ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

Research on State Influence in Cross-border Mobility Credit System Based on Fuzzy Cooperation

Zuohui Chen, Guang Zhang

Business School, University of Shanghai for Science and Technology, Shanghai 402100, P.R. China

Abstract

In the context of COVID-19, in order to control the spread of the epidemic and promote global economic recovery, countries have implemented differentiated controls on people entering and leaving the country. This paper uses a practical scenario to study the influence of countries in the fuzzy cooperative cross-border personnel flow credit system. First, the type of vaccine approved by the alliance is determined according to the type of vaccine approved by each country. Second, add the fuzzy parameter of how much countries trust each other. Then, a correlation coefficient between the number of commonly recognized vaccine types and the degree of country participation in the alliance is introduced to the degree of impact on global economic recovery; finally, the solution of the fuzzy alliance is obtained by using the priority objective programming model.

Keywords

COVID-19; Difference control; Global economic recovery; Fuzzy cooperation; Multi-priority objective programming model; Cross-border personnel flow credit system.

1. INTRODUCTION

In the face of the rapid spread of overseas epidemics, many countries have taken early and aggressive preventive and control measures, imposed border controls, and established strict travel restrictions. However, these measures have exerted great pressure on both the consumer and production sides of the world, making the global economic and trade environment more difficult. The increasingly integrated global industrial chain has suffered some impact, adding to the resistance to world trade. Therefore, to a certain extent, the quarantine and restriction measures to control the epidemic can be considered as a pause button for the economy. [1] In addition, the confrontational strategies adopted by some countries in the face of the global spread of the epidemic have created a huge obstacle to global epidemic control and economic recovery. In order to prevent the spread of the epidemic and, to a certain extent, to promote global economic recovery. It is necessary to promote the establishment of cooperative alliances among countries to combat the epidemic and to form an extensive credit system for the movement of people across borders in order to promote global economic development. Only if more and more countries can bring "positive benefits" and be willing to join in the construction of the mutual trust system against the epidemic and jointly promote the rapid recovery of the world economy. We can overcome the spread of the global epidemic as soon as possible and at the same time. In addition, resolve the risks arising from the change of the international monetary system, commodity price fluctuations, food crisis, industrial chain breakage and international trade and investment. It is noteworthy that the world's economy will be able to overcome the spread of the global epidemic as soon as possible. [3] It is worth noting that the

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

more countries join the alliance, the better. Although some countries may benefit from joining the system, it is not excluded that some countries' joining may bring down the mutual mechanism of the whole alliance. Therefore, a good mutual trust system for combating the epidemic must evaluate and judge the member countries and potential members of the alliance. In this paper, we assume that the potential members of the MMS will be able to contribute to the development of their economies and trade to some extent after joining the MMS, so they will make some changes and adjustments to the MMS access requirements in order to meet the given access criteria. The focus of this paper will be on the assessment of each country's role in the global economic recovery in the MTS, and will explore the method of judging the influence of each member based on the fuzzy cooperative game theory, which has implications for other MTSs. [4]

In reality, the degree of cooperation of alliances often varies. In the case of new vaccines developed in countries around the world, it is clear that the degree of acceptance of vaccines developed in different countries varies in other countries. For example, in countries A, B, and C, if countries A and B do not share a common type of vaccine. In addition, do not want to believe that the vaccine used in the other country is safe and at an acceptable level of disease control in their countries. There is usually a certain degree of "hostility" between the two countries. In addition, the mutual trust system formed by their cooperation is often the mutual trust system formed by their cooperation often does not produce alliance benefits and is therefore called an ineffective alliance [5]. If the number of vaccines approved with mutual trust between countries A and C is much smaller than that between countries B and C. Moreover, if the benefits of cooperation with country A are much smaller than those in cooperation with country B. For country C considering the international relations between countries and their knowledge of epidemic control in countries A and B. Then the alliance formed by A and C is said to be less important than that formed by B and C. Accordingly, the alliance formed by B and C is said to be less important than that formed by A and C. The alliance formed by A and C is called less important than the one formed by B and C. Accordingly, the alliance formed by B and C is relatively important. Given the "rational human" nature of countries, cooperative alliances have certain priorities in the process of formation, and this is also reflected in the level of cooperation. Therefore, in this paper, we use fuzzy cooperative game to study the construction of cross-border arbitrary flow credit embodiment and evaluate the influence of countries in credit embodiment based on the allocation rules of fuzzy cooperative game.

The innovation and academic contributions of this paper are in three aspects. First, based on the importance of cooperative alliances, a fuzzy cooperative game is used to build a cross-border trust embodied objective planning model to assess the strength of the linkage between countries based on the epidemic control situation of different countries and the type and quantity of vaccines commonly accepted among countries. And then to analyze the role of countries in global economic recovery after the establishment of mutual trust based on the cooperative game solution. Second, the fuzzy theory is introduced into the trust relationship between countries to measure the trust level based on the types of vaccines that are commonly accepted among countries and their respective epidemic prevention and control status, which is more realistic. Third, based on the model and results of the analysis of the cross-border movement of people, we suggest ways to improve the influence of the member countries of the system at the international level and ultimately to mitigate the impact of the epidemic on global trade and economic recovery.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

