Theorizing Corruption

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Abstract

The aim of this paper is to gain the broad explanation of corruption using simple computational model. We elaborated further the model of corruption described previously in Situngkir (2003b), with some additions in model's properties. We performed hundreds of experiments computationally using Swarm and constructed the explanation of corruption based upon these results. We show that corruption should be understood as complex social-phenomena, which relates not only with economical aspect, but also with many other social and anthropological aspects.

Keyword: corruption, agent-based modeling, Swarm, dynamic of corruption.

1. Introduction

Corruption is ubiquitous, especially in the country like Indonesia. This paper contains further elaboration from the one described in Situngkir (2003b) with some additional in model's properties. The aim of the paper is to present broader explanation on corruption through a very simple micro model.

As discussed in Situngkir (2003a) and Situngkir (2003b), according to Gambeta's analytical map of corruption (2000), we use two categorizations on what we call agents: the government (***G***) and the citizen (***P***). The government agent is given trust to manage public services, and the types of corrupt behavior will be related to the interaction between the twos.

In micro situation, the abuse of trust given to government agent, ***G,*** in her service to citizens, ***P***, will compel citizens to pay more (***y***) in order to get her rights as it has been stated literally in the law (***x***), otherwise there will be reduction on what citizens should get.

An act of corruption is then defined by the amount of some currency, say ***b****, received by member of ***G*** as compelled by member of ***G*** or persuaded by the member of ***P***. This will make members of ***G*** abuse the trust they received. We can say that the value of ***b**** to fulfills

$$y + b^* > x$$

This is the value that motivates members of ***G*** to abuse the trust they received. Member of ***P*** can vary the value of ***b*,*** and in return the members of ***G*** obviously can reject the offer because it is too small relative to the cost they will incur by obeying the rule or probably because their integrity: moral values keep them not to abuse the trust. It is important to note that there should be an exchange or agreement between members of ***P*** and ***G*** for each possible corrupt action.

Thus, we build two set of agents, representing members of ***G*** and members of ***P***. Each agent will interact in the trust game based on the pre-defined payoff matrix. The agents will have the neighbors who are chosen randomly from the member of each set. At each round of game, each agent of ***P will*** choose the corruption partner from the collection of members of ***G*** randomly, and will have a payoff based on the action chosen by her and her partner, whether it to corrupt or not corrupt (figure 1). As explained above, corruption itself will occur only when two partnership agents agree to do corrupt.

In the simple model, as adapted from Hammond (2000) to choose whether to corrupt or not to, every agent will consider two subjective considerations, they are:

- Subjective thought whether or not her partner will agree to corrupt in the next round, denoted by F,

$$F = \frac{Match\ corrupt\ partners}{Memory}$$

- Subjective thought whether or not she will be caught, denoted by C,

$$C = \frac{Friends\ in\ jail}{Corrupt\ friends}$$

while the payoff matrix is described in table 1.

