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A Note on the Process of Forming Public Opinion and its Effect on Japanese Public Pension System

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Abstract

The purpose of this study is to examine how people's distrust in public pension system and its propagation will effect on Japanese public pension system. For the sake of clarifying the relationships between them, in this paper, we devote some space to the discussion of it. For that purpose, we renew our previous model in [10] [15] by implementing DSIT (Dynamic Social Impact Theory) and BA (Barabasi-Albert) model. Moreover, we build the mechanism of Japanese public pension, which was revised in 2004, into our new model.

In this paper, we create our new model with care and attention for economical, sociological and network theoretical points. The result clearly shows that the propagation of people's distrust in public pension system have a considerable impact on public pension system in comparison with the impact of the changes in future economic condition.

Keywords : distrust in public pension system, DSIT(Dynamic Social Impact Theory), scale free network, public pension system, multi agent based simulation

1. Introduction

The current situation surrounding Japanese public pension system is growing steadily worse. It is partly due to the aggravation of the financial condition of the public pension system accompanying Japanese rapidly aging population and a declining birth rate, and is partly due to the presence of citizens who have signed up but are delinquent in their pension premium payments. In addition to this, recently in Japan, a problem, which many people's pension account numbers do not correspond to public pension record (about 50 million!), make citizens more distrustful of public pension system. Despite these situations, there has been no study that tried to clarify the effect of the change in people's thinking or attitude for Japanese public pension system on itself. The propagation of people's distrust in public pension system should results in considerable impact on Japanese public pension system, since many people do not come to pay pension premium. However, it was not clarified by previous studies how people's distrust in public pension system was propagated and how it would effect on public pension system. In many researchers' and government simulation model, the propagation of people's distrust in public pension system was not considered or was assumed that it is remained constant. Their models insufficiently explained what will happen to Japanese public pension system. Therefore, we think that the analysis of these relations and its simulation deserves careful attention.

The purpose of this study is to examine how people's distrust in public pension system and its propagation will effect on Japanese public pension system. We studied about this theme in Murakami & Tanida (2006), Tanida & Murakami (2007), in which we used ABM and word-of-mouth communication model. However, our old model was far adequate model in that the propagation of people's distrust in public pension system remained insufficiently answered. In addition to this, what seems to be lacking in our old model is the expression of the demographic change in Japan more precisely. For the sake of improving our old model, we will build Morio (2003) and Barabasi-Albert model into our new model.

2. Survey and Modeling

2-1 Unpayment Behaviour as a Formation of Public Opinion

In this section, we will explain about the interaction of agents that is built in our new model. In Murakami & Tanida (2006) and Tanida & Murakami (2007), we considered how people's distrust in public pension system and its propagation would effect on Japanese public pension system. To clarify this subject, we introduced word-of mouth communication model into our old model, and looked at the relation between the propagation of people's distrust in public pension system and the amount of pension fund. The result indicated that people's distrust in public pension system have decisive influence on public pension system.

However, our old model was not necessarily adequate model in terms of the expression of the

propagation of people's distrust in public pension system. Since we did not build the limiter that stop the spread of agent's distrust in public pension system into our old model, the numbers of agent who have distrust in public pension system infinitely increased with the number of simulation steps grew. At the end of simulation, almost all agents had distrust in public pension system.

To clear this problem, we require the change in the theory and the method that we depend principally on. In Japan, many people might form their own opinion about Japanese public pension system. On the ground of their opinion about Japanese public pension system, they should determine whether they should pay pension premium. However, recently in Japan, the negative opinions for Japanese public pension system become common and many people do not come to pay pension premium. Why does the number of people non-paying pension premium increase? It is partly because some people's negative opinion in public pension system penetrates into many others. It is not difficult to understand that the propagation of people's distrust in public pension system is the conformation of public opinion, in a way. Therefore, we treat this subject as the process of forming public opinion.

Many studies have been made on the process of forming public opinion in the area of sociology, especially, in the area of Dynamic Social Impact Theory (DSIT) and the simulation by using it.

As the first step in our work, we have carefully examined a series of works in terms of DSIT. DSIT and its simulation capture how a collective phenomenon is emerged as a result of the interpersonal interaction in terms of "Consolidation", "Clustering", "Continuing Diversity" and "Correlation". According to Latané & Morio (2000), in the area of DSIT, many researchers used "Latané's (1981) individual-level theory of social impact to explain and predict the emergence of group-level phenomena as consequence of social influence among interacting people."[1)]

Latané (1981) is billed as the study that start from clarifying the gap between the theory of Asch (1951), Abelson(1964) and practice, in which they concluded that individuals easily defer to the opinion of the majority. As a corollary to these conclusions, all people should have same opinion. However, in reality, people have different opinions in a variety of context. To clarify this subject, Latané (1981) developed SIT and DSIT.[2)]

Although, in this area, Latané (1981) is the pioneering study, many literatures also have proposed improvements. The latest research developments in Japan seem to be Shimura et al. (2005), Morio (2003).

