The Procrastination of the Global Agreements on Greenhouse Gasses Emissions: Local Solutions to the Tragedy of the Global Commons

Yoshifumi Ueda[1]
Faculty of Economics
Hiroshima University
1-2-1,Kagamiyama, Higasihi-Hiroshima
JAPAN

Gert Tinggard Svendsen
Department of Economics
The Aarhus School of Business
DENMARK

Ichiro Nishizaki
Graduate School of Engineering
Hiroshima University
JAPAN

Introduction

Based on the recognition that global agreements on cutting greenhouse gasses emissions are apt to be procrastinated, local initiatives on a voluntary basis is proposed as a complement to the ongoing intergovernmental negotiations. The preservation of the atmospheric quality is regarded as a global public good, and we investigates the efficacy of financing it by means of raffle lotteries. We derive the conclusion that the efficacy depends both on the organizational form of the lottery enterprise, i.e. on what type of entrepreneur runs the

enterprise of the "selective incentive-cum-global public good," and on consumers' consciousness of the ecological benefit of the global public good.

That is because a network must be formed prior to financing and providing the global public good. The network is indispensable, firstly because many of the beneficiaries of the global public good such as the atmospheric quality may not be even conscious of the benefits themselves, and secondly because even if they are conscious, they must be confident in their belief on other members' consciousness in order for all of them to join in the concerted cooperative actions. Once the network is formed somehow, their concerted actions for a social optimality are made possible through various kinds of information transmissions without inflicting a further organizing cost.

Therefore, the network formation is an economic activity, whose output is a reduction in transaction cost, i.e., an increase in free time. However, it takes some heavy cost, time & energy, to form a network. Each player has to weigh the benefit against cost of the network formation. In order to investigate the network formation from the motivational perspective, we build a non-cooperative game model of network formation by recourse to the graph approach to cooperative games inspired by Myerson(1977), and Aumann & Myerson(1988).

In our paper, each player makes decision on what links to form with others. He can obtain the benefits from joining in a connection where each member is indirectly or directly connected. He can gain bigger benefits when the size of connectedness becomes larger in terms of saving on communication cost. On the other hand, he has to bear the cost of forming the direct links. So, he has to weigh the benefit with the cost, when he makes decision on what links to be formed. This network formation game is an application of the ideas created by Wolinsky(1996), Bala & Goyal(1999), Slikker & Neuweland(2001),and Watts(2001).

From this game model, both a star and a line type of network are proved to be not only efficient, but also the outcome of a strong Nash Equilibrium. In this sense, both types of networks are stable, once they are formed. The benefit of each network is the same in terms of the size of connectedness, but the cost to join in each is different. The cost to the non-center players ofjoining in the star network is cheaper than in the line network, but the cost to the center player is much heavier. For an example of the star networks, we can take ubiquitous observations of a hub-spoke type of not-for-profit-organization. As an example of line networks, we can take "information transmission networks in line" among community members with consciousness of their common interests. This difference in the cost of network formation is attributed to the difference in consumers' consciousness of their common interests, i.e., the benefit of the global public good. The less conscious they are, the more indispensable it is to form the star network.

When the center player of the star network bears the heaviest linkage cost, he has to be compensated for that cost, in order to induce him to take on the task. But if he is also a self-motivated type of individualist, how can he be motivated to do it?

If he can gain the biggest benefit from the global public good, he may be compensated for the cost incurred by his networking work. This is one story, but he must be a special type of player who is very ecologically conscious. Another possibility is that he is compensated with pecuniary rewards at a later stage when the global public good is financed. That is, he may be compensated with his sharing in the sales profit of the selection incentive scheme enterprise. In order to implement that compensation scheme, however, the organizational form of the "selective incentive-cum-global public good" enterprise cannot be of a naive type of not-for-profit-organization which is run by so-called voluntary social organizers, called *social entrepreneur* in this paper. They can be compensated for their network cost with the benefit of the public good itself. On the contrary, that organization must be able to pay a portion of the sales profit to the center player of the star network, in order to motivate him to make effort of taking the initiative in forming the network. It must be a for-profit-organization type of organization. The entrepreneur of this organization form is called *business entrepreneur,* as usual.

When the "selective incentive-cum-global public good" enterprise is run by a for-profit-organization, only a portion of the profit can be put into use for the collective good. When it is the case, this selective incentive scheme is not compatible to the social objective of alleviating the inefficiency problem of public good. In this case, voluntary contribution schemes are less inefficient. This is because the less conscious the consumers are of their common interests, then the higher portion must be shared by the business entrepreneur, and the less of the global public good.

