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The Sustainable Framework of Climate Change and
Financial Crisis 2008-09 .

Hiroshige TANAKA

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Professor of Faculty of Economics, Chuo University, Higashinakano
742-1, Hachioji-city, Tokyo 192-0393, JAPAN.

Abstract

The model indicates the optimal conditions theoretically that make sure sustainable framework of the climate change for global multi-stakeholder society. The conditions are decided in a given parameter such as scheme of international cooperation, monitoring system, market price of carbon. This model expresses the relation between economic and social activities of the corporation and parameters regarding international public policy. We could manage the policy instruments according to indexes funded by the optimal conditions. This model analysis makes clear that development and decline of globalization is controlled by the countervailing interaction between the negative and positive stakeholders. Proceeding to a common target of climate change facilitates sustainability of communities economically, socially and environmentally. London Accord could refer some indexes presented here to construct efficient policy system¹.

Keywords: Climate Change, Globalization, Financial Crisis, Innovation of Environmental Technology.

1. Introduction

Climate change is a common challenging target for the world. Globalization in economic and social system has been expanding rapidly from 1980s. The globalization causes large scale of developments, some

¹ Corporation of London (2006), *The London Accord(2007,2008,2009)* publish on this program. This paper develops theoretical analysis based on Tanaka(2007a),(2008),(2009)

environmental problems and enlargement of earnings differentials simultaneously in many countries and area. As large number of people refuse negative effects such as environmental problems and enlargement of earnings differentials, the globalization encountered anti-globalization movements. If the negative damage of globalization could not be mitigated, the globalization could not be accepted as a prime principle of the world².

So many policies of the mitigation have been proposed and executed. The mitigation are only on the way to make some effects and have many problems to be solved as follows. Policies on climate change sometime intend to slowdown the economic development accelerated by the globalization. On the other hand, the policies contribute to make sure the sustainability of the globalization in some aspects.

The world financial crises in 2008-09 made serious damage to the world economy. Recovering the recession in the world economy could not be achieved without the benefits of the globalization. Many policies to cope with the slowdown of economies stems from the financial crisis of 2008 seek to prevent the total breakdown of economies. But some are targeted to accelerate the innovation of environmental technology. US and Japanese governments initiate industrial strategy to promote anti-carbon technology in car and electric power industry in 2009. Without globally networking markets any government could not execute adventurous strategy of environment. In general, globalization has been increasing economic activities all over the world. Consequently, the movement of globalization tends to make negative effects on climate change. But anti-carbon ecological technology innovation accompanied by competitive market mechanism of globalization is expected to be realized in the relief project of the world scale recession from 2008. The expanding economies on the flag of free market or free trade are one of the major driving forces of globalization. On the world recession many governments intensively attempt to recover the domestic economies so that free trade could not propel globalization powerfully. The purpose of this paper is summarized as follows. First, employing an integrated model this paper makes clear analytically that development and decline of globalization are determined by the countervailing interaction

² The subject regarding globalization and sustainability is discussed in Salih(2009).Guesnerie and Tulkens(2008). Dawson,B. and M.Spannagle(2009) review the theoretical analysis of globalization and sustainability.

between negative and positive stakeholders. Second, proceeding to a common target of climate change facilitates sustainability of communities economically, socially and environmentally³.

The construction and main results of this paper is sated as follows. In the section 2, the model analysis of corporate social responsibility (Tanaka(2004)) is applied on the globalization⁴. In the section 3 makes clear the theoretical relation among climate change, globalization and financial crisis. The section 4 focuses on the influence that the positive and negative stakeholders affect in the cycle of globalization. The section 5 develops incentive analysis on the market price of carbon. The section 6 states the conclusion. We state main result briefly.

Proposition 1 demonstrates the reason that we should make an effort to induce the corporation to commit the community more positively in the process of globalization. Proposition 2 proves the following three results. First, the international agreement or standard construction for the climate change restores the sustainable management of corporation. Second, the rise of carbon market price, lowering emission upper limits of emission, strengthening monitoring standard make the corporation more positive toward the climate change. Third, those policies initiate to stimulate innovation of environmental technology. Proposition 3 proves the mechanism of globalization is explained by comparing the evaluations in the both the negative and the positive stakeholders. The section 6 make clear the relation between the market price of carbon and the environmental effort of the corporation.

2.The theoretical model of multi-stakeholders communities

We consider the sustainable management of corporation in the context of climate change. Multi national corporations could not be protected by only a single state and must be accepted by global communities. Since the corporation is supposed to perform sustainable management, it seeks not only the private activity such as production to attain the profit, but also the public activities such as observance of regulations, CSR(Corporate Social Responsibility). x denotes the total amount of outputs. Each corporation

³ Dawson and Spannagle(2009),Guesnerie and Tulkens(2008) and Stern(2007) offer us comprehensive information of climate change.

⁴ Tirole(2001)develops theoretical foundation on corporate governance.

performs managements based on internal and external evaluation. Many indexes or methods on the evaluation of management are developed largely. The private net benefit such as profit, market share and financial performance is evaluated by the method adapted by the corporation and represented by $\Pi(x)$.