2. FUZZY COOPERATIVE GAMES AND RELATED CONCEPTS

2.1. Classical Cooperative Game

We call a binary (N, v) a cooperative game with transfer utility, or TU game or game for short, where $N = \{1,2, \dots, n\}$ is the set of insiders and $v: 2^N \rightarrow R$ is a characteristic function defined on the set N of insiders that assigns to any coalition $S \subseteq N$ a payoff of $v(S)$. Call an n-dimensional vector $x = (x_1, x_2, \dots, x_n) \in R^n$ a payoff vector whose payoff assigned to an insider $i \in N$ is x_i.. Moreover, for any $S \subseteq N$, denote $(e^S)^i = 1$ if $i \in S$, otherwise $(e^S)^i = 0$. For any one payoff vector $x = (x_1, x_2, \dots, x_n) \in R^n$, we call it individually rational if there is $x_i \geq v(\{i\}), \forall i \in N$; the payment vector is said to be valid if it satisfies $\sum_{i \in N} x_i = v(N)$; the payment vector satisfies group rationality if $\sum_{i \in S} x_i \geq v(S)$ holds for any union $S \subseteq N$.

2.2. Cooperative Fuzzy Game

We call the vector $\tilde{A} = (s_1, s_2, \dots, s_n) \in [0,1]^N$ a fuzzy coalition, where s_i is the level of participation of the insider $i \in N$ in the fuzzy coalition $\tilde{A}$. Usually we use $\mathcal{F}^N$ instead of $[0,1]^N$ to denote the set of all fuzzy coalitions defined on the set N of insiders. For any given fuzzy coalition $\tilde{A} \in \mathcal{F}^N$, $car(\tilde{A}) = \{i \in N | s_i > 0\}$ is called the carrier of $\tilde{A}$, which denotes the set of insiders in the fuzzy coalition s with non-zero participation, i.e., members who contribute to the coalition. For each $\tilde{A} \in \mathcal{F}^N$, its fuzziness is denoted as $\varphi(\tilde{A}) = |\{i \in N | s_i \in (0,1)\}|$. The cooperative fuzzy game with insider N is a mapping $v: \mathcal{F}^N \rightarrow R$ from $\mathcal{F}^N$ to the real number space and satisfies $v(e^{\emptyset}) = 0$. The mapping v assigns a real number to each fuzzy coalition, which represents the value that can be created by this fuzzy coalition in the cooperation. FG^N is denoted as the set of all fuzzy games defined on the set N of insiders. For any $v \in FG^N$, its transitive is $I(v) = \{x \in R^n | \sum_{i \in N} x_i = v(e^N), x_i \geq v(e^i), \forall i \in N\}$, which represents the set of payment vectors satisfying validity and individual rationality. With the help of the definition of transitivity, we can obtain an important solution concept of fuzzy games, the Aubin kernel. For any fuzzy game $v \in FG^N$, the Aubin kernel is: $C(v) = \{x \in I(v) | \sum_{i \in N} s_i x_i \geq v(\tilde{A}), \forall \tilde{A} \in \mathcal{F}^N\}$. The implication is that the sum of the payments of any fuzzy subcoalition is not less than the benefit of that subcoalition.

3. MODEL CONSTRUCTION OF CROSS-BORDER PERSONNEL CREDIT SYSTEM

3.1. Research Scenario and Motivation

Although vaccines have been developed and used to control the epidemic, there are differences in the prevention and control of the epidemic in different countries and in the type of vaccines used to vaccinate foreigners, resulting in different quarantine policies and duration of quarantine for foreigners, which leads to different domestic and foreign economic benefits. The economic benefits are also different. Therefore, this paper investigates the evaluation of the impact of international countries based on a fuzzy cooperative game and objective programming from the perspective of cross-border human mobility credit collection. In this model, all countries participating in the cross-border credit system are considered as one big alliance. The relationship between the benefits of different alliances and the degree of trust among their member countries is constructed based on the commonly accepted vaccine types, so as to determine the ease of cross-border movement of people based on the accepted vaccine types and their impact on economic recovery.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

3.2. Description and Setting of Symbols

Let $S_{i,j}$ denote the degree of trust between countries, i.e., the degree of trust of country j on country i, x_i denotes the degree of influence of country i on global economic recovery, $v(N)$ denotes the degree of influence of country coalition N on global economic recovery, and $S \subseteq N$ is a sub coalition in the grand coalition. For any fuzzy coalition$\tilde{A} \in \mathcal{F}^N$, let $Q(\tilde{A}) = \{s_i | s_i > 0, i \in N\}$, $q(\tilde{A})$ be the number of elements in$Q(\tilde{A})$, and arrange the elements in $Q(\tilde{A})$ in ascending order as $h_1 < h_2 < \cdots < h_{q(\tilde{A})}$.

Choquet integral definition: For all bounded nonnegative measurable functions $f: \rightarrow R^+$ on a nonempty set M, its Choquet integral with respect to v is defined as $\int f dv = \int_0^\infty v(F_\alpha) d\alpha$, where $F_\alpha = \{x | f(x) \geq \alpha\} (\alpha \in [0, \infty))$ is the α-intercept set of the function f.

