ISSN: 2664-9640

Design of Allocation Algorithm in Space Exploration

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Abstract

As the space that has not been completely occupied by human beings, how we should allocate space resources has become a big problem. Those who can do more work will get more work. According to this definition, we use TOPSIS Model Based on entropy weight method to calcu-late a country's strength score and the score of harvested resources respectively, and divide them to obtain the matching coefficient of the country. Then, the equity coefficients of various countries are fused to be the global equity coefficient. After that, we calculated the global equity index of these six groups of data in two different time periods, and got two values (0.865, 0.804) and verified the correctness of our model. We design a set of theoretically feasible rules to meet the vision of asteroid mining. Through calculation, the addition of asteroid mining will reduce the coefficient of global equity, which is also in line with the expectation of our team. In order to analyze the causes of this phenomenon, we select four variable categories from our model for analysis, use the control variable method to explore the impact of the change of each factor on the global equity index, analyze the phenomenon in combination with social reality, and give four conclusions on how to affect equity. Through model simulation, we have verified that they are of positive significance in promoting social equity.

Keywords

TOPSIS Model Based on entropy weight method; Global equity; Asteroid mining; Performance distribution model.

1. Introduction

Public resources are limited. When international public resources are occupied and used, the international community will have the consequences of insufficient supply of public resources. This may lead to two negative consequences: first, the problem of over exploitation, that is, the competitive use of public resources, which leads to the excessive consumption of resources because of its non exclusivity, and then leads to the imbalance of ecological environment, which is the "tragedy of public land"; Second, countries compete for public wealth, which leads to the turbulence and unrest of the international order, which in turn leads to the inefficient use of resources, which is what we call the "dilemma of collective action". These two negative effects can be classified as the allocation of international public resources, which is not only reflected in the competition for public resources such as high seas fisheries and Antarctic minerals, but also in the solution and treatment of seabed resources and outer space problems. Therefore, in order to avoid the occurrence of "public land tragedy" and "collective action dilemma", we must restrict and regulate the distribution of public funds through an external institutional force. [4]

ISSN: 2664-9640

Our method can effectively eliminate the competitiveness and exclusivity, and fundamentally eliminate the disputes caused by the uneven distribution of resources.

Firstly, based on literature review, we have a preliminary understanding of asteroid mining. Then, we decide to use TOPSIS Model Based on entropy weight method. Secondly, we use our model to select some representative countries for substitution analysis, and select 2008 and 2020 to verify the model. Then, we will establish the model of asteroid mining, deduce the theoretical value, and bring it into the initial model to get a global fair evaluation. Then we make a special analysis based on the changes of several variables and draw conclusions. Finally, combined with the existing conclusions, we provide valuable opinions for the UnitedNations.

2. Methods

2.1. Notations

The key mathematical notations used in this paper are listed in Table 1.

Table 1: Notations used in this paper

Symbol	Description	Unit
σ_i	A country's equity index	
α_i	National power score	
β_i	National resources score	
SSE	The sum of squeres due to error	

2.2. Data Description

Through our website, we found 12 sets of data for 9 countries, of which the data for 2008 was compared with the data for 2020. They are GDP per capita, number of Nobel Prize winners, foreign exchange savings, total population, carbon emissions per capita, and land area. Since the specific values in the data cannot find the law, they are omitted. From the table, we can see that each country is not fully developed, and there will always be certain shortcomings in some aspects.

2.3. Global Equity Assessment Model

Global equity refers to through the reasonable allocation of resources and mobilize, to distribution according to work, each country almighty much, the condition of the poor countries, both at the same time caused by narrowing the existing global economic order developed with home and the gap between the rich and the poor in developing countries, economic globalization and endowed with the connotation of social justice and reflect human universal moral standards, achieve win-win co-existence. Simply put, global equity is the matching of national power with corresponding national gains. Ensure rationalization of resource allocation. Our evaluation model is mainly divided into two parts, which are evaluated from two aspects: national strength and national income. The stronger the assessed country is, the higher the corresponding national income is, the fairer the resource distribution of the country is. Finally, the matching degree of multiple countries is integrated to obtain the final global fair result.

