ISSN 2616-5872 Vol.4, Issue 3: 22-26, DOI: 10.25236/AJEE.2022.040305

Research on the Fairness of the Asteroid Mining Industry Based on the Comprehensive Evaluation of the Harmonization Ratio

Weikang Su, Haobo Geng, Yan Peng

School of Information and Communication Engineering, Harbin Engineering University, Harbin, Heilongjiang, 150006, China

Abstract: *This paper makes a modeling analysis and research on the problem of asteroid mining. Firstly, we collected 4 indicators from 9 countries in the world, and then scored according to the entropy of these indicators and the representative data of the previous year. The rank sum ratio comprehensive evaluation method (RSR) of this method is quantitatively analyzed, and the national comprehensive score index (CSI) is obtained. The ranking is analyzed by using the ideas of linear regression and cluster analysis, and compared with the actual resource consumption ranking of various countries. Through clustering thinking, all countries are divided into mining leading countries (upstream), mining aid countries (middle reaches) and mineral processing countries (downstream) according to their development level, and the impact of this benefit distribution model on global equity is analyzed. Finally, we come to the conclusion that a country with a large population, high level of development and high status like the United States does need to consume more resources, which is a fair reflection.*

Keywords: *Asteroid mining; Rank sum comparison method; Construction of index system*

1. Introduction

With the development of economy and technology, the resources on the earth are decreasing year by year. In order to obtain more resources, human beings are eager to explore and use outer space, including the moon and other celestial bodies. The goal of the United Nations is to promote global equity and what will affect global equity as asteroid mining becomes possible in the future, so this paper models and analyzes the problem of asteroid mining.

2. Model preparation

2.1. Determination of indicators

The people's evaluation model (fairness within the country) selects the unemployment rate, urbanization rate, enrollment rate of colleges of higher learning, and gross mortality rate (per 1,000 people) as the secondary indicators. To explore whether fair distribution is equitable Resources, we selected nine countries, including USA, Germany, Korea, China, Russia, India, Brazil, Egypt, and Indonesia. The economic levels, geography, climate, and resources of these nine countries vary making our model more globally universal. The data corresponding to the above indicators are all from the World Bank public data [1].

2.2. Model overview

The global equity model first uses the entropy weight method to obtain the weight of each index, and then comprehensively evaluates each country based on the rank-sum method (WRSR), and sorts and divides the consumption levels. Finally, we compare the order of the nine countries with their actual resources consumption ranking to verify that the two rankings mentioned above are consistent. If the results are consistent, the model is correct.

ISSN 2616-5872 Vol.4, Issue 3: 22-26, DOI: 10.25236/AJEE.2022.040305

3. The People's Evaluation Model

3.1. Weight calculation of domestic indicators

First normalize the data corresponding to the four indicators of the nine countries, i represents the row the country and j represents the row index.

$$z_{ij} = \frac{Z_{ij} - \min(Z_{1j}, Z_{2j}, ..., Z_{nj})}{\max(Z_{1j}, Z_{2j}, ..., Z_{nj}) - \min(Z_{1j}, Z_{2j}, ..., Z_{nj})} \quad (1)$$

Then, calculate the proportion of each data in all the data of the corresponding index. Finally, we obtain the weights for each indicator in Figure 1:

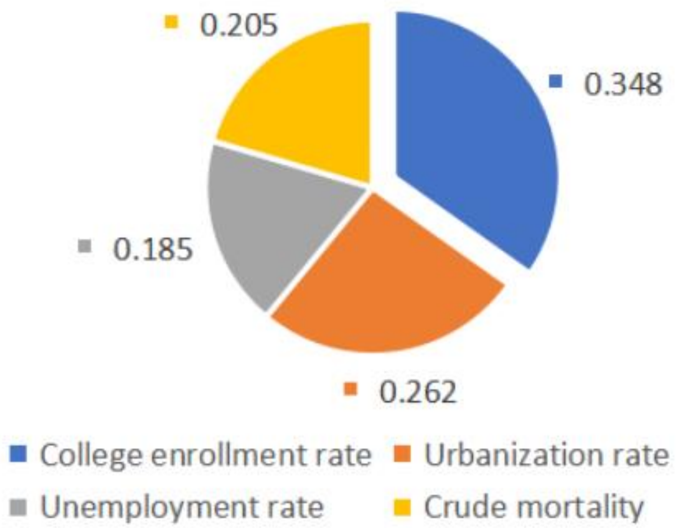

Figure 1: Weight of national internal indicators

We can see that the enrollment rate of colleges is the most weighted and the weight of urbanization is second. This is because the enrollment rate of colleges is directly related to the allocation of educational resources within the country, and the urbanization indicates the gap between the rich and the poor, which are fair, so the calculation results are reliable.