The characteristic function of the fuzzy coalition, i.e., the expected return $\tilde{A}$ obtained by the fuzzy coalition $\tilde{v}(\tilde{A})$: $\tilde{v}(\tilde{A}) = \sum_{r=1}^{q(\tilde{A})} v([\tilde{A}]_{h_r})(h_r - h_{r-1})$, where $[\tilde{A}]_{h_r} = \{i | s_i \geq h_r, i \in \tilde{A}\}$, $r = 1,2, \dots, q(\tilde{A})$, for any $\tilde{A} \in F(N)$ specifying $h_0 = 0$.

In this paper, we consider fuzzy coalitions with priority relations in which the priority of the coalition is denoted by the priority factor of the goal planning $P_1, P_2, \dots, P_k, P_{k+1}$ and specify $P_k \gg P_{k+1}$ to denote the priority of the importance of the kth coalition over the importance of the kth+1th coalition. $|[\tilde{A}_{k_l}]|$ is the number of innate countries in the fuzzy coalition $\tilde{A}_{k_l}$, i.e., the base of the classical coalition $[\tilde{A}_{k_l}]$. The sum of the assigned values of the countries in $\tilde{A}_{k_l}$ participating in the grand coalition $\sum_{i=1}^{i \in \tilde{A}_{k_l}} x_i$ has a negative deviation $d_{\tilde{A}_{k_l}}{}^-$ or a positive deviation$d_{\tilde{A}_{k_l}}{}^+$ from the gain value of coalition $\tilde{A}_{k_l}$.

3.3. Constraints

(1) Individual rationality: The corresponding contribution that individual countries can make to global economic recovery by forming alliances is not less than the contribution that individual countries can make by "going it alone". That is

$$x_i \geq s_i \cdot v(i)$$

If the participation level $s_i = 1$, then it is individual rationality in the classical cooperative game, i.e. $x_i \geq v(i)$.

(2) Validity: the contribution of the whole coalition can be all specified to which country from the coalition, the total contribution that the coalition can bring to the creation of global economic recovery is equal to the sum of the corresponding contributions of all countries in the coalition. That is

$$\sum_{i=1}^{n} x_i = \sum_{r=1}^{q(N)} v([\tilde{A}]_{h_r})(h_r - h_{r-1})$$

where it is valid in the classical cooperative game if the participation level of all participants in any coalition is 1, i.e., $\sum_{i=1}^{n} x_i = v(N)$.

(3) Group rationality: $\sum_{i \in S} x_i \geq v(S), \forall S \subseteq N$,the sum of the contributions to global economic recovery brought by several countries participating in this coalition explicitly in the grand coalition is not less than the contribution brought by them individually forming a new minor coalition $\tilde{A}_{k_l}$. That is

$$\sum_{i \in S} x_i + d_{\tilde{A}_{k_l}}{}^- - d_{\tilde{A}_{k_l}}{}^+ = \sum_{r=1}^{|[\tilde{A}_{k_l}]|} v([\tilde{A}]_{h_r})(h_r - h_{r-1})$$

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

(4) The actual conditions that need to be satisfied for the objective planning solution: only positive deviations $d_{\tilde{A}_{k_l}}^{+}$ or negative deviations $d_{\tilde{A}_{k_l}}^{-}$ are satisfied, but not both positive and negative deviations, and both positive and negative deviations should be numbers that are not less than zero. That is

$$d_{\tilde{A}_{k_l}}^{-} d_{\tilde{A}_{k_l}}^{+}=0, d_{\tilde{A}_{k_l}}^{-} \geq 0,\ d_{\tilde{A}_{k_l}}^{+} \geq 0$$

(5) Judgment criteria for prioritization: Based on the mutual trust and the number of types of commonly accepted vaccines that countries have with other countries in the fuzzy coalition as a starting point. Since the bureau requires that the value of their contributions in the grand coalition exceeds the contributions they would bring if they formed a new minor coalition $\tilde{A}_{k_l}$ alone. And the larger the better, they are required to determine $\sum_{i\in\tilde{A}_{k_l}} x_i + d_{\tilde{A}_{k_l}}^{-} - d_{\tilde{A}_{k_l}}^{+} = \sum_{r=1}^{|\tilde{A}_{k_l}|} v([\tilde{A}_{k_l}]_{h_r})(h_r - h_{r-1})$ in the order of priority of the smallest negative deviation $d_{\tilde{A}_{k_l}}^{-}$.

3.4. Model Construction

Through the above analysis, the multi-priority objective planning model corresponding to the minimization reach function under certain objective constraints is

$$min\ Z = \sum_{m=1} P_m(d_{\tilde{A}_{k_l}}^{-})$$

$$s.t\begin{cases} x_i \geq s_i \cdot v(i) \\ \sum_{i=1}^{n} x_i = \sum_{r=1}^{q(N)} v([\tilde{A}]_{h_r})(h_r - h_{r-1}) \\ \sum_{i\in S} x_i + d_{\tilde{A}_{k_l}}^{-} - d_{\tilde{A}_{k_l}}^{+} = \sum_{r=1}^{|[\tilde{A}_{k_l}]|} v([\tilde{A}]_{h_r})(h_r - h_{r-1}), S \in N \\ d_{\tilde{A}_{k_l}}^{-} d_{\tilde{A}_{k_l}}^{+} \geq 0, k = 1,2,\dots,(2^N - 1) \\ d_{\tilde{A}_{k_l}}^{-} \geq 0,\ d_{\tilde{A}_{k_l}}^{+} \geq 0 \end{cases}$$

where denotes the priority, i.e., the determined order of preference. The optimal solution must satisfy the conditions of individual rationality, validity, and group rationality.

