Article

An Agent-Based Approach for Social Exclusion from the Perspective of Social Networks

Masatoshi Murakami* and Noriyuki Tanida**

Abstract

In this paper, we examine the effects of the current state of social exclusion. We focus particularly on the relationship between individual social networks and their effects on reducing social exclusion. To tackle these issues, first, we revise and develop our original 2013 simulation model Secondly, we show the three dimensions of social exclusion as represented in our new simulation model and how these dimensions are passed on to future generations. Thirdly, we examine the relationship between a lack of social connection and the strength of social exclusion and present our results, which show that: 1) the degree of social participation is positively correlated with the number of links for each agent; 2) the gap between agents who have the same number of links is widened at a later point of simulation; 3) the degree of social participation is not correlated with the betweeness centrality of each agent in the random network model, and 4) the degree of social participation is correlated with the betweeness centrality of each agent in the threshold model.

Keywords : Agent based Simulation ; Poverty ; Social Exclusion ; Social Networks
Classification Number : 15-60 ; 15-83

1. Introduction

In this paper, we examine the effects of the current state of social exclusion. We focus particularly on the relationships between individual social networks and their effects on reducing social exclusion.

To tackle these issues, first, we revise and expand our simulation model developed in 2013. In particular, we implement a social network model into our simulation model. In the field of network theory, various social network models and indices have been developed

*) Faculty of Economics, Hannan University
**) Faculty of Economics, Kansai University

(Freeman, L. C. 2004). In this paper we have selected social network models with the criteria that they have small world phenomenon and meet scale freeness. Secondly, as shown in our new simulation model, we pass on to future generations the criteria of the three dimensions of social exclusion, that is, low income, low social participation and political rights. Thirdly, we examine the relationship between a lack of social connection and the strength of social exclusion. Incrementally, we analyze the relationship between the strength of social exclusion and various network indices, which represent *the average shortest path,* the *clustering coefficient, betweeness centrality* and *degree distribution.*

In the following sections, the settings of our simulation model are described in detail. Next, we show our simulation results. Finally, we summarize our research results and refer to the tasks ahead.

2. Simulation Settings

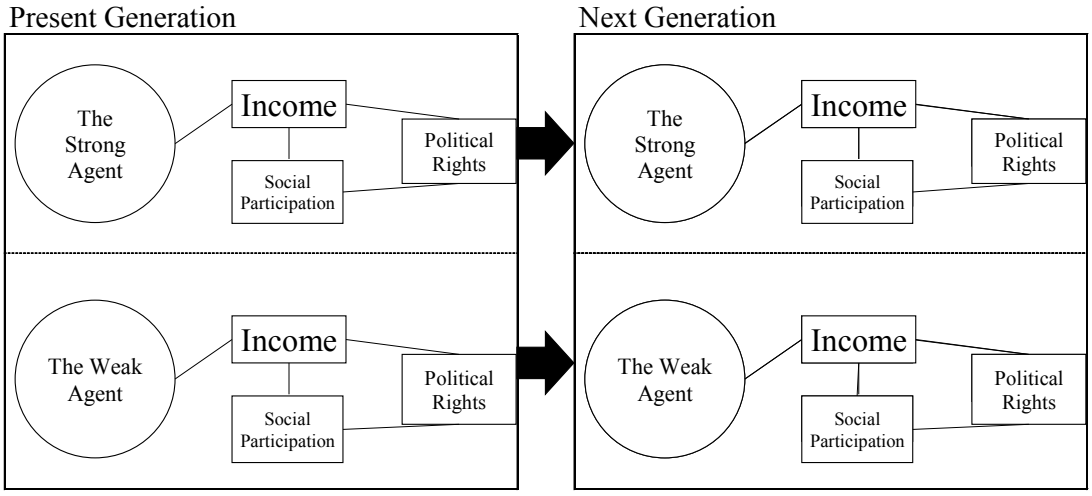

Figure 1 The Characteristics of our Simulation Model in 2013

As shown in Figure 1, our 2013 simulation model is based on the Sugarscape model (Epstein and Axtell 1996). However, this model is not a complete model for analyzing the interrelation between the strength of social exclusion and the lack of social connection. Therefore, we have revised and developed our original 2013 model simulation model without changing the model framework where social exclusion is transmitted to the next generation and three factors are connected to each other. For example, if an agent has a low income, he or she is restricted in many aspects of social participation and political

rights. Our simulation model includes some social network models. In addition, social problems, as they occur in an aging society, for example, are expressed by our simulation model.