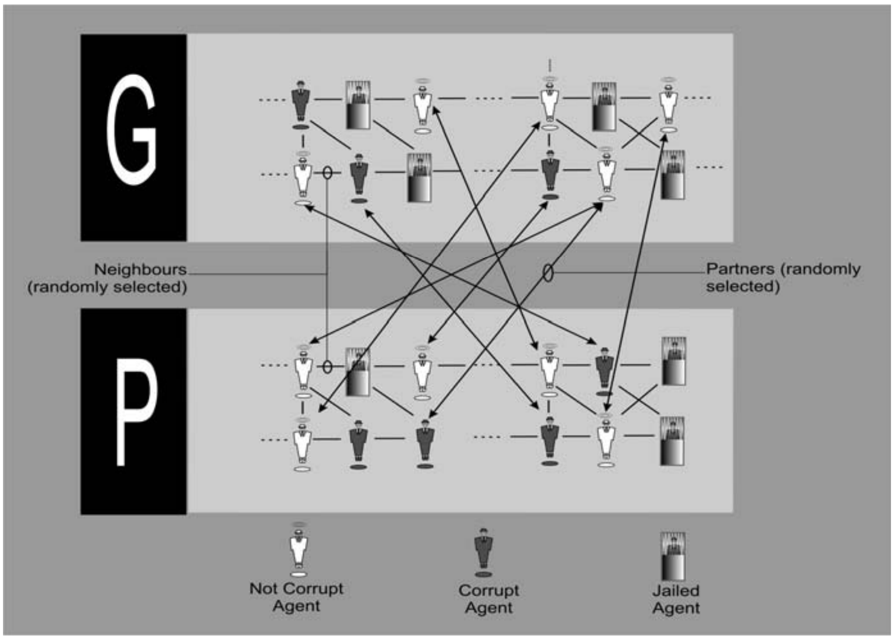

Figure 1
The way the game roles. At initial condition, each agent will choose her neighbors randomly. While each round, the *P* agent will choose different *G* agent as her partner chosen randomly.

Table 1
The Payoff matrix of the Game

	Corrupt	Not-Corrupt
Corrupt	α	β
Not-Corrupt	β	β

In our toy model, we also gave each agent the honesty index, the index depicting how corrupt one to be. Technically, the index is (truncated) Gaussian distributed random numbers, $N\ (0.02, \mu)$ in the interval $[0,1]$. This variable also determines the expectation value of each agent. The closer the index to unity, the greedier the agent be,

$$\alpha^* = (1-i)\alpha$$

where the α^* is the expectation of the corruption, and i is the honesty index.

To evaluate the expectation value of corruption, each agent uses the limited information which constrained by several aspects, including her social network, her memory, etc. The agent never knows and calculates the macro-state of the system. The expectation value of each agent is calculated by evaluating her neighborhood,

- From subjective thought *F,* we can see that each agent will evaluate the possibility that her partners will agree to do corruption. The agent will calculate this possibility by referring to the action of her partners in last rounds (we represent it with the memory of agent with certain length that records the last action of her partners in certain length of rounds). Clearly, the expectation value of corruption is bigger when the agents always interact with the partners who chose corrupt in the previous interactions.

- However, each agent should consider that there is possibility of being caught when she chooses to do corrupt. Each agent will evaluate this possibility by calculating the recent value of *C*. The expectation of the corruption of one agent is bigger, when there are many friends of her doing corrupt but only few go to jail; the smaller of value of *C* the bigger expectation of the agent is.
- Beside that, the agent should also consider that she will lose the not-corrupt payoff (β) for certain of k rounds when she is caught and sentenced into jail. In this case we can consider k as the length of jail term. The agent will consider the possibility of losing this payoff by evaluating how many friends got into jailed when they do corrupt. In other word, the expectation of the agent will also governed by the value of *C* and the jail period (k), the bigger of *C* and k, the smaller expectation of agent.

From the explanation above, we summarize the expectation value of corruption as follows:

$$E(x) = (1-C)\left[F\alpha^* + (1-F)\beta\right] + C(\beta - k\beta)$$

If the expectation $E(x) > \beta$, which means the expectation of the corruption $E(x)$ is bigger than the expectation of not to corrupt (β), then the agent have been greedy enough to do corruption. It is obvious that each agent builds up subjective perspectives on her environment then chooses to corrupt or not-corrupt.

2. CGame – The Swarm Model of Corruption

We use Swarm[*)] as programming language to simulate the model, and then analyze the dynamic and evolutionary process of corruption on various numerical variables and parameters. Swarm is programming language originally written in objective-C. The reason behind the using of Swarm to simulate our model is obvious, for Swarm provided with well organized and structured programming language which also consists of the set of methods that commonly used in agent-based computer model and simulation.

In our Swarm model of corruption – we call it **CGame** – there are two types of Agent**,** i.e. *G-agent* that represent members of ***G*** and *P-agent* that represent members of ***P***. All agents will have a given variables, i.e. the id, randomly distributed of honesty index among agents (Gaussian distribution and truncated Gaussian distributions with certain mean), and her social network.