Shimura et al. (2005) has eased to restriction on physical distance among agents, which is a key factor in DSIT, in consideration of the development of ICT. However, they described agent's attitude score that shows the change of agent's attitude for a matter as the discrete value (0 or 1). We can see that such an attitude score is given by step function. It is too simple and may not follow reality in the

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[1)] See, Latané & Morio (2000), p.96.
[2)] See, for example, Ishiguro et al.(2000), Yasuno (2006).

sense that it cannot indicate the intermediate people's attitude score.

By contrast to this, Morio(2003) is different from Shimura et al. (2005) in that agent's attitude score does not change rapidly, since the function that he adopts is continuous function. An agent's attitude score changes non-linearly and gradually. Also, Morio's attitude function can have various style depending on the value p of linearity coefficient, for example, step function, non-linear function, and linear function for $p = 0, 0.5, 1$, respectively. In terms of describing the change of people's attitude more precisely, it is clear that Shimura et al. (2005) model is a special version of Morio (2003) model. In addition to this, according to Latané & Nowak (1997), "The assumption that attitudes have a flip-flop character is at odds with the long tradition of attitude measurement in social psychology that seems to show that attitudes are continuous." Moreover, according to Latané & Nowak (1997), "As recent developments have shown, however, the dividing line between the dynamics of models lies not between continuous and discrete models, but between linear and nonlinear ones."[3] These clearly show that non-linear and continuous function is better function than step function for describing the dynamics of agent's attitude more precisely.

For these reasons mentioned above, we implement Morio (2003) model into our new model to reveal the transition process of peoples opinion concerning about public pension system.

Let us explain Morio (2003) model in more detail. In his model, the influence function $y = f(x)$ that the decision function of getting feedback from the other is defined as follows:

$$f(x) = \begin{cases} x^p M^{p-1}, & if\ x \geq 0 \\ -(-x)^p M^{p-1}, & if\ x < 0 \end{cases} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

where x is the input value, and p is the linearity coefficient and M is the maximum value of agent's attitude score.

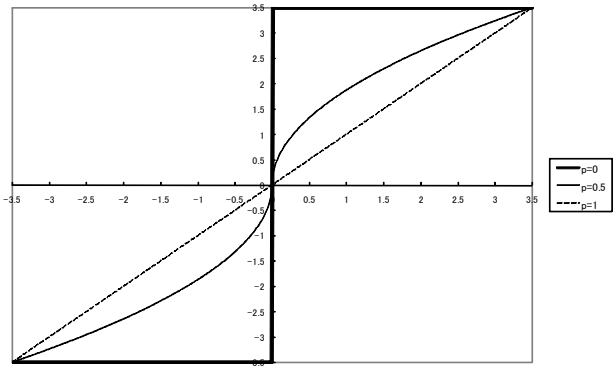


Figure 1 The Decision Function Divided by p

(Source) Morio (2003), p.161, Figure 1

[3] See, Latané & Nowak (1997), pp.66-67.

Given that p is 0, 0.5 and 1, the shapes of the function (1) can be drawn as in Figure 1. As in Figure 1, the shape of the function (1) is changed with an increase in p. If p is 0, the function (1) get into step function. On the other hand, if p is 0.5, the function (1) get into non-linear function. In addition, if p is 1, the function (1) get into linear function. It means that the function (1) become non-linearity function if p is greater than 0 and lesser than 1.

In addition to this, the aggregate sum of influence from the other agents I is defined as follows:

$$I = \frac{1}{n}\sum \frac{X_j}{d^m} \quad \text{……..(2)}$$

where X_j is j th agent's attitude score, and m is distance coefficient, and n is total number of agent, and d is the distance between i th agent and j th agent,

With these definitions described above in mind, we will now take a look at function I in more detail. In Morio (2003) model, the value of X_{ij+1} which is i th agent's attitude score in next step, is defined as follows:

$$X_{ij+1} = f(q)$$
$$q = \left| wX_{ij} + (1-w)I_j \right| \quad \text{……..(3)}$$

where w is the weight of "ego-involvement." $1-w$ is the weight of the influence from the other agents. I_j is total sum of influence from the other agents to i th agent, X_{ij} is i th agent's attitude score in j th step, and q is the absolute value of the weighted average which is calculated between the attitude score of i th agent and the other agents.

We implement the functions as stated above into our new model. However, it is important to notice that our new model differ substantially from Morio (2003). Our new model is not concerned with the closed set of agent. In his model, the number of agent is predetermined and it is not change. By contrast to this, in our new model, each agent gets older and dies in his (or her) bed. At the beginning of year, new agents (20 years old) are created. In these regards, our new model is different from Morio (2003) and these points are important for making our new model fit well in real world.

2-2 The Foundation of Our Simulation Model

2-2-1 Demographic Change

In this section, we will explain the basic structure of our simulation model. Our new simulation model is designed for analysing how people's distrust in public pension system and its propagation by people's interaction will effect on Japanese public pension system. In order to do so, we should

express the environment surrounding Japanese public pension system precisely. The key factor of environment surrounding Japanese public pension system is the acceleration of demographic aging in Japan. If our new model does not accurately represent the acceleration of demographic aging in Japan, which is the basic part of our new simulation model, the result of our simulation will also become inaccurate. Therefore, we should be careful to ensure if our simulation model can accurately express the acceleration of demographic aging in Japan. For these reasons as stated above, we calculated “population aging rate” from the number of agent and agent’s age in our simulation model. Comparing our new model’s population aging rate with government’s one, we have strictly audited the correctness of our simulation program.

