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Global Equity Assessment of Asteroid Mining

Summary

The emergence of asteroid mining brings new resource allocation problems, which will further affect the issue of global equity. The paper aims to define a new global equity, analyze the impact of asteroid mining on global equity, and formulate effective policies to improve equity.

Firstly, we select five comprehensive evaluation indicators of economy, technology, education, labor resource and natural resources to define global equity as a whole. In order to evaluate global equity concretely, we use the **entropy method** and **the coefficient of variation method** to create a Global Equity System Model (**GESM**), and finally divide the evaluation into three levels through **cluster analysis**. To demonstrate the feasibility of the model, we conduct specific regional equity assessments for four continents. The percentages of unfair are: 20% in Europe, 30% in America, 50 % in Asia and 66.7% in Africa.

Secondly, owing to the asteroid mining, we reconstruct the GESM. The three aspects of economy, technology and natural resources are preserved through **grey relational analysis**. So as to ensure the accuracy of equity assessment by GESM, the degree of monopoly is introduced as an inequity factor to establish the Optimized Global Equity Model (**OGEM**). The percentages of unfair are: 10% in Europe, 56% in the Americas, 63.3% in Asia and 80% in Africa. Asteroid mining exacerbates the internal inequity of each continent.

Thirdly, a Global Equity Analysis Model (**GEAM**) is developed to analyze the effects of selected factors on the final equity using the control variable method and **the neural network autoregressive method**. The visualization of the final analysis results shows that economy, technology, resources and global equity are positively correlated, while monopoly degree is negatively correlated with global equity.

Finally, based on the sensitivity and robustness analysis, our recommendations are:

1. Prohibit illegal possession and allow global participation.
2. Establish a new asteroid mining technology sharing way.
3. Take anti-monopoly measures.

Keywords: global equity, asteroid mining, entropy method, neural network autoregression

Contents

1 Introduction

1.1 Problem Background

With the progress of science and technology and the gradual augment of the population, the demand for natural resources has become higher and higher, especially in recent centuries. In addition, the intensity and speed of the exploitation of natural resources have increased sharply. So it is necessary to consider the feasibility of resource exploitation in external space. Space engineering has been able to reach the outer space of the earth in the last century with the development of human spaceflight technology. Therefore, most countries in the world signed the "Outer Space Treaty" issued by the United Nations in 1967. The treaty states that no country could use or occupy outer space, including the moon and other celestial bodies according to the global equity [1].

Huge cost and economic feasibility are both issues that need to be considered in asteroid mining. Despite the guarantees of the Outer Space Treaty, the development of asteroid mining will inevitably lead to global inequity. Therefore, it is necessary to research the issue of asteroid mining around the concept of "global equity".

1.2 Restatement of the Problem

Based on the description in the problem background, we establish some mathematical models to solve the following problems:

(1) Define global equity, establish a mathematical model, measure global equity, and verify the established model.

(2) There are many unknown conditions for the development of asteroid mining, such as the determination of developers, the way to obtain funds, and the attribution of the benefits of mineral mining. Based on the global equity model established in Question (1), a possible future small-industry working model of planetary mining industry is proposed, and the affects on global equity is analyzed.

(3) The future operation mode of the asteroid mining industry proposed in question (2) will select some conditions, and try to establish an analytical model to analyze the impact on global equity when these selected conditions change.

(4) It is assumed that the United Nations will update and revise the Outer Space Treaty to resolve the issues related to asteroid mining, so that it can benefit all mankind. We try to put forward reasonable policies for this move, and encourage relevant departments to promote the development of asteroid mining, so that it can generate global benefits.

1.3 Our Work

We create a Global Equity System Model (GESM) using the economy, technology, education, labor resources and natural resources as evaluation indicators. And through the entropy method and the coefficient of variation method to give weights to them, so as to achieve a quantitative comprehensive index. After cluster analysis, three levels of equity, relative equity and lack of equity were determined. Statistics on equity across continents. After considering the new mining method of asteroid mining, we adjust the influencing factors, and retained the three angles that contributed the most to fair evaluation in GESM through the grey relational analysis method GESM is reconstructed, and the reconstructed model is OGEM. To analyze the impacts of changes in economics, technology, resources, and monopoly degrees on the future vision of asteroid mining about global equity, we use the control variables approach and neural network autoregressive method to develop a global equity analysis method (GEAM), and analyze the effects of selected factors on the final equity one by one. Finally, the sensitivity and robustness of OGEM and GEAM are verified, and directions for improvement are proposed.

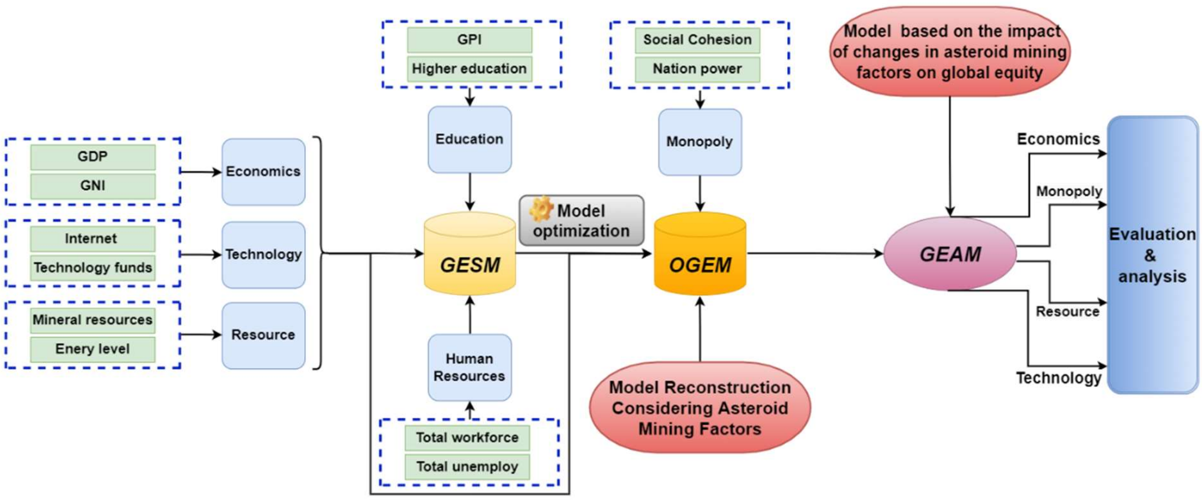

Figure 1: The overall Flow Diagram

2 Assumptions and Justifications

To simplify our model, we make the following assumptions and test for plausibility:

The issue of global equity is a complex international comprehensive issue. Considering that the evaluation of equity in the daily evaluation system has different indicators in different fields, it involves politics, economy, ecology, technology, population, education and many other disciplines to quantify global equity. We can't fully take every factor into account, which complicates the problem.

Therefore, we will make the following assumptions and test their plausibility.

Assumption 1: The collected data are reliable.

Justification: The data we select are all from the databases of relevant international organizations, so it can be considered that these data are consistent with objective facts.

Assumption 2: In the establishment of the model, we only include the main factors into the evaluation system, and consider that there is no mutually restrictive nonlinear relationship among main factors.