We assume that corporations make decision in the multi-stakeholders community⁵. The stakeholders receive some benefits or costs from the corporation. When consumers are not satisfied with prices or quality of the product, they will not buy the products of the corporation. Depending on their valuation the stakeholders might change the relation with the corporation. The corporation researches requests or satisfaction levels of consumers in many ways. Shareholders make benefits from the improvements of the performance indexes to influence the stock market price. Shareholders are interested in the evaluation of management performances. Each stakeholder makes an evaluation of the corporation in their interests. The stakeholders depict the various evaluations of the corporation. The well known theory of principal and agency economic model assumes asymmetric information between the corporation and stakeholders. The corporation could influence the evaluation of stakeholders by employing effective means. The corporation pays t_i such as benefits for employee, environmental costs and contribution to the local communities for stakeholder i to survive in well managed relationship between n stakeholders. So many types of investments are not expected to increase the amount of sale or profit directly in the large scale. However, such investments might obtain effects to improve evaluation of consumers and investors. The investment in advance is necessary for corporations to perform sustainability management. In this paper by developing the model initiated in Tanaka (2004) we make clear theoretical relationship among the financial crisis 2008-09, the innovation of technology on climate change and the recent trend of globalization. The investment to delete CO₂ emission raises the expectation or evaluation of the corporation by governments, habitants and shareholders deeply interested with environment. This type of investment to accrete environmental innovation is dented by t_i . Although so many types of payments t_i should be investigated, we consider mainly investment for environmental

⁵ Nyssens(2006) discusses multi-goal and multi-stakeholder organizations.

innovation⁶. Total payment for stakeholders t is defined by

$$t = \sum_{i=1}^n t_i .$$

Stakeholder i observes the influence of the firm and evaluates $V_i(x, t_i, \alpha)$ for the production activity x and payment t_i for stakeholder i . The model is revised by adding parameter α reflecting expectation. The asymmetric information assume that the corporation could not obtain the accurate information of evaluation $V_i(x, t_i, \alpha)$ by i . We refer $V_i(x, t_i, \alpha)$ for a pair (x, t_i) to external evaluation by stakeholder i . In particular, when the shareholder is denoted by j , the shareholder value is represented by a $V_j(x, t_j, \alpha)$. To simplify the analysis we employ the following notation. The investment of environmental innovation is exhibited by t^i . The innovation influences on l stakeholders such as the shareholder, governments, suppliers, residents. When the effects of the innovation is denoted by t_{j1}, \dots, t_{jl} , it is assumed that the equation

$$t^i = t_{j1} + \dots + t_{jl}$$

is satisfied. The payment for stakeholder i t_i is not necessary to correspond to a single term, but integrated by multiple terms.

The total value of external evaluation is expressed by

$$\sum_{i=1}^n V_i(x, t_i, \alpha) .$$

It is assumed that the payment t_i improves external evaluation $V_i(x, t_i, \alpha)$ by stakeholder i . $V_i(x, t_i, \alpha)$ is monotonously increasing with t_i . The inequality $\frac{\partial V_i}{\partial t_i} > 0$ is satisfied. It is supposed that the stakeholder i

sets ideal evaluation value V_i^* and that this higher target value could not be achieved. This assumption is expressed by

$$V_i^* > V_i(x, t_i, \alpha) .$$

⁶ Other types of payments t_i are discussed by Tanaka(2005) ,(2006), (2007a)and (2007b).

As the value of $V_i^* - V_i(x, t_i)$ increase, stakeholder i will require the corporation to improve $V_i(x, t_i, \alpha)$ more positively by using effective means. If the corporation does not make better i 's evaluation, it might suffer social sanctions such as suit by the residents, boycott of the consumers and enforcement of a tightened regulation by the authority. $V_i^* - V_i(x, t_i)$ indicates the social cost evaluated by i . The social cost should be shared with the corporation and stakeholders. The allocation of the social cost is determined for a long term verification and bargaining. The firm is obliged to pay a part of social cost as $c_i(V_i^* - V_i(x, t_i, \alpha))$ with a positive coefficient c_i . c_i means a forced cost for the management and is refer as a risk indicator of sustainability for i . When $V_i^* - V_i(x, t_i, \alpha)$ means emission beyond the lower target to emit CO₂, the corporation must purchase the emission permits by price c_i . The emission tax for is explained similarly by c_i . As c_i increases, the corporation becomes to suffer greater risk for sustainable management regarding to i . We confirm straightforwardly that

$$\frac{\partial c_i \{V_i^* - V_i(x, t_i, \alpha)\}}{\partial t_i} = -\frac{c_i \partial V_i}{\partial t_i} < 0$$

is satisfied. The corporation decreases the social cost and the risk with i by payment t_i . We conclude that organizing scheme or standard to induce firms to increase t_i is an appropriate method to promote CSR. Maintaining t_i appropriately makes effort on sustainable management for many corporations.