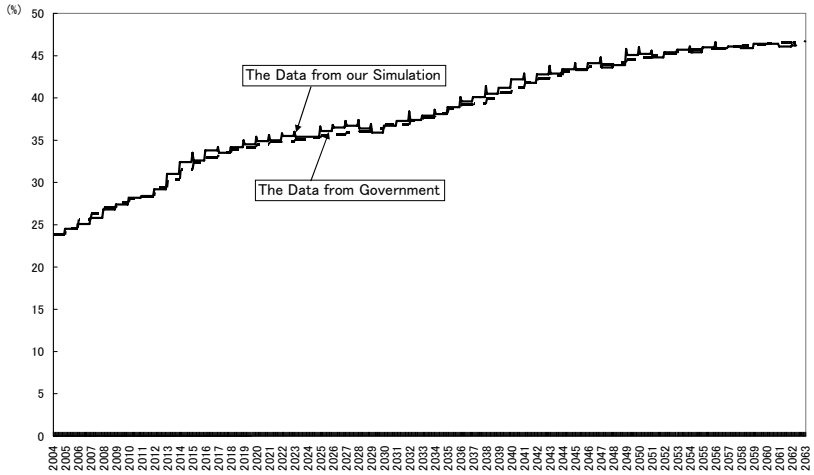


Figure 2　The Comparison of the Population Aging Rate
(Source) The National Institute of Social Security Research (2008)

In general, it is forecasted that the population-aging rate in Japan will grow rapidly. And it is estimated that there will be two peak years of the population aging rate. We can find the first one after 12 years and the second one in the year around 2033. Figure 2 shows that the comparison between our new model’s population aging rate with government’s one [from the National Institute of Social Security Research (2008)]. In our new model, we have set one simulation step as one month. In our new simulation model, the 192nd step corresponds to 2020, and the 348th step corresponds to 2033. As shown in Figure 2, our new simulation model almost precisely follows the population-aging rate and its change in Japan.

2-2-2 The Structure and the Recent Revision of Public Pension System in Japan

In addition to stated above, we implement the transition rate among pension categories, which is set in government pension simulation model [e.g. Ministry of Labour and Welfare (2005)], into our

new model. “The transition rate among pension categories” is the percentage of people who move from a pension category to the other one. For example, since many young people aged over 20 years do not enter employment, most of them will belong to Category I. However, if they enter employment, they will transit Category I to Category II. The respective definitions about pension categories are described in Table 1.

Table 1 The Definition of the Pension Category in Japan

Category Ⅰ insured people: All registered residents of Japan aged 20 or over but under 60, except for the Category Ⅱ or Ⅲ insured people. The people included in this Category are mainly, self-employed people, freelance workers and students as well as their spouses
Category Ⅱ insured people: People enrolled in the Employees’ Pension Insurance system or Mutual Aid Association (except for people aged 65 or over but under 70 who are eligible to receive pension due to old age or retirement)
Category Ⅲ insured people: Category Ⅱ insured people's dependent spouses aged 20 or over but under 60

(Source) Social Insurance Agency (2008)

As described above, in Japan, people can move between each pension category in the event of being employed, leaving business, and getting married etc., therefore, we implement the transition rate among pension categories” into our new model as a basic structure of it. It is based on the data that released by government.

In addition to stated above, we build the mechanism of Japanese public pension, which was revised in 2004, into our new model. Because of the acceleration of demographic aging, Japanese government adopted “the new pension scheme in 2004”. The new government’s pension scheme is described as follows. Firstly, government plan to gradually raise the share of tax revenues in public pension system from 30% to 50% until 2009. Secondly, the premium payment rate in employees' pension is raised from 13.58% to 18.3% by 2017. Then it is fixed. At the same time, the amount of national pension premium is gradually raised from 13,300 yen to 16,900 yen in 2017. Moreover, the government plans to make the standard pension benefit level retain about 50% of average salary of working population (Currently, it is 59.3% and it will be 50.2% in 2023).

Additionally, a unique mechanism is introduced to “the pension scheme in 2004”, which is generally called “macro economy slide system”. In this system, the amount of pension benefit is tied to the wage growth rate and the price growth rate. According to Social Insurance Agency (2008), Research Institute of Economy, and Trades and Industry (2005), macro economy slide rate is a mechanism that “will restrain the rate of increase of pension benefits by taking into consideration the declining number of the working labor force and the possible further extension of life expectancy, thereby keeping the total amount of pension benefits compatible with the decreasing population and

slower GDP growth rate in the long-run."[4] To introduce this mechanism, the amount of pension benefit provided to people who start to receive pension benefit is increased in line with the wage growth rate minus the macro economy rate. At the same time, the amount of pension benefit provided to people who have already received pension benefit is also increased in line with the price growth rate minus the macro economy rate. Incidentally, Japanese government have an assumption that the macro economy rate remain at 0.9 %.