The nature of the optimal solution: if the fuzzy cooperative alliance satisfies the condition that the contribution to the global economic recovery of the alliance can find the corresponding contributors. And the sum of the contributions of several countries in the alliance to the global economic recovery is not less than their individual contributions to the global economic recovery of the small alliance, that is to say the two conditions of validity and group rationality are satisfied, the fuzzy game exists Aubin kernel. In this way, the contribution of each country to the global economic recovery by participating in the coalition is no less than its own contribution to the global economic recovery if it does not join the coalition, i.e., it satisfies individual rationality, and the optimal solution of the model is obtained. Conversely, if there is an optimal solution to this multilevel prioritization scheme, then it also indicates the existence of a kernel for the fuzzy cooperative alliance.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

4. APPLICATION EXAMPLES

4.1. Original Contribution Allocation

Illustrate: $a_{i,j} = |t_i \cup t_j|^{|t|}$, where t_i denotes the vaccine types recognized by country i, t_j denotes the vaccine types recognized by country j, and $|t_i \cup t_j|^{|t|}$ denotes the number of vaccine types jointly recognized by country i and country j. Assume that the correlation coefficient between the number of commonly endorsed vaccine types $a_{i,j}$ and the degree of trust $S_{i,j}$ between country i and country j in terms of the contribution of the country to the global economic recovery is k.

The contribution of this cross-border credit system to the benefits of the system varies among countries and is represented by the matrix

$$\alpha = \begin{bmatrix} kS_{1,1}a_{1,1} & \cdots & kS_{1,n}a_{1,n} \\ \vdots & \ddots & \vdots \\ kS_{n,1}a_{n,1} & \cdots & kS_{n,n}a_{n,n} \end{bmatrix}$$

For an alliance A˜_i, its total gain from joining this cross-border credit system, i.e., this fuzzy alliance, is

$$\tilde{V}\left([\tilde{A}]_i\right) = \sum_{i\in\tilde{A}} (kS_{i,i}a_{i,i} + \sum_{j\in\tilde{A}/\{i\}} kS_{i,j}a_{i,j})$$

In the context of widespread global spread of the epidemic, three countries are identified as country 1, country 2, and country 3 based on the need for economic development to establish a credit system for cross-border movement of people in the context of the global spread of the epidemic to facilitate global economic recovery.

If the types of vaccines recognized by country i are denoted by t_i, then country 1 recognizes the three types of vaccines a, b, and c, i.e., $t_1 = \{a, b, c\}$; country 2 recognizes the two types of vaccines a and c, i.e., $t_2 = \{a, c\}$; and country 3 recognizes the three types of vaccines b, d, and e, i.e., $t_3 = \{b, d, e\}$.

This cross-border credit system can be viewed as a grand coalition $\tilde{A}_7 = \{1,2,3\}$, and to prioritize the distribution of benefits among countries, the grand coalition needs to be viewed as several minor coalitions, i.e., $\tilde{A}_1 = (\{1\})$, $\tilde{A}_2 = (\{2\})$, $\tilde{A}_3 = (\{3\})$, $\tilde{A}_4 = (\{1,2\})$, $\tilde{A}_5 = (\{1,3\})$, $\tilde{A}_6 = (\{2,3\})$. $a_{1,2} = |t_1 \cup t_2|^{|t|} = |\{a, b, c\} \cup \{a, c\}|^{|t|} = 3$, and similarly we can get $a_{1,3} = 5$, $a_{2,3} = 5$, $a_{1,1} = 3$, $a_{2,1} = 3$, $a_{2,2} = 2$, $a_{3,1} = 5$, $a_{3,2} = 5$, $a_{3,3} = 3$. State 1's trust in State 1 $S_{1,1} = 0.5$, $S_{2,1} = 0.3$ for country 2, $S_{3,1} = 0.2$ for country 3; similarly set $S_{1,2} = 0.5$, $S_{2,2} = 0.4$, $S_{3,2} = 0.1$, $S_{1,3} = 0.1$, $S_{2,3} = 0.1$, $S_{3,3} = 0.8$.