Our new simulation model includes three network models, namely, the Random network model, the Barabasi-Albert model and the Threshold model. The outline of our new simulation model is shown in Figure 2.

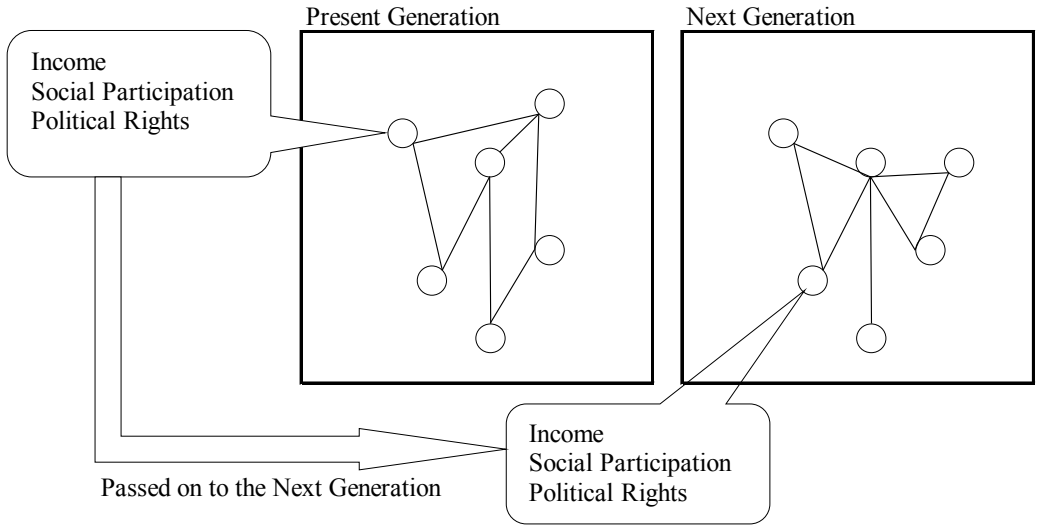

Figure 2 The Outline of our new Simulation Model

Based on this simulation model, we analyzed the relationship between the strength of social exclusion and that of social connection using certain network indices. For example, we see if there is a strong negative correlation between the number of links and the strength of social exclusion. Of course, the relationship in these two variables is altered by a change in the network structure. Therefore, these relationships are induced by conformational changes in network structure.

Basically, each agent goes through life, earns income, and dies a natural death. One step is defined as one month. Also, the agents pass on their situation of social participation and political rights to the next generation.

3．Simulation Results

3－1 The Relationships between the Number of Links and the Strength of Social Participation

We have obtained various results from our new simulation models. A network model should fit in well with the reality of people's networks. In other words, the averages of the shortest path are small, the clustering coefficients are relatively high and the degree distributions have good fit with power law. These points lead to two types of simulation result. The first simulation results are from the random network model (Case 1). The second results are from threshold model (Case 2).

Figure 3 (Case 1) shows the results of a simulation that indicates a relationship between the number of links of each agent and the strength of social participation. Figure 4 (Case 2) shows the result of a simulation that indicates a relationship between the number of links of each agent and the strength of social participation.