We also implement this mechanism into our new model. As described above, Japanese government have an assumption that the macro economy rate remain at 0.9 % a year, the wage growth rate remain at 2.1% a year, the price growth rate remain at 1% a year, and these situations will last up to 20 years. However, we make these variables change without limit in our new model.

In addition to stated above, agent's income is one of the key factors that really does affect the situation of Japanese public pension system. Therefore, we assign each agent with income (the average is 5,600,000 yen a year and the standard deviation is 35). If agents belong to Category II, the earnings-related component of his (or her) pension premium is paid in promotion to his (or her) income.

2-3 Creating a Network for Expressing People to People Relationships

We link each agent for expressing people relationships. In this regard, it is important and critical problem how we should link each agent. If we leave the real society out of consideration, linking each agent by random network might be the best-qualified method. However, from a practical point of view, it seems to be unreasonable to describe people's relationships as random network. In addition, in our new model, agents are born and died. Moreover, agents form "new link" as they get older.

Therefore, we will go even a little further and innovate a way to link agents. From the point of this view and our careful investigation, we have reached that BA (Barabasi-Albert) model, which have a feature of (i) network expand continuously by the addition of new vertices and (ii) new vertices attach preferentially to sites that are already well connected[5], might play an appropriate role in linking agents. The other agents who have linkage to him (or her) influence him (or her). In this instance, each agent expresses his (or her) opinion in accordance with the functions, which are defined as in section 2.1.

Many simulation models based on DSIT allocate a certain number of agents in a reticular pattern or in a random manner. However, it seems to be unreasonable to have an assumption that once a network is established, it neither collapse nor expand. Therefore, we do not adopt the method of allocating a certain number of agents in a reticular pattern or in a random manner. Moreover, when

[4] See, Social Insurance Agency (2008), Research Institute of Economy, and Trades and Industry (2005).
[5] See, Barabasi & Albert (1999), p.509.

we take “the strength of each relationship among agents” into consideration, it makes sense to divide a space into spaces by age group. We therefore create 9 age group spaces. The image of our new model is shown in Figure 3.

In each space, agent put a link to the other agent who has a slight difference in age. For example, when an agent who has linkage to the other agent at the “space for 20-24 years old agents” reaches 25 years of age, he (or she) moves to the “space for 25-29 years old agents” and forms new network. The execution screen of our simulation is shown in Figure 4.

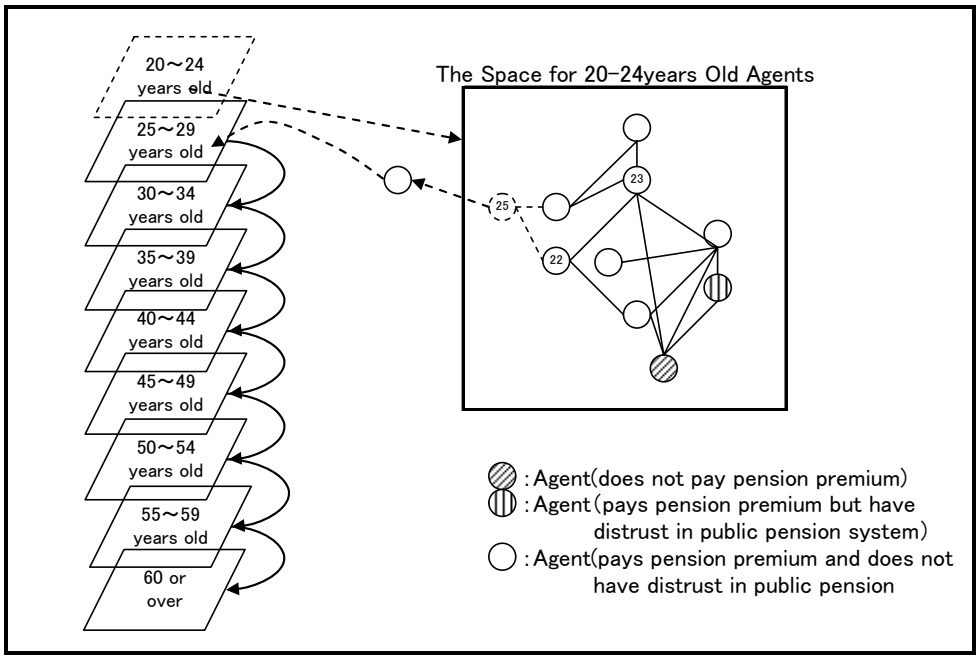
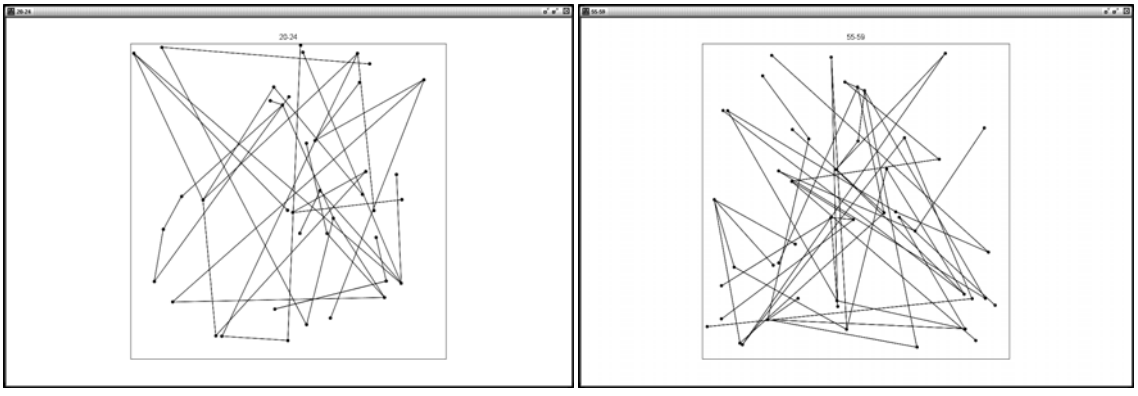