Stakeholders have complicated interests with the corporation. Stakeholders are classified into two types. The stakeholders whose evaluation is increasing function of x are named as positive stakeholder. In many cases employees and suppliers might be classified in positive stakeholder. On the contrary, the negative stakeholders are defined to have decreasing functions of x . The environmental NPO is the representative of negative stakeholder for manufactures. The corporation could obtain common interest with positive stakeholder relatively easy. It sometimes conflict with negative stakeholders.

The corporation seeks to obtain accurate information of the total value of

external evaluation for sustainable management. It must pay large amount of costs and efforts for this purpose. As many parts of the external evaluation are obtained by stakeholders, we construct communication mechanism, such as monitor, audit, between the firms and stakeholders. Well maintained communications prompt sustainable management. The firm could estimate δ percent of $\sum_{i=1}^n V_i(x, t_i, \alpha)$. Although δ does not improve it's profit directly, δ implies the function of communication between the firm and stakeholders. As the corporation involves to improve the external economies, δ is supposed to increase. δ is referred to altruistic coefficient in this essay. δ is an efficient indicator for sustainable management⁷. In the network community, each stakeholder i contributes y_i to improve the altruistic coefficient δ ⁸. The total contribution is represented by $y(= y_1 + \dots + y_n)$. δ is increasing function of y ,

$$\frac{d\delta(y)}{dy} > 0, \quad \frac{d^2\delta(y)}{dy^2} < 0. \quad (1)$$

It is assumed that y_i is determined by outside organization i to influence the consideration of the firm to externality. When a fund of SRI k is represented by y_k ⁹, the fund makes effort to induce other stakeholders to persuade the corporation moving into sustainable management. It is assumed that for the stakeholder j agrees with the SRI to move towards sustainable community, the inequality

$$\frac{dy_j}{dy_k} > 0. \quad (2)$$

is obtained. For stakeholder j who is indifferent to the SRI fund the equality

$$\frac{dy_j}{dy_i} = 0 \quad (3)$$

is satisfied. To simplify the analysis we consider the communities of indifferent stakeholders in the following section.

3. Climate change, globalization and financial crisis

The climate change requires a cooperative global framework. The object

⁷ Barrow(2006) offers us fundamental information of environmental management for sustainability.

⁸ Tanaka(1998) considers operational aspect of altruistic concept.

⁹ Tanaka(2005) attempts to apply the CSR model of Tanaka to financial projects.

function of net social benefit for sustainability is written by

$$\delta(y) \sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i\}. \quad (4)$$

The first order optimal condition of y_i^* is expressed by

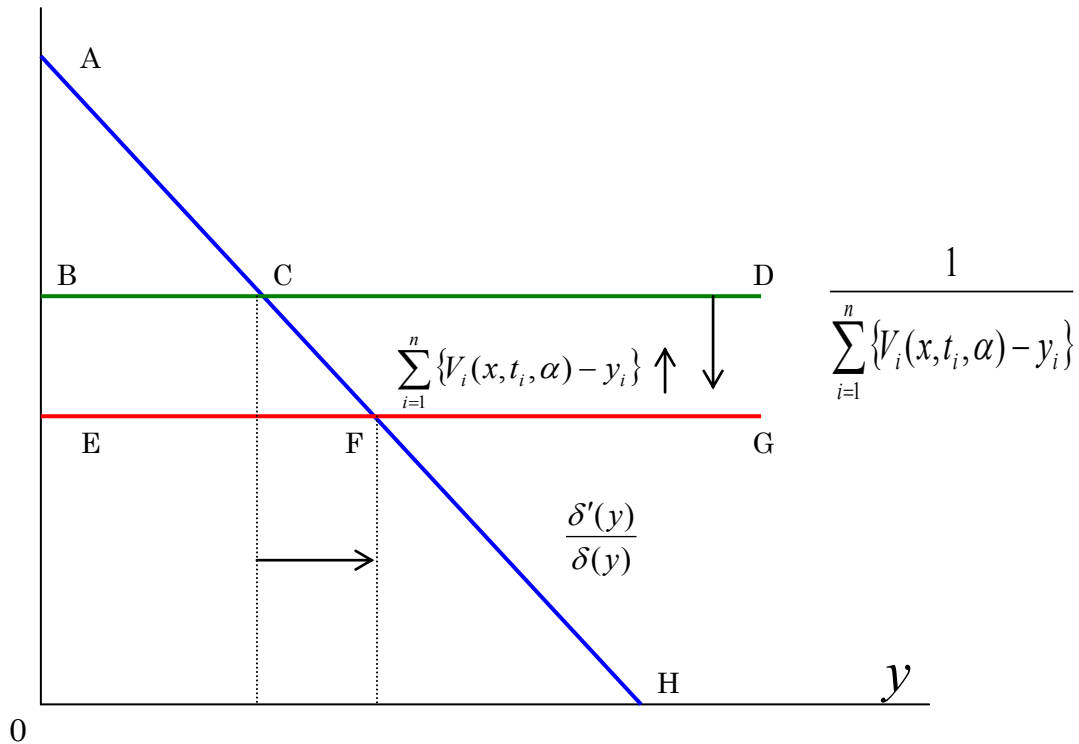
$$\frac{d\delta}{dy} \sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i^*\} - \delta(y^*) = 0. \quad (5)$$

Considering that (5) is rewritten by

$$\frac{\delta'(y)}{\delta(y)} = \frac{1}{\sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i\}}, \quad (6)$$

and that the left side of (6) is decreasing with regard to y ($\frac{d}{dy} \frac{\delta'(y)}{\delta(y)} < 0$), we could conclude the following results.

