

Dynamics of the Silence of Majority from the Perspective of Social Dilemma

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Abstract. While previous researches have explained the silence of majority from the perspective of erroneous perception of being majority, this study regarded it as the result of strategic interactions between agents concerning willingness to express opinion. The social dilemma was used to describe it in that there is conflict between individual interest of not expressing and collective interest of being majority by expressing. An agent-based model has been built to explore the conditions and dynamics of the silence of majority. As a result, this study showed that the relationship between the payoff of being majority and that of keeping silent is crucial in the dynamics of the silence of majority.

Keywords: Silence of majority; Willingness to express; Social dilemma; Evolutionary game theory, Agent-based modeling; Opinion dynamics

1 Introduction

To have an opinion is one and to express it is another, thus the willingness to express opinion has been one of the key topics in public opinion research. First of all, the content of opinion has been identified as one of the key factors of opinion expression. Since people are reluctant to become the person who conveys bad news, they tend not to express negative news or opinions [1]. This is especially the case in upward communication in the organizations [2]. Also, the perceived environmental context is another factor of willingness to express opinion. More favorable context is better for opinion expression [3], especially in the organizations where the supervisor is approachable and responsive [4]. And who are the reference group [5] and whether the communication is face-to-face or computer-mediated [6] are included in the context factors. Third, the anticipated consequences of opinion expression can influence the willingness to express [7] in that this anticipation can function as the self-monitoring [8]. Based on these various considerations, individuals may decide whether to express their opinions or not.

The reason this willingness to express is crucial in public opinion is that what the people really think is sometimes different from what the people seem

to think apparently. Thus, in order to further understand the public opinion, we should pay attention to the unexpressed opinions as well as expressed one and why people do not express their opinions. It is particularly important when the unexpressed opinion is majority actually so that the majority-minority relationship is reversed in expressed opinions. This is so called the ‘silence of majority’ and this may lead to either desirable or undesirable social outcome. The aim of this study is to find out the conditions that may lead to the silence of majority and with what dynamics it occurs.

2 Theoretical Backgrounds

2.1 Silence of Majority

Most of previous researches explained it from the perspective of erroneous perception of being whether majority or minority. The *spiral of silence* [7] is one of the most widely used theory in explaining that phenomenon. It assumed that the fear of isolation is one of the strongest factors of the willingness to express opinion so people tend to keep silent when they perceive their own opinion belongs to the minority. The point is that the perception is more critical than they really are. For instance, although some people’s opinion is shared among majority of people in society, they think themselves as minority and do not speak up when the mass media says in the opposite. The silence of majority may occur due to this collective misperception, and it was identified by Noelle-Neumann [7](p.46) herself as one of the possible consequences of spiral of silence.

Similar explanation has been provided by theory of *pluralistic ignorance* [9]. The term was used to name the phenomenon of “widespread conformity to social norms in the absence of widespread private support” [10](p.298). Like the spiral of silence theory, it is about the erroneous perception of other people in the group that they would share, receive, or be influenced by some opinion while the self would not. Thus some socially not-supported action or opinion can be generated or continued when the people in the society have incorrect perception of others’ view on that action or opinion [11]. Due to this reason, the undesirable action is persisted even though the majority does not like that action.

2.2 Strategic Interactions in Willingness to Express Opinion

The spiral of silence theory has been criticized, both theoretically and empirically. The main theoretical critique is that the influence of anonymous people cannot be equal to that of the people who are close or familiar with, and some research have tried to find other factors such as peer group effect [5, 12]; for example, online discussion participants are more influenced by the opinion climate of other participants of the discussion than that of general public [13]. Also, there has been inconsistency in empirical evidence [14]. Some researches suggested that minority opinion upholders sometimes rather actively express their opinions to persuade other people [15]. Concerning the fear of isolation, the key

factor of spiral of silence, some empirical evidences did not support the influence of fear of isolation on willingness to express opinion [16], while others did [6,13].

These critiques lead to the assumption, which is the key of this study, that some strategic interactions would occur in decision making process of whether to express opinion. In other words, people decide (not) to express opinions based on the result of interactions among other people or surrounding environments. As a result, other agents' expressing opinion may influence my willingness to express, and my expressing may influence others' willingness to express [17]. In the same way, being majority may influence the willingness to express opinions, and more expressing opinion may raise the possibility of being majority in expressed opinions.