ISSN: 2664-9640

A country's equity index σ_i is equal to the country's national power score divided by the corresponding resource allocation score.

$$\sigma_i = \frac{\alpha_i}{\beta_i} \tag{1}$$

Global Equity Index

$$\sigma = \sqrt[n]{\sigma_1 \sigma_2 \cdots \sigma_n} \tag{2}$$

2.4. Topsis model based on entropy law

According to the explanation of the basic principle of information theory, information is a measure of the order degree of the system, and entropy is a measure of the disorder degree of the system; According to the definition of information entropy, for an index, the entropy value can be used to judge the dispersion degree of an index. The smaller the information entropy value is, the greater the dispersion degree of the index is, the greater the impact (i.e. weight) of the index on the comprehensive evaluation. If the values of an index are all equal, the index will not play a role in the comprehensive evaluation. Therefore, information entropy can be used to calculate the weight of each index, so as to provide basis for multi index comprehensive evaluation.

We establish a matrix X for the indices

$$Z = \begin{vmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & x_{22} & x_{23} \\ \vdots & \vdots & \vdots \\ x_{i1} & x_{i2} & x_{i3} \\ \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & x_{n3} \end{vmatrix} \tag{3}$$

Where Xij(i = 1 ~ n, j = 1 ~ 3) represents the value of the j-th index at the i-th country.

In order to eliminate the influence of different dimensions of indices, we standardize the matrix.

The unnormalized score of the ith evaluation object can be calculated by using the same method to obtain the strength score and resource allocation score of each country, and then the evaluation value of global fairness can be obtained through formula (1) and (2).

Here we select data from several countries for specific verification. The global fairness in 2008 and 2020 were obtained by the above methods. The global fairness in 2008 was 0.865, and the global fairness in 2020 was 0.804. There is a certain gap between the two sets of data, but according to the actual situation, we find that due to the rapid development of modern economy, the economic gap between countries is getting bigger and bigger. Therefore, the relative decline of our global equity index is acceptable, so the model test conforms to the actual situation.

3. Experiments

To explore how changes in the asteroid mining industry affect global equity, we can do so by changing the different ways in which asteroid mining is affected. We found 4 variables whose variations could have an impact on the assessment of global equity: the market share of

ISSN: 2664-9640

countries, the average cost of asteroid mining, the proportion of UN taxes in the mining process, and the proportion of UN taxes allocated to countries. Then, according to the way of controlling the variables, the gradient changes the variables, and brings the changes into the designed asteroid mining model, the assessment of global fairness is obtained, and then the scatter plot is made, and the corresponding fitting curve is made using the fitting algorithm, so as to obtain the correlation degree between the variables and global fairness.

Table 2. The sum of squares and goodnes

	Japan	China	United States	United Kingdom
SSE	1.237×10^{-8}	7.121×10^{-9}	1.205×10^{-8}	1.982×10^{-8}
R^2	0.9977	0.9983	0.9999	0.9995

	France	Tax rates	Proportion of tax distribution
SSE	6.796×10^{-8}	1.1222×10^{-6}	5.701×10^{-8}
R^2	0.997	0.9999	0.9991

Chart: The sum of squares and goodness of fit (R*R) of errors calculated after fitting a curve

The closer the sum of errors to squares (SST) to 0 and the closer the goodness of fit (R*R) to 1, the better the fit curve of the article. The two error indicators generated by the data we fitted are within the range where we can determine that the fit is perfect, so we have reason to believe that the fitted curve truly reflects the actual situation. By changing on [-3.5%, 3.5%], we bring in the model and plot the scatters, using fitted algorithms to explore the impact of the changes on global equity.

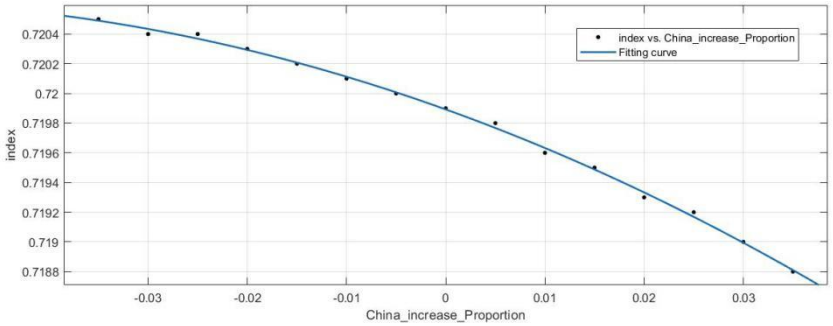

Figure 1. The proportion of the Chinese market has changed

The fitted curve of the plot is： f(x)=-0.1978x^2 +0.024x +0.7199

The chart reflects that when China's market share grows from small to large, the global fairness index will decline, which is negatively correlated, and in the range of 3.5%, as the market share increases, the decline rate of the global fairness index gradually accelerates.

