On dissemination mechanism of corporate social responsibility (CSR): Analysis with agent simulation

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Abstract. Corporate Social Responsibility (CSR), such as pro-environmental behaviour and fair trade, is a kind of normative behaviour by private companies to provide a quasi-public good. We study dissemination mechanism of CSR with a multi-agent model in which corporation agents and consumer agents interact with each other. We show that the mechanism to disseminate CSR is a positive feedback between the corporations' popularity seeking behaviour and the consumers' social learning in which CSR-seeking preference is evaluated according to both the local average of the preferences of surrounding consumers and the global average of the investment in CSR by all corporations. We also discuss an institutional design to establish CSR from an objectionable social state.

Keywords. CSR (corporate social responsibility), Quasi-public good, Institutional design, Positive Feedback, Multi-agent simulation

1 Introduction

Corporate Social Responsibility (CSR) is to take responsibility by organizations including private companies for the effect of their activities on all stakeholders such as customers, employees, shareholders, investors, communities and so on. A typical CSR activity is pro-environmental behaviour. CSR is a kind of normative action by private companies and is considered as an enlightened movement, since such activity must contribute to sustainability. From economic theoretical viewpoint, however, it is said that CSR is inefficient and impossible to maintain in a competitive market. If we consider CSR is an effective means for attaining sustainable society, we need to know a scheme to disseminate and to establish CSR activities in our society. Further, considering the scheme, both theoretically

and empirically, may lead us to an understanding of a method to make agents behave normatively.

In this paper, we study dissemination mechanism of CSR activities using a multi-agent simulation. We think of CSR as an institution. Here we use the term institution in Veblen's sense, namely an institution is a habit of thought common to the majority of individuals in a society [1]. A habit of thought is a kind of a value or a preference. In order to establish CSR activities in a society, stakeholders must have value/preference that CSR activities are nice or agreeable for them in spite of demerit such as higher prices of private goods. Although preference of people must change in order to disseminate CSR, preference is taken as fixed in the standard economic theory. Thus, we consider a multi-agent system for flexible modelling of agents' thought and behaviour.

2   Modelling CSR

2.1   Conceptualization of CSR

Before making a multi-agent model of CSR, we need to conceptualise CSR itself. Here we look at CSR as to provide both a private good and a quasi-public good by companies in their activities. A quasi-public good means the following two.

- Consuming the good by any individuals is not excluded (non-excludability) and one's consumption lessens the benefit of others' consumption (rivalness). Global environment is an example.
- A good produces private benefit in addition to social benefit. Donation is an example, in which we can feel satisfaction which is a private benefit.

2.2   Multi-agent modelling of CSR dissemination

We describe an outline of our multi-agent model. In the model, there are two types of agents, corporations and consumers, both are aligned in two-dimensional planes, respectively. The two-dimensional planes are models of relational space of the agents, not physical/geographical spaces.

The corporations produce private and quasi-public goods simultaneously. They have strategies to decide ratios of invest in the quasi-public goods, $\theta_i = [0, 1]$, called "invest ratio". The higher the invest ratio of a corporation is, the higher the price of the corporation's product is. The dissemination of CSR in this model is defined as follows: most corporations are going to take very high value of the invest ratio.

Each consumer buys a product of a corporation. The consumers have preferences that decide the ratio of importance of the quasi-public good to the price of the private good, denoted by $\alpha_j = [0, 1]$ and called "importance ratio". Each consumer chooses one corporation according to his/her importance ratio, where he/she is likely to adopt a corporation having the similar value of the invest ratio to that of his/her importance ratio. This choice is not always exact. We use the Boltzmann distribution in order to take probabilistic choice into account.

The corporations change their strategies according to the popularity share, that is, how they are adopted by the consumers. They try to copy the invest ratio of the most popular corporation in their vicinity (8 agents). This adoption is also not exact. A normal random noise with 0 mean and 0.1 standard deviation is added to the original value.

Concerning the preference of consumers, we investigate four models, one is fixed and three adaptive:

1. fixed preference
2. income standard
3. local standard
4. glocal standard (glocal means global + local)

Each consumer evaluates his/herself and surrounding consumers (8 agents) according to a standard, which is different point among the three adaptive preference models.

In the second model, the consumers refer to the income as the standard. Since a consumer with higher value of the importance ratio buys a product with higher price, his/her income gets lower. Therefore, the income standard is the synonym for disregard of the quasi-public good.