This dynamic understanding, which is implied in the original work of Noelle-Neumann [7], has been common among many opinion dynamics models which studied the shaping and change of public opinion by local interactions of agents [18–20]. They focused on the way that people influence each other rather than the inherent characteristics of each individual. By that, they tried to show how the global public opinion can emerge from the local interactions of agents. This study also focuses on the strategic interactions among individuals and the consequential opinion dynamics in the group level.

2.3 Social Dilemma and Game Theoretical Approach to Opinion Dynamics

One of the ways that those strategic interactions can be described is social dilemma. The essence of social dilemma can be summarized as the conflict between interests in individual and group level [21, 22]. One action might be beneficial to each individual in the group, but when that action is taken by all individuals nobody can get benefit any more. This study employs social dilemma approach to understand the silence of majority phenomenon. We can consider that having one opinion is beneficial to each individual when that opinion is shared by majority of people in the group. But they are not able to know each other's opinion before expressing externally. Thus, in order to keep majority status and continue to get benefit from being majority, majority opinion upholders need to keep expressing opinion externally as well as to maintain that opinion internally.

The problem is that it takes some costs to express opinion; it can be monetary costs such as using communication media, psychological costs such as concern in disclosing identity or being blamed, or even physical cost such as being arrested or killed in some extreme settings [8]. Since the majority opinion is not majority anymore if everyone with the majority opinion keep silent, each majority opinion upholder should play some role, say, pay the cost of expressing opinions, to keep their majority status. The point here is that individuals should pay some cost to get benefit collectively from being majority while it is beneficial for individuals to avoid paying that cost. The research question of this study is to find out under what conditions the strategy of not expressing is adopted by individuals, so that the silence of majority occurs, and with which dynamics.

This question will be pursued by game theoretical approach in opinion dynamics. There have been critiques to previous opinion dynamics models that they are too simple to fully catch the underlying dynamics in public opinion shaping [23]. To this criticism, some researches have tried to adopt game theoretical approach to include strategic behavior in their models. After two pioneering researches [24,25], several studies have used (evolutionary) game theory to explain various social phenomena related to public opinion [26,27]. Along the line of these researches, this study adopts evolutionary game theory to approach the silence of majority phenomenon from the perspective of the social dilemma problem discussed above. Some strategies on expressing opinion will be presented, and it will be investigated that which behavior between expressing and keeping silent is evolved into dominant one with what dynamics and under what conditions.

3 Model

An agent-based model of the silence of majority was built. The fundamental difference of this model from previous ones is that the agents do not change their opinions; they only make decisions whether or not express their opinions. In other words, the each number of actual upholders of opinion A(majority) and opinion B(minority) is constant and the only change is in the number of upholders who expressed theirs. So even though the real number of upholders of opinion A is greater than that of opinion B, the latter can be shown as the majority when many of the upholders of the former do not express their opinions.

3.1 Agents and Environment

In the model, there are 100×100 patches which represent each agent. Initially, they have random opinion either A(majority) or B(minority), and they are randomly distributed spatially in vertically and horizontally wrapped world. The ratio of majority opinion in the population is one of the parameters in running simulation. Agents also have score(fitness) which represents their relative success after interactions.

3.2 Interaction Rules

Agents have one of four strategies which determines their behavior; 1)Always Silent, 2)Silent when Majority and Express when Minority, 3)Express when Majority and Silent when Minority, and 4)Always Express. In the beginning of simulations, they are in the status of either expressing opinion or keeping silent, which is randomly chosen. Agents observe other agents' expressed opinions in 8 neighboring patches and perceive themselves as majority if the proportion of the same opinion with theirs is greater than 0.5, and as minority otherwise. And they behave(express or keep silent) based on the result of observation and their own strategies. After all agents either express opinion or keep silent, they observe again and figure out the result of their behavior.

After this, they get payoff(score) based on the result of their and neighbors' behaviors. Each agent gets payoff α when their opinion is majority among expressed opinions of 8 neighboring agents, and β when minority. And they δ when they did not. All values are assumed to be greater than 0.