The *P-agent* following certain rules as their behavior:

- The *P-agent* will choose one of member of un-jailed G-agent as her partner, and make offer to her to do corrupt or not-to-corrupt.
- The *P-Agent* who chooses to corrupt will have the probability of getting busted.
- The *P-agent* will calculate the expectation value based on her subjective thought, honesty index and jail term as described in previous section.
- The *P-agent* changes her choice whether or not to do corruption based on her expectation value.

While the *G-agent* follows certain rules:

[*)] See Luna, et. al (2002), for more examples on Swarm.

- The *G-agent* will interact with *P-Agent* and decides whether or not she agrees to corrupt
- The *G-Agent* who chooses to corrupt will have the probability of getting busted.
- The *G-agent* will calculate the expectation value based on her subjective thought, honesty index and jail term as described in previous section.
- The *G-agent* changes her action, whether or not to do corruption based on her expectation value.

Our model also consists of some global parameters which can be varied for particular simulations; including the initial number of *P-agent* and *G-agent*, the number of social network, the length of memory, the probability to be caught, the length of jail period, the mean of honesty index, and the payoff value of corrupt (α) and the payoff value of not-to-corrupt (β).

One round of the game consists of the following sequential methods or schedules that executed by every agent:

- *makeOffer*, method for every *P-agent* in our system to choose the partner randomly, and then interact with them by making offer to do corrupt. From her interaction the *P-agent* will receive payoff according to her action and her partner's. The action of her partner will also be recorded in her memory.
- *receiveOffer*, method for every *G-agent* to receive an offer from *P-agent*, and decide to agree or not to do corrupt, and then receive payoff. The agents also record the action of her *P* partner on her memory.
- *calcultatedCorruptFriend*, method for every agent to calculate how many corrupt agents in her social network.
- *sendAgentToJail*, method that make every corrupt agents (both of *P-agents* or *G-agents*) have the probability of being caught. The jailed agent should be removed from game for a certain rounds (k) and cannot make an offer or receive it. Furthermore, along the jail term, she does not receive any pay-off.
- *calculateExpectation*, method for every agent to calculate her expectation value of the corruption
- *changeTheAction*, method for every agent to choose whether or not she corrupt based on the expectation value she has.

With the ingredients of methods above, we observe and analyze the result of simulation as the macro properties of the system, including the number of corrupt agents at each round, the number of corrupt actions (both of partnership agents agree to corrupt), and the average number of the corrupt agent and corrupt action after 1000 rounds. We vary the variable of simulation to analyze what kind of structure that emerges from particular properties of the agent. We summarize the result of the simulation in the next section.

3. Dynamics of Corruption in CGame – Theorizing Corruption

We do a lot of simulations by modifying the respective numerical variables and parameters. It should also be noted that the modification we do is based on the structures and structural alternative solutions that frequently used to solve and handle the corruption in practice. Simply, the aim of our experiments is to see how the social system of corruption getting its stable macro-state. We are also interested in analyzing how the particular properties and behaviors at micro (individual) level emerging particular macro properties of corruption on social system. Furthermore, we summarize the social theory of corruption based on the result of simulation, and finding several dominant aspects that affecting the corrupt behavior.

a. The law enforcement as one of the solution to combat corruption

In the first simulation, we would like to see how the effect of heavy punishment on the caught corrupt acts. We do this based on the common thinking that corruption could be solved with such shock therapy. The result of our series of experiments is showed in figure 3. Apparently the result of the simulation has proved this proposition. When the jail period is made longer, the average of corrupt action is smaller. In other words, the heavier the given punishment will bring big impact on the reduction of corrupt actions.