Figure 3　The Image of our New Model



(a) The Space for 20-24 years old agents　　(b) The Space for 55-59 years old agents

Figure 4　The Execution Screen of our Simulation

3. Execution of Simulation

3-1 Simulation Cases

In this section, we will explain our simulation scenarios. Each simulation scenario is shown in Table 2. As Table2 indicates, we have set six simulation cases. The difference among each case is based on the combination of some factors. Combining some factors, we can assess how much each factor is involved in the result of simulation. Some factors that have a big effect on the result of simulation seem to be (1) the change of economic situation and (2) the propagation of people's distrust in public pension system.

Table 2　Simulation Settings

	Economic Condition		The Propagation of Distrust
	Wage Growth Rate	Price Growth Rate	
Case 1	S	S	E
Case 2	D / H	D / H	E
Case 3	D / L	D / L	E
Case 4	S	S	I
Case 5	D / H	D / H	I
Case 6	D / L	D / L	I

S : Same as the Condition of Government Forcast
D : Different from the Condition of Government Forcast
I : Included in Simulation
E : Not Included in Simulation
H : Higher than the Condition of Government Forecast
L : Lower than the Condition of Government Forecast

It is quite likely that pension financing will be hurt, if the future economy gets worse. It is because Japanese public pension system is associated with economic condition, especially, price growth rate and wage growth rate. For this reason, we assume three simulation scenarios (cases) in terms of future economic condition. The first is the case that the future economic condition is same as it shown in government forecast (Case 1, Case 4). The second is the case that the future economic condition gets better, in comparison with it shown in government forecast (Case 2, Case 5). The third is the case that the future economic condition gets worse, in comparison with it shown in government forecast (Case 3, Case 6). In Case 1, 2, 3, the percentage of agent having distrust in public pension system stays constant.

In Case 2 and Case 5, we set wage growth rate at 3.4%, and price growth rate at 1%. These figures are the result of regression analysis using the data provided by Statistics Bureau (2008) On the other hand, in Case 3 and Case 6, we have a assumption that Japanese economy go bad to worse. We set wage growth rate at 1.5%, and price growth rate at 1%.

Pension financing will also be hurt if people's distrust in public pension system is propagated, since the increase of people who have signed up but are delinquent in their payments result in the

decrease of pension fund. For this reason, we assume two simulation scenarios (cases) in terms of the propagation of people's distrust in public pension system. The first is the case that people's distrust in public pension system is not propagated (Case 1, 2, 3). The second is the case that people's distrust in public pension system is propagated (Case 4, 5, 6).

By observing the degree of the differences between Case 1, Case 2 and Case 3, we can assess the economic factors involved in the result of simulation. In addition to this, by observing the differences between Case 1 and Case 4, we can also assess the factors that associate with the change of people's thinking or attitude for Japanese public pension system. From Case 4 to 6, the result of simulation tend to be more sensitive to agents' behaviour or their attitude score. That is, the result of simulation is affected a lot by the interaction of agents. To manage these factors, in our simulation, we identify the agent who serves as a network hub, and pick up his (or her) attitude score. By doing this, we can establish a cause for the variation of the result of simulation.

3-2 Execution of Simulation

3-2-1 The balance that Deducts Expenditure from Revenue

In the simulation, data were gathered from 700 turns (steps), i.e., the time series of the balance that deducts expenditure (pension benefit) from revenue (payment of premium) from the start of a simulation until about 60 years are completed. Twenty times simulations were performed in each case and the average and the shape of distribution of their result were used for analysis.