After each interaction, they update their strategies based on their relative success represented by score. Replicator dynamics will be used here. They compare their own score with the average score of other agents with same opinion. If the former is less than the latter, they change their own strategy into the one with the highest score. The bigger the difference, the higher their probability to change their strategy.

3.3 Running Simulations

Various combinations of payoffs, α , β , γ , and δ , represented different conditions in which the interactions would occur. And the varying proportions of majority in the population were used. The basic assumption about the parameters is $\alpha > \beta$ and $\delta > \gamma$, so that the situation is the social dilemma. In each time step, the number of expressed opinions of A and B will be counted, and the opinion reverse, which is the number of expressed opinion B is greater than the number of expressed opinion A, during 500 time steps will also be counted.

4 Results

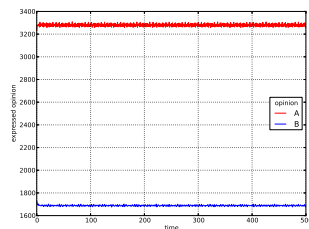


Fig. 1. Typical run when all payoffs are same. $\alpha = \beta = \gamma = \delta = 5$, $majority-proportion = 0.66$.

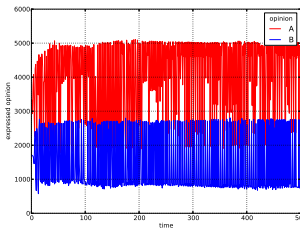


Fig. 2. Typical run when α is greater than other payoffs. $\alpha = 7$, $\beta = \gamma = \delta = 5$, $majority-proportion = 0.66$.

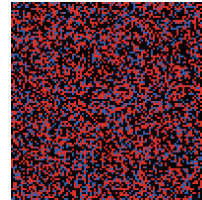


Fig. 3. The spatial distribution of expressed opinions. Red is expressed majority, blue is expressed minority, and black is who didnt expressed.

4.1 Preliminary Runs: Influence of Single Payoff Difference

In order to explore the functions of α and δ respectively, we ran the simulations under the conditions that are inconsistent with the basic assumption of social dilemma situation, $\alpha > \beta$ and $\delta > \gamma$.

First, we set $\alpha = \beta = \delta = \gamma$. Under this condition, there is no considerable change in the number of expressed opinions of majority and minority(Fig.1). Since the payoffs are same, agents have no sufficient reason to change their existing strategies into new ones, so the dynamics showed only tiny oscillations.

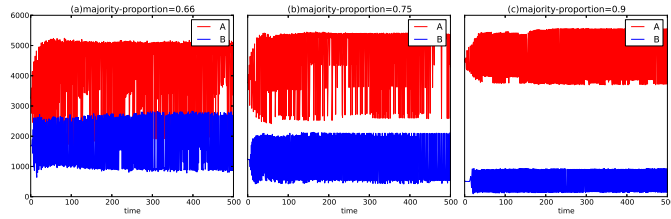


Fig. 4. Typical run of influence of the *majority-proportion*. $\alpha = 7$, $\beta = \gamma = \delta = 5$.

Next, we set $\alpha > \beta = \delta = \gamma$. Fig.2 shows the oscillation of expressed opinions both in majority and minority. This means that the opinion reverse can occur by the payoff difference between majority and minority. In the initial state of the simulation, there exist regions where globally minority opinion is locally majority and minority opinion upholders get payoff of being majority, as shown in Fig.3. Since they should continue to express to keep local majority status, strategy of expression is spread temporarily among minority opinion upholders and this may increase the number of expressed opinions in minority. Since, however, majority opinion upholders are still majority in many other regions, they get payoff of being majority and strategy of expression is spread among majority opinion upholders, so that minority opinion expression is shrank again. Due to this dynamics, oscillations occur both in majority and minority opinion expressions, and opinion reverses take place during those oscillations. This dynamic was basically same when the value of α was increased, and there was no considerable change in the number of opinion reverse as α increased(figure omitted). The *majority-proportion*, however, had influences on the opinion reverse since the overlapped range of oscillations got smaller as the *majority-proportion* got larger(Fig.4).