Figure 1. Construction of global framework for the standard.



Proposition 1 As the diversity or externality of multi-stakeholder

community enlarges $\sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i\}$ in the process of globalization, we should make an effort to induce the corporation to commit the community more positively.

The expression (6) is depicted in the figure 1. As the number of stakeholder increase in the globalization, total external evaluation $\sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i\}$ also raises. The left side of (6) is expressed by the line AH. The right side is drawn by the line BD and EG. The globalization and climate change moves the line corresponding to the right side BD to EG. The solution of (6) is shift from point D to point E. The optimal y is increasing in the process of globalization and climate change. It becomes more effective means in our global communities to make clear the total external evaluation by forming communication among stakeholders. We must have the systematic approach for the policies to improve y . It is difficult to construct social framework to arrange y . But some efforts such as the conventions of the climate change seek to influence y .

The formulation defined by Tanaka (2004) is applicable to investigation on globalization and climate change. The object function for sustainable management is expressed by

$$NB = \Pi(x) + \delta(y) \sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i\} - t - \sum_{i=1}^n c_i (V_i^* - V_i(x, t_i, \alpha)), \quad 1 \geq \delta \geq 0. \quad (7)$$

The firm seeking sustainable management determines x, t_1, \dots, t_n to maximize the Net Benefit (NB). The first order conditions of maximization are written by¹⁰

$$\frac{\partial \Pi}{\partial x} = \sum_{i=1}^n -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha)}{\partial x}, \quad i = 1, \dots, n, \quad (8)$$

$$1 = (\delta + c_i) \frac{\partial V_i}{\partial t_i}, \quad i = 1, \dots, n. \quad (9)$$

Equations of (8) show that the share of positive and negative stakeholders could influence the activity of the corporation. The two types of stakeholders

¹⁰ The optimal conditions (8) and (9) are referred as the basic conditions in many papers. For example, (6) and (7) of Tanaka (2006) correspond the conditions.

have different roles in the communication of global communities. We

Figure 2. Control policies of economic performance by the negative stakeholders.

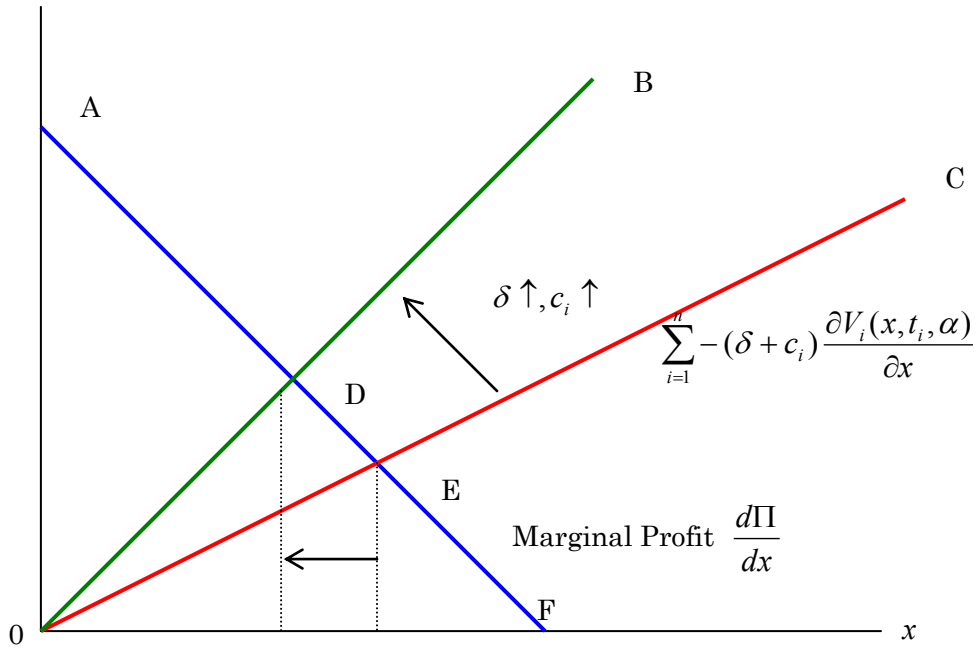
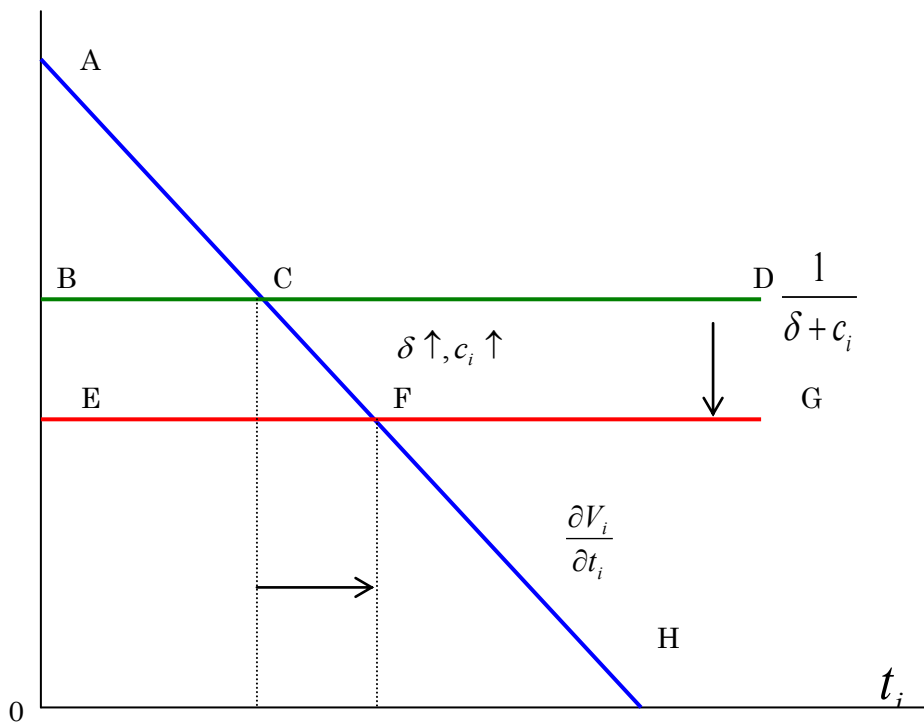