The resulting:

$$\alpha = \begin{bmatrix} 1.5k & 0.9k & 1k \\ 1.5k & 0.8k & 0.5k \\ 0.5k & 0.5k & 2.4k \end{bmatrix}$$

Only one country participates: $\tilde{V}(\tilde{A}\{1\}) = 1.5k$, $\tilde{V}(\tilde{A}\{2\}) = 0.8k$, $\tilde{V}(\tilde{A}\{3\}) = 2.4k$

Two countries participate: $\tilde{V}(\tilde{A}\{1,2\}) = 1.5k + 0.9k + 0.8k + 1.5k = 4.7k$

$\tilde{V}(\tilde{A}\{1,3\}) = 5.4k$, $\tilde{V}(\tilde{A}\{2,3\}) = 4.2k$

With three countries participating: $\tilde{V}(\tilde{A}\{1,2,3\}) = 9.6k$

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

Table 1. Gain values of fuzzy coalition

Fuzzy coalition Fuzzy coalition gain	**Values**
$\tilde{A}_1 = 1$	$\mathbf{1.5k}$
$\tilde{A}_2 = 2$	$\mathbf{0.8k}$
$\tilde{A}_3 = 3$	$\mathbf{2.4k}$
$\tilde{A}_4 = 1,2$	$\mathbf{4.7k}$
$\tilde{A}_5 = 1,3$	$\mathbf{5.4k}$
$\tilde{A}_6 = 2,3$	$\mathbf{4.2k}$
$\tilde{A}_7 = 1,2,3$	$\mathbf{9.6k}$

Due to the number of vaccine types commonly accepted among the three countries, the situation of epidemic prevention and control within each country, and the different international relations and trust between the countries, coalition {2,3} receives less benefits. The coalition {2, 3} formed by country 2 and country 3 is said to be the second most important coalition and should be considered last in the allocation process. Therefore, given a fuzzy coalition $\tilde{A}_{11} = \tilde{A}_5 = \{1,3\}$ with priority P_1,$\tilde{A}_{21} = \tilde{A}_4 = \{1,2\}$ with priority P_2,$\tilde{A}_{31} = \tilde{A}_6 = \{2，3\}$ with priority P_3, and $P_1 >> P_2 >> P_3$

This leads to the following model:

$$minZ = P_1\left(d_{\tilde{A}_{1_1}}{}^{-}\right) + P_2\left(d_{\tilde{A}_{2_1}}{}^{-}\right) + P_3(d_{\tilde{A}_{3_1}}{}^{-})$$

$$s.t\begin{cases} x_1 \geq 1.5k \\ x_2 \geq 0.8k \\ x_3 \geq 2.4k \\ x_1 + x_2 + x_3 = 9.6k \\ x_1 + x_3 + d_{\tilde{A}_{1_1}}{}^{-} - d_{\tilde{A}_{1_1}}{}^{+} = 5.4k \\ x_1 + x_2 + d_{\tilde{A}_{2_1}}{}^{-} - d_{\tilde{A}_{2_1}}{}^{+} = 4.7k \\ x_2 + x_3 + d_{\tilde{A}_{3_1}}{}^{-} - d_{\tilde{A}_{3_1}}{}^{+} = 4.2k \\ d_{\tilde{A}_{k_l}}{}^{-} d_{\tilde{A}_{k_l}}{}^{+} = 0(k = 1,2,3; l = 1) \\ d_{\tilde{A}_{k_l}}{}^{-} \geq 0，d_{\tilde{A}_{k_l}}{}^{+} \geq 0(k = 1,2,3; l = 1) \end{cases}$$

Solving the above objective planning model yields

$d_{\tilde{A}_{1_1}}{}^{-} = 0$, $d_{\tilde{A}_{2_1}}{}^{-} = 0$, $d_{\tilde{A}_{3_1}}{}^{-} = 0$, $d_{\tilde{A}_{1_1}}{}^{+} = 0$, $d_{\tilde{A}_{2_1}}{}^{+} = 0$, $d_{\tilde{A}_{3_1}}{}^{+} = 0$, $Z^* = \left(d_{\tilde{A}_{1_1}}{}^{-}\right) + P_2\left(d_{\tilde{A}_1}{}^{-}\right) + P_3\left(d_{\tilde{A}_{3_1}}{}^{-}\right) = 0$,

Therefore the contribution value of the three countries is

$$X^* = (2.9500k, 1.7500k, 2.45000k),$$

That is, the contribution value of country 1 is 2.9500k, the contribution value of country 2 is 1.7500k and the contribution value of country 3 is 2.4500k.

4.2. Country-adjusted Contribution Allocation

Based on $a_{i,\ j} = |t_i \cup t_j|^{|t|}$, $\tilde{V}\left(\left[\tilde{A}\right]_i\right) = \sum_{i \in A}$ （$kn_{i,j}a_{i,j} + \sum_{j \in A/\{i\}} kn_{i,j}a_{i,j}$), and the criterion of priority: $\sum_{i \in \tilde{A}_{k_l}} x_i + d_{\tilde{A}_{k_l}}{}^{-} - d_{\tilde{A}_{k_l}}{}^{+} = \sum_{r=1}^{|\tilde{A}_{k_l}|} v(\left[\tilde{A}_{k_l}\right]_{h_r})(h_r - h_{r-1})$. We can know that the authority i has a claim to greater $Y(i)$ and benefit $\tilde{V}(i)$ from itself. The first case is to make one's own personal ability t_i enhanced to a certain extent to the $t_i{}'$. It can results in the

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

$Y(i)'$ and the $\tilde{V}(i)'$, and let it compare with the original $Y(i)$ and $\tilde{V}(i)$ to find out whether such a parameter change is from the perspective of a rational person. The second is to improve one's own image with other insiders, i.e., to increase other insiders' trust in oneself. The second is to improve one's image with the other insiders, i.e., to increase one's trust in the other insiders, by changing to $\tilde{A}_{\mathrm{j,l}}'$ (condition: $j \in \tilde{A}/\{i\}$); the third is to fully participate in the grand coalition, i.e., to increase one's trust in the other insiders, by changing to $\tilde{A}_{\mathrm{j,l}}$ (condition: $j \in \tilde{A}/\{i\}$). It should be noted that the second and third points are to some extent contradictory, and the final benefits depends on the actual situation.