Finally, we set $\delta > \gamma = \alpha = \beta$. Fig.5 shows the rapid convergence to the strategy of keeping silent both in majority and minority. When converging, some opinion reverses might or might not occur, though not many. Since the payoff of keeping silent is greater than that of expressing and there is no relative advantage of being majority, all agents adopt the strategy of keeping silent. This dynamic was basically same when the value of δ was increased, and there was no considerable change in the number of opinion reverse as the δ increased(figure omitted). The *majority-proportion* had no influence on the opinion reverse since the distance between the trajectories of expressed opinion

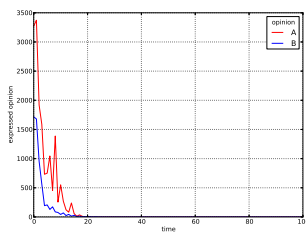


Fig. 5. Typical run when δ is greater than other payoffs. $\delta = 7$, $\alpha = \beta = \gamma = 5$, $\text{majority-proportion} = 0.66$.

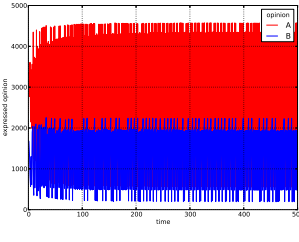


Fig. 6. Typical run when $\alpha > \delta > \beta = \gamma$. $\alpha = 7$, $\delta = 6$, $\beta = \gamma = 5$, $\text{majority-proportion} = 0.66$

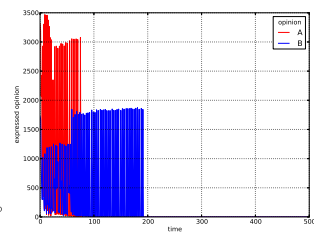


Fig. 7. Typical run when $\alpha = \delta > \beta = \gamma$. $\alpha = \delta = 7$, $\beta = \gamma = 5$, $\text{majority-proportion} = 0.66$

of majority and minority got bigger, so there might be rarer instances of opinion reverse(Fig.8).

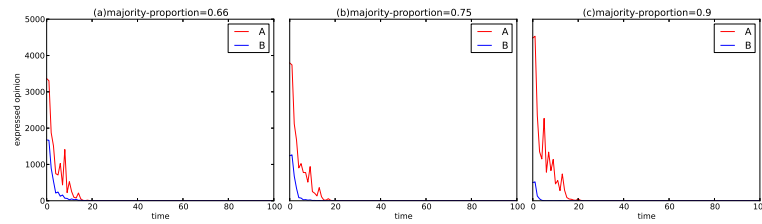


Fig. 8. Typical run of influence of the $\text{majority-proportion}$. $\alpha = \beta = \gamma = 5$, $\delta = 7$.

4.2 Three Dynamics of the silence of majority

In this section, the conditions that meet social dilemma situation were employed to explore the dynamics regarding silence of majority. By large number of simulation runs, three different dynamics were identified as follows.

Oscillation (when the payoff of being majority is greater than that of keeping silent) Similar to Fig.2 in previous section, the number of expressed opinions oscillated both in majority and minority under the condition of $\alpha > \delta > \beta = \gamma$ (Fig.6).

Under this condition, the number of opinion reverse decreased as α increased, and increased as δ increased(Fig.9). This means that the bigger the payoff difference between being majority and keeping silence, the less likely the

silence of majority occurs. The big payoff of being majority can be a good motivation for the majority opinion upholders to express their opinions and to keep their status as majority. That may also motivate minority opinion upholders, but the payoff of keeping silent is greater than that of being minority the strategy of keeping silent are spread among minority opinion upholders. That means the big payoff of being majority cannot be a strong motivation for minorities to express opinions.