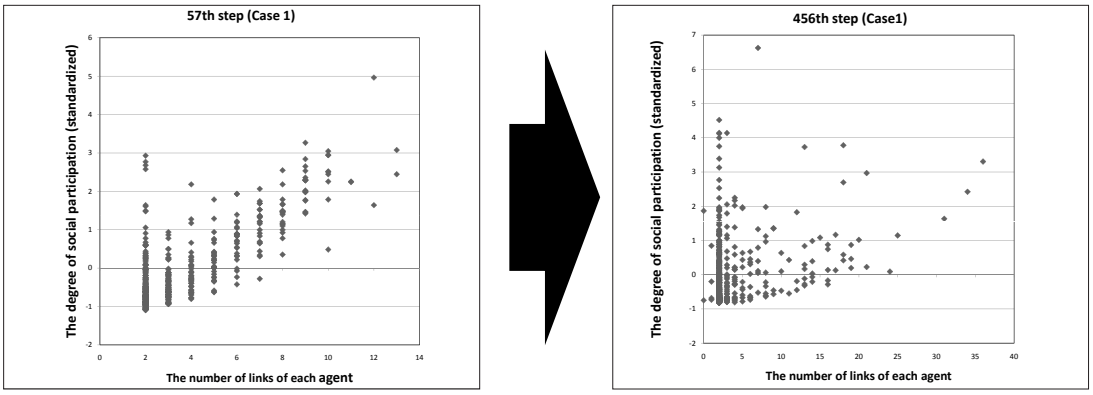

Figure 3 The Results of the Simulation in Case 1

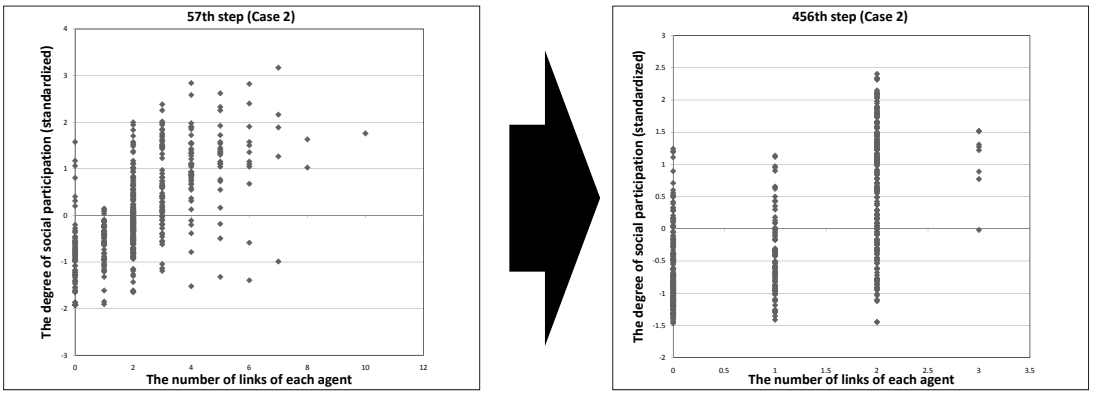

Figure 4 The Results of the Simulation in Case 2

As shown in Figure 3, the degree of social participation is positively correlated with the number of links of each agent at an early stage of simulation. However, the gap between agents who have the same number of links is widened at a later point of simulation. It appears that the network structure and the state of social exclusion transmitted to the next generation is partly a reflection of these results.

Moreover, as shown in Figure 4, as is the case with Case 1, the degree of social participation is positively correlated with the number of links of each agent at an early stage of simulation. However, the gap between agents who have same number of links is widened at a later point of simulation, as in Case 2. In the threshold model, all of agents have the weight w_i $(i = 0, 1, \cdots, n)$ and any w_i are distributed according to the probability density function $f(x)$. If the sum of w_1 and w_2 exceed or even equal the threshold, agents link with each other. Therefore, the number of links of each agent is much lower than in a random network. However, the gap between agents who have the same number of links is greater than that in Case 1. We set threshold value at 0.5 in Case 2.

In practical network structure, the state of social exclusion is transmitted to the next generation result under the widening disparity in social exclusion.

3-2 Relationships between the Strength of Social Participation and Betweeness Centrality

Is the strength of social participation defined just by the number of links of each agent? Even if an agent does not have many links, he or she might build up a close network centered on themselves. Also, the relationships might be characterized by a high degree of social participation.

Therefore, in this section, we would like to look at the relationship between the strength of social participation and the agent's betweeness centrality. As is the case in analyzing the relationships between the number of links and the strength of social participation, we use the random network model (Case 1) and the threshold model (Case 2) and show the results of the simulation for these two models. Figure 5 and Figure 6 show the result of simulation that indicates a relationship between each agent's betweeness centrality and the strength of social participation in Case 1 and Case 2, respectively.