Justification: Secondary factors have little impact on the results. If all factors are considered, the model complexity will further increase, which is unbeneficial to our analysis of the problems. The secondary factors are removed and only the main factors are kept. At the same time, so as to facilitate the model to solve practical problems, we consider that the nonlinear relationship among various factors can be ignored.

Assumption 3: In the analysis process, so as to make the analysis results more accurate, we decided to treat North America and South America as a whole for statistics, which is helpful for us to objectively evaluate the authenticity of the model.

Justification: The area distribution of North American countries is extremely uneven. The United States, Canada and Mexico occupy most of the area with great differences in the comprehensive national strength. Therefore, if North America is evaluated as a single state, there will be too large differences in unfairness, which does not represent the overall situation of the entire continent. So we consider that combining North and South America into the America will help us obtain more objective evaluation and analysis.

Assumption 4: We randomly select 30 countries from each continent to represent the overall situation of the continent. We assume that random sampling can objectively represent a class of characteristics.

Justification: The main advantage of random sampling is that the samples drawn are random. From the perspective of probability theory, we believe that such samples can not only objectively evaluate the overall situation, but also calculate the error caused by sampling. This facilitates our analysis of reliability. Therefore, we think this sampling method is also reasonable.

3 Notations

The key mathematical symbols used in this article are shown in the table below.

Table 1: Notations used in this paper

Symbol	Description
x_i	The i-th evaluation index
x_{ij}	The i-th evaluation index of the j-th sovereign country
y_{ij}	The i-th normalized evaluation index of the j-th sovereign state
w_i	The weights of the initial 10 evaluation indicators
X_i	The i-th comprehensive evaluation index
W_i	The weight of the i-th comprehensive evaluation index
Q_j	The j-th sovereign state
$\zeta_i(k)$	The k-th correlation coefficient between the i-th subsequence and the parent sequence
r_i	The i-th subsequence and the parent sequence

4 Global Equity Model

4.1 Indicator Selection

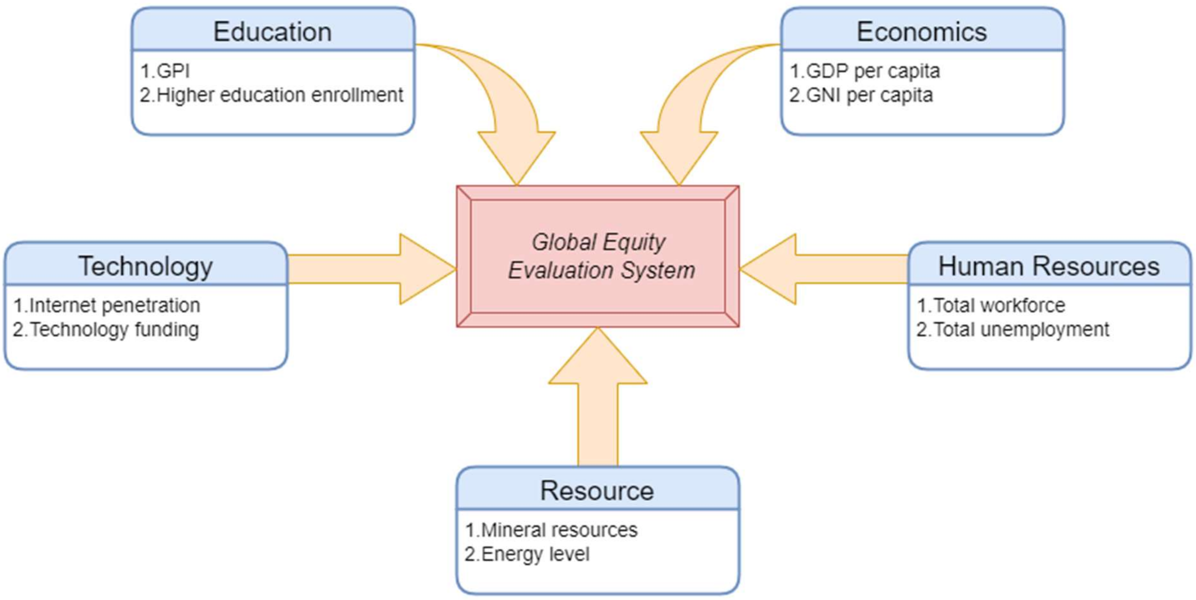

Figure 2: Establishment process of evaluation system

From the five perspectives of education, economy, resources, human resources, and science and technology, the model defines 10 related indicators. The background of the topic is asteroid mining. Therefore, mineral resources are selected as one of the indicators of resources.

(1) Education: We think that education can better reflect the equity of a region, and the level of education can reflect the most basic local equity. Therefore, we adopt School enrollment, primary and secondary (gross), gender parity index (GPI) and the enrolment rate of higher education as a measure of equity in education.

(2) Resources: Natural resources are the basis of a country's development, and various natural resources need to be rationally developed and utilized from the viewpoint of sustainable development. Combined with the assumption background of this question, we choose ore resources and energy level as the measure of natural resources. The basis of per capita natural resource possession is the basic natural resource reserves of each country. If natural resources are relatively scarce, it is natural that everyone’s needs cannot be taken into account, so it is difficult to ensure the equity of resource distribution.

(3) Economy: The degree of economic development affects all aspects of today's countries. With a high degree of economic development, the corresponding material resources are abundant, and everyone's basic needs can be met, which can avoid the distribution of personal material caused by the economy to a greater extent of unevenness. There are many ways to measure economic indicators. We use the most traditional GDP and GNP, which together form an indicator of economic development.

(4) Science and technology: The progress of science and technology promotes the development of all walks of life. The development of science and technology can firstly expand employment positions and provide more people with a fairer employment environment and opportunities. At the same time, with the development of science and technology, medical and other series of infrastructure construction will develop rapidly, which can create the richness of basic social security to a greater extent and provide more convenient choices for more people. From the perspective of today's development, Internet technology is the trend of development, so the investment of technology funds and the development of the Internet can represent the level of a country.

(5) Human resources: Human resources actually reflect equity. Lower unemployment and higher labor are generally considered to be the driving force for national development. Although lower unemployment is not absolutely related to high-quality employment, but on the whole, countries with low unemployment rate have more jobs, and people can choose employment freely and equally.

4.2 Determination of indicator weights

Next, we need to determine the weight of the evaluation indicators defined in the first subsection, and we use the entropy method to determine. The entropy value can be used to judge the randomness and disorder degree of an event, and it can also be used to judge the degree of dispersion of an index, and then measure the degree of influence of the index on the comprehensive evaluation according to the degree of dispersion [2].

The entropy method is an objective method of assigning values, so the results obtained are more accurate and can better explain the results we get.

First, we need to standardize the 10 evaluation indicators of a total of 120 sovereign countries, denoted by $x_i\,(i \in [1,10])$, each of which x_i is subdivided into 120 values , denoted by $x_{ij}\,(i \in [1,10], j \in [1,120])$, which x_i representing the i-th evaluation index and x_{ij} representing The value of the i-th evaluation index of the j-th sovereign country is substituted into the following calculation formula, and then we can obtain the standardized value y_{ij} of each evaluation index of each selected country.

$$y_{ij} = \frac{x_{ij} - \overline{x_i}}{S_{\mathrm{td}}} \tag{1}$$

which S_{td} represents the standard deviation of x_{ij}.