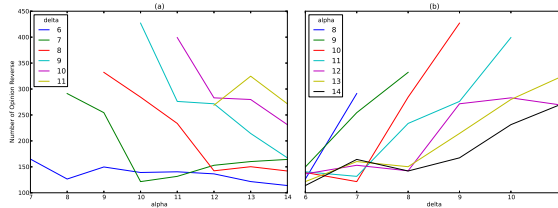


Fig. 9. The influence of α (a) and δ (b). Average of 100 runs. $\beta = \gamma = 5$, $\text{majority-proportion} = 0.66$

To examine the influence of $\text{majority-proportion}$, we ran simulation when it is 0.51(slightly more than the minority), 0.66(two times larger than the minority), 0.75(three time larger than the minority), and 0.9(nine times larger than the minority). As shown in Fig.10, α influenced occurrence of silence of majority only when the $\text{majority-proportion}$ is big enough. Except when $\text{majority-proportion}$ was 0.51, the results of simulation(Fig.10) were consistent with Fig.9, in that the bigger the payoff of being majority, the less likely the opinion reverse occurs.

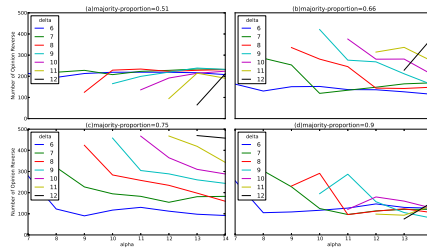


Fig. 10. Influence of $\text{majority-proportion}$. Average of 100 runs. $\beta = \gamma = 5$.

Oscillation and sudden stop (when the payoff of being majority is same with that of keeping silent) Under the condition of $\alpha = \delta$

$> \beta = \gamma$, the dynamics of expressed opinions showed oscillation and sudden stop, as shown in Fig.7. This means that the strategy of keeping silent was suddenly spread in both groups while it differed when it began. Under this condition, the number of opinion reverse decreased as $\alpha(= \delta)$ increased and it converged to specific value(Fig.11).

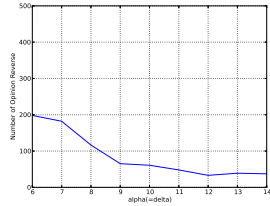


Fig. 11. Influence of $\alpha(= \delta)$. Average of 100 runs. $\beta = \gamma = 5$, $\text{emphmajority-proportion} = 0.66$

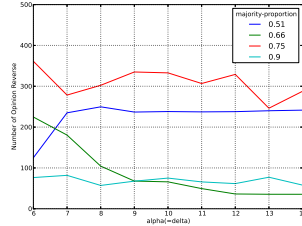


Fig. 12. Influence of $\delta > \alpha > \beta = \gamma = 5$. Average of 100 runs. $\beta = 6$, $\text{emphmajority-proportion} = 0.66$

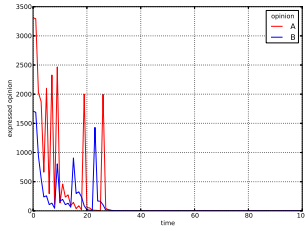


Fig. 13. Typical run when $\delta > \alpha > \beta = \gamma = 5$. $\text{emphmajority-proportion} = 0.66$.

This dynamic was changed when *majority-proportion* was changed. As shown in Fig.12, when *majority-proportion* was too big or too small, the payoff of being majority, which is equal to that of keeping silent, did not have considerable impact on opinion reverse.

Convergence to silence (when the payoff of keeping silent is greater than that of being majority) When $\delta > \alpha > \beta = \gamma$, the number of expressed opinion in both majority and minority quickly converged to zero with small number of oscillations(Fig.13). This means that the strategy of keeping silent spread quickly among both majority and minority. During converging, opinion reverses took place, but not many, as it did in Fig.5.

As shown in Fig.14, the bigger δ was than α , the difference in trajectory got larger, so it was less likely for opinion reverse to occur. And we could see that ,as δ increased, the height of oscillation got higher in majority while it got lower in minority. It means that, before completely converge to silence, the minority got less likely to express and the minority got more likely to express, as the payoff of keeping silent increases.