Figure 3. Communication between firm and stakeholders.



consider the mechanism of communication later. Let us investigate implications of (9) first. Notice that (9) is transformed into

$$\frac{1}{\delta + c_i} = \frac{\partial V_i}{\partial t_i}, i = 1, \dots, n, \quad (10)$$

and $\frac{\partial V_i}{\partial t_i}$ is supposed to be decreasing with t_i . (8) and (10) are depicted by

Figure 1 and Figure 2. It is concluded that an increment of risk indicator c_i or altruistic coefficient δ increase the right side of (8) and lowers value of (10) for negative stakeholder i and increases payment t_i for positive and negative stakeholder i . The well known Coase theorem implies the effective approach of communication between the corporation and negative stakeholders. But the investment for environmental innovation appears as a cost at the present. But it is evaluated by the shareholders as the promising profits for the future and by green consumers as an effective contribution for climate change. In the context of the climate change the proposition 2 obtained.

Proposition 2 First, the international agreement or standard construction for the climate change restores the sustainable management of corporation. Second, the rise of carbon market price, lowering emission upper limits of emission, strengthening monitoring standard make the corporation more positive toward the climate change. Third, those policies initiate to stimulate innovation of environmental technology.

4. Mechanism of globalization and common target for climate change

Stakeholders are assumed to be divided into positive and negative stakeholders. The globalization from 1980's and financial crisis 2008-09 are investigated appropriately by properties of the two types of stakeholders. P indicates the set of positive stakeholders. N expresses the set of negative stakeholders. The summation of number of P and N is equal to n. (8) is transformed into

$$\frac{\partial \Pi}{\partial x} = \sum_{i \in P} -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha)}{\partial x} + \sum_{i \in N} -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha)}{\partial x}. \quad (11)$$

The first term in the right side of (11) is negative and the second term of it is positive. When the evaluation by the positive stakeholders increases relatively in comparison with the second term in the right side of (11),

the value of (10) decreases. On the contrary, increments of relative evaluation by the negative stakeholders raise the value of (11). Since the marginal profit of the output $\frac{\partial \Pi}{\partial x}$ is decreasing, the evaluation of the negative stakeholders affects to decrease production and the evaluation of positive stakeholders make effect to increase production. Suppose that the corporation is a representative one in the global economies. This paper makes clear that the balance of evaluations in the two types of stakeholders could explain the mechanism of global economies between the globalization from 1980s and financial crisis 2008-09.