Here we do simulations with two scenarios: the big punishment to *P-Agent* and G-Agent distinctly. In the first scenario, the decreasing of the average number of corrupt *P-agent* has not been followed yet by the decreasing of the average number of corrupt *G-agent*. The average number of corrupt *G-agent* did not decrease drastically as the corrupt *P-agent* decreasing fast. The fact can easily be understood since the lower jail period of *G-agent* has made the *G-agent* still choose to corrupt. The minimum punishment has made the payoff being corrupt is more tempting than not-to-corrupt. In turn, as we can see in figure 2, with the dominance of corrupt *G-agent* in the system, the corrupt action still occur in small numbers, even when we performed longer jail period to the corrupt *P-agent*. This fact shows us that to combat corrupt behavior is not enough merely just by giving the "shock therapy" to corrupt citizens in the form of strict enforcement of law, while in other side there is not enough punishment to the corrupt government. The corrupt government can attract the citizen to do corruption. This also concludes the common thinking that corrupt government will induce the citizens to corrupt.

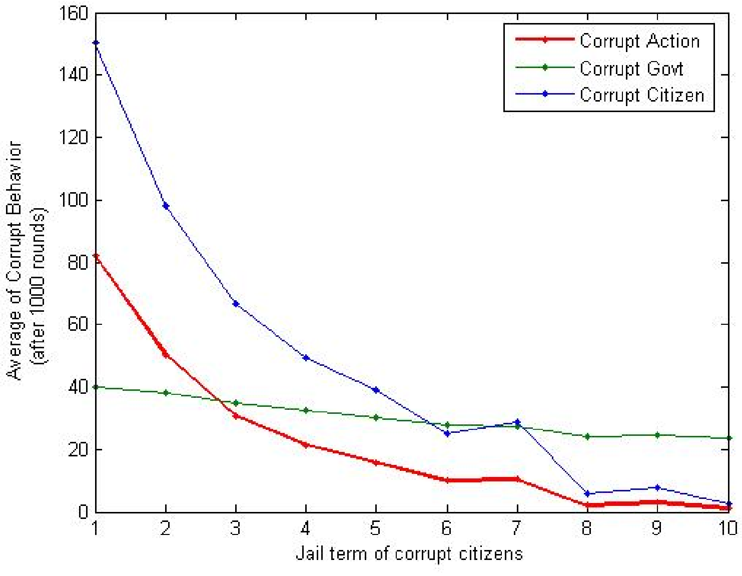

Figure 2

The effect of jail term of corrupt citizen to the corrupt behavior.

The second simulation showed the alteration of jail period of corrupt government that affects the corrupt action occurred in the system, we have found different result. As we can see from the figure 3, the average number of corrupt *G-agent* decrease drastically at even shorter of jail period relative to the previous one, which in turn will make the average number of corrupt actions also decrease drastically.

By comparing the result in figure 2 and figure 3, we can see that the increasing of jail period in both kinds of agent will decrease the average of corrupt action significantly, but computationally, each of these has different result, especially when we compare the effectiveness of the solution to solve the corruption. The longer jail period to the population of governmental bureaucrats will make corrupt action decreased more significant than when applied to the population of citizen. However, we should note that the strict enforcement of law should be performed proportionally regarding to the both types of agent, since we found that one of the population of corrupt agents, be it bureaucrats or citizens, could be still dominant if we perform the heavy punishment mere on only one side of the populations.

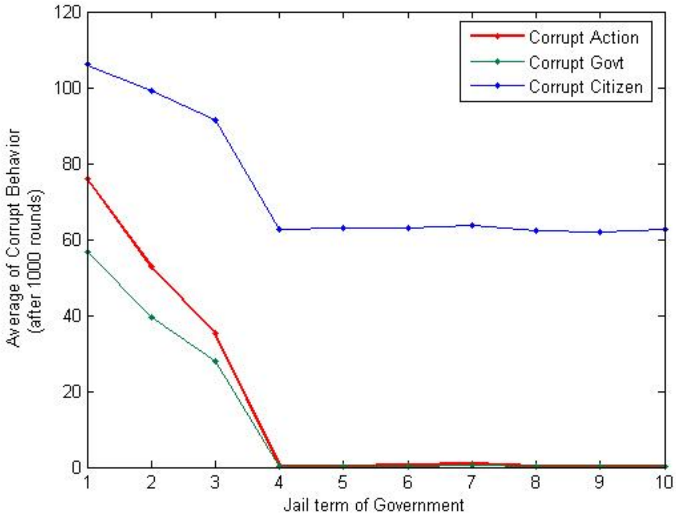

Figure 3

The effect of the jail term period of corrupt Government to the corrupt behavior.