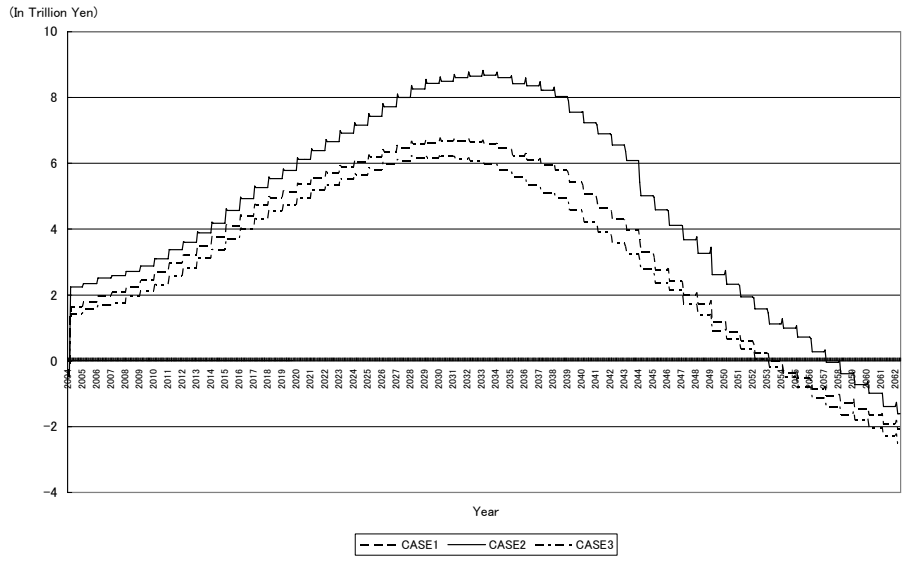


Figure 5 The Balance that Deducts Expenditure from Revenue

The time series of the balance that deducts expenditure from revenue in Case1, 2, and 3 are shown in Figure 5. From Figure 5, we can find the following results. (1) For all cases, pension premium

fund continues to increase monotonically by the year 2030, after that it decreases. (2) It varies widely in response to the change of economic condition. The reason why (1) occurs is that the amount of pension premium come to run short as a result of the acceleration of demographic aging. In addition to this, the reason why (2) occurs is that the amount of pension premium is influenced by the economic condition.

However, the impact of economic factor on the balance that deducts expenditure from revenue is modest at best. The balance that deducts expenditure from revenue becomes negative in 2054 (Case1), 2058 (Case2) and 2052 (Case3). From these results, it is reasonable to suppose that without major improvement in economic condition, Japanese public pension system will collapse. This means that the revision of Japanese public pension system, which government have made in 2004, is inadequate to stabilize the financial resources to fund the pension system.

Having clarified the effect of economic factors on the balance that deducts expenditure from revenue, we will now explain how agent's thinking and attitude for Japanese public pension system affects the amount of the premium and benefit difference.

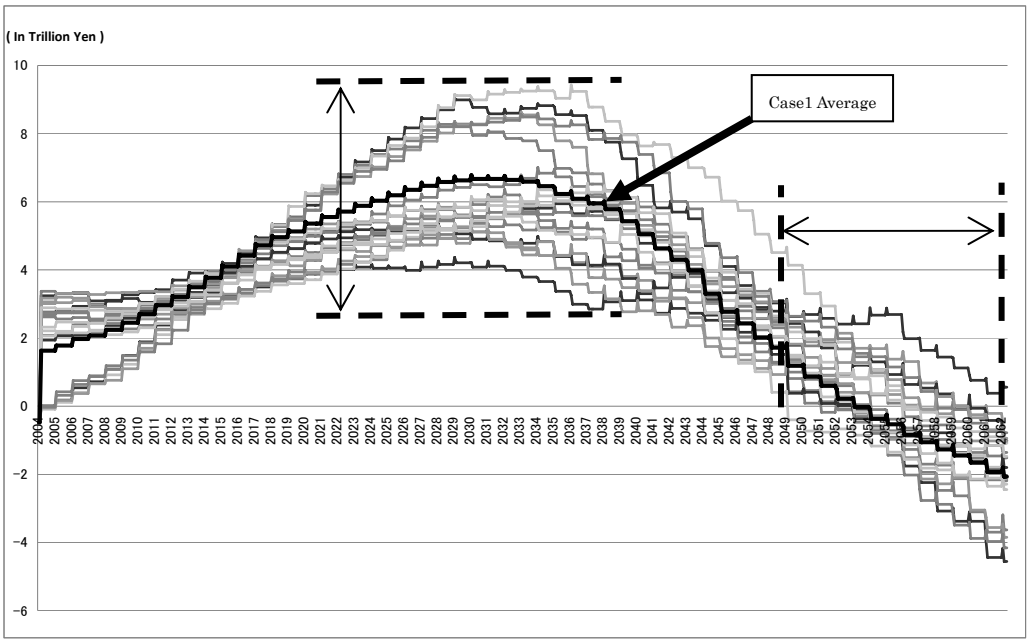


Figure 6　The Comparison between the Average of Case 1 and the Distribution of Case 4

The time series of the balance that deducts expenditure from revenue in Case1 and the range of it in Case 4 are shown in Figure 6. As stated above, the results of simulation tend to be more sensitive to agents' behaviour or their attitude score. That is, it is affected a lot by the interaction of agents. For assessing these factors, in case 4, we will show the shapes of the distributions in themselves. As Figure 6 indicates, we can find that the balance that deducts expenditure from revenue in case 4 take

on a wide range of values. The balance that deducts expenditure from revenue becomes negative are in the range 2049 - 2061.