In the third model, the local standard, the consumer uses a weighted arithmetic average of the disregard, $(1 - \alpha)$, and the importance ratio, α, of the quasi-public good to evaluate themselves. The weight of the importance ratio is the local average of the importance ratio of the neighbouring agents. The evaluation standard is defined by the following equation:

$$V_{ij}^{\mathrm{L}}(t) = (1 - \langle \alpha_i(t) \rangle)(1 - \alpha_{ij}(t)) + \langle \alpha_i(t) \rangle \alpha_{ij}(t) \ , \tag{1}$$

where

- $V_{ij}^{\mathrm{L}}(t)$: the evaluation of the jth consumer of the ith consumer's neighbour at the tth period in the local standard model,
- $\langle \alpha_i(t) \rangle$: the average of α of 8 consumers in the neighbour of the ith consumer at the tth period,
- $\alpha_{ij}(t)$: the importance ratio of the jth consumer of the ith consumer's neighbour at the tth period.

In the fourth model, the glocal standard, the consumers use both global and local information to evaluate themselves. While the local information is the same as the local standard model, $\langle \alpha_i(t) \rangle$, the global information is the average of invest ratios, θs of all the corporations' and is used only for the weight of the importance ratio term. That is,

$$V_{ij}^{\mathrm{GL}}(t) = (1 - \langle \alpha_i(t) \rangle)(1 - \alpha_{ij}(t)) + (\langle \alpha_i(t) \rangle + \langle \theta(t-1) \rangle)\alpha_{ij}(t) \ , \tag{2}$$

where

- $V_{ij}^{\mathrm{GL}}(t)$: the evaluation of the jth consumer of the ith consumer's neighbour at the tth period in the glocal standard model,

- $\langle \theta(t-1) \rangle$: the average of invest ratio θ of all corporations at the $(t-1)$th period.

We use social learning, i.e., imitation, for the adaptive change of agents' preferences. The reason why we take social learning is that we consider agents as social individuals that the individuals' ways of thought, including values, preferences and cognitive frameworks, develop through interactions with others in a society[2]. In each adaptive model, if a consumer takes the lowest in the neighbour according to the standard, he/she imitates the importance ratio of the highest consumer in the surrounding. The imitated value is perturbed by a normal random number with 0 mean and 0.1 standard deviation.

3   Simulation Results

We summarise the results of computer simulations of the above four models. The sizes of the corporation plane and the consumer plane are 10×10 and 100×100, respectively. Thus, the total number of corporations and consumers are 100 and 10000, respectively. The initial states of the invest ratios and the importance ratios are prepared with a uniform distribution.

There is no interesting phenomenon in the fixed preference and the income standard models. In the fixed preference model, the CSR is not disseminated. A little corporations takes high invest ratio. But that is a mere reflection of the existence of the consumers with high importance ratio prepared by the initial uniform distribution. This result is qualitatively equivalent to an economic theoretical model [3]. This is a reasonable consequence since the fixed preference is the equivalent setting to the presumption of the standard economic theory.

Since the income standard means disregard of the quasi-public good, as we mentioned already, the society is occupied by the consumers with very low importance ratio in the income standard model. As they select cheap price products, the corporations also take the low invest strategy in the quasi-public good. The CSR fades away.