This conclusion is in conflict with Morgan (2000a, 2000b), according to which the raffle lottery scheme can finance public goods and alleviate the inefficiency problem, providing public goods in a more efficient way than voluntary contribution schemes. But his model is based on the assumption that all sales profits are put into use for the public goods. It amounts to assuming that the organizer is not a self-motivated type, or that a social entrepreneur type of organizer is ready to take on the task to form a fully connected network. Pecorino (2001) also makes the same assumption on the organization form of the "private good-cum-lobbying" business. In this paper we take up the special roles of the social entrepreneurs in providing the global public good on a local scale.

In order to explain our logic, a three-stage game is put forth. At the zero stage, an entrepreneur decides on whether to enter the enterprise of a selective incentive-cum-global public good. His decision depends not only on the prospect of the demand for the global public good and

selective incentive, but also on what type of entrepreneur he is, because the type determines his payoff function. At the first stage, a network is formed. It is an indispensable precondition for funding the global public good. Only the consumer-players connected somehow at this stage can become conscious of the benefit of the global public good. At the second stage, the global public good is financed through selling the selective incentive, raffle lotteries, to those consumer-players. From the analysis of this game, we come to the conclusion that the social entrepreneur or the organizational form of NPO is more in consistent with the ultimate social goal of the provision of a global public good than the business entrepreneur.

This paper is organized as follows: In the first section, the basic model is presented. In the second section, the network formation game is formulated, and in the third, the equilibrium of that game is derived. In the fourth section, the entry decisions of the entrepreneurs are examined. In the fifth section, the logic of procrastination tendency is briefly summarized.

1.The Basic Model

The conventional models of public goods implicitly assume that all consumers (or potential beneficiaries) are well conscious of their own benefits obtainable from those public goods. In the case of global common pool resources (hereafter, abbreviated as GCPR) such as the global atmosphere, however, all of the potential beneficiaries are not necessarily even conscious of the benefit itself, because of their lack of scientific knowledge, or because of uncertainty on it.

What is worse, they are uncertain on whether or not other community member are conscious of the benefit, even if they themselves are conscious of their own benefits. Under such circumstances, why and how can the social optimality be achieved? Here, we are required to take into allowance some costs in addition to the direct provision cost taken for granted by the conventional approaches. Even if the selective incentive schemes such as raffle lotteries are regarded as an efficacious means to finance public goods, as proved by Morgan(2000) and Pecorino(2001), even those schemes have to get over the above cognitive problem, i.e., the costly cognitive process must be gotten through somehow.

In this paper, we take up, in particular, a cognitive cost to make the players interested to be not only conscious of the benefit but also confident that they belong to a group consisting of those being conscious of the benefit obtainable from a GCPR. When such a group is organized somehow, it is called a *network*. Once a network is formed, all members of the group can save communication cost indispensable for any concerted actions. Once it is formed, a social organizer can put any

proposal to carry out a selective incentive-cum-GCPR scheme to the networked members with negligible transaction cost.

This cost saving is regarded as an economic output, but any player who joins in a connected network has to pay his own linkage cost, incurred when he is connected directly with someone of the group. What type of network is formed depends on each player's weighing the benefit against the cost of the network.

So, we begin the whole processes of public good provision with a link formation game. After this first stage, the stage of financing the public good follows. That is the stage where the participating players decide on their own purchase of the lottery ticket. At the last stage the public good is financed by a portion of the lottery sales profit, and provided by the organizer of the lottery enterprise, who is social or business entrepreneur depending on their objective functions or the organizational form of the enterprise.

Let's begin with explaining the network formation game[2].

Players:

There are assumed to be n potential beneficiaries of a GCPR, and the players' set consisting of them is defined as $N= (1,2,..., n)$ in what follows.

Strategies:

The strategies of the players are composed of their decision on direct links with other players. The strategy of i is denoted by g_i, which is defined as:

$$g_i := (g_{i1},..., g_{in}), \quad i \in N$$

$$g_{ij} = \begin{cases} c_{ij} \square 0, & j \in N \square i \\ \Phi & \end{cases}$$

$$g_{ii} = 0$$

$g_{ij}=c_{ij}$ means i would like to form a link with j, and is ready to incur the cost of c_{ij} for this link formation. $g_{ij}= \Phi$ means i has no intention to form a link with j. The n-tuple vector of all players' strategies is defined as:

$$g := (g_1, ..., g_n)$$

A link between i and j, denoted by $\{ i, j \}$, is formed, only when $g_{ij}=c_{ij}$ and $g_{ij} = c_{ji}$. A set of links, $l(g)$, formed under a strategy, g, is defined as the following:

$$l(g) := (\{ i, j \} \mid g_{ij} = c_{ij}, \ g_{ji} = c_{ji}, \text{ for } i, j \in N)$$

A connected set including i under a strategy vector, g, is defined as a

---

[2] Regarding the basics of the concepts in this subsection, refer to Myerson(1977).

set, denoted by $L_i(g)$, if the players are directly or indirectly connected with i. It is assumed that when a set of players is connected, they can communicate with others without any further transaction cost. They can send their messages free. The saving of this communication cost is the output of that connection.