Under this condition, neither the increase of α nor of δ brought the considerably more opinion reverse(Fig.15). Since δ is bigger than any other payoffs, keeping silent may become dominant strategy in short time. The influence of δ was similar with varying values of *majority-proportion* except when it was 0.51(Fig.16). When the proportion of majority opinion upholders is large

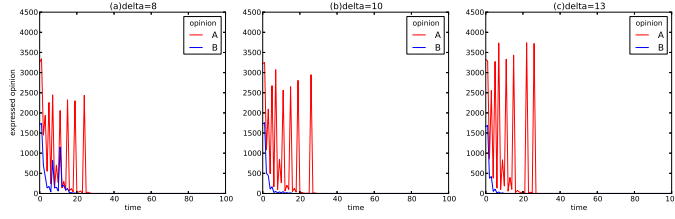


Fig. 14. Typical run when δ increase. $\alpha = 6$, $\beta = \gamma = 5$, $\text{majority-proportion} = 0.66$

enough, the increase of δ did not influence the opinion reverse since keeping silence dominates in short time.

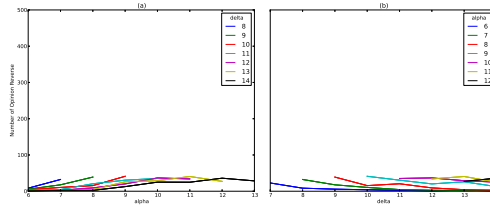


Fig. 15. The influence of α (a) and δ (b). Average of 100 runs. $\beta = \gamma = 5$, $\text{majority-proportion} = 0.66$

5 Discussion

The biggest finding of this study is that the silence of majority can take place by the local interactions of agents. Also, it has been also shown that those local interactions may not be simple mutual effect but strategic interactions that reflect other agents' behaviors. The other big finding is that various social dilemma situation regarding decision making on expressing opinion can produce various opinion dynamics such as oscillation, oscillation and sudden stop, and convergence to silence.

More detailed findings are as follows. The condition that the payoff of being majority is greater than that of keeping silent is better for the silence of majority to occur than the opposite condition in that it leads to the oscillations in expressed opinions in both groups. And, under this condition, it is more likely to occur when the difference between those two parameters are smaller. Also, big payoff of being majority cannot be a strong motivation for minorities to express opinion. Yet this is only the case under the condition that the proportion of the number of majority opinion upholders is large enough.

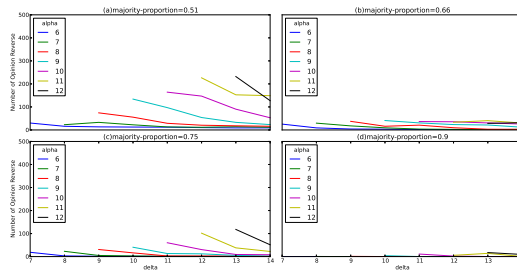


Fig. 16. The influence of *majority-proportion*. Average of 100 runs. $\beta = \gamma = 5$.

When the payoff of keeping silent exceeds that of being majority, the strategy of keeping silent becomes dominant and all agents converge to it in short period of time. But the increasing payoff of keeping silent has different impact on majority and minority. In course of converging to the strategy of silence, increasing payoff of keeping silent brings less expression to minority while more expression to majority.

Under the conditions that the payoff of being majority equals to that of keeping silent, dynamics of oscillation and sudden stop are shown. This means that the strategy of keeping silence is spread suddenly and quickly both in majority and minority. During the time that the majority already converged to silence but the minority did not yet is the time when the silence of majority takes place in abundance.

This study has some limitations. First of all, it lacks spatial aspect of silence of majority. Considering that the ‘hardcore majority’ (Noelle-Neumann, 1974) are tend to get together, how the minority are distributed spatially would influence the dynamics of opinion expression and consequential public opinion shaping. In addition, more explanation on the sudden stop needs to be provided. Some social and psychological factors might function when the payoff of being majority and that of keeping silent are equal. Finally, while this study focused only on whether agents expressed their opinions or not, more detailed analysis can be conducted on the strategies of agents since same behavior of expressing opinion can be the outcome of different strategies.

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Appendix: ODD Protocol

Overview

Purpose The purpose of the model is to find out under what conditions the majority opinion upholders collectively do not express their opinions so that the minority opinion is shown as majority. Also, it tries to show the dynamics that the silence of majority takes place.