Figure 4 depicts the relation expressed by (11). One of the outstanding features of the globalization is increase of numbers of stakeholders n . In particular, enlargement of stakeholders in the global economies reflects the foundation of G20 in addition to G7 from 1999. On the upward stage of globalization increase of n and minus impacts of the first term in the right side of (11) make effects relatively. Consequently, in this stage (11) tends to decrease and approximately corresponds to the lowest line OG. At the boom of the globalization the solution of (11) is indicated by the point H and shows the enlargement of world economies. The globalization makes market frailer in large scale especially differentiations of incomes and global environmental problems. In this stage evaluation of negative stakeholder is increasing. The financial crisis of 2008-09 adds abrupt shrinkage of evaluation in positive stakeholders to the downward moving fundamental trend of (11). By employing parameter α , the relation is stated by the following inequalities. α_1 and α_2 indicate increasing and decreasing stage each other.

$$\frac{\partial V_i(x, t_i, \alpha_1)}{\partial x} > \frac{\partial V_i(x, t_i, \alpha_2)}{\partial x} > 0 \quad \text{for } i \in P \quad (12)$$

$$0 > \frac{\partial V_i(x, t_i, \alpha_1)}{\partial x} > \frac{\partial V_i(x, t_i, \alpha_2)}{\partial x} \quad \text{for } i \in N \quad (13)$$

Summing up (12) and (13), the inequality

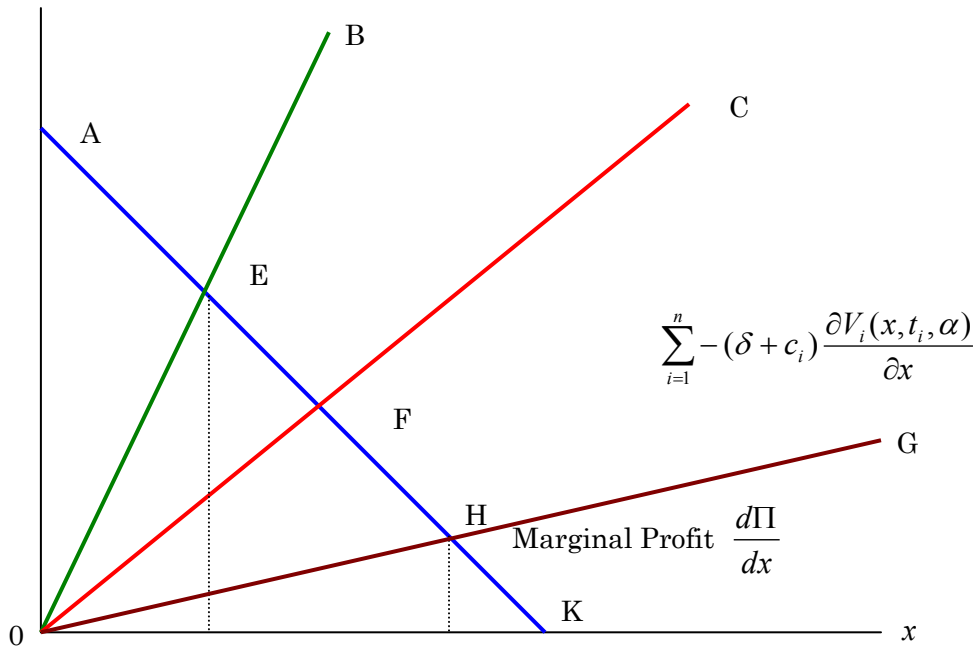
$$\begin{aligned} & \sum_{i \in P} -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha_1)}{\partial x} + \sum_{i \in N} -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha_1)}{\partial x} \\ & < \sum_{i \in P} -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha_2)}{\partial x} + \sum_{i \in N} -(\delta + c_i) \frac{\partial V_i(x, t_i, \alpha_2)}{\partial x} \end{aligned} \quad (14)$$

is satisfied. Reminding $\frac{d\Pi}{dx}$ in (11) is decreasing with x , the following proposition 3 is ensured from (14).

Proposition 3. In the initial stage of globalization economies tend to enlarge excessively by the evaluation of positive stakeholders and increase of stakeholders. But in the latter stage of globalization economies are depressed by revising evaluation in the both the negative and the positive stakeholders.

Considering policies to maintain or to improve global economies, we should recognize the effects of those policies on evaluations of stakeholders. Figure 4 shows the implication of Proposition 3 by graphical consideration.

Figure 4. Financial crisis 2008-09.