The feasible connected set, denoted by $M_i(g)$, is defined as follows:

$$M_i(g) := \{ \{ i, j \} \in l(g) \mid \sum_{\{k,m\} \in l(g), L_i(g)} (c_{km} + c_{mk}) \leq V(L_i(g))$$

In the above definition, $V(L_i)$ means the output of a network formed by the connected members of $L_i(g)$. The *feasibility* means that the output of a connected network should exceed or be equal to the total sum of the linkage costs.

Payoff:

We defined the output of a connected network as the saving of communication costs to the players of the network. Denoting by $V(S)$ the output of a connected network formed by a set of players, $S \subseteq N$,

$$(1)\ V(S) = \begin{cases} \sum_{\{i,j\} \in M_i(g)} c_{ij} + \text{for } \exists\ i_c \in S \\ \sum_{\{j,i\} \in M_i(g)} c_{ji} \\ \left(c_{i_1 i_2} + c_{i_2 i_1}\right) + \left(c_{i_2 i_3} + c_{i_3 i_2}\right) + \ldots + \left(c_{i_{s-1} i_s} + c_{i_s i_{s-1}}\right) \end{cases}$$

In the above, $i_s := | S |$, the cardinality of S, and i is the center, when the network is a star type. Here, keep in mind that the output is the volume of the saving to be achieved in the most efficient way.

If N is divided into m separated connections, the total output of these m connected networks, denoted by $V(S_1,\ldots,S_m)$, is defined as follows:

$$(2)\ V(S_1,\ldots,S_m) = V_1(S_1) + \ldots + V_m(S_m)$$

It is obvious $V(N) > V(S_1,\ldots,S_m)$. Then, the payoff function of j at this stage, $\Pi_j(g)$, is derived as follows:

$$(3)\ \Pi_j(g) = V(S_1\ldots,S_m) - \sum_{\{j,k\} \in M_j(g)} c_{jk}\ S_h = M_j(g) \text{ for } {}^{\forall}h.$$

So, when N is connected under g,

$$(4)\ \Pi_j(g) = V(N) - \sum_{\{j,k\} \in Mj(g)} c_{jk}\ {}^{\forall}j \in N$$

When it is assumed the linkage costs are symmetric, $c_{ij} = c_{ji} = c$ for $i,j \in N$. Then, (1) and (4) are simplified as the following:

$$(1)'\ V(N) = 2c\ (|N| - 1) = 2c\ (n - 1)$$

$$(4)'\ \Pi_j(g) = 2c\ (n - 1) - \sum_{\{j,k\} \in M_j(g)} c$$

2. The Nash and Strong Nash Equilibrium of the Network Formation Game

It is proved that two sets of strategies bringing about a star and line type of network are not only a Nash but also a strong Nash Equilibrium. In what follows, we assume the benefits and costs of the networks are symmetric.

Proof of the Nash Equilibrium:
Let's denote the Nash Equilibrium by g^* for both types of networks to avoid abuse of terms.

(i) Assume g^* has brought about a line type of network. When $j \square N$ is located between two players, his payoff under g^* is : $\Pi j(g^*) = 2c\ (n-1) - 2c$. If he is located at one of the end points, $\Pi j(g^*) = 2c\ (n-1) - c$. Suppose he deviates from the Nash strategy, and sever one link. (It is obvious that he has no incentive to sever more than two links.) Then, his payoff is reduced to: $\Pi_j(g_j, g^*_{-j}) = 2c(\ |S_1|\ -1) + 2c\ (|S_2|\ -1) - c = 2c\ (n-1) - 3c$, for the former case. $\Pi_j(g_j, g^*_{-j}) = 2c\ (n-2) = 2c\ (n-1) - 2c$ for the latter case. Thus, the payoffs obtainable from the deviation turn out to be reduced for both cases.

(ii) Assume g^* has achieved a star type of network. When $j \in N$ is not the center, his payoff is, $\Pi_j(g^*) = 2c\ (n-1) - c$. If j is the center, $\Pi_j(g^*) = 2c\ (n-1)\ c\ (n-1) = c\ (n-1)$. Suppose j deviates from the Nash strategy and severs one link. Then, his payoff is changed to:

$\Pi_j(g_j, g^*_{-j}) = 2c\ (n-2) - c = 2c\ (n-1) - 3c$, for the former, and
$\Pi_j(g_j, g^*_{-j}) = 2c\ (n-2) - c\ (n-2) = c\ (n-1) - c$, for the latter.