In a major alliance, if a player wants to gain a larger share of the benefits of the alliance Y, he can do so in three ways. The first is to speed up the development of vaccines in his own country, so that he can use more types of vaccines in his country. The second is to control and prevent the epidemic in his country, so that he can improve his trust in the epidemic situation in his country; and the third is to achieve a higher level of trust in the other players. The final benefits is determined by the amount of change in these three parameters, which may make Y larger or make the gain of a player larger, but may also make Y smaller or make the gain of a player smaller.

Here, for example, we take country 1 as an example, where the initial contribution of country 1 in the alliance is Y_1=41.2587%.

(1) Increase in the number of types of vaccines developed [9]

Here is the t1 increase, assuming that the increase is $t_1' = \{a, b, c, d, e, f\}$, when the corresponding variables also follow, we can get

$$\alpha' = \begin{bmatrix} 3k & 1.8k & 1.2k \\ 3k & 0.8k & 0.5k \\ 0.6k & 0.5k & 2.4k \end{bmatrix}$$

Table 2. Gain values of fuzzy coalition

Fuzzy coalition Fuzzy coalition gain	**Values**
$\tilde{A}_1 = 1$	$3k$
$\tilde{A}_2 = 2$	$0.8k$
$\tilde{A}_3 = 3$	$2.4k$
$\tilde{A}_4 = 1,2$	$8.6k$
$\tilde{A}_5 = 1,3$	$7.2k$
$\tilde{A}_6 = 2,3$	$4.2k$
$\tilde{A}_7 = 1,2,3$	$13.8k$

Priority relationship: $P_2 >> P_1 >> P_3$, resulting in the new model

$$minZ = P_1\left(d_{\tilde{A}_{2_1}}{}^{-}\right) + P_2\left(d_{\tilde{A}_{1_1}}{}^{-}\right) + P_3(d_{\tilde{A}_{3_1}}{}^{-})$$

$$s.t\begin{cases} x_1 \geq 3k \\ x_2 \geq 0.8k \\ x_3 \geq 2.4k \\ x_1 + x_2 + x_3 = 13.8k \\ x_1 + x_3 + d_{\tilde{A}_{1_1}}{}^{-} + d_{\tilde{A}_{1_1}}{}^{+} = 7.2k \\ x_1 + x_2 + d_{\tilde{A}_{2_1}}{}^{-} + d_{\tilde{A}_{2_1}}{}^{+} = 8.6k \\ x_2 + x_3 + d_{\tilde{A}_{3_1}}{}^{-} + d_{\tilde{A}_{3_1}}{}^{+} = 4.2k \\ d_{\tilde{A}_{k_l}}{}^{-} d_{\tilde{A}_{k_l}}{}^{+} = 0(k = 1,2,3; l = 1) \\ d_{\tilde{A}_{k_l}}{}^{-} \geq 0,\ d_{\tilde{A}_{k_l}}{}^{+} \geq 0(k = 1,2,3; l = 1) \end{cases}$$

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

Solving the above objective planning model yields

$d_{\tilde{A}_{1_1}}{}^- = 0$, $d_{\tilde{A}_{2_1}}{}^- = 0$, $d_{\tilde{A}_{3_1}}{}^- = 0$, $d_{\tilde{A}_{1_1}}{}^+ = 2.0000k$, $d_{\tilde{A}_{2_1}}{}^+ = 0$, $d_{\tilde{A}_{3_1}}{}^+ = 0$, $Z^* = \left(d_{\tilde{A}_{1_1}}{}^-\right) + P_2\left(d_{\tilde{A}_1}{}^-\right) + P_3\left(d_{\tilde{A}_{3_1}}{}^-\right) = 0$,

Therefore the contribution value of the three countries

$$X^* = (6.8000k, 2.8000k, 2.4000k),$$

That is, the contribution value of country 1 is $6.8000k$, the contribution value of country 2 is $1.8000k$ and the contribution value of country 3 is $2.4000k$. At this point, the contribution value of country 1 in the coalition $Y_2 = 61.8182\%$.

(2) Countries1 have strengthened and improved their own domestic epidemic prevention and control

The trust in country 1 increases due to the better treatment of the epidemic in country 1, which is set as $S_{1,1}{}' = 0.7, S_{2,1}{}' = 0.7, S_{3,1}{}' = 0.3$

The trust in country 2 and country 3 decreases to some extent, given that $S_{1,2}{}' = 0.2, S_{1,3}{}' = 0.2, S_{2,2}{}' = 0.3, S_{2,3}{}' = 0, S_{3,2}{}' = 0, S_{3,3}{}' = 0.7$, and the corresponding variables also change.