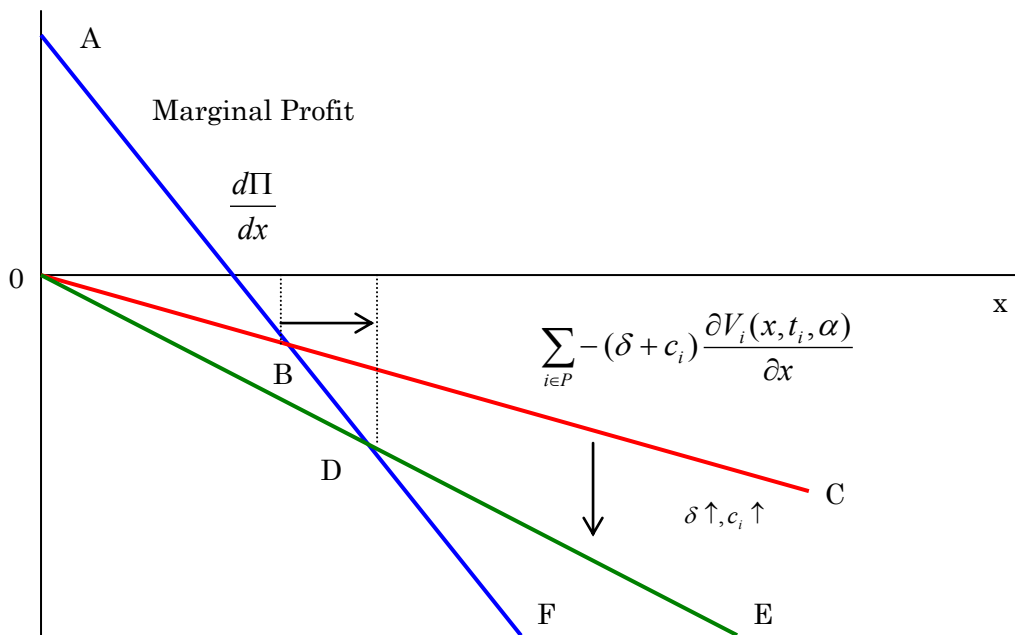
The solution of (11) in the initial stage of globalization is denoted by point H. Point E is the solution of latter stage. The globalization expands economies from the point F to the point H. After the boom revise of evaluation of stakeholders bring economies from the point H to the point E. The financial crises which occur in the latter stage of the globalization sometimes amplify shrinkage of economies in the large scale. The crisis of

2008-09 might be remembered as a representative example of the proposition 3.

When we concern the positive stakeholder only, (8) is depicted by Figure 4. Reminding that Figure 2 is the counterpart of Figure 4, risk indicator c_i or altruistic coefficient δ represents reverse policy implication between the two types of stakeholders.

It is concluded that an increment of risk indicator c_i or altruistic coefficient δ decrease the first term in the right side of (8) for the positive stakeholder i and raises the economic activity. Improvement of evaluation c_i such as shareholder value and market credits and increase of δ by founding global standard stimulate the corporation to enlarge economic activities. Figure 5 depicts the above relation in community composed by positive stakeholders only. Increase of c_i or δ shifts the point B of solution (8) to the point D in this figure and encourages the economies.

Figure 5 Positive stakeholders and global economies



A significant driving force of globalization is the enlargement of economies in expanding process of global markets. On the contrary, in the decreasing stage of global markets the driving force loses the dominant power. It appears to be reasonable that the benefit of globalization could not sustain for a long period. It is becoming much more important to make clear the

sustainability of the global economies.

Proposition 3 implies that the process of globalization cloud not be expanding for a long time and that the mechanism are controlled by the countervailing functions of the positive and negative stakeholders. It argues also the possibility that the balance of the two powers triggers excessive contraction of global economies such as financial crisis 2008-09. We should prevent great fluctuation in global economies and societies to attain sustainability. The net benefit of the multinational corporation is exhibited by (7). The global framework to increase δ raise the relative value of

$$\delta(y) \sum_{i=1}^n \{V_i(x, t_i, \alpha) - y_i\} - t$$

and could mitigate fluctuations occurred by the market economies in the global communities. To share a common target for climate change in the world make the effect to improve δ . Proposition 2 implies that the target gives impulse to accelerate investment for environmental innovation.

5. Incentive and index for the climate change

The incentive analysis focuses on the effect of environmental policy instrument considered in the previous sections. The theory explains that the creation of market price increases the deletion of carbon as follows.

It is assumed that firms perform two types of activities, the ordinary economic activity and environmental activity. The environmental activity seeks largely to reduce emission of CO₂. The level and price of ordinary economic activity are denoted by y and p . The ordinary economic activity uses input x_1 with price r_1 , and makes effort e_1 . In the environmental activity the market is not established well. The firms must seek economic rationality. Without output and value in environmental activities the firms could not perform rational management. The firms are supposed to manage to evaluate the values from the markets. Although the firms are sure perfect evaluation of the values, we assume that the evaluations are derived from the market information. Since imperfect information might mislead the decision of the firms, estimating the most appropriate estimation for the environmental management is important theme. Since q is assumed to be market valuation of the environmental activity, we refer q as the rate of

environmental earning¹¹. We have the approach to estimate that deletion of emission and market price of carbon, are expressed by z and q . In this paper, q means the market price of carbon and grant of government for the deletion. The environmental activity uses input x_2 with the price of r_2 , makes effort e_2 . The two types of activities are exhibited by,

$$y = f(x_1, e_1) \quad (15)$$

$$z = g(x_2, e_2) \quad (16)$$

Total amount of efforts are constant E . The equation $E = e_1 + e_2$. Firms spend r_2x_2 to achieve emission regulation as a sunk cost. Firms make effort e_2 voluntarily beyond the level of regulation. Financial constraint of environmental activity is expressed by

$$qz - e_2 \geq 0 \quad (17)$$

Net benefit is defined by

$$\Pi = py + qz - r_1x_1 - r_2x_2 - E \quad (18)$$

The optimal condition of production is derived from Lagrange expression

$$L \equiv pf(x_1, e_1) + qg(x_2, e_2) - r_1x_1 - r_2x_2 - E + \mu(qz - e_2) \quad (19)$$