3.2. Domestic quantitative score

The non-integer rank sum ratio method [2] is an improvement of the whole rank sum ratio method to rank the index value to obtain the rank R [3]. Using the average of the rank has the advantage of not easy to lose the quantitative information of the original index value. First, constructed the data matrix:

$$\begin{bmatrix} Z_{11} & Z_{12} & \cdots & Z_{1m} \\ Z_{21} & Z_{22} & \cdots & Z_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ Z_{n1} & Z_{n2} & \cdots & Z_{nm} \end{bmatrix} \quad (2)$$

and n is the number of countries, namely, n=9, and m is the index number, m=4.

Then ask for rank:

$$R_{ij} = 1 + (n-1)\frac{\max(Z_{1j}, Z_{2j}, ..., Z_{nj}) - Z_{ij}}{\max(Z_{1j}, Z_{2j}, ..., Z_{nj}) - \min(Z_{1j}, Z_{2j}, ..., Z_{nj})} \quad (3)$$

Next, we will find the rank-sum ratio. Finally, WRSR was used to stall and rank the evaluation objects.

Table 1: Domestic quantitative score and ranking

Country	Domestic quantitative score (WRSR)	Domestic quantitative ranking
South Korea	0.972763309021514	1
America	0.824847492150741	2
Germany	0.738003926824319	3
Russia	0.712697010306327	4
China	0.648765649994401	5
Brazil	0.639109015502175	6
Indonesia	0.567268607047949	7
Egypt	0.463638803682983	8
India	0.350844412010924	9

4. Global equity model

Using entropy method to evaluate seven indicators of fairness between countries (land and Marine protection area rate, total population, patent applications [4-6], GDP, R & D spending (proportion of GDP), domestic score, international crime rate) of the weight of figure, it is worth noting that the international crime rate as a negative index.

$$z_{ij} = \frac{\max(Z_{1j}, Z_{2j}, ..., Z_{nj}) - Z_{ij}}{\max(Z_{1j}, Z_{2j}, ..., Z_{nj}) - \min(Z_{1j}, Z_{2j}, ..., Z_{nj})} \tag{4}$$

Conisotrend session, then sorted by WRSR and calculated average rank R−. List the frequencies *f* and calculate the cumulative frequencies for each group [7-9]. The group frequencies *f* is listed and the cumulative frequencies of each group are calculated, and the downward frequency *f*′ is calculated. Converts the cumulative frequency to probability unit Probit values.

Linear regression model was established, with probit value as the independent variable and WRSR as the dependent variable, with the results presented in Table.2.

Table 2: Linear regression

		Unstandardized Coefficients	Standardized Coefficients	*t*	*p*	VIFd	R^2	Adjusted R^2	F
		B	Standard error						
Constant	-0.617	0.122	-	-5.07	0.001***	-	0.909	0.896	F=69.87
Probit	0.192	0.123	0.953	8.359	0.001***	1			P=0.000***
Dependent variable WRSR									

From the testing analysis of F, a P value of 0.000*** so the level was significant. R^2 was 0.909, so the model fit met the requirements. The VIF of less than 10 has no multilinearity problem, and the model is well structured.

Figure 2: Fit the renderings

The Porbit cutoff was taken into the regression model to calculate the WRSR cutoff value (fit value) and obtain the stall rank cutoff Table 3. The WRSR fit values calculated by the regression equation and the WRSR critical fitting values in Table4 were interval compared, yielding the classification rank level Table 4. Larger the Level value indicates that the higher the classification level, the better the benefit.

ISSN 2616-5872 Vol.4, Issue 3: 22-26, DOI: 10.25236/AJEE.2022.040305

Table 3: Ffile sorting critical value

The table of threshold values for the classification sort			
level	Percentile threshold	Probit	WRSR fitting critical value
Level 1	<15.866	<4	<0.1514
Level 2	15.866~	4~	0.1514~
Level 3	84.134~	6~	0.5354~

Table 4: Summary of the classification and grade results

Country	Rank	Probit	WRSR Regression	Level	Resource consumption
America	1	6.915	0.711	3	High consumption
China	2	6.221	0.578	3	
Germany	3	5.765	0.490	2	General consumption
India	4	5.431	0.426	2	
South Korea	5	5.140	0.370	2	
Brazil	6	4.860	0.317	2	
Russia	7	4.567	0.261	2	
Indonesia	8	4.235	0.197	2	
Egypt	9	3.779	0.191	1	Low consumption

Figure 3: Nine countries ranked

Figure 4: Grading results

Country ranking shown in Figure 3 and rank results in Figure 4. Larger the Level value indicates that the higher the classification level, the better the benefit.

