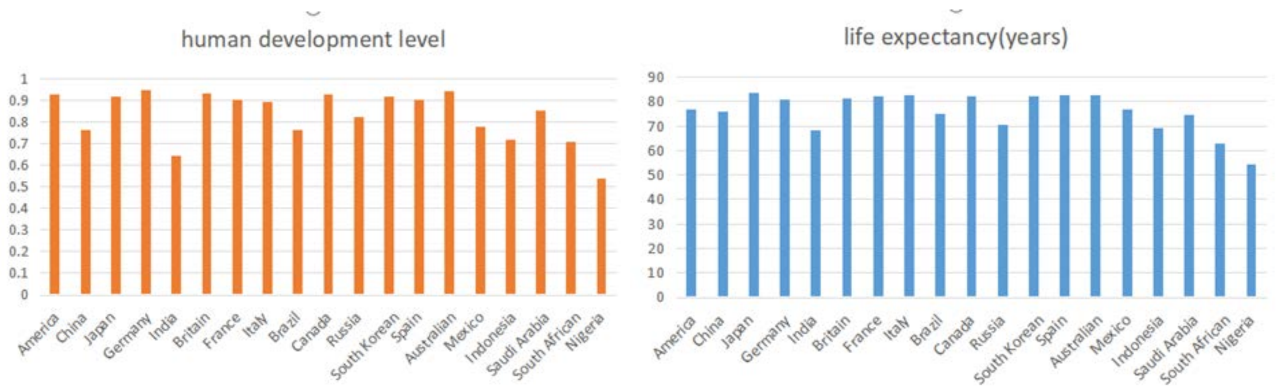


Figure 1. Evaluation indicators in different countries

In order to eliminate the order of magnitude difference caused by the unit of these data itself, we standardize this data matrix.

$$p_j' = \frac{p_j}{\sum_{i=1}^{19} p_j^2} \tag{1}$$

We can use the TOPSIS analysis method to score comprehensively.[8]

$$Z^+ = (Z_1^+, Z_2^+, \dots \dots, Z_6^+) \tag{2}$$

$$Z^- = (Z_1^-, Z_2^-, \dots \dots, Z_6^-) \tag{3}$$

Then the distance between the ith evaluation object and the maximum value is:

$$D_i^+ = \sqrt{\sum_{j=1}^{6} \left(Z_i^+ - z_{ij}\right)^2} \tag{4}$$

Between the ith evaluation object and the minimum value is:

$$D_i^- = \sqrt{\sum_{j=1}^{6} \left(Z_i^+ - z_{ij}\right)^2} \tag{5}$$

Then, it can get the score of the evaluation object:

$$S_i = \frac{D_i^-}{D_i^+ + D_i^+} \tag{6}$$

After normalizing this score, we get a fair distribution scheme of resources based on comprehensive factors such as population, overall economy, and average development level.

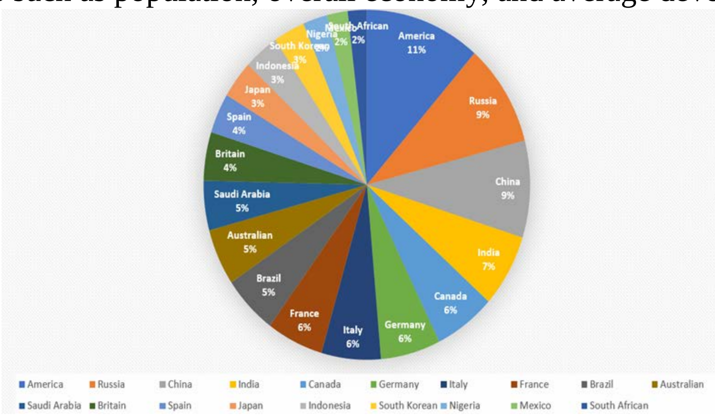


Figure 2. Resource fair allocation results

In this plan, we see that a developing country with a large population, such as India, should allocate a certain proportion of resources to maintain the survival level of its vast population. At the same time, a country with a large area and high per capita development level, such as Canada, can also allocate a considerable amount of resources to support high-quality social development.

