

**Self-organization and Responsiveness:
A Simulation of Collaborative Governance**

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Abstract

A key issue in the literature on collaborative governance has been the question of how to ensure the responsiveness of the system to the general public interest as well as to specific underrepresented interests. In particular, it is unclear whether or not the self-organizing nature of collaborative governance can serve to enhance the responsiveness of the system. This paper investigated two aspects of responsiveness – global and local – in the context of a self-organizing collaborative governance system by developing a computational model of collaborative governance that focuses on information sharing and coalition formation. Using agent-based modeling, this study generated collaborative governance systems among artificial actors that represented specific constituents and acted according to their goals and their tendency toward collaboration. Mixed results regarding the trade-off between global and local responsiveness were found through the simulation. On average, collaborative actors achieved higher global responsiveness and lower local responsiveness than non-collaborative actors. Furthermore, collaborative actors could better reconcile global and local responsiveness over time. Non-collaborative actors that pursued improvement in local responsiveness ironically ended up enhancing global responsiveness. Actors that pursued improvement in both global and local responsiveness were least successful in achieving their goals. Based on the results of the simulation, six propositions regarding responsiveness in self-organizing collaborative governance systems are proposed.

Self-organization and Responsiveness: A Simulation of Collaborative Governance

Collaborative governance has become an emerging research interest in recent years (Bryson, Crosby, & Stone, 2006; Cooper, Bryer, & Meek, 2006; McGuire, 2006; O'Leary, Gerard, & Bingham, 2006). The notion of collaborative governance generally refers to groups of stakeholders, usually from multiple sectors, who work together to develop and implement policies that are more responsive to the needs or interests of those stakeholders than is typical of those achieved through top-down approaches to policy formulation. The major merits of collaborative governance frequently identified include broader participation, more deliberation, mutually beneficial conflict resolution, trust-building among participants, and better balance among diverse interests (Bogason & Musso, 2006; Booher, 2004; Fung & Wright, 2003). Compared to traditional government management, in which participation is mobilized by governmental entities and the decision-making process is predetermined by rules and regulations in a top-down manner, the process of public decision-making in collaborative governance is self-regulating in nature (Folke, Hahn, Olsson, & Norberg, 2005).

A critical issue in the literature on collaborative governance has been the question of how to ensure the responsiveness of the system to the general public interest as well as to specific underrepresented interests (Beierle & Konisky, 2001; Bryson, Cunningham, & Lokkesmoe, 2002; Vigoda, 2002). In particular, it is unclear whether or not the self-organizing nature of collaborative governance can help to enhance the responsiveness of the system. This issue has not been adequately addressed in part because there is no agreement on the appropriate subjects and objects of responsiveness (Saltzstein, 1992). In collaborative governance, it is important to clarify to whom the system is to be responsive or accountable (Bryson et al., 2002). While

government ideally should be responsive to the general public, participants in a collaborative governance system typically represent different sets of constituents. Pressures to respond to the narrow interests of represented constituents often hinder participants from acting in the collective interest, even when such collaboration could help generate better outcomes at the overall system level. In sum, whether a self-organizing collaborative governance system harnesses higher responsiveness to the general public, specific constituents, or both, is an open question.

The purpose of this paper is to investigate these two aspects of responsiveness in the context of a self-organizing collaborative governance system. By developing a computational model of collaborative governance that focuses on information sharing and coalition formation, we explore the extent to which these systems are conducive to generating responsiveness to the general public as well as to particular constituents. The research question addressed through the model is whether participants in collaborative governance can reach collective decisions while reconciling the conflict between responsiveness to the constituents they represent and responsiveness to the general public. Drawing on literature that specifies characteristics of collaborate governance systems, this study aims to develop a computational model that is based on the self-organization of actors with different goals and tendencies toward collaboration, and to examine the performance of the system in terms of its responsiveness to particular sets of constituents as well as to the overall population of constituents.

In the next section, we summarize relevant literature on collaborative governance to establish the conceptual foundations of a computational model of collaborative governance and address the relationship between global and local responsiveness. In the methods section, details of the simulation are described, and the results of simulations under different starting conditions

are presented in the subsequent section. In the last section, we discuss some implications of the results and offer propositions for theory building about collaborative governance.

Conceptual Foundations

To address the above research question, this study developed a computational agent-based model of collaborative governance that incorporates theoretical components identified in the collaborative governance literature. From the perspective of agent-based modeling, the starting point is to clarify agents' characteristics and their rules of interaction (Arrow, McGrath, & Berdahl, 2000; Epstein, 2006). Global variables of interest emerge from the local behaviors of the agents (Lomi & Larsen, 1996). To help specify the conceptual foundation of the computational model, common features of collaborative governance systems, i.e. basic building blocks suggested by the literature, are identified below. We then turn to a discussion of the relationship between global and local responsiveness.

Features of Collaborative Governance

Based on a comprehensive review of literature on collaborative governance, Ansell and Gash (2008) define collaborative governance as a “governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets” (544). From this literature, some common features of collaborative governance can be identified. To begin, collaborative governance is a collective decision-making process. Participants in collaborative governance are endowed with substantive authority to make collective decisions. Ansell and Gash (2008) point out that participation without decision-making authority is not collaborative governance but simply consultation or a

hearing. At the same time, collaborative governance is a deliberative process (Bouwen & Taillieu, 2004; Dryzek, 2000). Behavioral manifestations of deliberation are that participants share their knowledge and information, they consider all the information available before reaching a collective conclusion, and all opinions are considered equally important (Beierle & Konisky, 2001). Thus, a computational model should incorporate the idea that collaborative governance is a deliberative process among participants that includes information sharing, comprehension of the information available, and equal consideration of participants' opinions, resulting in a shared understanding or mental model of the needs of the constituency (Klimoski & Mohammed, 1994).

In collaborative governance, participation of as many diverse actors as possible is crucial (Bryson et al., 2002). Because collaborative governance is a decision-making process, it is important to involve stakeholders whose interests will be affected by the decision the system makes. Diverse actors may bring with them different sets of knowledge and information, which can allow the actors to reach a decision more responsive to the public through a process of social learning (Blatner, Carroll, Daniels, & Walker, 2001). Because collaborative governance usually involves various actors from the private, public, and nonprofit sectors, it is important to recognize and incorporate the heterogeneity of local actors. For example, Bryson et al. (2002), in their case study of the African American Men Project of Hennepin County, Minnesota, identified more than thirty participants in the process, whose goals, resources, and willingness to participate in the process were diverse. Thus, the properties of agents in the computational model should reflect the heterogeneity of actors in terms of the political philosophy or policy preferences they advocate, the information they possess, and their tendency toward collaboration.

First, collaborative governance usually incorporates diverse, even conflicting, policy preferences in the process of deliberation. Local actors at the table may differ in terms of the constituents they represent and the policy preferences they advocate. Because a government policy is usually multidimensional in that the policy prescribes actions that may affect different aspects of social life, participants may also differ in the dimensions of the policy they are interested in. For example, some actors may have only a broad opinion about health care reform while other actors may focus on specific aspects of the health care system such as funding of public hospitals or immunization services. To reflect this idea, a computational model of collaborative governance should incorporate heterogeneity of local actors in terms of their constituencies and policy preferences.