5. The impact of asteroid mining on global equity

In this paper, the mining capacity of nine countries is clustered by clustering thought, and it can be considered that all countries can be divided into three levels. The result is shown in figure 5. We can analyze that, given the limited level of space, asteroid mining can only be achieved by a few mining-dominant countries. However, global economic integration has become a general trend, and no country can accomplish all tasks on its own.

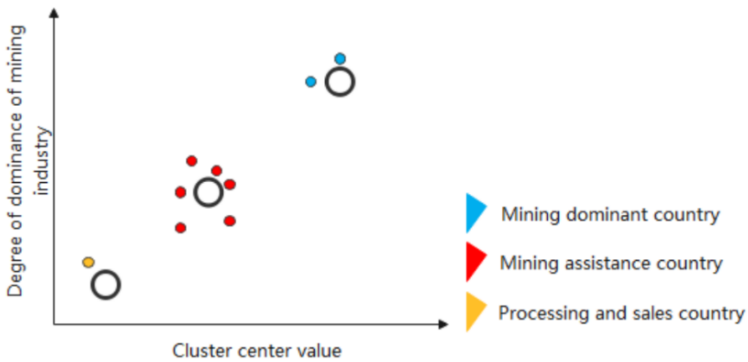

Figure 5: Mining capacity classification

Asteroid mining is similar to high-tech industry, and the industrial chain involves countries with different levels of development. Developed countries are responsible for the research and development of asteroid mineral mining technology, and provide equipment to collect mineral resources to Earth, and then transport them from developing countries to Earth for mineral processing, such as crushing, smelting, etc. The products are eventually produced by an industrial chain of high-end products such as iPhones.

We can predict that when the asteroid mining industry develops in the traditional industrial chain, developed countries will firmly occupy the vast majority of profits. This way of interest distribution will exacerbate the global injustice, because developed countries master key technologies and occupy the upstream and downstream of the industrial chain, which are the two parts of the highest profits, while developing countries can only complete the middle link with lower profits. Just as high-tech industries will exacerbate global distribution inequality.

6. Conclusion

Global equity is an important topic in the process of human development, so this paper collects relevant economic indicators, and then carries on the quantitative analysis of rank sum ratio comprehensive evaluation method (RSR), and obtains the national comprehensive score index (CSI). The ranking is analyzed by using the ideas of linear regression and cluster analysis, and compared with the actual resource consumption ranking of various countries. It is concluded that a country with a large population, high level of development and high status like the United States does need to consume more resources, which is a fair reflection.Finally, it analyzes the impact of asteroid mining on global equity, and concludes that asteroid mining will exacerbate global inequity.

References

[1] https://data.worldbank.org.cn/.

[2] Tian Feng tune. Rank-sum ratio method and its application [M]. Beijing China Statistics Press, 1993.

[3] Luo Y onggang. (1988). Outlook to solve the future mineral resources demand problem. Geology of China (07), 25-27.

[4] Zhang Kewei, Li Huaizhan, Wang Yunjia, Deng Qizhong, Li Changgui, Wang concentration... & Yang Yang. (2020). Current status, opportunities and challenges of space mining. Journal of China University of Mining and Technology (06), 1025-1034. doi: 10.13247/j.cnki.jcumt. 001165.

[5] STRANBROPHY J R, MUIRHEAD B. Near-earth asteroid retrieval missionARMstudy[C]// 33rd International Electric Propulsion Conference. USA [s.n.], 2013.

[6] GE N, LANDAU D, LANTOINE G, et al. Overview of mission design for NASA asteroid redirect robotic mission concept [C]//33rd International Electric Propulsion Conference. Washington USA [s.n.] 2013.

[7] Feng J C , Yang S T . Research on Excess Return Distribution of PPP Traffic Project Based on the Theory of Fairness Preference[J]. Soft Science, 2017.

[8] Deng Julong. Gray prediction was compared with gray decision-making [M]. Wuhan: Huazhong University of Science and Technology Press, 2002

[9] Zhang Jing. (2010). On the International System Guiding the Development of natural resources in Outer Space (Master's dissertation, diplomatic college). https://kns.cnki. net/KCMS/detail/detail.aspx? dbname=CMFD2011&filename=2010243832.nh.