In information theory, entropy is a measure of uncertainty. The greater the amount of information, the smaller the uncertainty and the smaller the entropy. If the system has n different states under the i-th evaluation index, each state appears the probability of P_{ij} and P_{ij} satisfying the condition of $0 \le P_{ij} \le 1, \sum_{j=1}^{n} P_{ij} = 1$,therefor we can evaluate the entropy of the system as:

$$E_i = -K \sum_{j=1}^{n} P_{ij} \ln P_{ij} \tag{2}$$

In which:

$$K = \frac{1}{\ln n} \tag{3}$$

Calculating the information entropy E_i of each evaluation index, the following formula is used to further calculate the weight of each evaluation index w_i.

$$w_i = \frac{1 - E_i}{\sum_{i=1}^{10} (1 - E_i)} \tag{4}$$

Based on the weights of the ten evaluation indicators obtained above, five comprehensive evaluation indicators of the second layer are established on this basis:

$$X_i = \sum_{j=1}^{120} w_{2i-1} y_{2i-1j} + w_{2i} y_{2ij}, (\mathrm{i} = 1,2,3,4,5) \tag{5}$$

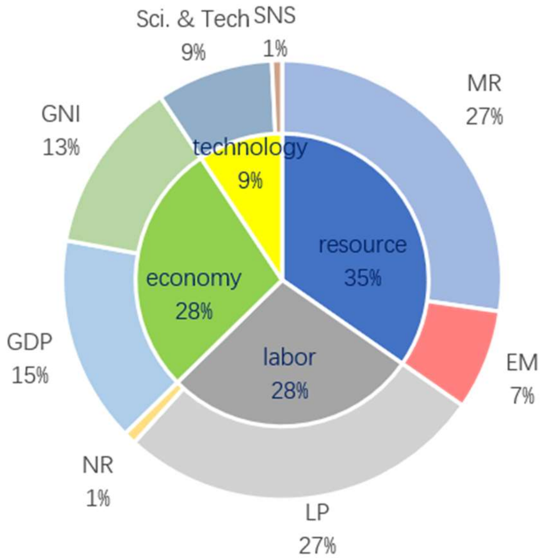

Figure 3: First-level weight and second-level indicator diagram

The purpose of obtaining these five comprehensive evaluation indicators is to use the coefficient of variation method to obtain the weights, and then use the method of weighting and merging to generate the final and unique comprehensive evaluation indicators corresponding to each country as a standard for measuring global equity. Here is a brief introduction to the coefficient of variation method:

Obviously, the dimensions of each index in the five comprehensive evaluation indexes obtained are different, and it is not suitable to directly compare the degree of difference. In order to eliminate the influence caused by the different dimensions of each evaluation index, it is necessary to use the coefficient of variation of each index to measure the degree of difference in the value of each index. The formula for the coefficient of variation is as follows:

$$V_i = \frac{\sigma_i}{X_i} \tag{6}$$

In which V_i represents the coefficient of variation of the i-th index and σ_i represents the standard deviation of the i-th index, and then the following formula can be used to calculate the weight of each evaluation index:

$$W_i = \frac{V_i}{\sum_i^5 V_i} \tag{7}$$

After the weights are obtained, the global equity index of 120 countries can be obtained

$$Q_j = 100\sum_{i=1}^{5} W_i X_i, \left(j = 1,2,3,\cdots,120 \right) \tag{8}$$

4.3 Fuzzy Cluster Analysis

The final score of each country's equity through calculation. Since global equity is a new evaluation system proposed by us, it does not have a specific score as the difference between pass and fail like regular test scores. Therefore, so as to make the similarity between the same classes as large as possible after classification, and at the same time, the objects that are not in the same class have obvious differences, we use the clustering method for classification. In the common clustering method, we use K-Means clustering method, which is easy to understand and implement, and its biggest advantage is that it can converge quickly [3].

In order to easily understand the implementation of the algorithm, we have adopted a pseudo-code representation as follows:

```
    INPUT:
    Raw_data:{Datasets that need to be clustered}
    Create k points as starting centroids (chosen randomly)
    While(The cluster assignment result of any point changes):
      For all data in Raw_data:
        For all each centroid:
          Calculate distance between centroid and data point
        Assign a data point to its closest cluster
      For each cluster:
        Find the mean and update it to the centroid
    End
OUTPUT
```

Calculate the equity of the 120 extracted countries (120 are divided into 30 in Asia, 30 in Europe, 30 in North and South America, 30 in Africa and 30 in the Middle East), and use the fuzzy cluster analysis to divide the country's equity into three categories: excellent equity, lack of equity, relative equity Specifically as shown below:

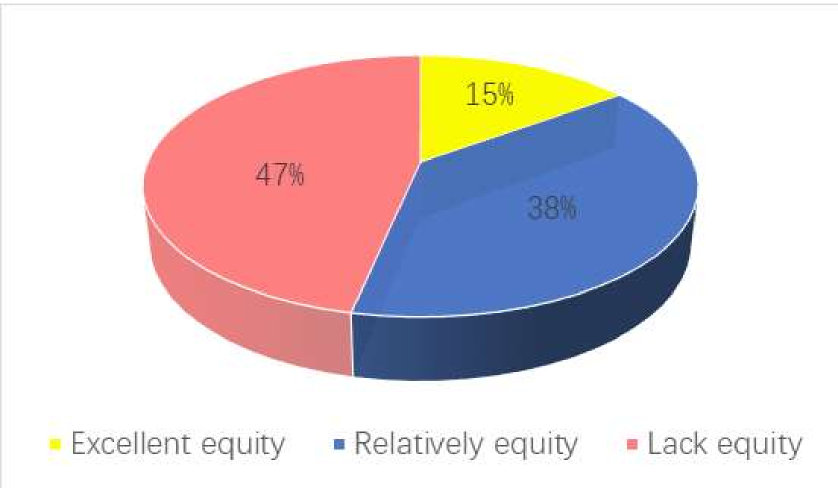

Figure 4: Cluster analysis results

Since this new evaluation system does not have a fixed measurement model, we consider that so as to better demonstrate the credibility of the model, we can place the specific classification of 120 countries in Asia, Europe, North and South America, Africa and the Middle East. It will be convenient for us to observe the objectivity and correctness of the evaluation system from the perspective of regional and historical development. The following figure can be obtained from the statistics:

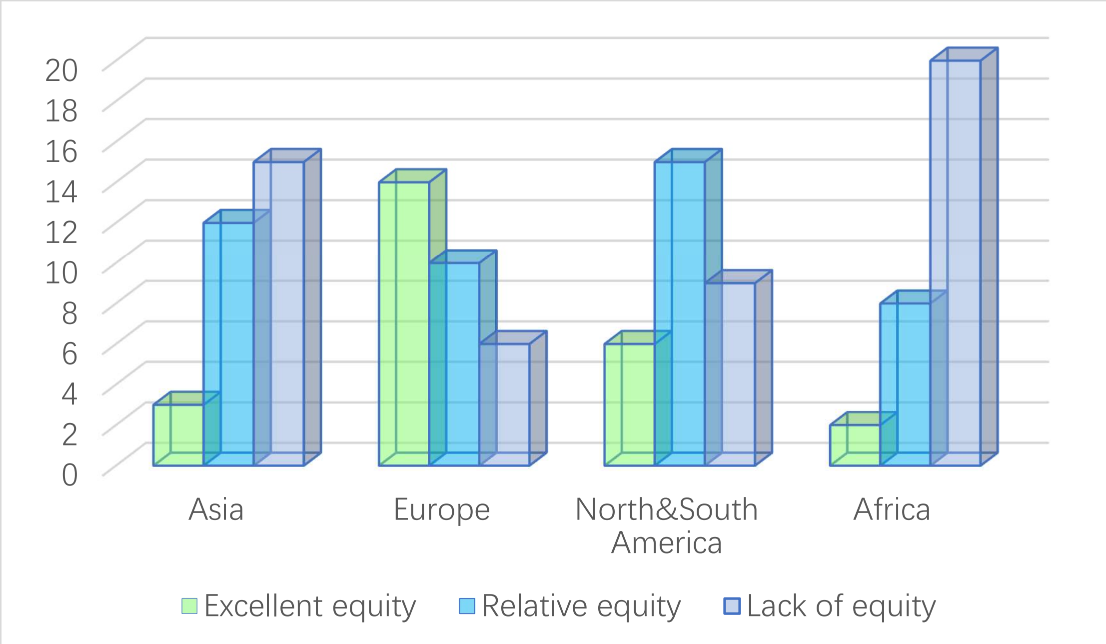

Figure 5: Equity by state

It can be clearly seen from the above figure that Europe has the best overall equity. Due to the greater differences in development among countries, the Americas are generally less fair than Europe. More countries in Asia are relative equity and lack of equity, while Africa is mostly in lack of equity. From the perspective of regional development and historical development, Europe was the first to enter into industrial development, with relatively good economic development, certain high-quality resources and excellent environmental conditions. Therefore, the general living standard of the people is higher, the social welfare is better, and the equity is naturally higher. In contrast, some countries in Asia and most countries in Africa are affected by the level of living resources and economic development, and the basic social welfare is relatively low, and the equity of per capita income is poor. Therefore, the evaluation system of this model has a certain rationality and relatively accurately defines global equity from the perspective of history and reality.

5 Optimized Global Equity Model

5.1 Future Prospect of Asteroid Mining

Introduction: In the future, the industry operation mode of asteroid mining is that under the leadership of countries with high comprehensive level, various countries around the world will participate in the mining industry.

Description: Under the leadership of the permanent members of the United Nations, countries around the world provide funding, technology, and human resources support according to their comprehensive level, and do their best to develop common spacecraft and mining-related machinery investment Asteroid mineral resources collection project. Mineral resources obtain from mining are allocated according to the mineral resources corresponding to the resources invested in asteroid mining by each country.

Demonstration: As of June 2021, only three countries, Russia, the United States, and China, have independently developed spacecraft that have successfully landed in space. A total of 23 countries, including the United Kingdom, France, Germany, Japan, and Italy, have gone to space with the help of other countries. There are only a few countries that can launch rockets for extraterrestrial exploration. The economic level and scientific and technological strength of other countries are not enough to support the exploration of the outer space of the earth, and they can only seek cooperation with big powers [4].

5.2 Impact Analysis

According to the above analysis and the actual background of asteroid mining, to optimize the first question model, as we described above, it is necessary to consider the size of each country's mining capacity, whether it forms a monopoly and one is dominant, which will affect the evaluation indicators. lead to an imbalance of equity. Therefore, the optimized model needs to introduce the influencing factor of whether to form a monopoly. This factor does not directly affect equity, but affects the economic level and thus indirectly affects global equity. Therefore, we decided to introduce monopoly factors and delete and replace some evaluation indicators in the original model. So as to ensure the objectivity of deletion, we use the grey relational analysis method. Here is a brief introduction to the grey relational analysis method:

Grey Relational Analysis (GRA) is a method to determine the degree of correlation between factors by analyzing the similarity of the changing trends of factors over time or different objects. The greater the degree of similarity, the greater the degree of correlation.

Note $\Delta_i(k)=\left|y(k)-x_i(k)\right|$, then $y(k)$ the $x_i(k)$ correlation coefficient with is:

$$\zeta_i(k)=\frac{\min_i \min_k \Delta_i(k)+\rho \max_i \max_k \Delta_i(k)}{\Delta_i(k)+\rho \max_i \max_k \Delta_i(k)} \tag{9}$$

Then the correlation is:

$$r_i=\frac{1}{n}\sum_{k=1}^{n}\zeta_i(k), k\in 1,2,\Lambda,n \tag{10}$$

The following values can be obtained through the grey correlation analysis method. The results show that the correlation between technology, economy and resources is relatively high, indicating that the final score is more closely related to these three indicators.

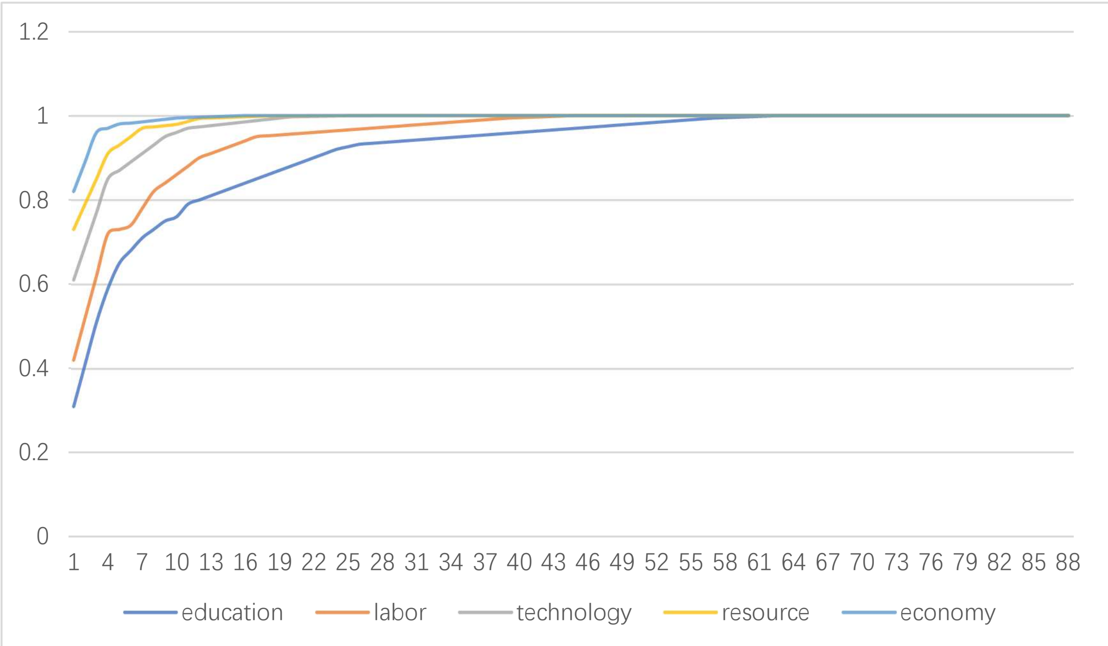

Figure 6: Grey correlation analysis diagram

Considering that the asteroid mining industry driven by technological progress requires personnel with professional knowledge and skills to operate, and is likely to be replaced by automated machinery, we believe that human resources are not the dominant factor in this context.