Second, as shown in the study of collaborative water policy making that includes the San Francisco Estuary Project, the CALFED Bay-Delta Program and the Sacramento Area Water Forum (Connick & Innes, 2003), participants from government and nonprofit organizations come to the table with different expertise regarding the pertinent policy issue. In spite of a concern about the erosion of professionalism due to involvement of outside, nonprofessional stakeholders in bureaucratic decision processes (Rourke, 1992), studies of collaborative governance have recognized that the social intelligence needed to solve wicked problems (Roberts, 2000) is distributed among diverse actors in the policy arena (Connick & Innes, 2003), such that their participation is indispensable for information purposes (Booher & Innes, 2002). Information asymmetry among actors who possess unique local knowledge about the facts pertinent to the policy issue is a critical factor that determines the quality of collective deliberation (Beierle & Konisky, 2000; Bouwen & Taillieu, 2004). Homogenous information generally shared by participants does not add much value to the deliberation process, as is found

in strong tie networks (Granovetter, 1973) or group decision-making processes (Stasser & Titus, 2003). Ultimately, information diversity and asymmetry is one of the major virtues of collaborative governance. Thus, a computational model of collaborative governance should include actors that are heterogeneous in terms of the information and knowledge they possess.

Third, participants in collaborative governance may not always be equally collaborative. That is, they are heterogeneous in terms of their tendency toward collaboration. Many preconditions can affect actors' tendency to collaborate with each other at the beginning of the process, and this property may in turn be sensitive to their actual collaborative experiences. Furthermore, preconditions of participation at the initial stage of collaborative governance, such as the prehistory of cooperation or conflict among actors and incentives for participation, may vary across issues (Ansell & Gash, 2008). However, the tendency toward collaboration can also be an inherent property of the actors themselves. This property can be conceived as being composed of two elements, namely, activity to contact other actors and tolerance of heterogeneous actors. If actors are not very motivated to interact with other actors, or not very tolerant of other actors different from them in terms of their policy preferences, the inclusiveness of the collaborative governance system may be limited. A computational model of collaborative governance should therefore incorporate heterogeneous actors in terms of their tendency toward collaboration, which in turn reflects their level of activity and tolerance.

In addition to the above properties, actors in a collaborative governance system develop a "model of anticipation" (Holland, 1995) that describes the relationship between behaviors they take and rewards they receive, which enables them to pursue their goals through adaptation to environmental circumstances. Ansell and Gash (2008) identified three collaborative processes – trust building, shared understanding, and commitment to the process – that can be interpreted as

learning mechanisms used by participants in collaborative governance. Trust building is a process of learning with whom to work in the future in order to accomplish goals associated with participation in collaborative governance. Shared understanding implies a process of deliberation and development of a shared mental model regarding the policy issue. Commitment reflects a process of adapting the level of devotion to the collaborative governance system based on the benefits of participating in the system. A computational model of collaborative governance should incorporate learning mechanisms used by actors for the purposes of updating their history, collective deliberation, and changing collaborative strategy.

Global and Local Responsiveness

Responsiveness is one of the values to be pursued in public administration in a democratic society, along with effectiveness, efficiency, equity, accountability, and responsibility (Stivers, 1994; Vigoda, 2000). According to Vigoda (2002: 529), responsiveness implies that public servants are sensitive to their duties and committed to serving citizens. Accuracy, i.e., the degree of fit between citizens' needs and service providers' responses, and timeliness have been suggested as two indicators of responsiveness (Thomas & Palfrey, 1996; Vigoda, 2002).

In collaborative governance, responsiveness may be one of the most important criteria by which to judge a system's performance, because citizens are less dependent on the legislative process and public administration is more directly involved in the policy-making process. Because decision-making authority in collaborative governance is distributed among participants, it is not an exclusive function of government to ensure system responsiveness. Rather, as suggested by complexity theory (Connick & Innes, 2003), the responsiveness of the system as a

whole is an emergent phenomenon derived from the behavior of interconnected actors who try to achieve their own goals (Levinthal, 1997). In other words, individual actors' actions may affect the system's overall responsiveness, but the level of responsiveness may not be attributable to specific actors (Arrow et al., 2000).

Of the various difficulties associated with the concept of responsiveness (Saltzstein, 1992), one problem is the challenge of clearly defining to whom a governance system should be responsive. On one hand, interest groups who are participating in collaborative governance on behalf of their constituents may want to focus on their constituents' preferences and try to affect the collective decision toward those preferences. This is common at least at the early stage of collaborative governance, because collaborative governance is itself often the last resort among actors who have been unable to find a solution that meets all of their needs (Ansell & Gash, 2008). Sticking to their own constituents' interests, however, sometimes leads to a failure to reach consensus and thus dissolution of the collaborative process (Connick & Innes, 2003). At the same time, however, one of the obvious merits of collaborative governance is that it allows these diverse voices to be heard by all relevant actors in an effort to find a mutually acceptable solution. Indeed, responsiveness to disadvantaged actors is one of the important political and administrative concerns of collaborative governance (Fossett & Thompson, 2005). Diverse voices are the source of unshared information that enhances the deliberation process among people when information is distributed asymmetrically among them (Stasser and Titus, 2003). From this viewpoint, actors' being responsive to their own constituents may facilitate information sharing and collective learning.

On the other hand, collaborative governance systems can potentially benefit from the participation of actors who are focused on pursuit of the general public interest rather than just

the specific interests of particular constituents. A problem here is that the concept of the public interest, which guides much public discourse and collaborative governance deliberations, is often vague or misguided (Saltzstein, 1992). While all citizens have their own unique preferences regarding desired public services, a collective entity such as the general public may not exist in reality but instead is simply a convenient mental construct. This construct is sometimes used to refer simply to the majority voting coalition, and the articulation of its meaning is also readily influenced by professionals and powerful actors (Rourke, 1992). In collaborative governance, the construct of general citizen is useful for calling attention to a broad range of citizen interests that might otherwise be ignored. This is the case especially when government agencies and/or key interest groups are coopted by those who can mobilize more resources, influence, and voice than anyone else in the political system, systematically restricting the capability of the system to recognize and respond to the full array of citizens' needs.

This contrast between global responsiveness, i.e. responsiveness to the general public, and local responsiveness, i.e. responsiveness to each participant's own constituents, raises a question regarding the nature of the relationship between these two goals in the context of a collaborative governance system. While some tension between the two can be expected, another possibility is that they may be reconciled through a participatory, self-organizing collaborative governance process that involves diverse actors, interests, and information. From a knowledge perspective, reconciliation of the tension between pursuit of narrow local interests and broader general interests can result from "knowledge-as-participation" (Bouwen & Taillieu, 2004: 146), i.e., knowledge formed in the interaction among different actors or situated in the coordinated actions among actors. In other words, what is important is not the knowledge retained by individual participants, but the knowledge generated and shared among them. Compared to

hierarchical systems in which information processing rules are often predetermined and inflexible, participants in collaborative governance systems can share information about constituents' needs and interests more easily and their decision-making processes can be more flexible. In these conditions, actors are more likely to learn about other constituents' needs, supported by knowledge developed collectively, which may enable them to reach consensus more readily.