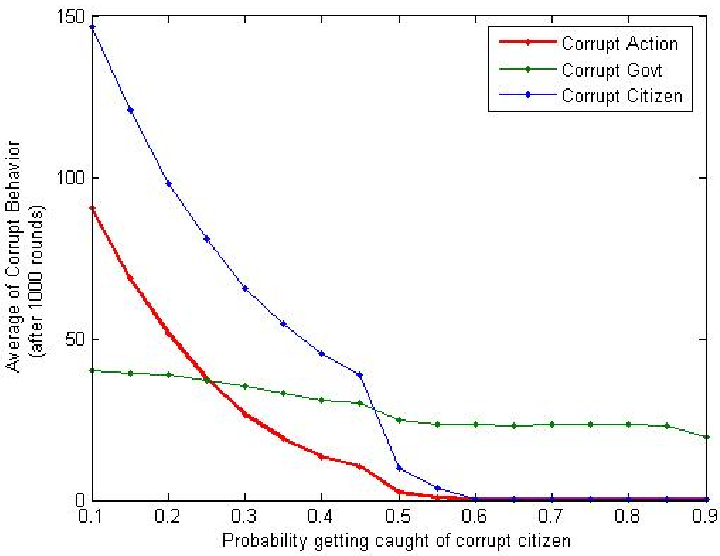

Figure 4

The effect probability of being caught for corrupt citizen on corrupt behavior

Another aspect that has been believed by common people as alternative solution to solve the corruption is the high discipline of highest authority or law officer to taking care the law-enforcement among government and citizen. The corrupt people, be it government or citizens must be captured and sentenced to jail regarding to the rule of law, no matter how heavy the punishment is according to the legal aspects. In our simulation, we vary the probability being caught of corrupt agent to show how this aspect can affect the behavior of corruption in the system. The result of simulation can be seen in figure 3. From this figure we can see that the average number of corrupt actions in the system decrease significantly when the probability to be caught of corrupt agent is high enough. When we look in detail to the dynamic of system as we can see in figure 5, the system with probability being caught of the corrupt agent is high enough are characterized with the fast transition from the corrupt regime to not-corrupt regime. This fact shows us that in order to combat corruption, it is important for the highest authority to keep the law works well among the population of governmental bureaucracy and citizen. It will force the system to change endogenously to not-corrupt regime.

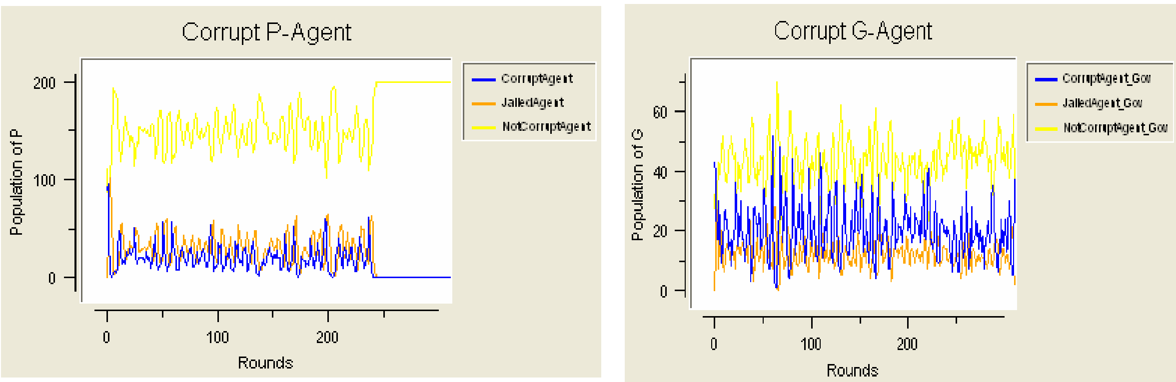

Figure 5
The system tends to change endogenously to the not-corrupt regime when the probability being caught is high enough