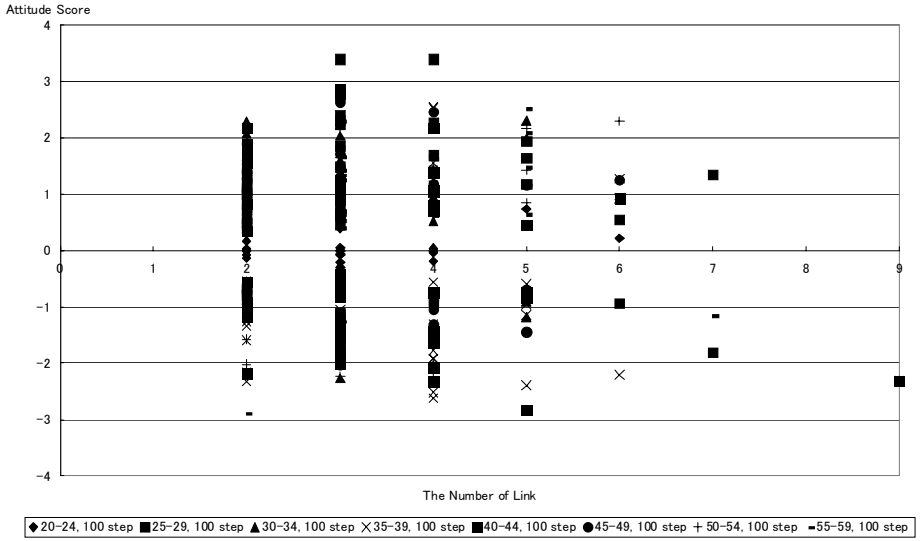
Why does the amount of the premium and benefit difference vary among simulations? Some explanations for this are as follows: (1) The number of agents who have distrust in public pension system and do not pay pension premium become so large that the number of old-age agents without pension benefit also extremely increase. Accordingly, it dose not cause a significant decrease in the financial resource to fund Japanese public pension system. (2)The increases in the number of agents who have distrust in public pension system and do not pay pension premium have direct impact on the financial resource to fund Japanese public pension system. As a result, it causes a significant decrease in the financial resource to fund Japanese public pension system.

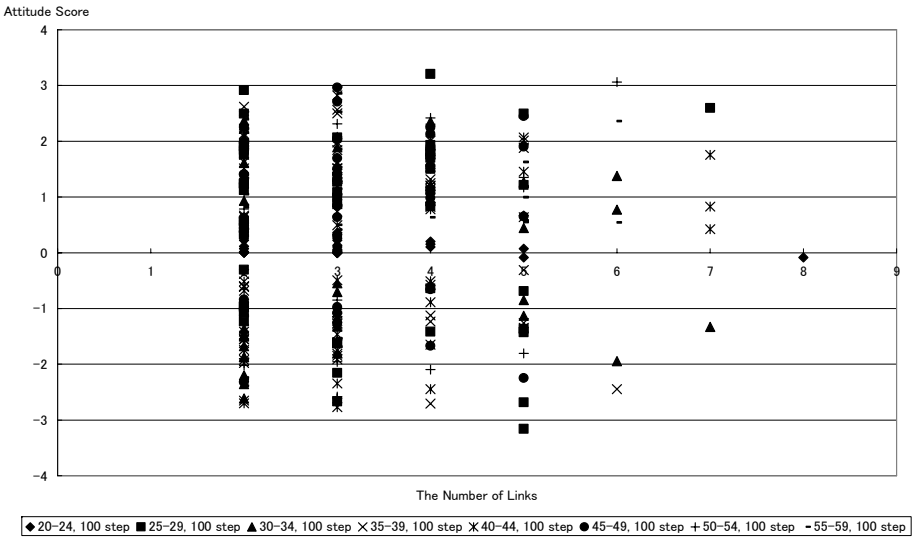
As stated above, there seem to be two interpretations for the variation of simulation results. However, there is no proof that the explanation stated above is correct. Therefore, we would like to take a closer look at the relationships between pension premium fund and agent's attitude.

3-2-2 The Relationships between Pension Premium Fund and Agent's Attitude

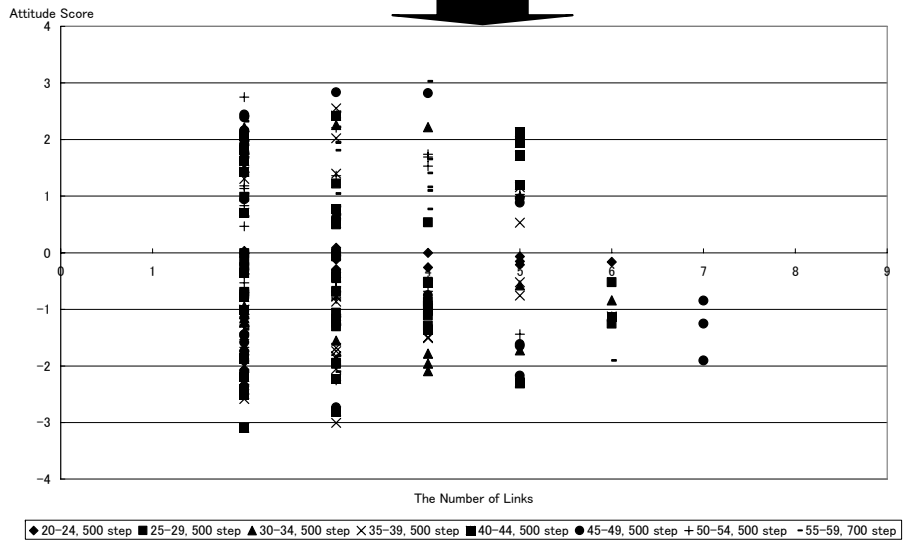
In previous section, we have indicated Figure 6 in which the result of twenty times execution of simulation in Case 4 is drawn. In this section, we would like to pick up two extreme versions in simulation results for answering the question stated above. Two extreme versions of simulation result are "the first trial of simulation" and "the fourth trial of simulation." The former is the case that the amount of pension premium fund extremely small at the end of simulation, the latter is the case that it did not go negative even at the end of simulation. Two extreme versions of simulation result are drawn in Figure 7.