Capra (2002) points out that human organizations contain both designed and emergent structures, with the latter more important for organizational survival in a turbulent environment. However, traditional structures and processes of public decision-making are more designed than emergent, due to concerns regarding accountability and control issues. Therefore, self-organizing capabilities have been limited in traditional governance systems, constraining their learning capacity. As social problems become more complex and uncertain, coordination through emerging forms of governance becomes more important (Moynihan, 2008). However, there is still a need for theoretical development regarding the capability and consequences of self-organization among actors engaged in a collective process of addressing a social concern. A number of case studies have been accumulated that demonstrate the success or failure of efforts to reconcile the natural tension between the two types of responsiveness (Ansell & Gash, 2008; McGuire, 2006). To add to those efforts, and to explore this issue in a way that may contribute to the development of theory on this topic, we utilize a dynamic computational model that incorporates key elements of a collaborative governance system.

Methods

The method employed in this study is agent-based simulation modeling, in which the real-world issues of preference representation, information aggregation, policy coalition

formation, and responsiveness are represented by artificial agents and rules in a virtual world. Agent-based modeling is helpful for theory building regarding a bottom-up process such as collaborative governance, using just the building blocks of agents and rules (Epstein & Axtell, 1996). The method also helps to increase the sophistication of collaborative governance theory by allowing researchers to consider heterogeneity of actors in the model and to obtain the logical consequences of the formal model (Miller & Page, 2007). Finally, the method is helpful for dealing with contingencies pertinent to collaborative governance (Ansell & Gash, 2008). Performance of a collaborative governance system depends on the initial conditions in which the system is established. Agent-based modeling, through computer-aided simulation, can help identify the different consequences of different conditions including characteristics of actors and institutional conditions.

The simulation model developed for this study was designed as a simplified representation of a collaborative governance system, intended to reflect the assumptions discussed in the previous section and to perform virtual experiments of the effects of different starting conditions among the collaborating agents. In this virtual governance system, there were one thousand constituents each with its own particular set of policy preferences. Thirty interest groups represented these constituents' policy preferences in a collective decision-making process, in which interest groups formed coalitions to share information about their constituents' policy preferences and to vote consensually for a policy option that reflected the majority preferences of their constituents. After a process of coalition formation, a collective policy decision was made by the votes of all thirty interest groups, and the global and local responsiveness of the chosen policy was determined. Simulations of six different scenarios were run, reflecting differences in interest group characteristics (i.e., goals and tendency toward collaboration) at the start of the

simulation. Within each scenario, since interest groups represented different constituents, they possessed different information about constituents' preferences. The interest groups were also adaptive agents, that is, they adapted their collaborative behavior in response to results from prior collaboration. There were one hundred rounds of decision-making in each simulation, and the outcomes of interest are the patterns of local and global responsiveness that emerged in the different scenarios. Additional information on key features of the simulation is provided below.

Constituents

Constituents were defined as comprising two properties, political position and policy preference. The political position of a constituent represented its position on a spectrum between bipolar political philosophies. Technically, a political position was defined by a five-digit string. Each digit had a value of either 1 or 2. With five digits and two values in each digit, thirty-two different political positions between two polar positions could numerically be defined. For example, a constituent whose political position is 1 1 1 1 1 is the farthest in distance from a constituent whose political position is 2 2 2 2 2.

The political position of a constituent defined its policy preference. A constituent's policy preference was composed of five sectors, each of which corresponded to one of the five digits of the political position. Each sector was composed of eight digits, with the value of each digit being either 1 or 2. Consequently, a constituent's policy preference was defined by a forty-digit string. The policy preference was designed to correspond to the constituent's political position. Reflecting some discrepancy between people's political philosophy and their real preferences, i.e., due to the complexity of policy problems and solutions as well as some irrationality of the human mind, the degree of fit between a constituent's political position and its policy preference

was set to .7. This means that if a constituent has a '1' in the first digit of its political position, an average of 70% or 5.6 out of 8 digits in the corresponding policy preference sector would be a '1' (across all policy preference generations during the simulation), and an average of 30% or 2.4 digits in that sector would be a '2.' Factoring in these rules, each of the one thousand constituents' policy preferences was randomly generated.

Agents

The primary agents in the model were the thirty interest groups, each of which represented the policy preferences of specific groups of constituents that possessed similar political positions. The characteristics of these agents can be described in terms of four categories: political identity, goals, tendency toward collaboration, and adaptation. These characteristics are explained below and summarized in Table 1.

Political identity. As with the constituents, an interest group's political identity was composed of both political position and policy preference. Constituents and interest groups were linked by equivalence in their political positions. For instance, an interest group whose political position was 1 2 1 1 2 represented all constituents whose political position was also 1 2 1 1 2. When an interest group represented its constituents, it possessed complete information about those constituents' policy preferences. Consequently, interest groups with different political positions represented different sets of constituents and possessed different information about constituents' policy preferences.

One variation on the above was employed in the design to generate some information asymmetry among interest groups. All interest groups were randomly assigned "digits of ignorance," the number of which varied from zero to four. If an interest group's political position

was 1 2 1 1 2 and its digits of ignorance were the third and fourth, then the interest group represented constituents whose political position was 1 2 * * 2 (the asterisks denoting that both 1 and 2 are acceptable). Because an interest group does not pay attention to the ignored digits, it does not have information about its constituents' policy preferences in those sectors of ignorance.

Goals. Interest groups were designed to pursue either or both of two goals. In the real world, stakeholders that participate in collaborative decision-making bring different goals with them to the process. First, they participate in the collaborative process to promote their constituents' interests and to make sure that their voice is heard by the others involved in the decision. Their goal is to advocate the best they can for their constituents' preferences, i.e., to be locally responsive. Second, participants in collaborative governance may sincerely pursue the "public interest," i.e., they may strive to be globally responsive to the full range of stakeholders. In the simulation, interest groups were designed to pursue one or both of these goals. When they exclusively pursued improvement in responsiveness to their own constituents (hereafter called "local responsiveness"), they focused on whether their collaboration with other interest groups was successful in increasing their level of local responsiveness. When they exclusively pursued improvement in responsiveness to all constituents (hereafter called "global responsiveness"), they focused on whether their collaboration with other interest groups was successful in increasing the level of global responsiveness in the system. When interest groups pursued both of the goals (hereafter called "joint responsiveness"), they focused on whether their collaboration enhanced both local and global responsiveness simultaneously.