From the simulation results explained above, we can see that the law-enforcement regarding to the all population of bureaucracy and citizen can be used as solution to combat corruption. We can also note that the law-enforcement must be performed in all aspects, including the rising of the discipline of the highest authority or law officer to keep the law works well without discrimination whether to citizen or government, and also performing the strict punishment proportionally to all corrupt government and citizen.

Another interesting fact that we found here is that the law enforcement cannot stop the motivation to be a corrupt agent but definitely important to reduce the successful corrupt action solicited among agents. The effort to corrupt will surely persistent, but the law enforcement reduces one successfully done.

b. Managing the individual integrity/morality to resolve the corruption

There is alternative solution proposed by commonsensical thoughts that corruption could be solved completely if every people on the system turn to be honest. Practically, this solution manifests into several methods such as moral campaign, or similar action that commonly relates with belief or religious aspect among people. In order to see how the effect of such solution on the corruption system, and to prove whether or not the assumption is true, we do several simulations by varying the mean of honesty index of the agent from zero to unity. We can see the result of simulation in the figure 6. From this figure, we can see that the corrupt action on system is decreasing when the mean of honesty index of the agent closer to unity. However, the corrupt action still occurs even when the mean of honesty index equal to unity. From the simulation result, we can also see that the bigger of mean honesty index will not make both of *P-agent* and agent *G-agent* turns to be not-corrupt agents completely; they still choose to do corrupt. This fact shows us that to combat the corruption is almost never sufficient merely by increasing the morality or integrity of the people. Corruption can occur when its payoff is tempting enough; while in the other side, there is no real mechanism of punishment to the corrupt people, in the form of law-enforcement. The corrupt action could be not changing significantly by mere campaign the people to be not-corrupt agents without implementing law-enforcement.

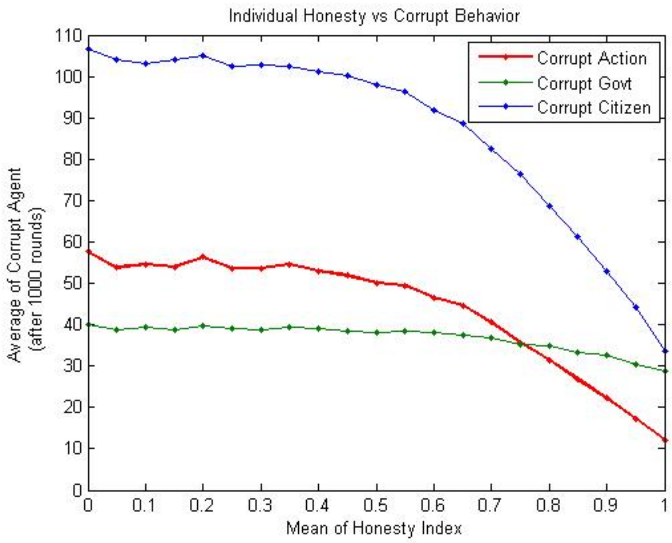

Figure 6

The corrupt behavior of the system on the various mean of honesty index

c. The Effect social network on Corrupt Behavior

The social network size of agent will reflect how much information in the surroundings could be gained by the agent. It also reflects indirectly the level of the democratization in our social system for the assumption that the more democratic the social system is, the more information about other agents can be gained by social agents.

There is an opinion on some people that transparency and accountability of the government will reduce the corruption as well. In our simulation for varied government social network sizes – as we can see in figure 7a – the result shows us very interesting properties for there are stable corrupt regime when social network is consisted of 2 up to 7 agents. Furthermore, if we add bigger social network size, the average number of corrupt actions, corrupt government and corrupt citizens decrease fast. In the other hand, in simulation with varied social network sizes among citizens, the stable corrupt regime dominated when their sizes consisted between 2 to 10 agents. This is also followed by the fast decaying in overall corrupt behavior when we add more social network size on each agent.