For each case, the payoff from deviation is reduced. (Q. E. D.)

Proof of the Strong Nash Equilibrium:
Let's take up the star type, first. To derive a contradiction, there must exist
$\square S \subset N$ such that S satisfies the following conditions:

$$\Pi_j(g_S, g^*_{-S}) \square \Pi_j(g^*_S, g^*_{-S}) \quad \forall j \in S$$

and for at least one player, $\exists k \in S$, a strict inequality holds. In the above, g_S is $\square S \square$tuple strategy vector of the deviating coalition S, and g_{-S} that of $N \square S$.

We can classify the coalitions made by S into two cases. In the first case, S does not include the center player i of N. If, then, S forms a line network, the payoff of $j \square S$ is:

$$\Pi_j(g_S, g^*_{N \square S}) = \begin{cases} V(S) + V(N \square S) - 2c \\ \quad = 2c(n-1) - 4c, & \text{for } j \square S \text{ not at the end} \end{cases}$$

points

$$V(S) + V(N\square S) - c$$
$$= 2c(n-1) - 3c, \quad \text{for } j\square S \text{ at the end points.}$$

Both of them are less than $\Pi_j(g^*)$.

If, on the other hand, S forms a new star, the payoff of $j\square S$ is :

$$\Pi_j(g_S, g^*_{N/S}) = \begin{cases} V(S) + V(N\square S) - c \\ = 2c(n-1) - 3c, \\ < 2c(n-1) - c = \Pi_j(g^*) \text{ for the non-center players} \\ \\ V(S) + V(N\square S) - c(|S|-1) \\ = 2c(n-1) - c(|S|+1) \\ < 2c(n-1) - c = \Pi_j(g^*) \quad \text{for the new center of S} \end{cases}$$

Any player of S cannot increase his payoff by the coalition S, either.

Let's move to the second case that S includes the center i of N. The case that S is connected by a new star or line is meaningful. Then, the payoffs of the players of the new star of S are:

$$\Pi_j(g_S, g^*_{N\square S}) = V(S) + V(k_1,\ldots, k_m) - c$$
$$= 2c(|S|-1) - c, \quad \text{for } {}^{\square}j \square S,\ j \neq \text{the center}$$

$$\Pi_j(g_S, g^*_{N\square S}) = V(S) + V(k_1,\ldots k_m) - c(|S|-1)$$
$$= c(|S|-1), \quad \text{for the center of S}$$

In the above, $(k_1,\ldots, k_m) = N\square S$, $m = n - |S|$. $V(k_1,\ldots, k_m) = V(\{k_1\}) + \ldots$, $V(\{'k_m\}) = 0$. All of them are less than $\Pi_j(g^*)$, because $|S| < n$.

On the other hand, the payoffs of the players of the new line of S are:

$$\Pi_j(g_S, g^*_{N\square S}) = V(S) + V(k_1,\ldots, k_m) - 2c$$
$$= 2c(|S|-1) - 2c \quad \text{for the players not at the end points.}$$

$$\Pi_j(g_S, g^*_{N\square S}) = V(S) + V(k_1,\ldots, k_m) - c$$
$$= 2c(|S|-1) - c \quad \text{for the players at the end points.}$$

Obviously, all payoffs are less than $\Pi_j(g^*)$, because $|S| < n$. (Q.E.D.)

It has just been derived that the network formation game has two stable networks in the meaning of strong Nash Equilibrium. At this point of time, we cannot say yet which type is more likely to come into being. In the case of the line type, the players at the end points can gain larger payoff than those between them. On the other hand, the payoff of the center player of the star network is mush smaller than those of non-center players. In the forth section, it is explained that the star network is that formed by community members unconscious of their common

interests, and that the line network reflects that formed by those members conscious of their common interests.

3. Fund-raising Stage[3]

At the second stage, a player of a network formed at the first stage comes up with a selective incentive scheme, *a fixed raffle lottery.* At the end of the first stage, all players know that not only they themselves but also other players of the network are conscious of the benefits of the GCPR. And furthermore, all of them know they belong to a network where they can save a communication cost. At this point in time, they can become confident in the reality of the potential benefit of the GDPR. At this point in time, the benefits of the GCPR can come into being in their utility functions. In this subsection we formulate the utility functions of those ecologically conscious players.

The players belonging to the connected network obtain benefits not only from private goods but also from the GCPR. The private goods are comprised of a numeraire good and the prize of the raffle lottery. They know at least a portion of the profit of the lottery enterprise is put into use for funding the preservation of the GCPR. They are not confident that their fund-raising effort is sufficient to achieve their ultimate goal, because they are still a minority relatively to the global community as a whole. But they can obtain a benefit from the belief that their fund-raising activities can contribute to providing the GCPR in spite of being "a bit of. So, we assume that they obtain the benefit of the GCPR from the fund being put into use for preserving the GCPR by any means.