Tendency toward collaboration. An interest group's tendency toward collaboration was defined by two independent factors. The first is its activity level, which refers to how many other groups an interest group is willing to contact as potential collaborators. The level of activity was

set from one to fifteen (i.e., half the number of interest groups in the system). The second is its tolerance level, which refers to how much distance in political position an interest group will tolerate when recognizing others as potential collaborators and accepting offers of collaboration. Given a level of tolerance, an interest group collaborates only with those that are close enough to it. The distance between two interest groups was calculated as the degree of difference of political positions. Since there were five digits in the political position, the maximum distance possible was five, and the range of tolerance was set from one to five accordingly.

Adaptation. After each round of collective decision-making, interest groups received feedback regarding achievement of their goal, which was taken into account in an evaluation of their current collaborative strategy (i.e., their activity and tolerance levels). Depending on the historical pattern of this feedback, they decided either to keep the same strategy or to adopt an alternative strategy (see Table 2 for a specification of the four possible strategies).¹ By choosing a different strategy, an interest group revised its tendency toward collaboration by increasing or decreasing one or both of the dimensions of collaborative tendency.²

Collaboration Process

The computational model of collaborative governance focused on the process of forming coalitions to share information among interest groups and develop consensus about the policy options they would collectively advocate when making the decision. Interest groups were

¹ With their first strategy chosen at random, interest groups then kept a record of the outcomes of the collaborative strategies they used in terms of the achievement of the goal they pursued. The group added a point to its current strategy when the goal was achieved and subtracted a point from its current strategy when the goal was not achieved. At the beginning of the next round, the interest group then chose the collaboration strategy with the highest score. When more than two strategies had the same score, one strategy was randomly selected.

² In the case when an interest group reached the upper or lower limit of either dimension of tendency toward collaboration, it would add or subtract a point from its current collaboration strategy depending on whether or not it accomplished its goal, and change strategies accordingly, but its level of activity or tolerance would never go beyond the upper or lower limit of those dimensions.

designed to self-organize into coalitions to share information and agree on policy preferences. Specifically, in each round of the simulation (with a total of one hundred rounds), interest groups repeated the following procedures (see Table 3 for details).

First, interest groups contacted one another to explore the possibility of developing a relationship. Each interest group initiated contact with the number of other groups specified by its level of activity (one to fifteen). An interest group contacted by the initiator calculated the political distance between their political positions. If the distance fell in the receiver's tolerance level, the receiver regarded the initiator as close enough to collaborate and sent a "positive sign" to the initiator. Then each of them added (in its own records) a unit of credit to the other's account. If the receiver did not want to collaborate because the distance between them was outside its tolerance level, the receiver sent a negative sign to the initiator and they each subtracted a unit of credit from the other's account. These credit scores were used to determine which other groups an interest group would contact at the beginning of each round, with highest priority going to those with the most accumulated credits.

Next, after making their contacts, interest groups invited all other groups with positive credits in their accounts to form a coalition. Whereas the previous step was analogous to identifying similarities and establishing trust among actors, this step reflected the process of actually forming coalitions among multiple actors. When one interest group sent invitations to other groups with which it had built a positive relationship, the invitees were provided with a complete list of the other groups also being invited to join the coalition. If the list included too many other groups that had a negative credit in the invitee's records, it rejected the invitation.³ If

³ Another characteristic of interest groups, namely "ignorance level," regulates their behavior at this point. Ignorance level refers to how many negative relationships with other groups an interest group is willing to accept in a prospective coalition. If tolerance is a threshold with which to determine if another interest group is close enough to

the number of other invitees with negative scores was not too high, the invitee accepted the invitation to join the coalition.⁴

Once coalitions were formed through this process, the members of a coalition shared their information about their own constituents' policy preferences. Based on the majority policy preferences of this combined set of constituents, the members of the coalition reached consensus on the policy preferences they would advocate in the decision-making process. Then, to make the final decision of the collaborative governance system as a whole, each coalition's vote was counted and weighted by the size of the coalition (i.e., the number of members). The final policy selected by the collaborative governance system was determined by the majority vote among the interest group coalitions.

Finally, after determining whether or not it achieved its goal and, accordingly, adding or subtracting a point to its current strategy, each interest group decided whether or not to adopt a new strategy and thereby adjust its tendency toward collaboration. After making these adjustments, the constituents' political positions and policy preferences were newly and randomly generated according to the rules described above, and a new round of decision-making began with interest groups repeating the process of developing relationships and forming coalitions.

collaborate in a dyadic relationship, ignorance level is a threshold with which to determine if a coalition, overall, is composed of interest groups close enough for the invitee to be willing to join. The initial value of an interest group's ignorance level was set at three times the level of its tolerance, so as to correlate with a group's tendency toward collaboration. This made it easier for interest groups to form coalitions early on, before they had accumulated sufficient mutual credit scores. Ignorance level increased by one unit when an interest group accomplished its goal. Conversely, it decreased by one unit when a group failed to accomplish its goal.

⁴ The order in which interest groups made these invitations was determined by their accumulated credit scores earned from the other interest groups. The interest group that had the highest total score made its invitations first. Invitations were received sequentially, such that an interest group had to either accept or decline the first invitation and would only receive another invitation if the previous one were declined. The acceptance of an invitation was exclusive, i.e., once it accepted an invitation, an interest group could not then accept another.

Experimental Design

To compare the emergent processes of self-organizing collaborative governance systems composed of interest groups with different properties, this study employed an experimental design. Since the simulation was based on agent-based modeling, different paths of self-organization could start from variations in characteristics of agents, i.e. interest groups. This study employed a 2 x 3 factorial design (high or low tendency toward collaboration, and three goal orientations) that resulted in six different scenarios examined in the simulation (see Table 4). Fifty different political systems were generated in each of the factorial categories. Each political system was composed of thirty interest groups and one thousand constituents. Interest groups made collective decisions one hundred times while they kept updating their history of interactions with other groups.

Interest groups possessed two important characteristics. One was the tendency toward collaboration, i.e. activity and tolerance. Interest groups started off the simulation as one of two types. In one type, used in three of the experimental scenarios, both activity and tolerance were set initially at the highest level (hereafter called “collaborative actors”), while in the other three scenarios, activity and tolerance were set at the lowest levels (hereafter called “non-collaborative actors”). The second characteristic was the goal of the interest group. Interest groups fell into one of three categories, each used in two of the experimental scenarios. In one category, interest groups exclusively pursued improvement in local responsiveness at the individual level. Specifically, they compared the local responsiveness of their current policy preferences (after joining a coalition) with the average local responsiveness of their policy preferences across all previous rounds. In the second category, interest groups exclusively pursued improvement in

global responsiveness at the system level, that is, they focused on the global responsiveness of their collective decision and on improving it (compared to its historical average) in the next round of decision-making. In the last category, interest groups pursued both local and global responsiveness simultaneously. Only when they achieved improvement in both of these was their goal identified as having been accomplished.