This shows us that there is a kind of transition as the social network size grows, be it among bureaucrats or citizens. As introduced before, the social network size is related to the level of ability to gain information about his surroundings as broad as possible and that in governmental system practically this can be seen as the level of democratization in the social system. Thus, there are some points that social network sizes do not give any influence to the anti-corruption efforts, or in other words, there is a non-linear relatedness between the democratization with the corrupt activities in social system. However, to be sure, it is obvious that greater level of democratization must have played an important role in the struggle against corruption. As the level of democratization reach a certain point, the effect of democratization on corruption will be discovered significantly.

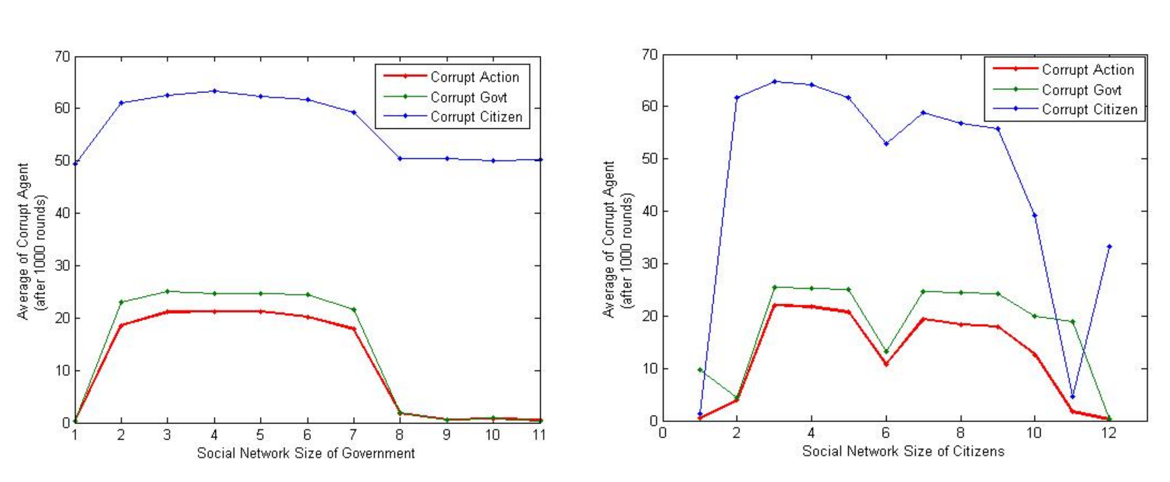

Figure 7

The effect of social network size on the behavior of corruption.