## 3. Asteroid Investment Model Based on Technology Ability

Recently, asteroid mining still needs to overcome various difficulties, and overcoming these difficulties requires countries to invest a lot of money and talents in the aerospace industry, which corresponding benefits should compensate.

In the previous model, we only considered a fair evaluation model common to all kinds of resources in the current world. However, asteroid mining has its particularity, and it has a high scientific and technological threshold. Economic and technological powers often take on more efforts in this process, which means return.

Therefore, we should evaluate the investment of various countries in the aerospace industry.

Through the statistics of space development of various countries in the past few decades, we get the following figure.

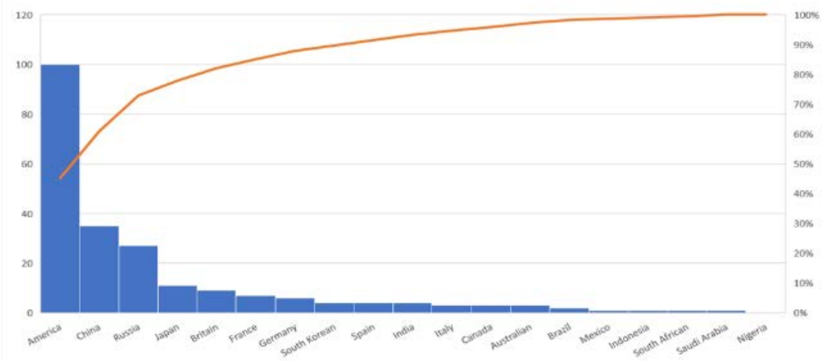



Figure 3. Different national aerospace development

According to the 80/20 principle, the United States, China, Russia, Japan, and the European Union (Britain, France, and Germany) have contributed the vast majority to human space exploration, and they should benefit from their efforts.[9]

Meanwhile, we found that although a large number of small and medium-sized countries have never carried out space exploration independently, they have also made achievements in the fields of artificial satellites through international cooperation, so we introduced the number of the world's top 1000 universities for scoring. We believe that the number of excellent universities can represent a country's contribution to science and technology.[10]

Based on the total scores of aerospace industry performance and academic science and technology, we get the investment proportion of various countries in asteroid mining as follows:

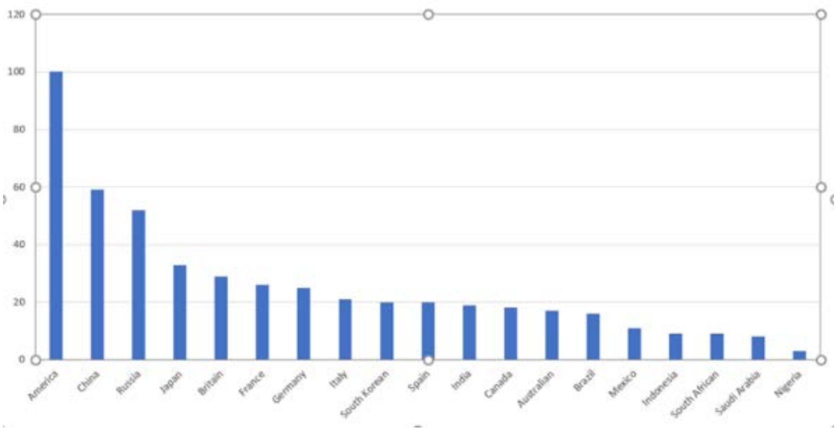



Figure 4. Investment in different countries

## 4. Asteroid Mineral Distribution Strategy Based on FairNESS and Interests

We can see a difference between the scheme I obtained with the goal of the survival and development of all mankind and scheme II obtained from aerospace development. The formulation of policies should consider the global fair distribution and the investment incentive. We have established the following model to find the balance between the two schemes.

We introduce two parameters: excitation parameters $\varphi$, Fair parameters μ.

The distribution of asteroid minerals will affect the economic growth by these two coefficients and the actual value of the allocated minerals.