The measures of local and global responsiveness are presented in Table 1. Interest groups' achievement of the above goals was then determined as follows. First, improvement in local responsiveness was measured by the ratio of local responsiveness achieved by an interest group in the current iteration to the average level of local responsiveness achieved by that group across all previous rounds in the simulation. Second, improvement in global responsiveness was measured by the ratio of the level of global responsiveness achieved by the collective decision of the governance system in the current iteration to the average level of global responsiveness achieved by the governance system across all the previous rounds. In both cases, if the ratio was greater than one, the goal was regarded as having been achieved. Interest groups with the goal of joint responsiveness achieved their goal only if both measures were greater than one.

Results

Rather than utilizing any kind of statistical analysis, the results presented below focus on an examination of the patterns that emerged in the simulations of collaborative governance systems in the six different scenarios. The unfolding of a complex adaptive system may not be adequately analyzed using statistical techniques that assume linear, unidirectional, and competitive causal relationships among variables that describe the status and change of the system. Complex system dynamics typically reflect key nonlinear relationships (Holland, 1995),

causality among variables internal to the system are often recursive (Arrow, McGrath, & Berdahl, 2000), and system behavior is developed and regulated through the interactions of multiple variables and relationships. To understand the outcomes of the simulations, then, we present the results by describing the history of changes that occurred in each scenario.

Trade-offs between Global and Local Responsiveness

Figure 1 shows the trends of changes in global responsiveness across the one hundred rounds of the simulation. To standardize the level of global responsiveness achieved across all decisions, the Y axis in Figure 1 is set as the ratio of the level of global responsiveness the collaborative governance system achieved to the maximum level of global responsiveness which could have been achieved.⁵

The historical trends of global responsiveness in the six scenarios suggest three major conclusions. First, although there were relatively sharp decreases in the level of global responsiveness among collaborative groups (Scenarios 1, 3, and 5) at the early stages, the long-term trends turned out to be a slight decrease (Scenarios 1), stabilization (Scenario 3), and a dramatic decrease from start to end (Scenario 5). As for non-collaborative groups, Scenario 2 and Scenario 4 showed increases of global responsiveness. The increase in Scenario 2 was obvious, and Scenarios 4 and 6 showed a slight decrease at the beginning and then a slight but gradual increase in the long run. Second, except for Scenario 5, collaborative groups (Scenarios 1 and 3) converged into higher global responsiveness than non-collaborative groups (Scenarios 2, 4, and

⁵ Because constituents' preferences were composed of forty digits with either 1 or 2, there was logically a maximum level of global responsiveness a collaborative governance system could reach, being around 50% plus or minus small deviations produced by random generation of initial preferences. In the simulations, the actual maximum level of global responsiveness reached was on average about 51.25%, meaning that the average degree of match between the collective policy decision and each constituent's policy preference was about 51.25%.

6) did. The result is compatible with theoretical ideas regarding the importance and virtue of collaboration in information processing. Third, somewhat surprisingly, interest groups pursuing both of the goals (Scenarios 5 and 6) performed worst regardless of their initial tendency toward collaboration. In particular, interest groups in Scenario 5, although they were collaborative and highly responsive to the general public in the beginning, ended with a significantly decreased level of global responsiveness.

Figure 2 shows the trends of changes in local responsiveness across the one hundred rounds of the simulation. Collaborative groups (Scenarios 1, 3, and 5) that started off with relatively low levels of local responsiveness showed improvement over time, and the rate of increase of local responsiveness in Scenario 5 stayed high throughout the simulation. In contrast, non-collaborative groups (Scenarios 2 and 4) that started off with relatively high levels of local responsiveness failed to improve it any further. The exception was the groups in Scenario 6, which had the highest level of local responsiveness. They started at a relative high level, like the other two non-collaborative groups, but they recorded even higher local responsiveness at the end of the simulation.

Figures 1 and 2 demonstrate mixed results regarding the trade-off between global and local responsiveness across the various scenarios. First, when focusing on Scenarios 1 and 3, in which collaborative interest groups pursued one of the two types of responsiveness, the results indicate that, in the long run, interest groups can improve their local responsiveness while maintaining, for the most part, the global responsiveness of the system. A contrasting pattern was displayed in Scenarios 2 and 4, where non-collaborative groups pursuing a goal of local responsiveness actually demonstrated steady decreases in local responsiveness along with improvements in global responsiveness. Finally, the results of Scenarios 5 and 6 suggest that

global responsiveness may suffer if an actor pursues joint responsiveness, i.e., tries to achieve two goals at the same time. Over time, interest groups in Scenario 5 sacrificed global responsiveness for the sake of local responsiveness. Interest groups in Scenario 6 made this tradeoff from the beginning, and maintained a high level of local responsiveness and low level of global responsiveness throughout the simulation.

In short, these results indicate that there isn't necessarily a trade-off between the global responsiveness of a governance system and the local responsiveness of separate interest groups participating in the governance process. When interest groups started off with a high tendency to collaborate and pursued either of the two goals, they were able to maintain a reasonably high level of global responsiveness while gradually improving their local responsiveness as well. By contrast, when interest groups started off with a low tendency to collaborate and pursued either of the two goals, a trade-off between global and local responsiveness was obvious. The pursuit of both goals (Scenarios 5 and 6), i.e. an effort to reconcile the trade-off between global and local responsiveness at the individual level, was not successful regardless of interest groups' tendency to collaborate. However, the trade-off was able to be reconciled at the system level when actors had a high tendency toward collaboration.

Internal Dynamics of the Model

To better understand the internal dynamics of collaboration that resulted in the trends in and relationships between global and local responsiveness, it is helpful to examine patterns in the interest groups' tendency toward collaboration at the micro level and emergent decision-making coalitions at the meso level. As Figures 3 and 4 show, interest groups' average levels of tolerance and activity converged to the median values in the long run. This result, however, does not mean

that all interest groups became moderately collaborative. The standard deviations of tendency toward collaboration increased, meaning that in all scenarios most of the interest groups tended to be polarized (see Figures 5 and 6). In Scenarios 1, 3, and 5, in which interest groups were collaborative in the beginning, some groups became very non-collaborative either in tolerance or activity, or both. Conversely, in Scenarios 2, 4, and 6, in which groups were non-collaborative in the beginning, some became very collaborative either in tolerance or activity, or both. Although the polarization of both tolerance and activity was the clear trend across all scenarios, significant correlations between interest groups' tolerance and activity levels were not found.

In spite of similar changes in interest group tolerance and activity across all scenarios, the dynamics of coalition formation were diverse across scenarios. Figure 7 shows the trend of the number of coalitions formed among interest groups in each scenario (with fewer coalitions signifying that the set of groups was less fragmented). It is clear from the figure that two sets of interest groups – those that began collaborative (Scenario 1, 3, and 5) and those that began non-collaborative (Scenario 2, 4, and 6) – each started off with a nearly identical number of coalitions, but then there was divergence across scenarios within each set. Interest groups in Scenario 3 were the most integrated and maintained their level of integration throughout the simulation. In contrast, the set of interest groups in Scenario 1 became more fragmented. Interest groups in Scenarios 2 and 4, which were non-collaborative in the beginning, showed similar emergent patterns, becoming more integrated over time. The results of Scenarios 5 and 6 are distinctive. They suggest that interest groups pursuing both goals did not receive positive outcomes from joining coalitions, resulting in the generation of a fragmented governance system. Groups in Scenario 6 were never successful in forming coalitions. They quickly moved into a totally fragmented state in which they remained for the duration of the simulation.