Among the objects counted by the education level considered in the previous model, there is the educational equity of primary and secondary schools, which overlaps with the evaluation index of science and technology level to a certain extent.

Therefore, the optimized model evaluation system is mainly about economy, technology and natural resources, and the results of grey correlation analysis are consistent with the results of objective analysis, so it is feasible to conduct impact analysis in this way.

There are many factors that determine the size of monopoly power. If we want to better analyze the impact of this factor on the final model, we must quantify it. At present, the main research shows that among the factors affecting monopoly, social cohesion and national decision-making execution will dominate, so we reconstruct the model. Through a modeling method similar to the first question, the entropy method and the coefficient of variation method (not described in detail here) are used.

However, the improved model deleted one of the original five comprehensive evaluation indicators, so there are only four evaluation indicators left in the calculation formula.

$$Q'_j = 100\sum_{i=1}^{4} W'_i X'_i, (j = 1, 2, 3, \cdots, 88) \tag{11}$$

We re-analyzed the final score and compared it with the results of the first question. The specific comparison results are as follows.

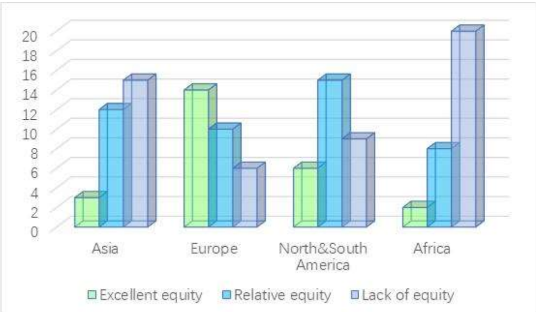

Fig.T1 model

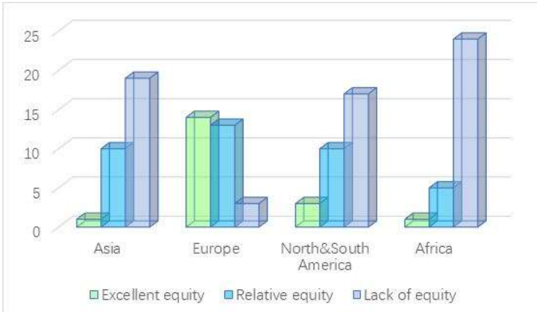

Fig.T2 model

Table2: Comparison of the results of the two models

	Proportion of GESM Lack of equity	Proportion of the OGEM Lack of equity
Asia	50%	63.3%
Europe _	20%	10%
N&S America	30%	56%
Africa	66.7%	80%

It can be seen that due to the introduction of monopoly, the uneven development of the continent has exacerbated its internal unfair proportion. The optimism in the data in Europe is mainly because the development of European countries is relatively consistent, and although the distribution of resources is somewhat unbalanced, the existence of European autonomous organizations such as the European Union has weakened this contradiction internally. Europe may be more attuned to its development.

6 Global Equity Analysis Model

6.1 Neural Network Analysis

The conditions we choose are mainly divided into four aspects, namely economy, technology, resource distribution and degree of monopoly. According to the model established above, we believe that the distribution of economy, technology and resources can be used as positive indicators, that is, the larger these indicators, the higher the contribution to global equity. From the above description, it can be seen that the degree of monopoly is undoubtedly unfavorable to equity. Therefore, when the degree of monopoly can be used as a negative indicator, that is, the greater the indicator, the greater the damage to equity. We consider that the evaluation method of this model cannot be realized by a single evaluation system, because the relationship between the four aspects and the final result is not a simple linear relationship, but there are other indirect effects of regional, national and historical exist. Finally, we decided to use a combination of the control variable method and neural network autoregression to evaluate the model.

The control variable method is a simplistic solution to multivariate complex problems. We analyze its influence on the final result through the orderly changes of a single variable.

The neural network can adjust the weights through the loss function to dynamically determine the weights. This dynamic adjustment method can more effectively predict and analyze different situations in different regions.

Considering that the actual development level of each country is not the same, at this time, the dynamic adjustment of weights using neural network analysis method can better evaluate the impact of different factors on different countries. At the same time, we refer to the linear autoregressive model, which is a method of processing time series. Although we do not deal with time series, we use a single variable as a lag input, so that when the neural network makes predictions, the calculation will iterative, we can use the historical data of the previous step as input when analyzing the following data. Such iterations will keep going backwards until all our desired predictions have been computed.

At the same time, we refer to the linear autoregressive model. We input a single variable as a lagged input, and the other variables are input normally, so that we get the relationship between the predicted result and the single variable lagged value. Through this relationship, we can better analyze the changes of equity evaluation in different regions and under the influence of different factors. The analysis diagram is shown below.

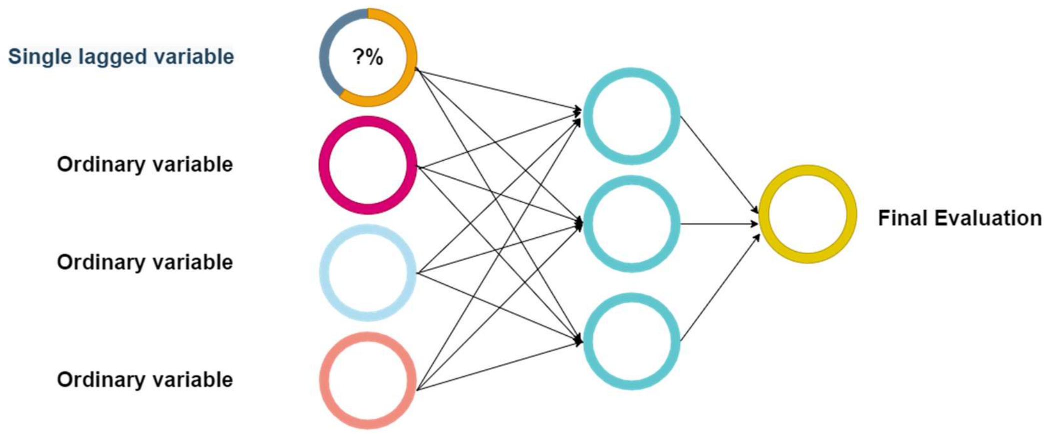

Figure 7: Neural Network Analysis

Explanation: Single lagged variable is one of the four factors of economy, technology, resources and monopoly, and the remaining ordinary variable is the remaining three factors.