It can be derived that:

$$\alpha = \begin{bmatrix} 2.1k & 0.6k & 0.5k \\ 2.1k & 0.6k & 0k \\ 0.9k & 0k & 2.1k \end{bmatrix}$$

Table 3. Gain values of fuzzy coalition

Fuzzy coalition Fuzzy coalition gain	**Values**
$\tilde{A}_1 = 1$	$2.1k$
$\tilde{A}_2 = 2$	$0.6k$
$\tilde{A}_3 = 3$	$2.1k$
$\tilde{A}_4 = 1,2$	$5.4k$
$\tilde{A}_5 = 1,3$	$5.6k$
$\tilde{A}_6 = 2,3$	$2.7k$
$\tilde{A}_7 = 1,2,3$	$8.9k$

Priority relationship: $P_1 >> P_2 >> P_3$, resulting in the new model.

$$minZ = P_1\left(d_{\tilde{A}_{1_1}}{}^-\right) + P_2\left(d_{\tilde{A}_{2_1}}{}^-\right) + P_3(d_{\tilde{A}_{3_1}}{}^-)$$

$$s.t\begin{cases} x_1 \geq 2.1k \\ x_2 \geq 2.1k \\ x_3 \geq 0.9k \\ x_1 + x_2 + x_3 = 8.9k \\ x_1 + x_3 + d_{\tilde{A}_{1_1}}{}^- + d_{\tilde{A}_{1_1}}{}^+ = 5.6k \\ x_1 + x_2 + d_{\tilde{A}_{2_1}}{}^- + d_{\tilde{A}_{2_1}}{}^+ = 5.4k \\ x_2 + x_3 + d_{\tilde{A}_{3_1}}{}^- + d_{\tilde{A}_{3_1}}{}^+ = 2.7k \\ d_{\tilde{A}_{k_l}}{}^- d_{\tilde{A}_{k_l}}{}^+ = 0(k = 1,2,3; l = 1) \\ d_{\tilde{A}_{k_l}}{}^- \geq 0,\ d_{\tilde{A}_{k_l}}{}^+ \geq 0(k = 1,2,3; l = 1) \end{cases}$$

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

Solving the above objective planning model yields

$d_{\tilde{A}_{1_1}}{}^{-} = 0$, $d_{\tilde{A}_{2_1}}{}^{-} = 0$, $d_{\tilde{A}_{3_1}}{}^{-} = 0.9000k$, $d_{\tilde{A}_{1_1}}{}^{+} = 0$, $d_{\tilde{A}_{2_1}}{}^{+} = 1.4000k$, $d_{\tilde{A}_{3_1}}{}^{+} = 0.3000k$, $Z^* = \left(d_{\tilde{A}_{1_1}}{}^{-}\right) + P_2\left(d_{\tilde{A}_1}{}^{-}\right) + P_3\left(d_{\tilde{A}_{3_1}}{}^{-}\right) = 0.9000k$,

Therefore the contribution value of three countries

$$X^* = (4.7000k, 2.1000k, 0.9000k),$$

That is, the contribution value of country 1 is 4.7000k, the contribution value of country 2 is 2.1000k and the contribution value of country 3 is 0.9000k. At this point the contribution rate of country 1 in the coalition $Y_3 = 61.0390\%$.

(3) 3.2.3 Country 1 increases the level of trust in Country 2, Country 3

At this point, suppose the trust of country 1 to country 2 changes from $S_{1,2} = 0.3$ to $S_{1,2}{}' = 0.4$, and the trust of country 3 changes from $S_{1,3} = 0.2$ to $S_{1,3}{}' = 0.3$, then the trust of country 1 to country 1, i.e., to itself, will change to $S_{1,1}{}' = 0.3$, and the corresponding variables will change accordingly, which leads to

$$\alpha = \begin{bmatrix} 0.9k & 1.2k & 0.5k \\ 1.5k & 0.8k & 0.5k \\ 0.5k & 0.5k & 2.4k \end{bmatrix}$$

Table 4. Gain values of fuzzy coalition

Fuzzy coalition Fuzzy coalition gain	**Values**
$\tilde{A}_1 = 1$	$0.9k$
$\tilde{A}_2 = 2$	$0.8k$
$\tilde{A}_3 = 3$	$2.4k$
$\tilde{A}_4 = 1,2$	$4.4k$
$\tilde{A}_5 = 1,3$	$4.3k$
$\tilde{A}_6 = 2,3$	$4.2k$
$\tilde{A}_7 = 1,2,3$	$8.8k$

Priority relationship: $P_2 >> P_1 >> P_3$, resulting in the new model

$$minZ = P_1\left(d_{\tilde{A}_{1_1}}{}^{-}\right) + P_2\left(d_{\tilde{A}_{2_1}}{}^{-}\right) + P_3(d_{\tilde{A}_{3_1}}{}^{-})$$

$$s.t \begin{cases} x_1 \geq 0.9k \\ x_2 \geq 0.8k \\ x_3 \geq 2.4k \\ x_1 + x_2 + x_3 = 8.8k \\ x_1 + x_3 + d_{\tilde{A}_{1_1}}{}^{-} + d_{\tilde{A}_{1_1}}{}^{+} = 4.4k \\ x_1 + x_2 + d_{\tilde{A}_{2_1}}{}^{-} + d_{\tilde{A}_{2_1}}{}^{+} = 4.3k \\ x_2 + x_3 + d_{\tilde{A}_{3_1}}{}^{-} + d_{\tilde{A}_{3_1}}{}^{+} = 4.2k \\ d_{\tilde{A}_{k_l}}{}^{-} d_{\tilde{A}_{k_l}}{}^{+} = 0 (k = 1,2,3; l = 1) \\ d_{\tilde{A}_{k_l}}{}^{-} \geq 0, d_{\tilde{A}_{k_l}}{}^{+} \geq 0 (k = 1,2,3; l = 1) \end{cases}$$