In addition to the number of coalitions, in order to better understand the integration and fragmentation of the governance systems, it is useful to consider the variation in the size of the coalitions that formed in these scenarios. Figure 8 indicates the number of interest groups that belonged to the biggest coalitions formed in each round of the simulation. The results show that half of the interest groups gathered into the biggest coalitions when they started off with a high tendency toward collaboration (Scenarios 1 and 3). Groups in Scenarios 2 and 4, although they started off with a low tendency toward collaboration, gradually increased the size of the biggest coalitions throughout the simulation. Figure 9 identifies the standard deviations of the size of the coalitions other than the biggest. The large standard deviations indicate that, in Scenarios 3 and 4, interest groups formed other big coalitions rather than gathering in small coalitions, while in Scenarios 1, 2, 5, and 6, interest groups primarily formed small coalitions.

Overall, the trend of the size of the biggest coalition shown in Figure 8 is similar to the trend of global responsiveness seen in Figure 1. The trend of the number of coalitions shown in Figure 7 approximates to the reverse pattern of Figure 8 and Figure 1, except for Scenario 1. The governance systems in Scenario 1 became more and more fragmented, but the size of the biggest coalitions remained relatively large. This pattern may explain how interest groups in this scenario, although they formed smaller coalitions from start to end, were successful in maintaining a relatively high level of global responsiveness. The pattern of the data may imply that the formation of coalitions, especially big ones, is highly related to the global responsiveness of a governance system. In order for a system to be globally responsive, it may help to form bigger coalitions in which as many interest groups as possible join.

Discussion

This study began with an overview of conceptual foundations on which to build a computational model of collaborative governance, with a focus on processes of information sharing and coalition formation. Using agent-based modeling, this study generated collaborative governance systems in which interest groups represented specific constituents and acted according to their goals and their tendency toward collaboration. The collaborative governance systems composed of collaborative interest groups which pursued improvement of either global or local responsiveness (Scenarios 1 and 3) yielded higher global responsiveness than did those composed of non-collaborative interest groups. Different patterns of relationship between global and local responsiveness were found in the simulation. Scenarios 2, 4, and 5 showed obvious trade-offs between global and local responsiveness. In Scenarios 2 and 4, improvement in global responsiveness was achieved at a cost of local responsiveness. In Scenario 5, local responsiveness was improved while global responsiveness decreased. Scenarios with collaborative groups (Scenarios 1 and 3) demonstrated a trade-off between global and local responsiveness in the early stages, but soon their local responsiveness improved while their global responsiveness remained relatively stable. When interest groups were collaborative or pursuing either global or local responsiveness, they formed bigger coalitions than interest groups that were non-collaborative or pursuing joint responsiveness. Interest groups that pursued both goals (Scenarios 5 and 6) were least likely to form coalitions at the end of the simulation.

The role of a computational model is to yield the exact logical consequences of conditions assumed by underlying theories. Our results, then, are the logical and numerical consequences of the conceptual foundations from the literature that were designed into the simulation and of the initial parameter values given to the agents. Typically, the results of a

simulation are used to generate theoretical propositions or hypotheses that are compatible with a set of starting assumptions (Harrison, Lin, Carroll, & Carley, 2007). Below, the implications of the simulation results are discussed, and propositions derived from these results are offered.

Implications and Propositions

The properties of interest groups manipulated in this study were their tendency toward collaboration and their goal. The simulation results regarding the relationship between global responsiveness and interest groups' tendency toward collaboration showed that governance systems with more collaborative interest groups yielded a higher level of global responsiveness than did governance systems with non-collaborative interest groups. In the simulation, collaboration meant sharing information with other interest groups and making a collective decision about policy preferences with those groups. Therefore, the result of the simulation may be best understood in terms of maximizing the use of distributed knowledge about the constituents of the political system to achieve a high level of systemic global responsiveness (Weber & Khademian, 2008).

Collaborative groups, which were by definition more open to other groups that advocated different policy preferences, and more willing to form reciprocal relationships with them, benefited from collaboration in two ways. First, at the individual level, those that had any ignored digit in their political positions could get more accurate information about (at least some of) their constituents' policy preferences from interest groups that possessed information pertinent to the ignored digits. Due to this feature, some interest groups were able to be even more responsive to their own constituents after joining the coalition. Second, at the coalition level, interest groups that participated in a coalition collectively possessed more comprehensive

information about a larger subset of the constituents. By enlarging the breadth of the coalition, community organizations could develop a policy proposal that may be more responsive to the general public.

The number and size of coalitions were also important. When the size of the coalitions remained large, as was the case in Scenarios 1 and 3, more information became available within the coalitions, resulting in a higher responsiveness to the general public. Diversity of information is important in deliberation. In the simulation, the richness of diverse information in coalitions enhanced the quality of the result of the simulated deliberation process and helped the interest groups achieve higher global responsiveness. While these collaborative actors had to sacrifice local responsiveness to some degree, they were able to collectively achieve higher global responsiveness than non-collaborative interest groups achieved. These results lead to the following propositions:

Proposition 1. As local actors are more active in trust building and more open to working with diverse others, they will collectively reach a globally more responsive policy decision by bringing their local knowledge to the deliberation process.

Proposition 2. As diverse information about constituents' preferences is available in coalitions, the formation of a big, comprehensive coalition rather than a lot of small coalitions will yield higher global responsiveness.

Another notable result of the simulation is that, as the results of Scenarios 3 and 4 indicate, even when interest groups aim to be responsive only to their own constituents, their collaboration may enable them to achieve high global responsiveness. This result echoes the claim in economics that pursuit of self-interest benefits the public through coordination by the invisible hand. If the invisible hand in economics is the market, the invisible hand in our model

is the collaboration process. Interest groups in Scenarios 3 and 4 were actually integrated into a few, big coalitions that facilitated comprehensive information sharing. This result may be significant since collaborative governance usually starts with participants who are interested in maximizing their own benefits through participation in the process, with varying degrees of collaborative attitude. According to our results, interest groups' self-oriented goal may not necessarily undermine the global responsiveness of the whole system. This discussion leads to the following propositions:

Proposition 3. Participants' self-interested focus, that is, the primary pursuit of responsiveness to their own constituents, may not be incompatible with achieving high global responsiveness.

Proposition 4. High global responsiveness by self-organizing participants in collaborative governance may be achieved when participants are more active in trust building and more open to working with diverse others, and when they form larger coalitions for deliberation.