The organizer of the lottery scheme, i.e., social or business entrepreneur, should be compensated not only for his entrepreneurship at this second stage but also for the cost incurred for his networking activity performed at the first stage. If he is the business entrepreneur, a portion of the sales profit of the lottery enterprise is awarded to him at this second stage in addition to a fixed salary, F, for his management work done at the second stage. His share in the profit is denoted by $1-\mu$, $0<\mu<1$. If he is the social entrepreneur, he is compensated with F and with the benefit of the GCPR.

Assuming a quasi-linear utility function, the expected utility of i non-organizer player, EU_i, is given by (5) and (5)' for each type of the organizational form of the enterprise.

$$(5)\quad EU_i = I_i - x_i + x_i R / X(N) + \square_i(\square(x(N) - R - F)), \text{ and}$$

$$(5)'\quad EU_i = I_i - x_i + x_i R / X(N) + \square_i(x(N) - R - F)$$

---

[3] Regarding to the details of the raffle lottery schemes below, refer to Morgan(2000), Morgan & Steften(2000).

The symbols in the above equations are defined as follows:

I_i := initial endowment of i

x_i := bet on the raffle of i

$x(N) := x_1 + x_2 + \ldots + x_n$

R := a fixed raffle, $0 \leq R \leq (x(N) - F)$

π_i := the benefit obtainable from the GCPR.

It is assumed $\pi'_i > 0$, and $\pi''_i < 0$ as usual.

When the GCPR is financed by voluntary contributions scheme, then the utility function, U_i, is changed to (6),

(6) $U_i = I_i - x_i + \pi_i(x(N))$, for any $i \in N$.

This change of the functional form is attributed to the change of the organization form from an enterprise led by an entrepreneur of any type to voluntary actions of all players.

Now, we derive the first-best and selfish outcomes for comparison. First, suppose the case that each player voluntarily makes decision on how much to contribute to the fund-raising for the GCPR, and that those contributions are put into use for it without any additional cost. Then, from the first order conditions for the maximization of (6), (7) are derived.

(7) $\pi'_i(x(N)) = 1$, for $x(N) = x^V$

x^V is called the selfish level of voluntary contributions.

Secondly, suppose the case that the contributions can be coordinated to achieve the social optimality without any additional cost. Then, the optimal level, denoted by x^*, satisfies the following condition:

(8) $\sum_{i=1}^{n} \pi'_i(x(N)) = 1$, for $x(N) = x^*$.

From (7) and (8), it is obvious that $x^* > x^V$.

Next, let's investigate the performance of a fixed-raffle lottery scheme. Assuming the inner solution of the maximization problem of (5), (9) is derived from the first order conditions.

(9) $\pi'_i(\pi(x(N) - R\text{-}F)) - 1 + x(_N\pi_i)\, R / (x(N))^2 = 0$, for $x(N) = x^W$

Since $x\,(_N\pi_i)\, R / (x\,(N))^2$ is positive and less than unity, $0 < 1 - x(_N\pi_i)\, R / x^2(_N) < 1$.

As, however, π is also less than unity, it is not a priori sure whether or not $\pi'_i(\pi(x^W - R\text{-}F))$ is larger than unity. It may be larger than unity,

if □is sufficiently small, so that the following inequality, $\square(x^W - R\text{-}F) < x^V$, can hold. In this case, the fund for the GCPR may be reduced below the sum of the voluntary contributions.

On the contrary, if the reward for the social entrepreneurship is a fixed amount, F, then μ is set at unity, and the necessary conditions (9) are changed to (10):

(10) $\square_i (x(N) - R - F) - 1 + x(N\square i)\, R / (x(N))^2 = 0$, for $x(N) = x^F$

In this case, $x^F - R - W > x^V$, which amounts to the same conclusion as Morgan (2000). But this conclusion is based on the implicit assumption that the entrepreneur is a social entrepreneur type. The social entrepreneur must be satisfied with a fixed compensation, F, and the direct benefit of the GPCR for his all works. Thus, the provision of the public good depends on what type of the social organizer takes the initiative for network formation.

4. Who Can Take the Leadership in Forming a Network?

In this section, we investigate the entry decision of the entrepreneur at the zero stage.

(4-1) Entrepreneur's Belief on Types of Consumers

In this paper we took up two types of social organizers, called social entrepreneur and business entrepreneur. The former type obtains the benefit from the global public good itself he takes the initiative in providing a community with. That is, he can be satisfied with the mission itself of his enterprise, to the extent that the direct costs are recovered. The latter type of entrepreneur, business entrepreneur, does not necessarily obtain the benefit from the public good itself, so that he must be rewarded for his networking effort with pecuniary incomes. The reward must be more or less in proportion to his effort.