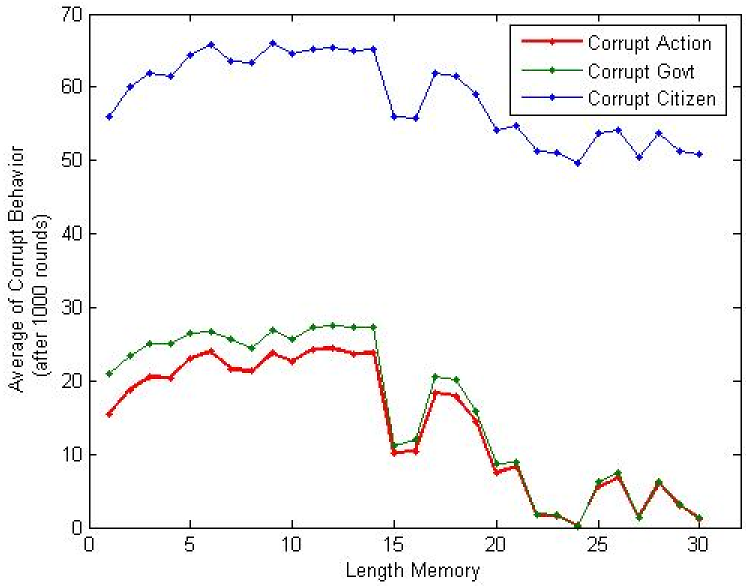

Figure 8

The effect of various length memories to the average of corrupt behavior

d. The effect of the length memory of agent to corrupt behavior of the system

In this last experiment, we would check how the effect of the memory length of agent could affect the dynamic of corruption in our artificial system. As we see in figure 8, we found a very interesting result. The growing memory of agents shows the decreasing of corrupt actions gradually. If we assume that the memory is the way an agent put in to account the information she has got from previous interaction, we can say that the more agents use information as valuable thing to be used to make up her decisions, the more corruption cannot be persistent in the whole society. From the result we also found that tendencies to corrupt are actually still high among citizens, but the successful corrupt action is diminishing as the memory grows.

4. Concluding remarks

Corruption is one of the complex phenomena in our social system which should not merely be related with economical aspect, but with many other social and anthropological aspects. In general, corruption is defined as the abusing of authority and power trusted to someone to gain self-benefit solicited by third party pursuing benefit from it. In our model, the process of corruption involves two interacting agents, i.e. the trusted agents and the agents who try to attract trusted agent to abuse the trust.

We have built agent-based model of corruption to capture the dynamics of corruption in social system, since the corruption phenomena itself can be seen as the macro-structure that is emerged by simple interaction among individual with particular properties at the micro level. By the computational simulation experiment, we have shown and tested some commonsensical hypothesis about corruption and how to reduce it in society. Here, we see that corruption cannot be seen mono-dimensionally. The root of corruption lies upon many social aspects, including political, economical and cultural aspects. In return, to combat corruption, we should arrange comprehensive strategies which also involving many fields of discourse. Again, it is obvious that corruption is an interdisciplinary of discussion.

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APPENDIX

List of Variables used in the simulation as shown in figures in the paper

Figure	Variables	Value
Figure 2	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	5
	Number Of Citizen Social Network	5
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	2
	Length Of Jail Period of Citizen	Varied from 0 to10 with interval 1
	Probability being caught of Government	0.2
	Probability being caught of Citizen	0.2
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	0.5
Figure 3	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	5
	Number Of Citizen Social Network	5
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	Varied from 0 to10 with interval 1
	Length Of Jail Period of Citizen	2
	Probability being caught of Government	0.2
	Probability being caught of Citizen	0.2
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	0.5
Figure 4	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	5
	Number Of Citizen Social Network	5
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	3
	Length Of Jail Period of Citizen	3
	Probability being caught of Government	0.2
	Probability being caught of Citizen	Varied from 0.0 to 1 with interval 0.1
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	0.5
Figure 5	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	5
	Number Of Citizen Social Network	5
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	3
	Length Of Jail Period of Citizen	3
	Probability being caught of Government	0.2
	Probability being caught of Citizen	0.5
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	Varied from 0.0 to 1 with interval 0.1

Figure 6	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	5
	Number Of Citizen Social Network	5
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	3
	Length Of Jail Period of Citizen	3
	Probability being caught of Government	0.2
	Probability being caught of Citizen	0.3
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	0.5
Figure 7a	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	Varied from 0 to 11 with interval 1
	Number Of Citizen Social Network	5
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	3
	Length Of Jail Period of Citizen	3
	Probability being caught of Government	0.2
	Probability being caught of Citizen	0.5
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	0.5
Figure 7b	Number of Government	75
	Number of Citizen	200
	Number Of Government Social Network	5
	Number Of Citizen Social Network	Varied from 0 to 12 with interval 1
	Memory Size of Government	3
	Memory Size of Citizen	3
	Length Of Jail Period of Government	3
	Length Of Jail Period of Citizen	3
	Probability being caught of Government	0.2
	Probability being caught of Citizen	0.5
	Payoff Not Corrupt	1.0
	Payoff To Be Corruption	20.0
	Mean of Distribution of Honesty Index	0.5