3.1   Local Standard Model

In the local standard model, the frequencies of the corporations' invest ratios and that of the consumers' importance ratios change with time as shown in Fig. 1. These graphs represent the dynamics of histograms with 0.1 bin width. The consumers converge to a distribution in which both large ($\alpha \geq 0.8$) and small ($\alpha \leq 0.2$) importance ratios have greater volumes. Other importance ratios are almost even. On the other hand, the corporations continually change their invest ratios. They pursue popularity share by changing their strategies. If a corporation has a top popularity, surrounding corporations come to take the similar invest ratio to the top corporation. As the number of corporations increase at the ratio range of the top popularity, they share the consumers. As a consequence, the popularity of each corporation at this ratio range declines.
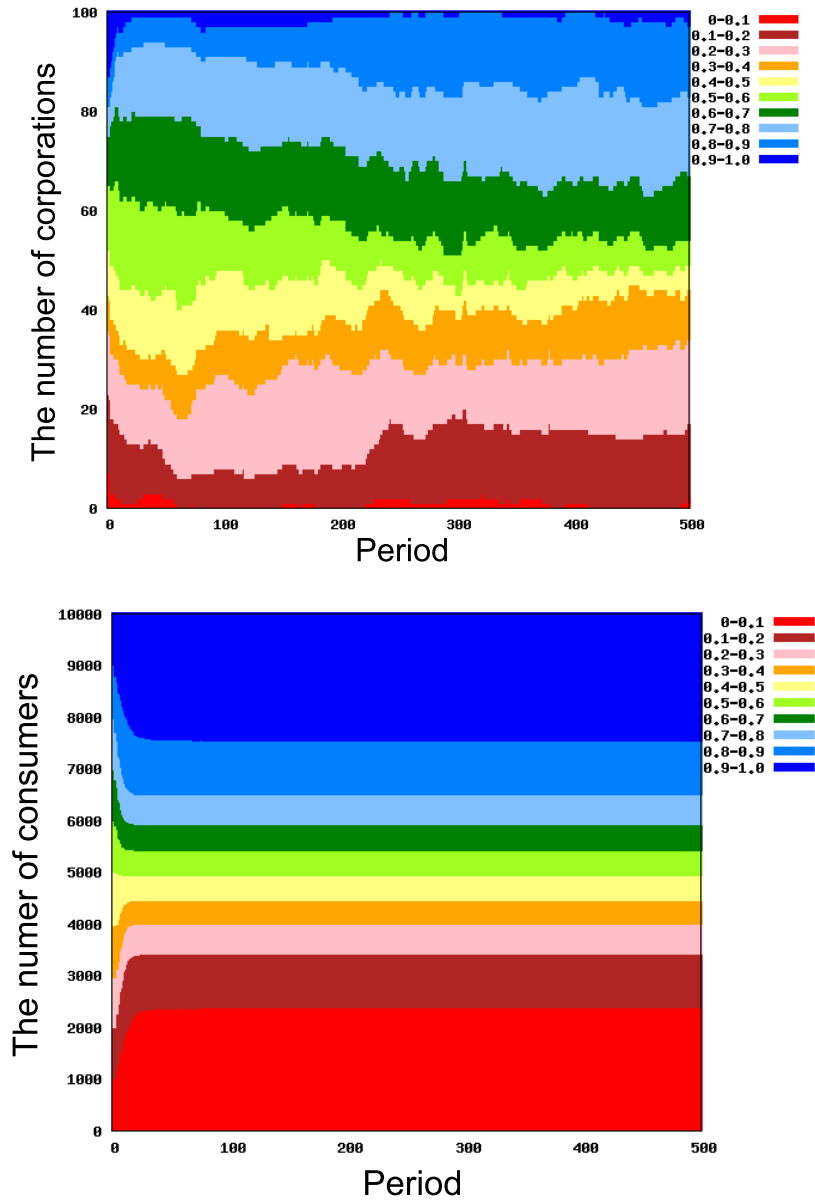
Fig. 1. The dynamics of the frequency of the corporations' invest ratios (upper) and that of the consumers' importance ratios (lower) in the local standard model. The x axis is the period and the y axis is the number of agents. The color legend is shown at the right upper corner.

By keeping such popularity seeking action, the frequency of the invest ratio does not converge to a fixed state.

Figure 2 shows the spatial configuration of the consumers' importance ratio in their two-dimensional plane. Interestingly, the plane converge to an inhomogeneous state. The consumers with high importance ratio (blue) and those with low ratio (red) form clusters. The intermediate ratio consumers are at the boundaries of two types of clusters.
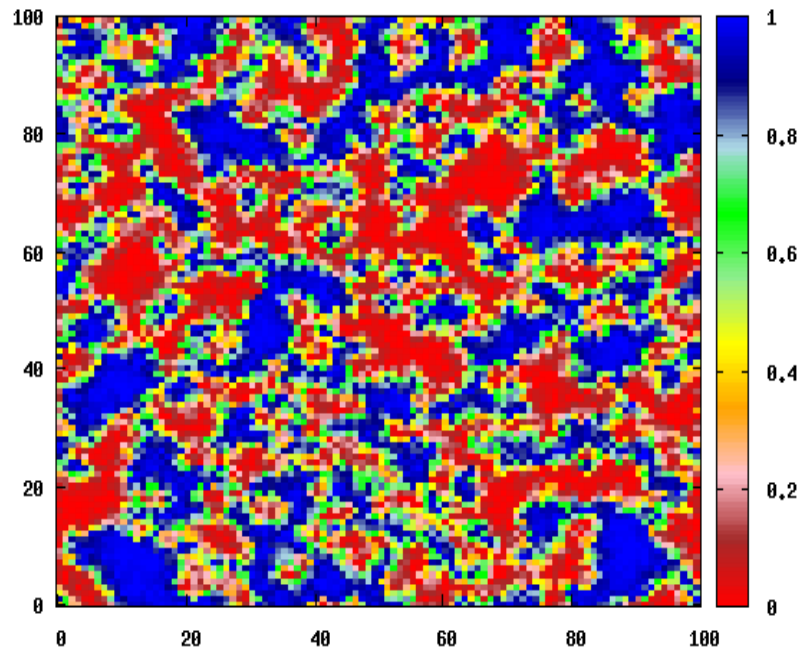