Before launching into a new enterprise, an entrepreneur of any type has to estimate the prospect of the enterprise. In the case of a "selective incentive-cum-GCPR" enterprise, he has to expect not only the demand for the private good (selective incentive), but also the demand for the global public good. The state of the demand for the global public good influences the cost of network formation. In this paper, we assume two different states of demand for the GCPR; a low and high state.

In the case of the low state, consumer-players are not even conscious of the benefit of the public good. They are not motivated to positively join in forming any links with other community members. On the contrary, they have to be persuaded, enlightened, and mobilized to join in a connected network. Such a network, if formed somehow,

should be of a star type. If, therefore, the entrepreneur believes that the market of his enterprise is of a low state type, he has to be determined to take on the task of the center player.

In the case of the high state, on the other hand, the consumer-players are well conscious of their own benefits obtainable from the global public good. They are motivated to communicate with others in order to confirm mutual consciousness. According to the terminology of this paper, they are motivated to positively form links with other community members. A line network is the efficient and stable outcome of those voluntary link formations. In this case, the entrepreneur expects the cost of forming a network to be low, and he can believe that he takes the leadership in forming the line network by paying the minimum cost of networking.

(4-2) The Entry Decision of the Entrepreneur

If a social entrepreneur is faced with the low state of market, he has to take the leadership in forming a star network as a precondition for the provision of the GCPR. The cost of his forming the star network may be able to be compensated both with the benefit obtainable from the GCPR and with a fixed salary of his management work.

If, on the contrary, a business entrepreneur is faced with the same low state of the market, the cost of his forming the star network is not be sufficiently compensated with a fixed salary for his management work, because he does not sufficiently obtain the benefit from the GCPR itself. In this case, his effort to form the network must be compensated by his sharing in the profit of the selective incentive enterprise. Here, it should be noted that only a "for-profit-organization" allows the entrepreneur to share the profit, but that a "not-for-profit-organization" does not. If, therefore, only NPO type is admitted to the market of the selective incentive-cum- GCPR, the business entrepreneur cannot be motivated to launch into the enterprise of selective incentive-cum-global public good for which a star network is indispensable. If it is the case, we come to the conclusion that a social entrepreneur type has to take the initiative in forming a star network for the "selective incentive-cum-global public good" enterprise. In what follows, we present the rational foundation of NPO, from the motivational perspective of the entrepreneur.

Now, let's return to the beginning of the game where the entrepreneur has to decide on whether to enter into an enterprise of selective incentive -cum-GCPR. The "selective incentive" is a fixed raffle lottery. His decision depends not only on the states of the demand for GCPR, High or Low, but also on which type of entrepreneur he is, a social or business entrepreneur. There are four combinations of the demand states and entrepreneur types, as shown in the table below.

	High	Low
SE	1	2
BE	3	4

In the above table, SE and BE stand for the social and business entrepreneur, respectively. Assuming that all consumers except for the entrepreneur are symmetric and that the communication costs, c_{ij}, are the same for all players, the payoff functions of SE in the cell 1 and 2 are given by (11) and (12), respectively. In what follows, it should be kept in mind that the entrepreneur has to take the leadership in forming any network.

(11) $U_s(|N|; H) = -c + F + \alpha_s(nx_f - R - F)$

(12) $U_s(|S|; L) = -c(|S| - 1) + F + \alpha_s(|S|x_f - R - F)$, for $S \subset N$.

In the above equations, α_s is the social entrepreneur's benefit obtainable from the GCPR, F is a fixed compensation for the management work, except for networking work, of the enterprise, and x_f is derived from the maximization of (5)' with $x_1 = x_2 = \ldots = x_{|S|} = x_f$, for $|S| \subset n$. Note that x_f is the function of $|S|$. From the same maximization condition of (5)' with symmetric consumers, it is derived that $d(x_f|S|)/d|S| > 0$.

When $\partial U_s(n; L) / \partial \subset S \subset = -c + \alpha_s'(nx_f - R - F) \subset 0$, the social entrepreneur can form a fully connected star network, subject to his individual rationality. Many schemes of the "selective incentive-cum-public good" have implicitly assumed such a type of social planner.

If, on the contrary, $\partial U_s(n; L) / \partial \subset S \subset = -c + \alpha_s'(nx_f - R - F) < 0$, even the social entrepreneur obtaining a benefit from the GCPR cannot form the fully connected network. It reflects the fact that his demand for the global public good is not sufficiently intense relatively to his burden of networking activity.