The actual code of the model is more complex, we use pseudo code for simple expression implementation, as follows:

```
INPUT:
Train:{(X_Single_lagged_variable,Y_Single_lagged_variable),(X_Ordinary_variable,Y_Ordinar_variable)}
Ling earning rate: Choose based on experience
Weights and Thresholds: Random number in range 0 to 1
While(Train_Condition):
  For all (X_j,Y_ j ) IN Train:
Calculate the output of the current Neural Network
Calculate the error between the output of the Neural Network and the label value
The error calculates the descending gradient of each parameter
Descent gradient update parameters
End
Until Accomplish Train_Condition
OUTPUT _
```

We conducted a Single_lagged_variable test for all four factors based on the control variable, and visualized the results as follows:

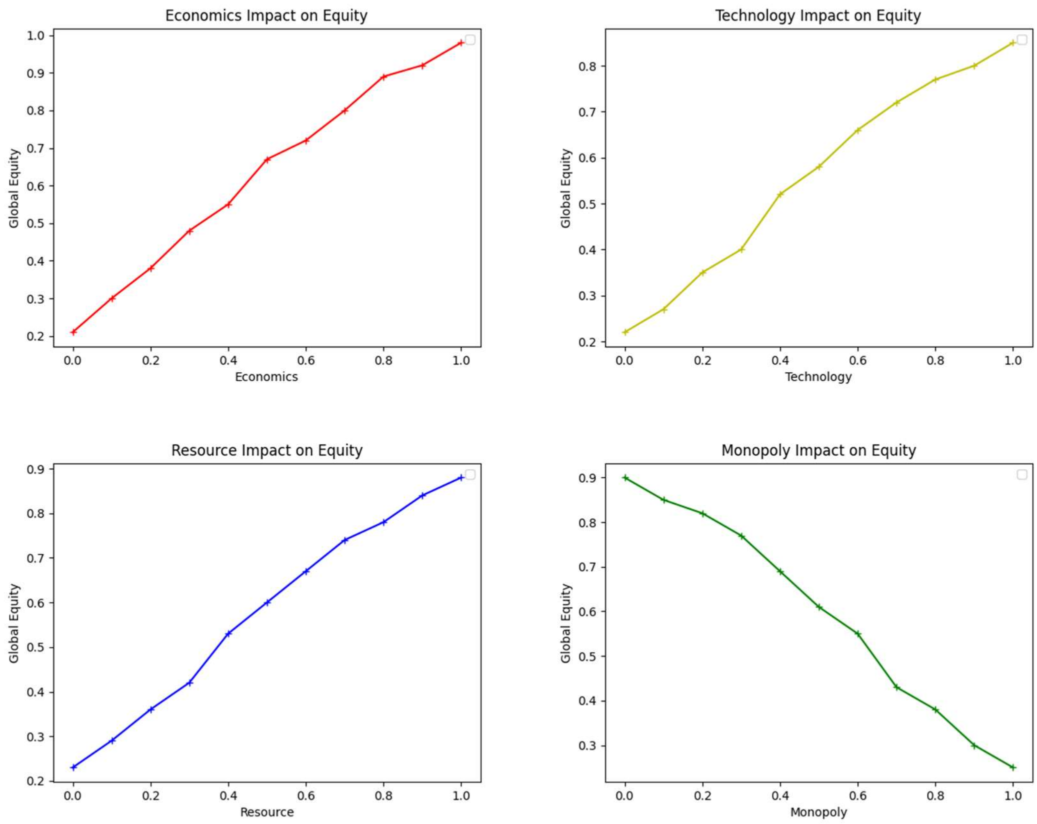

Figure 8: The relationship between each indicator and equity

It is evident from the four graphs above how changing factors in the conditions chosen in defining our future vision for asteroid mining affect global equity in the process. Economy, technology and resources have a positive correlation with equity while monopoly degree has a negative correlation.

6.2 Policy Support

Carry out strict supervision and prohibit any country from illegally occupying asteroid mineral resources and claiming sovereignty. On the other hand, any country on the earth is allowed to participate in the asteroid mining project to prevent monopoly, but the specific implementation requires many other policies support.

Mining project into outer space is carried out, compared with the limited resources on the earth, asteroids have extremely rich mineral resources, and the reserves of mineral resources increase rapidly, and even tend to be saturated, which will inevitably lead to mineral resources and other substitutes. The price of natural resources has dropped sharply, and many countries, especially developing countries, rely on the export of mineral resources as their main economic source. When mineral resources are abundant, the economic decline of these countries will lead to a negative side of global equity. Therefore, we should Economic subsidies are provided to countries whose economies are significantly affected by the new economic regime driven by asteroid mining [5].

Mineral mining needs sufficient scientific and technological strength to support, and the scientific and technological strength of many countries is not enough to support their participation in the asteroid mining project, and the profit model of distribution according to work is obviously worse for these countries. At the same time, there is no way to get the support of scientific and technological forces to participate in the global profit, which will further exacerbate the negativity of global equity. Therefore, it is possible to establish a mining technology sharing model, so that countries with weak scientific and technological strength can get the support of new technologies, and provide technical support, technology sharing, and technical training for students and professionals in these countries, so that they can learn high-tech from them, such as Space technology, automation technology, etc., so that these countries can initially develop their own space technology and automation technology.

Mineral resources obtained by mining should be properly shared. It is obviously unreasonable if they are evenly distributed, but if there is a monopoly, it will easily lead to the negativity of global equity. In addition, it is necessary to provide economic assistance to vulnerable countries so that they can participate in asteroid mining projects, help them build their own space centers, space stations, etc., and participate in the industrial value chain of asteroid mining.

7 Sensitivity Analysis

Due to the inaccurate judgment of the model due to the possible deviation of the original data, we conduct a sensitivity analysis of the indicators of equity, mainly considering several indicators with a large proportion of weight, such as resources. By changing the resource normalization data with a 95 % confidence interval, analyzing the changes in equity and the equity evaluation rankings among many countries, we find that there is no significant difference, and it can be concluded that our model is still stable.