With the increase of the actual value m of allocated minerals, the country's economy will rise, and the incentive parameters will increase φ will be about m positive proportional growth.

$$\varphi = \lambda m \tag{7}$$

However, when the actual value m of mineral resources allocated deviates from the country's reasonable allocation under the goal of the survival and development of all mankind, international cooperation will produce contradictions, barriers, and fair parameters μ. It will be reduced, and the country's economy will decline.

$$\mu = \frac{1}{m - m' + k} \tag{8}$$

Therefore, the model is:

$$\begin{cases} \dfrac{dy}{dt} = \dfrac{\lambda m^2}{m - m' + k} \\ \displaystyle\sum_{j=1}^{n} m_j = 1 \end{cases} \tag{9}$$

Through the calculation of the model, we get a distribution scheme that is most favorable to the overall development of the global economy. With the passage of time, the relative relationship between the economic and scientific, and technological strength of various countries will continue to change. We iterate the model in years to obtain the cumulative promotion of the distribution scheme to the economies of various countries in ten years and select the best distribution scheme as follows:

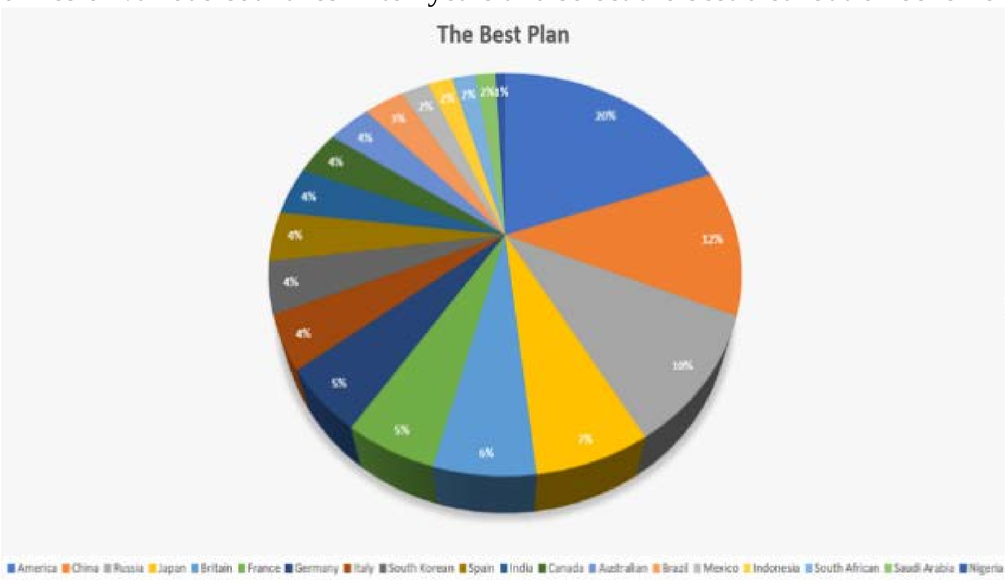



Figure 5. Best allocation plan

According to our model, under this distribution scheme, the total value of the U.S. stock market can rise by 22.8%, and the total value of the global stock market will also rise by 16.5%. A reasonable and fair distribution will play an essential role in promoting the stock market.

## 5. Conclusion

The fact that the development of outer space resources has become the primary concern of all States is directly related to the significant economic benefits that its development can generate. The issue of determining ownership of the recovery of outer space resources, promoted by the United States and Luxembourg, essentially represents the interests of the major space powers. Peaceful use and orderly exploration have always been the eternal themes in outer space. Thus, in determining ownership of recovered resources, States have a common interest in developing and ownership of outer space resources. The transfer and circulation of resources need the protection of international law. In addition, the author does not agree with the Chinese scholars' view of postponing the private development of outer space resources by us commercial aerospace.

On the contrary, the faster the PACE of commercial exploitation of outer space resources by the United States will promote the discussion among countries in the international legal system of outer space resources exploitation and accelerate the formation of a new legal system. U.S. space policy decisions are unlikely to be influenced by opposition from the international community, where the United States itself is the decision-maker in promoting and catalyzing the development of outer space resources. For this paper, from the perspective of national practice, it will be helpful to clarify the legal nature and national status of recovered space mineral resources as soon as possible and attract more aerospace companies to participate in the development of commercial aerospace.

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