Fig. 2. The spatial distribution of the consumers' importance ratios in the local standard model at the 500th period. The color legend is shown at the right of the figure.

The results shown here are similar to the reality. An empirical investigation says that consciousness about CSR and environment-friendliness is stratified in a society [4]. There are individuals with high consciousness followed by middle

and low. People with high consciousness often form groups. People inside of the group have strong relationships.

The spatial inhomogeneity remains because the consumer agents in the local standard model refer local (their surrounding) consumers to evaluate themselves, that is $\langle \alpha_i(t) \rangle$. There is no absolute standard. Under this circumstance, such a situation occurs that an agent A is the lowest rank according to an agent B's standard, but the agent B is the lowest rank according to the agent A's standard. In this situation, both agents do not have incentives to change themselves, thus the inhomogeneity and diversity are maintained.

Although the observed phenomena is realistic as well as interesting, and corporations with high invest ratio exist to some extent, the ratio of them is not enough. We conclude that CSR is not disseminated in the local standard model.

3.2   Glocal Standard Model

The change of the frequency of the corporations' invest ratios and that of the consumers' importance ratios are depicted in Fig. 3. In this case, very large importance ratio ($\alpha \geq 0.9$) permeates rapidly among the consumers. Behind the consumers movement, corporations with very large invest ratio ($\theta \geq 0.9$) also increase and finally occupy the society. We consider this state as CSR established. The spatial distribution of the consumers' importance ratios has islands in which consumers having very low importance ratio are at the core (Fig. 4).

We introduce the average of invest ratio of all corporation as global information into the weight for the second term of the evaluation standard (refer to eq. (2)) that puts importance on CSR, but not into that of disregarding CSR (first term of eq. (2)). This is a trick to expand large invest ratios. The mechanism to disseminate CSR is the followings:

1. There are consumers with high importance ratios to some extent.
2. Such consumers choose corporations with high invest ratio.
3. In order to improve *popularity*, corporations imitate the strategies of the chosen corporations.
4. As a result, the average of the corporations' invest ratio, $\langle \theta(t) \rangle$, increases.
5. The weight of the CSR-seeking term in the glocal evaluation standard, refer to eq. (2), increases and the *social learning* by the consumers is directed to higher importance ratio.
6. The consumers are likely to increase their importance ratio. (back to 2.)