Entities, state variables, and scales In the model, there are opinion upholders who are represented as patches. Their locations do not change. They also have opinion, A(majority) or B(minority), which do not change either. The only change is in whether they express their opinion or not. Agents have a variable which they store the proportion of same opinion with themselves among expressed opinions of 8 neighboring patches. If the proportion is greater than 0.5, they think themselves as majority, and minority in the other way around. Agents also have a strategy which determines their expressing behavior. The strategy is one of these; 1)Always Silent, 2)Silent when Majority and Express when Minority, 3)Express when Majority and Silent when Minority, or 4)Always Express. Finally, they have score which represents the relative success in the interactions. The model also has *majority-proportion* which determines how much proportion the majority opinion upholders occupy in the population.

Process overview and scheduling Agents in the model observe the expressed opinions of 8 neighboring patches. And they decide whether to express their opinion based on the result of observation and their own strategies. After that, they observe again. Then they get payoffs according to the behavior and their being majority or not. They get payoff *alpha* when they are majority, *beta* when minority, and also get payoff of *gamma* when they express their opinion, *delta* when keep silent.

After they get payoffs, they update their strategy. They compare their own score and the average score of other agents with same strategy, and change into other strategy if their score is below the average. The bigger the difference between their score and the average, the more likely they change into the strategy with the highest score.

Design Concepts

Basic Principles The willingness to express is the key element considered to approach the silence of majority phenomenon. In contrast to many previous models which pointed out the erroneous perception of being majority as the cause of that phenomenon, this model assumes that there are some strategic interactions in deciding whether to express opinion. Particularly, it focuses on the social dilemma situation, which represented in this model as the conflict between individual interest of keeping silent and group interest of keeping the

majority status by collectively expressing opinions. And evolutionary game theory is adopted in that some strategy is more suited in some environment and it would become dominant strategy in the population.

Emergence The dynamics of expressed opinions show oscillations both in majority and minority when the payoff of being majority is greater than that of keeping silent. The silence of majority occurs during those oscillations. When the payoff of keeping silent is greater than that of being majority, the strategy of keeping silent becomes dominant in short period of time and both majority and minority converge to keeping silent. Yet when the two payoffs are same, other pattern emerges—oscillation and sudden stop.

Adaptation Agents have one of four strategies which determine their behavior of expressing opinion; 1)Always Silent, 2)Silent when Majority and Express when Minority, 3)Express when Majority and Silent when Minority, or 4)Always Express. Based on these strategies and the result of observation on being majority, they make decision whether to express their opinion or not. And they change their strategy after each interaction if their own score is less than the average score of agents with same opinion. The less their own score is, the more likely the change strategy into the one with highest score.

Objectives Agents try to get more score which represents their relative success. The strategy with higher score is adopted by more agents.

Learning Agents change their strategy based on the result of their observation on their being majority in expressed opinions among 8 neighboring patches and their own strategy.

Prediction There is no prediction in the model.

Sensing Agents have status of either expressing opinion or keeping silent and this status can be observed by other agents. In other words, when agents decide to express their opinion, A or B, it is observed by 8 neighboring agents.

Interaction Interactions among agents take place in that they express opinion and observe others' opinions and that they make decision whether to express opinion based on whether being majority and their own strategy. There is also interaction in that they change their strategy into the most successful strategy if their own strategy are worse than average.

Stochasticity The random elements are mainly in initial conditions of agents. Agents have an opinion either A(majority) or B(minority) which are randomly assigned. Also, they initially have random status of either expressing opinion or keeping silent. Their initial strategies are also randomly assigned.

Collectives Agents belong to opinion group, A(majority) or B(minority). This belonging to group influence the opinion dynamics in that they compare their own score only with the agents in the same group.

Observation The total number of expressed opinions of A(majority) and B(minority) is counted to observe the opinion dynamics as a result of interactions. Also, the number of opinion reverse, which is when the number of expressed opinion of B is greater than that of opinion A, is counted during 500 time steps to observe the occurrence of silence of majority.

Details

Initialization In the initial state of the model, the proportion of majority opinion upholders are set by the parameter of majority-proportion. And the payoffs, *alpha*, *beta*, *gamma*, and *delta*, are varying among simulations since they represent the conditions that the agents interact.

Input Data There is no input data in this model.

Submodels There is no submodel in this model.