Figure 7　Two Extreme Version of Simulation Result

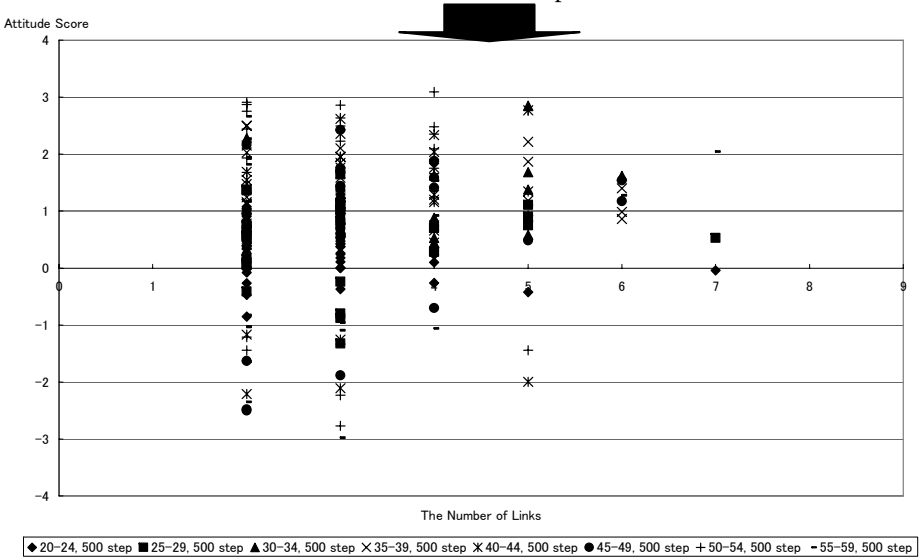




The 100th Step



The 100th Step



The 500th Step

Figure 8-1　The Result of the Fourth Trial of Simulation

The 500th Step

Figure 8-2　The Result of the Fourth Trial of Simulation

In each simulation, what are each agent's network and attitude score like? To analyze these points, we would like to check the relationship between the number of link that each agent have and each agent's attitude score.

The results are shown in Figure 8-1, 8-2. Figure 8-1 and Figure 8-2 are scatter diagrams in which the relationship between each agent's attitude score and the number of link that they have is drawn. The former is the result that is obtained from the first trial of simulation, the latter is the result that is obtained from the fourth trial of simulation.

At the 100th step, the distribution of agent who has negative attitude score is not much difference between Figure 8-1 and Figure 8-2. That is, many agents have distrust in public pension system for the initial period in each simulation. At the 500th step, the number of agent who has negative attitude score increase at the first trial of simulation, while the number of agent whose attitude score is negative falls dramatically at the fourth trial of simulation. In addition to these, at the first trial of simulation, many hub-agents have negative attitude score. The result is contrary to it in the fourth trial of simulation.

From the result of our analysis, an answer to two questions as stated above is that the increases in the number of agents who have distrust in public pension system and do not pay pension premium have direct impact on the financial resource to fund Japanese public pension system. These results clearly show that the propagation of people's distrust in public pension system have a considerable impact on public pension system. In addition to this, the situations, which occur in the first trial of simulation, has a big impact on other social security systems in Japan, i.e. public assistance. Since many people cannot receive pension benefit, they end up on welfare that is financed by tax. The people who pay pension premium faithfully will have a bigger burden, since his (or her) also has increased tax burden in addition to his (or her) premium payment.

4. Conclusion

This paper examined how pension premium fund would change with distrust. From what has been discussed above, we can conclude that people's distrust in public pension system and the propagation of distrust has a decisive influence on the pension premium fund. In addition to this, as in Figure 8-1, 8-2, it is important to recognize that the future of pension system will vary with the difference in the propagation of distrust. That is, the result is subject to people's network and their thinking or attitude for Japanese public pension system. From the political point of view, it seems to be impossible to shut down people's network. However, it might be possible not to spread of the propagation of distrust one way or the other. Although we can change hub-agent's attitude score in simulation, it is almost impossible to identify hub-people and change his (or her) thinking and attitude in reality. Thus, it is needed to design a pension system that is fair and secure for all of people in Japan.

The further direction of this study will be (1) to capture, calculate and analyze “agent’s cluster”, (2) to create agent’s network in accordance with people’s network in real world. By doing (1), we can understand the manner of the propagation of distrust in more detail. Moreover, by doing (2), our simulation model fit in well with real world.

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