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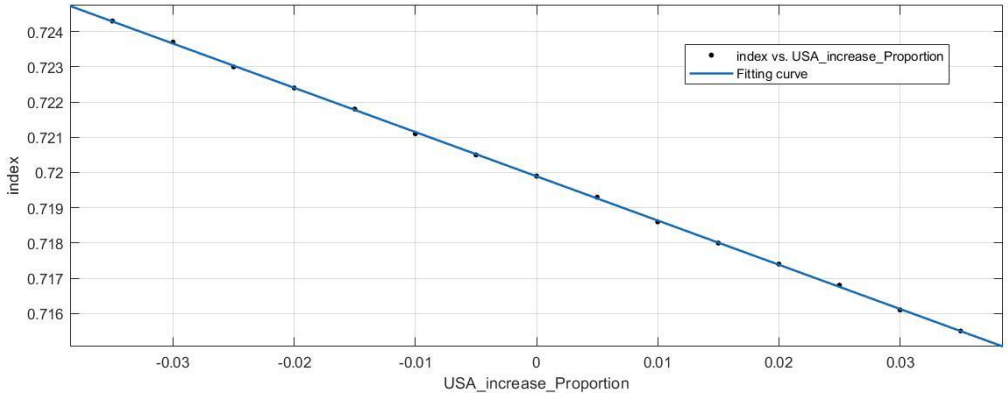

Figure 2. Changes in the U.S. market share

The fitted curve of the plot is： f(x)=-0.1256x +0.7199

The chart reflects that when the market share of the United States grows from small to large, the global fairness index will decline, which is negatively correlated, and in the range of 3.5%, the decline rate of the global fairness index will remain basically unchanged as the market share increases.

4. Analysis and Discussions

4.1. Strengths and Weaknesses

The stability of the model is very important. This is related to whether the model will change due to the interference of other factors. In order to test the sensitivity of our model, we choose to conduct sensitivity analysis in the model we established to evaluate world equity. We increased the government's tax proportion, the United Nations tax proportion, transportation cost (unit / USD 100 million), the Chinese market share, the American market share, the Japanese market share, the British market share, and the French market share by 2%, 2%, 2%, 0.5% and 0.5% respectively, and used the control variable method to bring them into our model one by one under the condition of controlling other variables unchanged. It can be seen from the figure that when we increase the tax proportion of the government, the tax proportion of the United Nations, the transportation cost (unit / USD 100 million), the proportion of the Chinese market, the proportion of the American market, the proportion of the Japanese market and the proportion of the British market by 2%, 2%, 2%, 0.5% and 0.5% respectively, the change range of the equity index level is very small and within the acceptable range. Therefore, we can think that our model is stable and can solve practical problems.

The relatively small amount of data we were able to find could lead to a lack of comprehensive response to the problem, so that we might not be able to fully summarize the factor of impact on asteroid mining. The conclusions we have reached, although based on known data, are somewhat idealistic on some issues, ignoring the special situation of a few countries.

4.2. Further Discussion

There is not enough data involved in our model, and more indicators can be found to add to make the model's evaluation of the World Fairness Index more comprehensive and accurate, and reduce unnecessary interference. Some mining specific scenarios can be refined so that more factors that may affect global equity can be discovered. Our model can not only effectively judge the problem of asteroid mining, but also can be used for the equitable distribution of international resources, which has great use value.

ISSN: 2664-9640

5. Conclusion

Our model can be used to effectively quantify world equity, and our asteroid mining program employs an authoritative theory that prioritizes fairness, effectively balancing the relationship between fairness and efficiency. Using models, we found that if asteroid mining were possible, it would have a greater impact on global equity, especially in weak countries. In the current international situation, there are some superpowers, and the global fairness index is impossible, asteroid mining will increase this gap, we can only find ways to reduce this gap, can not inhibit this gap continues to increase.

But I know that our mining program definitely has a lot to improve, there are many places that have not been taken into account, we have no way to completely and fairly allocate space resources, only to achieve relative fairness, can let all countries get benefits, but there is no absolute guarantee that their interests will not be infringed, their weak strength, determines their interests are embezzled This unchangeable fate.

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