Regarding another aspect of the trade-off between global and local responsiveness, the results of the simulation suggest that it is important to distinguish between the cross-sectional and longitudinal aspects of this trade-off. A comparison of Scenarios 1 and 3 (collaborative groups) to Scenarios 2 and 4 (non-collaborative groups) warrants special attention. First, the global responsiveness of interest groups in Scenarios 1 and 3 remained relatively high throughout the simulation, while the level of their local responsiveness remained relatively low. This pattern corresponds to a discrepancy frequently found in the real world between constituents' preferences and their representative's actions in a legislative process (Miller & Fox, 2007). In contrast, interest groups in Scenarios 2 and 4 recorded a relatively low level of global

responsiveness and a relatively high level of local responsiveness. In short, from a cross-sectional perspective, i.e., when comparing the overall levels of the two types of responsiveness across the different scenarios interest groups in collaborative governance systems that generate globally responsive policies may not be very responsive to their local constituents, and vice versa. This discussion leads to the following proposition:

Proposition 5. In general, from a cross-sectional perspective, there may be a trade-off between global and local responsiveness.

From a longitudinal viewpoint, however, the relationship between global and local responsiveness may not entail a trade-off. First, in Scenario 3 in particular, while the absolute level of local responsiveness was relatively low in the beginning, these collaborative interest groups gradually improved it over time. This improvement occurred even while the systems' level of global responsiveness was maintained, thereby reducing the gap between their level of local and global responsiveness. In Scenarios 2 and 4, the direction of the long-term trends of global and local responsiveness were opposite of each other. While this result is compatible with the logical expectation of a trade-off between global and local responsiveness, what is interesting here is the direction of this trade-off. The pattern over time was that *non*-collaborative actors improved global responsiveness while decreasing local responsiveness. This may have been made possible by the mutual trust that accumulated among interest groups, which led them to keep collaborating and eventually resulted, for some, in increased tolerance and activity.

In short, while it is natural to find a trade-off relationship between global and local responsiveness, deliberative processes among collaborative actors may yield a way to reconcile between them. Note that the simulation did not incorporate any features that required designing a creative solution. It is noteworthy that collaboration can mitigate the trade-off between global

and local responsiveness even when the context does not leave room for a creative, synergistic solution that requires more information inputs into the system. This discussion leads to the following proposition:

Proposition 6. As local actors are more active in trust building and more open to working with diverse others, they may be able to reconcile global and local responsiveness even when the context does not leave room for a creative solution.

Limitations of the Study and Future Research

This study employed a computational simulation for theory building purposes. The method of computational simulation is a way of representing and simplifying the real world, which is one of the purposes of theory building (Epstein, 2006). One limitation of the method is that, although the result of the simulation may anticipate empirical evidence that supports the result, the simulation empirically verifies no hypothesis. The method only provides theoretical propositions that can be logically derived from the underlying theoretical assumptions and the conditions a researcher builds into the investigation. Obviously, the simplification does not represent exactly the complexity of real-world collaborative governance. For example, a deliberation process involves complex mental processes at the individual level and political processes at the group level. This study simply assumed the ideal situation in which information is perfectly shared once interest groups form a coalition.

Limitations of the computational model used in this study point towards future research, which could include the following features in the model. First, the model did not take into account other forms of resources interest groups bring with them into the collaborative process. In the real world, mobilization of resources is a critical factor that determines the success or

failure of collaborative governance (Leach & Pelkey, 2001). In many cases, an interest group will not have perfect control over the resources necessary to satisfy its constituents' needs. Thus, a model in the future may include the heterogeneous distribution of resources among actors and a discrepancy between the distribution of resources and constituents' preferences. By adding this feature, the model may be able to simulate a process of finding a creative solution. Second, a model in the future may incorporate the nature of the public good. This study assumed that government services can be tailored unit by unit, that is, the forty digits of a policy decision can be determined independent of each other. In reality, subunits of a policy option may be interdependent and mutually constraining in a way that limits the capability of government to respond to citizens' specific needs even when government knows what the best option would be. A future model could investigate the effect of this additional complexity on the self-organizing process of collaborative governance and resultant local and global responsiveness.

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Table 1. Properties of interest groups in the simulation

Property		Definition	Expression / Value
Political identity	Political position	An agent's position in a spectrum between bipolar political philosophies	Five binary digits (e.g., 12112)
	Policy preference	The actual policy option an agent prefers	Forty binary digits/five sectors (e.g., 11121 / 21222 / 11111 / 21112 / 22222)
Goals	Global responsiveness	The average degree of fit between the collaborative governance system's decision and the policy preferences of all the constituents	$GR = \frac{\sum_g \left(1 - \frac{abs(P_s - P_g)}{L}\right)}{N}$
	Local responsiveness	The average degree of fit between an agent's policy preference and its constituents' policy preferences	$LR = \frac{\sum_c \left(1 - \frac{abs(P_a - P_c)}{L}\right)}{n}$
	Achievement of goal	The ratio between the current global or local responsiveness and the average global or local responsiveness (to date) is greater than one	$G_t = R_t / \left(\frac{\sum_{t=1}^{t-1} R_t}{t-1}\right)$
Collaborativeness	Tolerance	How much distance an agent tolerates in recognizing others as potential collaborators and in accepting an offer of collaboration	From 1 (only one difference out of the five digits of the political position is tolerable) to 5 (difference in all five digits is tolerable)
	Activity	The number of groups an agent contacts at each opportunity	From 1 (contacts only one other agent) to 15 (contacts half of the other agents)
	Ignorance	How many negative relationships with other groups an interest group will accept in a prospective coalition	Three times the tolerance level
Adaptation	Evaluation of the current strategy	An agent evaluates the current action strategy on the basis of achievement of its goal	$S_t = S_{t-1} + (G_t > 0)$ or $S_{t-1} - (G_t \leq 0)$
	Adjustment of collaborativeness	An agent adjusts its level of tolerance and activity according to the prescription of a new strategy, and their level of ignorance	$T_{t+1} = T_t + (L_{st})$ $A_{t+1} = A_t + (L_{sa})$ $I_{t+1} = I_t \pm (G_t > 0)$
<p>Note. <i>GR</i>, <i>LR</i>, and <i>CR</i> denote, respectively, global responsiveness, local responsiveness, and change in local responsiveness. P_s denotes the policy preference of the system, P_a denotes the policy preference of agent a, P_g denotes the policy preference of constituent g from the set of all constituents, and P_c denotes the policy preference of constituent c from among agent a's constituents. L denotes the number of digits in the policy preference ($L=40$). The function <i>abs</i> denotes the distance between the two terms. N denotes the total number of constituents ($N=1000$), and n denotes the number of agent a's constituents. G_t denotes the achievement of the goal at time t, and R_t denotes global/local responsiveness at time t. T_t, A_t, and I_t denote, respectively, the level of tolerance, activity, and ignorance at time t. S_s denotes the cumulative score of strategy s. L_{st} and L_{sa} denote, respectively, the prescription of the selected strategy regarding tolerance and activity.</p>			

Table 2. Collaboration adaptation strategies

		Activity	
		Increase	Decrease
Tolerance	Increase	Strategy 1	Strategy 2
	Decrease	Strategy 3	Strategy 4

Table 3. Summary of the collaboration process

A collective decision-making round starts (repeat one hundred times).