On the other hand, the payoff functions of BE in the cell 3 and cell 4 are given by (13) and (14), respectively. Note that this type of entrepreneur gains no utility from the GCPR, based on the assumption made for the sake of distinguishing the characteristics of his businesslike way of work.

(13) $U_b(n-1; H) = -c + F + (1-\alpha)\{(n-1)x_w - R - F\}$

(14) $U_b(|S|; L) = -c(|S| - 1) + F + (1-\alpha)\{|S|x_w - R - F\}$ for $S \subset N$.

In the above equations, x_w is derived from (5) with $x_1 = x_2 = \ldots = x_{|S|} = x_w$, for $|S| < n$. Note that x_w is the function of $|S|$. From (5) with the

above symmetric conditions, it is derived that $d(|S|x_w)/d|S|>0$.

If $d^2(|S|x_w)/d|S|^2<0$, it may be the case that $dU_b(|S|; L)/d|S|= -c+(1-\square)d(|S|x_w)/d|S|\square 0$, for $|S|<n$. In that case, the business entrepreneur is not motivated to form the fully connected network, even if he can share in the profit of the selective incentive enterprise.

By comparison of (11) with (13), and (12) with (14), it is easy to show that as $\square$gets close to unity, and $\square_s$ to zero, U_b approaches U_s. The conventional models implicitly assume them. When, however, neither type of entrepreneur can form a fully connected network under the condition of low demand, $\square$must be sufficiently small under the condition that $\square[(1-\square)/S|x_w] / \square\square>0$, and / or$\square_s$ must be sufficiently large. That is, both types must be distinctly different from each other in order for any type to be motivated to form a fully connected star link.

When, however, a business entrepreneur must be motivated by an increase in his profit sharing, i.e., $1-\square$, then the rest of the fund to be put into use for the GCPR must be decreased. Accordingly, the selfish objective of the business entrepreneur is not compatible with the provision of the global public good, if a connected star network is an indispensable precondition for the provision.

Then, should we have recourse to the social entrepreneurs in order to preserve the GCPR? If so, is it assured that there exists that type of entrepreneur on a sufficient scale? How is he endowed with such a special type of payoff function as to have the GCPR as an augment? It may be suggested that we should set up more of institutions and training courses for social entrepreneurship.

5. The Procrastination of Global Agreement[4]

The logic of this section is to support for looking for local solutions to the global commons' problems. The details should be referred to Ueda (2001a, 2001b).

The ego of a human being at the moment of making a plan is not necessarily the same as that at the moment of implementing the plan. Preference at the moment of making a plan is usually different from that at the moment of implementing it. According to the behavior assumption of the present-biased preference,[5] the cost to implement a plan actually becomes bigger than anticipated or calculated at the time of making the plan. If the preference of the player interested is subjected to the present-bias, she is apt to resist implementing the plan made by herself at an earlier stage, just when she has to do it. This is

[4] As to the detailed logic of the procrastination of the Kyoto Agreements, refer to Ueda (2001).

[5] See Strotz (1956), Pollark (1968), Akerlof (1991), Laibson (1997), O' Donghue and Rabin (1999a, 199b).

because the cost to implement the plan is immediate but the benefit comes later, and because the immediate cost weighs heavier now than was expected or calculated at the time of the planning.

Here, let's turn our eyes to GHGs emissions. If at least one of the negotiating players is subjected to the present-bias, she rejects implementing the agreed plan to cut emissions, just at the moment of having to do it. This can happen whenever the implementing cost has been found heavier at the stage of implementation than at the planning stage, owing to unexpected misfortunes such as unsuccessful technological innovations. When one key-player drops out of the concerted action, the net benefit of implementing the agreed plan becomes negative for all other players, according to the characteristics of the production function of the global atmospheric common. Then, those players also reject implementing the agreed plan, leading to canceling the agreement.

To make the matters worse, the players tend to repeat this agreement-cancellation cycle, because they do not conclude the agreement under the condition of their recognizing that they have the "naive belief on their own future selves.[6] According to the naive belief, a decision maker at any moment of planning tend not to take into consideration that she is subjected to the present-bias at the moment of implementation. So, she calculates the benefit and cost of the plan in a time consistent way, which leads to her under-evaluating the cost to be actually incurred at the time of implementing it. If, on the contrary, she has a "sophisticated belief on her future self, at the time of planning she takes into consideration that she is subjected to the present-bias at the moment of implementation. It means that this type of decision maker does not under-estimate the cost of the plan. In anticipation of falling to the present-bias at the moment of implementation, at the planning stage she sets some "alarming devises" to avoid suffering from damages caused by her canceling or postponing her initial plan. The punishment clause insisted by EU is one of the alarming devises, which means that EU is a sophisticated type.