Solving the above objective planning model yields

$d_{\tilde{A}_{1_1}}{}^{-} = 0$, $d_{\tilde{A}_{2_1}}{}^{-} = 0$, $d_{\tilde{A}_{3_1}}{}^{-} = 0$, $d_{\tilde{A}_{1_1}}{}^{+} = 0.7000k$, $d_{\tilde{A}_{2_1}}{}^{+} = 0$, $d_{\tilde{A}_{3_1}}{}^{+} = 0$, $Z^* = \left(d_{\tilde{A}_{1_1}}{}^{-}\right) + P_2\left(d_{\tilde{A}_1}{}^{-}\right) + P_3\left(d_{\tilde{A}_{3_1}}{}^{-}\right) = 0$,

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

Therefore the contribution value of the three countries

$$X^* = (2.6000k, 1.8000k, 2.4000k),$$

That is, the contribution value of country 1 is $2.6000k$, the contribution value of country 2 is $1.8000k$ and the contribution value of country 3 is $2.4000k$. At this time, the contribution value of country 1 in the coalition $Y_4 = 38.2353\%$

Comparing the magnitudes of Y_1, Y_2, Y_3, and Y_4, we can determine the extent to which country 1 can play a role in the alliance, which makes country 1 the largest contributor to the global economic recovery, and determine whether country 1's participation in the alliance can create greater benefits to determine whether to agree to country 1's participation in the system.

In terms of the benefits of country 1 in the alliance. The first scenario of increasing the number of vaccines developed and the second scenario of increasing and improving the control of the epidemic in country 1 are both greater than the original value of $2.95k$. While the third scenario of increasing the trust of country 1 in countries 2 and 3 is smaller than the original value of $2.6k$, and this scenario is excluded. The first and second scenarios are also larger than the original value of 41.2587%, and the third scenario is smaller than the original value, so the first and second scenarios are remain.

5. CONCLUSION

In view of the current development of the global epidemic, this paper establishes a cross-border movement of people credit system in order to control the epidemic, accelerate the economic recovery of each country, and exclude individual countries from creating confrontation as much as possible. First, the degree of trust between countries is different, that is, for two insiders, one insider has a degree of trust in the other insider, and it does not mean that the other insider has the same degree of trust in him. This is determined by taking into account the actual situation of the country's domestic epidemic prevention and control as well as international relations and cooperation. Secondly, the correspondence between the solution of the multilevel prioritized goal planning and the core of the fuzzy coalition cooperation game is taken into account when allocating the benefits of the grand coalition. The paper uses two parameters to determine whether such a change is rational. This paper introduces the concept of a credit system for cross-border movement of people, which provides new ideas and thoughts to promote global economic recovery.

REFERENCES

[1] Wang Guoyan,Fan Dong: Alert to the Tail Risks of the Global Epidemic: the Impact of Emerging Market Turmoil on the Global Financial Economy[J], Tsinghua Financial Review,(2020) No.08,p.49-51.

[2] Wang Xiaodong, Wang Weikang, Zhou Sheng: Research on Cross-border Credit Cooperation in "One Belt and One Road"-a Perspective of Data Circulation[J], Law and Society,(2016) No.22,p.89-90.

[3] Chen Ying, Zheng Yinli: the Experience and Inspiration of Cross-border Flow of Credit Data in EU Countries[J], Fujian Finance,(2014) No. 08,p.46-49.

[4] Nan Jiangxia,Wei Liuxiao,Li Dengfeng,Zhang Maojun: An Objective Planning Solution Model for Fuzzy Cooperative Game with Coalition Preference Relationship[J], China Management Science,Vol.30(2022)No.07,p.231-240.

[5] Xun Yue Kang: Evolutionary Game Analysis of Micro and Small Enterprises' Financing from the Perspective of Credit [J/OL], Credit, (2021) No. 06,p.30-35.

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202211_8(11).0013

[6] Liang, Kai-Rong, Li, Deng-Feng: A Non-cooperative-cooperative Two-type Game Approach for Optimizing Bilateral Link Network Formation With Triangular Fuzzy Numbers of Revenue[J]. Control and Decision Making,Vol.37(2022)No.05,p.1220-1230.

[7] Tian Shuhua: Rational Human Assumptions Rational Human Thinking [N], China Rural and Urban Finance News,(2021) No.B02.

[8] Liu Jin: Credible Quasi-kernels for Fuzzy Payment Cooperation Games[J], Fuzzy Systems and Mathematics,Vol.37(2020)No.02,p.56-68.

[9] Liu Yanchunzi: Wider Universal Vaccination of New Crowns Key to Boosting Global Recovery [N], Financial Times,2021-06-03(008).

[10] Sun Xiubao: Review of Critical Theory in International Relations Theory[J], China Business,(2008) No. 15,p.65.