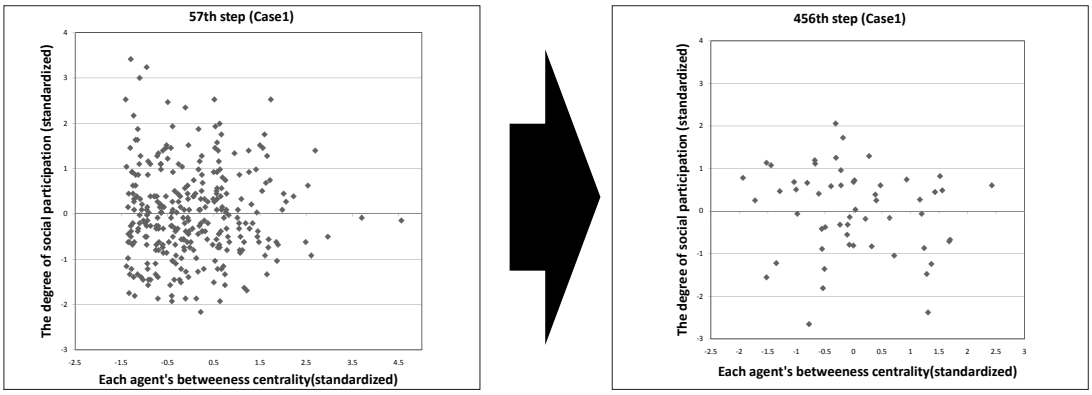

Figure 5 The Results of the Simulation in Case 1

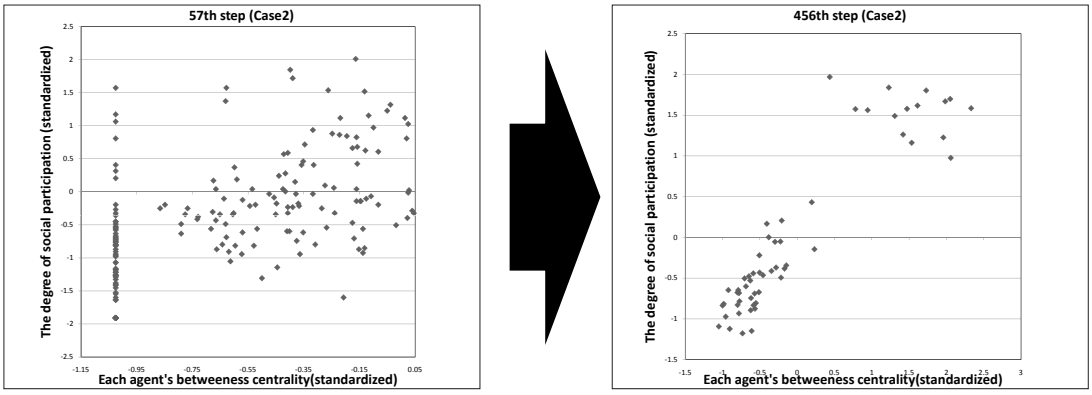

Figure 6 The Results of the Simulation in Case 2

As shown in Figure 5 and Figure 6, the relationship between the strength of social participation and betweeness centrality varies depending on the structure of the agent network. In Case 1, there is a poor correlation between the strength of social participation and each agent's betweeness centrality. In Case 1, because each agent randomly creates links to other agents, some prominent agents with a high betweeness centrality might not be created. Therefore, the strength of social participation seems to have less to do with betweeness centrality.

The results in Case 2 take on an entirely different aspect from those in Case 1. That is, there is a positive correlation between the strength of social participation and each agent's betweeness centrality. Furthermore, the gap in the strength of social participation becomes wider as time passes. Agents who have a lower value of betweeness centrality also have a lower value of social participation.

Though it is possible to see simulation results using other indices, for example, the number of cliques, we would like to show the results of a comprehensive analysis using these indices in future study.

4. Conclusion and Future Works

In this paper, we verified the relationship between individual social networks and the effects of reducing social exclusion. Although highly dependent on network structure, the degree of social participation is positively correlated with the number of links of each agent. However, the gap between agents who have same number of links is widened at a later point of simulation. In other words, the current state of social exclusion is a result of the widening disparity of social exclusion.

In addition, the degree of social participation is not correlated with betweeness centrality of each agent in a random network model. Also, the degree of social participation is conversely correlated with the betweeness centrality of each agent in the threshold model. However, at present, we cannot explain the difference in outcome in the two models.

Continuous examination of the relationships between individual social networks and the effect of reducing social exclusion should strengthen certain propositions in this article such as: 1) the degree of social participation is positively correlated with the number of links for each agent; 2) the gap between agents who have the same number of links is widened at a later point of simulation; 3) the degree of social participation is not correlated with the betweeness centrality of each agent in the random network model, and 4) the degree of social participation is correlated with the betweeness centrality of each agent in the threshold model. Therefore, by further refining our new simulation model with other social network indices, we would like to verify the social relationships discussed in this paper.

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