This is a positive feedback mechanism between the corporations' popularity seeking behaviour and the consumers' social learning. In this feedback loop, the consumers' CSR-seeking preference is evaluated according to both the local average of the preferences and the global average of all corporations' investment in CSR, and then the consumers learn socially, i.e., imitate locally. As a phenomenon level, this positive feedback is also observed as a mutual strengthen between the consumers' consciousness putting importance on CSR and the corporates' investment in the quasi-public good. Here, the important point is that
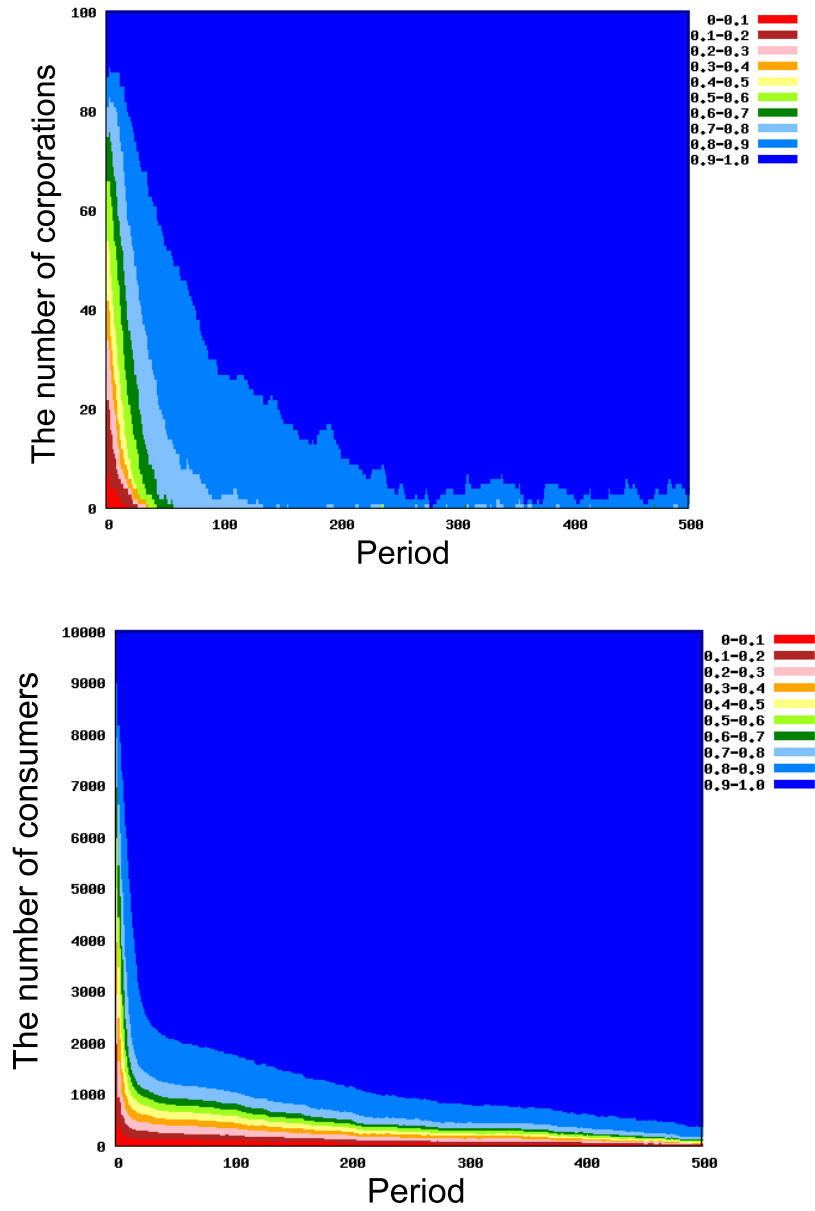
Fig. 3. The dynamics of the frequency of the corporations' invest ratios (upper) and that of the consumers' importance ratios (lower) in the glocal standard model. The x axis is the period and the y axis is the number of agents. The color legend is shown at the right upper corner.
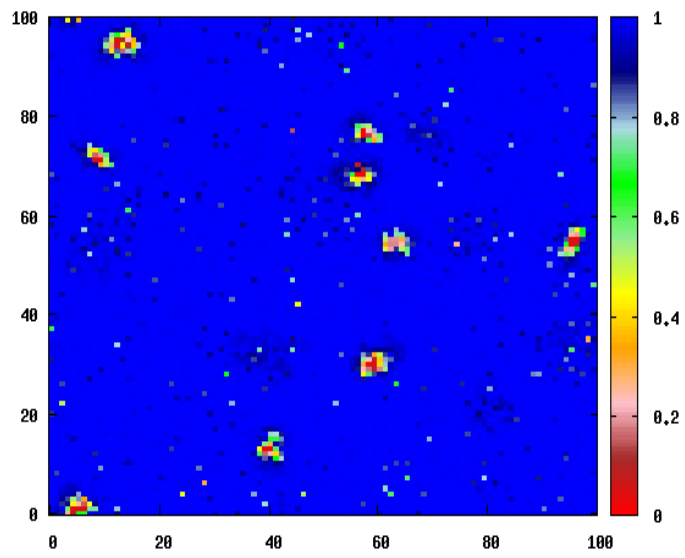
Fig. 4. The spatial distribution of the consumers' importance ratios in the glocal standard model. The color legend is shown at the right of the figure.

the corporations take just myopic actions, popularity seeking. The spread of the importance of CSR in the consumers precedes the strategy of corporations. That is, an institution to putting importance on CSR establishes in the sub-parts of consumer society first. The corporations pursue the institution, and this action promotes an atmosphere or a public opinion that CSR is important. The atmosphere, then, boosts the consumers' change to higher importance ratio through social learning.