Any international agreement on emissions cut is meaningless in its effects on the global warming, without full-participation of all key-countries including developing countries. Such an agreement, however, breaks down quite easily, when even one of the signatory players falls to the present-bias. That present-bias can emerge, when technological innovations to cut emissions, which are anticipated at the planning stage, turn out to be disappointed at the implementation stage. For fear of this disappointed state of technological development, some countries are opposed to a punishment clause being included in the agreement.

Even the negotiators of the non-signatory countries know about some potential danger of global warming. If they could make a decision

---

[6] See O'Donoghue and Rabin (1999 a).

only on a purely scientific basis, they might have been able to reach the same conclusion as the signatory countries. Such optimism may lead the negotiators of the latter countries to continue to attempt at the intergovernmental negotiations.

To make the matters worse, these fruitless negotiations tend to continue to be pursued by them, because they are relatively freed from the problem of the networking or organizing cost, that is, because they are paid by the government budget usually as an overhead. Those governmental negotiators even tend to look for chances of arranging any international negotiation, even if fruitless. It is hard for taxpayers to find a reason for stopping such international negotiations as to be able to appeal to the ideal of global peace or common interests. Thus, those intergovernmental negotiations which if the benefits-costs are calculated on a rational basis, are not pursued so long, tend to be repeated in international arenas, leading to not inspiring social entrepreneurship on a local scale.

But any decision made by the governmental negotiators cannot conflict with pursuing their national or domestic interests, even if these interests are believed to be false in the light of their scientific knowledge or conscience. Thus, the combination of their cost-unconsciousness with the severe reality of the international politics leads to repeating the intergovernmental negotiations, and therefore to the procrastination of the global agreement. We have to look for other complementary solutions.

6. A Short Summary

The global agreements on stopping global worming are tend to be procrastinated, owing to the physical characteristics of the global public good, to the present-bias with dynamic inconsistency, and to the cost-unconsciousness of the governmental negotiators. Even if it is admitted that intergovernmental negotiations are required for the global community to be able to take concerted actions, we have to look for alternative or complementary solutions to the "tragedy of the global commons."

The "selective incentive-cum-global public good" scheme is one of the solutions which can be voluntarily pursued on a local scale. So far as, however, a star type of network is a precondition for the scheme to be carried out, the initiative of the social entrepreneur is indispensable. The objective of a business entrepreneur is not necessarily consistent with the ultimate social goal of preserving the global atmospheric quality. At present, however, we cannot take it for granted that social entrepreneurs are ready to take the initiative in providing global public goods in each local community.

Reference

Akerlof, G. A.(1991). "Procrastination and Obedience," *American Economic Review,* 81(2), 1-19.

Aumann, R., and Myerson, R. (1988). "Endogeneous Formation of Links between Players and Coalitions: An Application of the Shaply Valu," *The Shaply Value,* (A. Roth, Ed.), Cambridge: Cambridge Univ. Press.

Bola, V., and Goyal, S.(1999). "A Non-Cooperative Theory of Network Formation," Discussion Paper TI99-025/1, Tinbergen Institute, Erasmus Univ., Rotterdom.

Laibson, D. (1997). "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics,* 112(2), 443-477.

Morgan, J.(2000). "Financing Public Goods by Means of Lotteries," *Review of Economic Studies,* 67(4), 761-784.

Morgan, J., & Seften, M.(2000), "Funding Public Goods with Lotteries: Experimental Evidence," *Review of Economic Studies,* 67(4), 785-810.

Myerson, R.(1977). "Graphs and Cooperation in Games," *Mathematics of Operations Research,* 2(3), 225-229.

O'Donghue, T. and Rabin, M.(1999 a). "Doing it now or later," *American Economic Review,* 89(1), 103-124.

_____(1999 b). "Incentives for Procrastinations," *Quarterly Journal of Economics, 114(3), 769-816.*

Pecorino, P.(2000). "Can By-Product Lobbying Firms Compete?" *Journal of Public Economics,* 82, 377-397.

Pollark, R.A. (1968). "Consistent Planning," *Review of Economic Studies,* 35(2), 201-208.

Slikker, M., & van der Neuland, A.(2001). "A One-stage Model of Link Formation and Payoff Division," *Game & Economic Behaviour,* 34, 153-175.

Strotz, R.H.(1955-56). "Myopia and Inconsistency in Dynamic Utility Maximization," *Review of Economic Studies,* 23(3), 165-180.

Ueda, Y. (2001a). "The Possibility of Full-cooperation in Curving Global Warming: Procrastination Tendency and New Principles," Mimeo.

_____(2001b). "The Institutional Design and Development of C02 Emissions-Permits Market," Mimeo.

Watts, A.(2001). "A Dynamic Model of Network Formation," *Games & Economic Behaviour,* 34, 331-341.