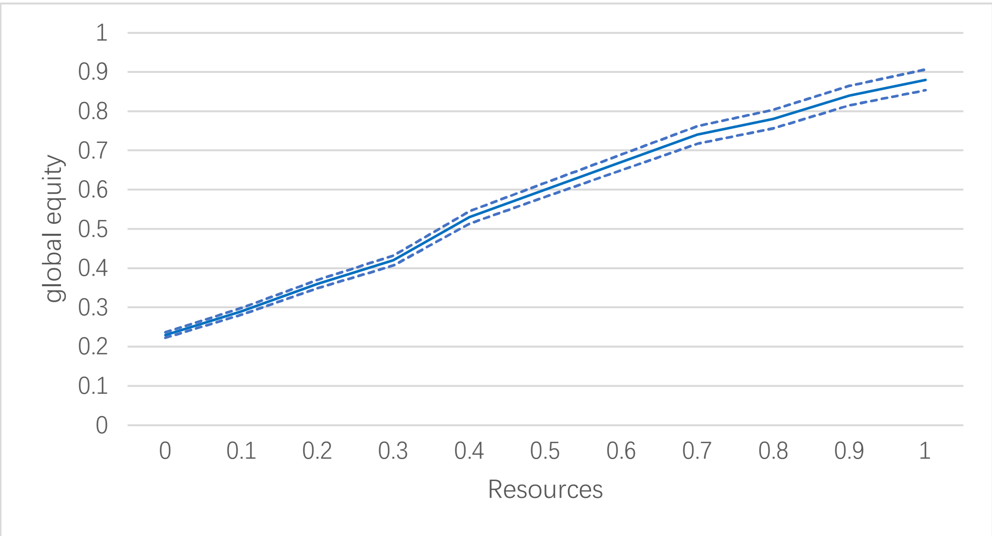

Figure 9: Sensitivity analysis of resources for global equity

8 Model Evaluation and Further Discussion

8.1 Strengths

1.Combination of methods

Since this topic is an interdisciplinary complex problem analysis, the establishment of a single model cannot guarantee the objectivity of the result analysis. In order to make the model better, we propose different models for different problems, and each model A composite modeling approach was used. For example, in the proposal of GESM, we first determined five angles and included ten representative factors. However, considering that if the weight of ten factors is directly determined, and then global fairness is measured, there may be a large error, and the final result cannot be objective and fair. Therefore, we first determine the weights of ten factors by the entropy method, then determine the standardized results of the five angles by the ten factors, and finally use the coefficient of variation method to analyze the weights of the five angles again. Values are analyzed for the countries that ultimately participated in the assessment. Adopting this two-level weighting method can greatly enhance the objectivity and accuracy of the model, so that the model has a certain practical evaluation ability.

2.Incremental optimization problem

So as to solve the impact of asteroid mining on global fairness, we decided to optimize GESM. We believe that the mathematical model is a solution for a certain type of problem, but when facing specific problems, we should fully consider the What are the characteristics of the problem. Therefore, when solving the impact of asteroid mining on global fairness, we made corresponding changes to the influencing factors of GESM and re-weighted them, which is our reconstructed OGEM model. We did not completely deny the relevant ideas of the GESM model, but we added new optimization conditions in the face of specific problems, which made the model have better analysis results for specific problems. Based on the establishment of the model of the first question, the solution of the remaining problems is gradual, gradually adapting or optimizing, making the problem solving simpler and obtaining a reasonable solution.

3.Set a reasonable vision

Mathematical models are only an idealized way to solve problems. If a model is established from a practical point of view, the model will be too complicated and the results may not be objective. Considering too many edge factors may add many unnecessary external constraints to our model in the application process. Therefore, when solving the impact of asteroid mining on global fairness, we reviewed a large number of relevant literatures, and only retained the factors that have a greater impact on the final result, and did not consider other more complex human factors. Problem solving requires the goal of promoting global equity, and the future vision set in this paper fully considers the impact of various situations, so that the final model is not complicated and practical, which is conducive to the rapid analysis of related issues by the model.

4.High policy feasibility

We believe that the proposed policies should fully consider different countries, because each country's development situation is different. From the current point of view, the world's development is still in a state of extreme imbalance. Each country has a different degree of participation in international decision-making, which requires us to pay attention to weak countries when formulating policies. Our policy recommendations are based on such an angle, while sharing space resources, sharing asteroid mining technology, Anti-monopoly and other related policies can better alleviate the impact of asteroid mining on global fairness, and have good practical significance for promoting global fairness.

8.2 Weaknesses

1. The selection of indicators is limited and subjective

Each of our models is built using the method of simplifying influencing factors. Although a large number of literatures are referred to, the final evaluation factors selected still have certain subjectivity and limitations, and there is also a certain nonlinear relationship between each factor itself.

2. Too few test samples and more incomplete data

During data selection, there are some missing data, only the average value is used to replace this part of the data, so the final result of the established evaluation system will be different from the actual one.

8.3 Further Discussion

The optimization of our team model is mainly analyzed from the shortcomings of the model itself

The evaluation indicators selected in the establishment of the model have certain subjectivity and limitations. Under the premise of sufficient calculation conditions, more complex factors can be considered to make the establishment of a global fair evaluation system more accurate and more credible.

In view of the shortcomings of missing data selection and too few samples, optimizing the model can widen the total number of samples, and reduce unnecessary errors when building the model by using as much data as possible.

In addition, the model assumes that the factors considered are linear relationships. In fact, there should be more complex nonlinear relationships between these factors. When the selection indicators are expanded, the model can be established on the basis of various nonlinear relationships. Considering the relationship between these factors, various potential relationships of the model can be mined, and the results predicted by the model are more accurate.

9 Conclusion

This paper establishes a model that can evaluate the evaluation value of each country's global equity. We use the entropy value method and the coefficient of variation method to calculate the global equity evaluation value of 120 countries, use fuzzy cluster analysis to define the equity standard, define There are three levels: Excellent equity, relative equity, Lack of equity. From the distribution of the three levels in each state, for example, the equity in Europe is relatively high. According to its historical development background and current economic level, it can be seen that: The higher the economic level and the richer the resources, the higher the average equity, and the more accurate the establishment of a global equity assessment system.

Based on this model, the future vision of asteroid mining is explained, and the evaluation index is re-selected through grey relational analysis to establish an optimization model to analyze the impact of asteroid mining on global equity. It shows that asteroid mining leads to monopoly factors being introduced into this evaluation system. After the introduction of evaluation indicators, the global equity has declined significantly, which has a negative impact on global equity.

Establish a global equity analysis model to analyze the changing relationship between economy, technology, resource distribution, and the degree of monopoly and equity. It can be concluded that the growth of economy, technology, and resources will promote the development of a country, influence each other, and make the overall level of the country. Improvement is positively related to equity, monopoly will lead to the tilt of the economy to several or one of them, and technology is closed, so it is negatively related to equity.

Finally, we propose several policies that can promote the realization of global equity, providing economic subsidies to countries whose economy is greatly affected by the new economic system; establishing a global mining technology sharing model to provide technical support for disadvantaged countries; implementing partial resource sharing to provide Economic assistance to vulnerable countries.

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Appendices

Appendix

Introduce : We have carried out relevant modeling and data processing after collecting a large amount of relevant data, but due to the limited appendix, we only show the raw data and normalized values of the top 40 countries in the relevant fields, as well as the final data of these countries. Score. On the left of Country Name is the normalized data, on the right is the original data, and the final score is the last row