4   Institutional Design

If the positive feedback mechanism works well, even in the society under an objectionable state, that is, only with low importance ratio consumers, CSR may be disseminated. We are able to also consider an institutional design in which a policy is employed to realise a desirable social state. Here we suppose a policy to regulate all corporations to maintain the least ratio of the investment in the quasi-public good.

We investigate how CSR is established by controlling the minimum value of the invest ratio of the corporations and the maximum value of the importance ratio of the consumers at the initial state. The former corresponds to the strength of the regulation by the policy and the latter the desirability of social state. We calculate the average of the consumers' importance ratio at the final (converged) state. While the definition of the establishing CSR in this paper is maintaining the higher invest ratio in a quasi-public good by the corporations, we observe the state of the consumer society, since we already know that establishing the institutions in the consumers leads the dissemination of CSR.

In Fig.5, the result of this calculation is shown. We can see two regions, establishment of CSR (the value of z is 1.0) and complete loss of CSR (the value of z is 0.0). There is a steep cliff between these two regions. This is because there is a threshold for the positive feedback mechanism above mentioned to work. This result suggests that if the social state is not so desirable but not too objectionable, say the maximum of α is 0.6, the regulation by the policy need not to be so strong, the minimum θ is 0.3.

In order to disseminate and establish CSR, we need to constitute a society like the fourth model, the glocal standard model. But the reality at the present seems to be in the third model, the local standard. The difference is whether people take the global information such as an atmosphere putting importance on CSR into consideration to evaluate themselves. From the viewpoint of institutional design, a possible way for the shift from the local to the glocal standard is to give publicity to the present status of corporations' CSR activities by municipality or government. When we successfully shift to the society supposed by the glocal standard model, there are two scenarios. One is an optimistic scenario in which CSR disseminate and is established by itself if there are consumers with enough high consciousness about CSR. The other is less optimistic one, we need a regulation on corporations activities to make a least level of investment in a quasi-public good, if there is not enough high conscious people.
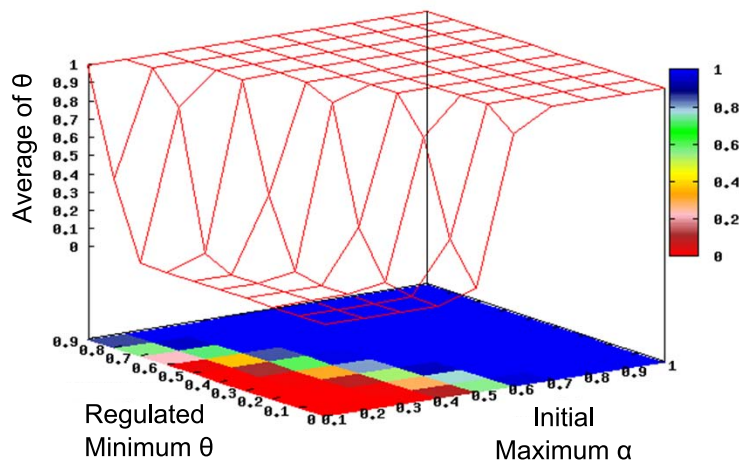
Fig. 5. The effect of regulation and the initial social state on the dissemination of CSR. The left axis is the minimum of the regulated invest ratio of the corporations, the right axis is the maximum of the initial importance ratio of the consumers, and the z axis is the average of the importance ratios of the consumers (averaged in 5 simulations).

5 Conclusion

In this paper, we study a mechanism to disseminate CSR activities, a normative action by corporations. The CSR is conceptualised as providing a quasi-public good simultaneously in addition to a private good. Using multi-agent simulations, we showed that the criteria to disseminate CSR were to take global information such as the average amount of investment in CSR into consideration to evaluate consumers themselves. The dissemination mechanism is a positive feedback between the consumers' social leaning of their preference putting importance on CSR and the corporates' popularity seeking. We also showed that by regulating the least amount of investment in CSR by corporates, dissemination could be launched even in an objectionable society.

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