μ is Lagrange multiplier. The first order condition is obtained by differentiating partially (19) with regard to x_1, e_1, e_2, μ . To consider incentive effects of carbon market, we investigate voluntary variable e_2 . It is assumed that e_2 is positive. Regarding e_2

$$\frac{\partial L}{\partial e_2} = (q \frac{\partial g}{\partial e_2} - 1)(1 + \mu) \leq 0 \quad (20)$$

$$e_2 \frac{\partial L}{\partial e_2} = e_2 (q \frac{\partial g}{\partial e_2} - 1)(1 + \mu) = 0 \quad (21)$$

hold. $(1 + \mu) > 0$ is supposed to be satisfied. When it is equal to zero in (21), e_2 is equal to zero at the same time. From (20) and (21), it is assured that

$$q = \frac{1}{\frac{\partial g}{\partial e_2}} \quad (23)$$

is satisfied. Employing (23) we could estimate the incentive effects of carbon market. In other words, (23) explains the relation between market price of carbon and effort to reduce carbon emission.

References

¹¹ Tanaka(2000) explains theoretical framework on the earning rate of environment. The empirical researches of this rate are developed such as Tanaka(2006).

- Barrow, C.J. (2006), *Environmental Management for Sustainable Development* 2ed., Routledge.
- Corporation of London (2006), *Financing the Future : The London Principles, the Role of UK Financial Services in Sustainable Development*, http://213.86.34.248/NR/rdonlyres/13F2434D-2209-4836-AEE3-D5C2E6A5F75E/0/SUS_financingfuture.pdf
- Dawson, B. and M. Spannagle (2009), *The Complete Guide to Climate Change*, Routledge.
- Guesnerie, R. and H. Tulkens (eds.) (2008), *The Design of Climate Policy*, The MIT Press.
- Hukkinen, J. (2008), *Sustainability Network: Cognitive tools for exert collaboration in social-ecological system*, Routledge.
- Krapivin, V.F. and C.A. Varotsos (2007), *Globalization and Sustainable Development : Environmental Agendas*, Springer-Praxis Publishing.
- The London Accord (2007, 2008, 2009)*, <http://www.london-accord.co.uk/>
- Nyssens, N. (ed.) (2006), *Social Enterprise: At the Crossroads Market, Public Policies and Civil Society*, Routledge.
- Salih, M. (2009), *Climate Change and Sustainable Development: New Challenge for Poverty Reduction*, Edward Elgar.
- Stern, N. (2007), *Economics of Climate Change : The Stern Review*, Cambridge University Press.
- Tanaka, H. (1998), "Redistribution Tax under Non-Benevolent Governments," *Public Choice* 96, pp.325-343.
- Tanaka, H. (2000), "Environmental Policies and Voluntary Contribution of Firm," Uzawa, H. and H. Tanaka (eds.) *Global Environmental Policy*, Chuo University Press, pp.153-168 (written in Japanese).
- Tanaka, H. (2004), "Theoretical Analysis for Corporate Social Responsibility," *Global Environmental Policy in Japan* No 9, pp.1-9 (written in Japanese).
- Tanaka, H. (2005), "How Bank Monitoring Can Work in the Development Project," *Journal of JBIC Institute* No22, pp.154-159 (written in Japanese).
http://www.jbic.go.jp/ja/investment/research/report/archive/pdf/22_06.pdf
- Tanaka, H. (2006), "A Fundamental Model for Sustainable Regional

- Communities, ” Tanaka H. (ed.) Plan and Strategy for Sustainable Regional Communities, Chuo University Press, pp.1-14 (written in Japanese). <http://c-faculty.chuo-u.ac.jp/~hiroshig/sus000>
- Tanaka,H.(ed.)(2007a), *Environmental Governance and communication function*, Chuo University Gendai GP. <http://c-faculty.chuo-u.ac.jp/~hiroshig/governance.pdf>
- Tanaka,H.(2007b). “A Theoretical Analysis for Sustainability Function of SRI Fund Organizations : A Sustainable Framework of London Mechanism,” *The Institute of Economic Research Discussion Paper Series of Chuo University, No 96 ,2007.*
- Tanaka,H.(2008), “Two Intensities Analysis of London Accord,” *The Institute of Economic Research Discussion Paper Series of Chuo University, No.103,2008.*
<http://www2.tamacc.chuo-u.ac.jp/keizaiken/discussno96.pdf>
- Tanaka,H.(2009), “A Theoretical Analysis of Sustainable Framework for the Climate Change: In the Case of London Mechanism,” *Keizaironsan (Chuo University)*, vol. 49, no,5 and 6, pp.1-12.
<http://www2.tamacc.chuo-u.ac.jp/keizaiken/discussno103.pdf>
- Tirole,J.(2001), “Corporate Governance, ” *Econometrica*,68(1),pp.1-35.

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