1	Technology_Std	Resources_Std	Human Resources_Std	Education_Std	Economy_Std	Total score_Std	Country Name	Economy	Education	Human Resources	Resources	Technology	Total score
2	1.99477181	-0.395543971	1.324879749	1.462247732	1.651143345	2.937114074	United States	57509.836	20.07598	154635454.4	3.36254154	1.61224E+11	94.37114074
3	2.309366241	-0.461848828	0.142855438	0.688154729	1.175147924	2.302496759	Germany	48140.169	15.4575353	41246995.45	2.7072994	1.83476E+11	88.02496759
4	8.198792973	-0.498362746	7.729438729	-0.095366384	-0.616675181	1.803691404	China	12869.269	10.78284	769007820.6	2.3464592	6.00035E+11	83.03691404
5	1.627934907	-0.433530374	-0.007039974	1.659234245	0.657984847	1.622655319	Korea, Rep.	37960.142	21.2512539	26867925.89	2.98714986	1.35278E+11	81.22655319
6	1.14102916	-0.483190686	0.019655742	0.512616033	0.826745022	1.137428697	France	41282.079	14.4102248	29428775.16	2.49639351	1.00839E+11	76.37428697
7	0.685401378	-0.404404324	0.052457533	0.284184413	0.884078076	0.683403813	United Kingdom	42410.643	13.047341	32575363.99	3.27498119	68612314581	71.83403813
8	0.621925995	-0.454912976	-0.195609246	1.16014651	1.285324427	0.619127468	Netherlands	50308.923	18.2735638	8778975.483	2.77584133	64122692683	71.19127468
9	0.553677071	-0.322288642	-0.139778681	-0.107307803	-0.02723668	0.551324044	Malaysia	24471.991	10.7115944	14134653.61	4.08647009	59295437689	70.51324044
10	0.498574408	-0.496433887	0.244446822	-0.610219641	-0.352469295	0.497957134	Mexico	18069.994	7.71108862	50992387.6	2.36552069	55398019361	69.97957134
11	0.415071773	-0.558079639	-0.238644274	0.32474203	2.103684128	0.412766688	Switzerland	66417.814	13.2893185	4650739.275	1.75632106	49491867473	69.12766688
12	0.113563876	-0.609330146	-0.264229886	1.038703106	1.838005824	0.112127445	Ireland	61188.105	17.5490002	2196379.338	1.24984998	28166175907	66.12127445
13	0.10670906	-0.515374869	-0.028450828	0.444553557	0.597626551	0.106249937	Italy	36772.027	14.004146	24814039.44	2.1783409	27681333885	66.06249937
14	0.082686884	-0.013906049	-0.088058486	0.586047918	0.98189772	0.08206383	Canada	44336.161	14.848339	19096034.83	7.1339885	25982242387	65.8206383
15	0.037375087	-0.491640212	-0.233504295	0.574768239	0.393585413	0.036307843	Czech Republic	32755.607	14.7810414	5143803.881	2.41289306	22777333233	65.36307843
16	0.008676437	-0.411685788	-0.236841599	0.950966252	1.092820749	0.00768882	Belgium	46519.61	17.0255388	4823665.106	3.20302384	20747474141	62.0768882
17	-0.038662148	-0.324525377	-0.234839684	0.505809195	1.23396752	-0.039488818	Sweden	49297.995	14.3696134	5015703.535	4.06436609	17399210019	61.60511182
18	-0.049427889	-0.397602366	-0.241694637	1.160863295	1.25044863	-0.050247617	Austria	49622.415	18.2778403	4358126.073	3.34219994	16637747796	61.49752383
19	-0.094965989	-0.36486578	4.418902982	-0.788600377	-0.994449896	-0.076739124	India	5433.0133	6.64682172	451436901.7	3.66571155	13416832278	61.23260876
20	-0.093864911	-0.540902129	-0.240642197	0.009769668	0.059272881	-0.094538012	Hungary	26174.877	11.4101097	4459083.81	1.92607376	13494711667	61.05461988
21	-0.105756417	-0.581753033	-0.248069685	0.611487031	0.523996925	-0.106420894	Israel	35322.675	15.0001155	3746584.62	1.52237431	12653623886	60.93579106
22	-0.114139007	-0.390774829	-0.052747771	1.342964214	0.502605188	-0.113984311	Spain	34901.592	19.3643028	22483298.05	3.40967147	12060722242	60.86015689
23	-0.135730435	-0.084513554	0.469085124	1.134544122	-0.063475655	-0.133390207	Russian Federa	23758.65	18.1208131	72541344.42	6.43622645	10533557831	60.66609793
24	-0.153511492	-0.575881612	-0.257911644	1.218136333	1.258663909	-0.154061218	Denmark	49784.128	18.6195465	2802471.61	1.58039725	9275901460	60.45938782
25	-0.161959571	0.319549217	0.708123707	0.09715141	-0.528267189	-0.15856567	Brazil	14609.524	11.9314524	95471682.07	10.4292817	8678367754	60.4143433
26	-0.18760819	-0.473865395	-0.25949335	0.073182941	0.233481261	-0.18805519	Slovak Republic	29604.058	11.7884501	2650742.713	2.5885485	6864237728	60.1194481
27	-0.208050169	-0.223692196	0.970998846	-0.563947157	-0.75829167	-0.203441656	Indonesia	10081.638	7.98716256	120688597.4	5.06082627	5418373946	59.96558344
28	-0.21845473	1.935414781	-0.16054917	2.532775915	1.055641262	-0.218400258	Australia	45787.756	26.4630358	12142195.65	26.3976929	4682458060	59.81599742
29	-0.219159951	-0.170799612	-0.259243909	1.062122814	1.859025319	-0.219502804	Norway	61601.861	17.6887284	2674670.891	5.58352478	4632577626	59.80497196
30	-0.226955782	-0.472093281	-0.195096237	-0.072643907	-0.178475539	-0.227015024	Romania	21494.95	10.9184084	8828187.078	2.60606101	4081177568	59.72984976
31	-0.229364587	-0.231776281	-0.259907197	1.425092814	0.899034536	-0.22967801	Finland	42705.052	19.8543039	2611043.426	4.9809372	3910802438	59.7032199
32	-0.24799928	1.305135601	-0.071612936	-0.967639059	-0.582154812	-0.247490172	South Africa	13548.78	5.57862934	20673612.77	20.1691072	2592768301	59.52509828
33	-0.24751801	0.447029716	-0.195233111	-0.082026101	-0.127151269	-0.247511432	Kazakhstan	22505.236	10.8624317	8815057.09	11.6890777	2626808578	52.52488568
34	-0.257395156	-0.491851652	-0.234558233	0.470376721	0.21664088	-0.257515917	Portugal	29272.566	14.1582138	5042702.341	2.41080355	1928196797	52.42484083
35	-0.257953488	-0.469322061	-0.280217733	0.853099989	0.201107242	-0.258257637	Estonia	28966.796	16.4416426	662707.5453	2.63344694	1888705905	52.41742363
36	-0.259684749	-0.549294863	-0.272330653	0.761194309	0.168330842	-0.259951354	Lithuania	28321.614	15.8933089	1419294.244	1.84313454	1766253588	52.40048646
37	-0.264462984	-0.280388878	-0.276951898	1.149026915	0.311912519	-0.264732797	Slovenia	31147.928	18.2072213	975990.4947	4.50053465	1428288418	52.35267203
38	-0.265468593	-0.423309714	-0.094523724	1.287544709	-0.25843616	-0.264995779	Argentina	19920.976	19.0336553	18475841.67	3.08815312	1357161600	52.35004221
39	-0.267858238	-0.4753771	-0.276958974	0.929662024	-0.004608726	-0.268117391	Latvia	24917.408	16.8984321	975311.6907	2.57360944	1188141669	52.31882609
40	-0.269234665	0.51776845	-0.253586615	0.782297914	-0.350380462	-0.269394876	Bulgaria	18111.111	16.0192186	3217360.154	12.3881366	1090786787	52.30605124