A trust building phase starts (repeat ten times).⁶

An interest group contacts another group (repeat as many times as the group's activity level).

The initiator selects an interest group to contact.

In principle, the initiator selects interest groups (up to the number of its level of activity) in a descending order of the credit scores the groups earned from previous contacts.

If more than two interest groups have the same score, the initiator randomly selects one of them.

(At the initial stage in which no record on other interest groups is available, the initiator randomly selects one.)

The initiator contacts the interest groups one by one, revealing its political position.

The receiver calculates the distance between their political positions.⁷

If the distance falls within the receiver's tolerance:

The receiver sends a positive sign to the initiator.

Both of them add a unit of credit score to each other's account.

If not:

The receiver sends a negative sign to the initiator.

Both of them subtract a unit of credit score from each other's account.

The trust building phase ends.

An invitation and coalition formation phase starts (repeat until everyone makes a decision whether to join a coalition or to remain alone).

The accumulated credit scores of all interest groups are calculated.

The interest groups are ordered according to the accumulated credit scores.

An inviter is selected according to the order.

The inviter sends invitations to all interest groups whose credit scores in the inviter's record are positive, with the complete list of all invitees.

An invitee counts the number of invitees in the list whose credit scores in the invitee's record are negative.

If the number exceeds the invitee's ignorance level:

The invitee rejects the invitation and becomes ready to receive another invitation.

If not:

⁶ In the simulation, the number of opportunities for interest groups to initiate contact with other interest groups was set at ten per round. Thus, if an interest group's activity level was seven, it made seventy contacts (7 x 10) in each round of the simulation. This means that interest groups could rapidly develop relationships at the early stages of the simulation.

⁷ The political distance between two interest groups was calculated as the number of digits in their political positions that were not in agreement.

The invitee accepts the invitation and forms a coalition with the inviter (and with other invitees that accepted the invitation).

The invitee receives no more invitations.

An interest group's invitation process ends.

The invitation phase ends.

The consensus formation phase starts in each coalition (repeat as many times as the number of coalitions).

All members in the coalition collectively share their information about their constituents.

The coalition builds a comprehensive list of constituents' policy preferences.

The coalition determines what the majority policy preference is, based on this information.⁸

All members accept the majority policy preference as their policy preference to advocate.

The consensus formation phase ends.

A decision-making phase occurs.

All interest groups vote for the policy preference they accepted.

The system's policy is determined by the majority rule based on the interest groups' votes.

Global responsiveness of the system is calculated.

Local responsiveness of each interest group is calculated.

According to whether interest groups achieved their goal or not:

Interest groups change their strategies.

Interest groups adjust their tendency toward collaboration (tolerance/activity) according to the prescription of the new strategy.

Interest groups adjust their ignorance level.

Interest groups add to or subtract from the coalition members' accounts in their records ten credit scores according to the success or failure of goal achievement.⁹

The decision-making phase ends.

The collective decision-making round ends.

⁸ The majority preference was calculated digit by digit. That is, policy preferences were decomposed into digits, and the coalition members formed a collective policy option from the majority values of each digit of the preferences. The same rule was also applied to the calculation of the majority preference of the system.

⁹ This feature was incorporated into the design of the simulation to reflect the effect of goal achievement on mutual trust. The feature is based on the assumption that interest groups may have higher trust in those with whom they successfully collaborate to achieve their goals.

Table 4. Experimental design scenarios

		Goal Orientation		
		Global	Local	Joint
Tendency toward Collaboration (at start)	High	Scenario 1	Scenario 3	Scenario 5
	Low	Scenario 2	Scenario 4	Scenario 6

Figure 1. Trend of global responsiveness

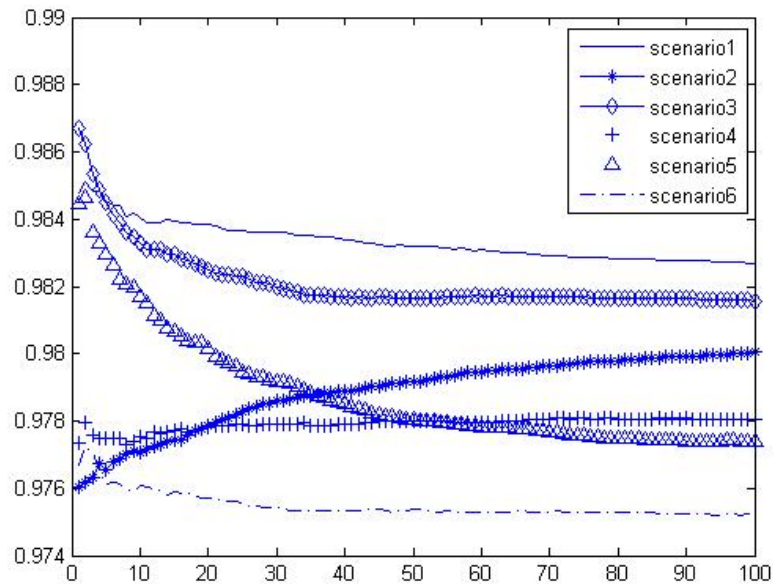


Figure 2. Trend of local responsiveness

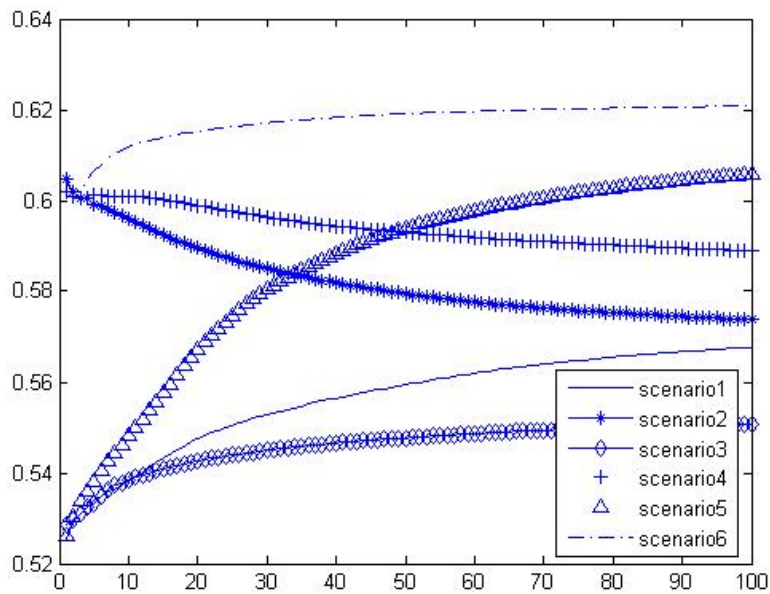


Figure 3. Trend of tolerance level

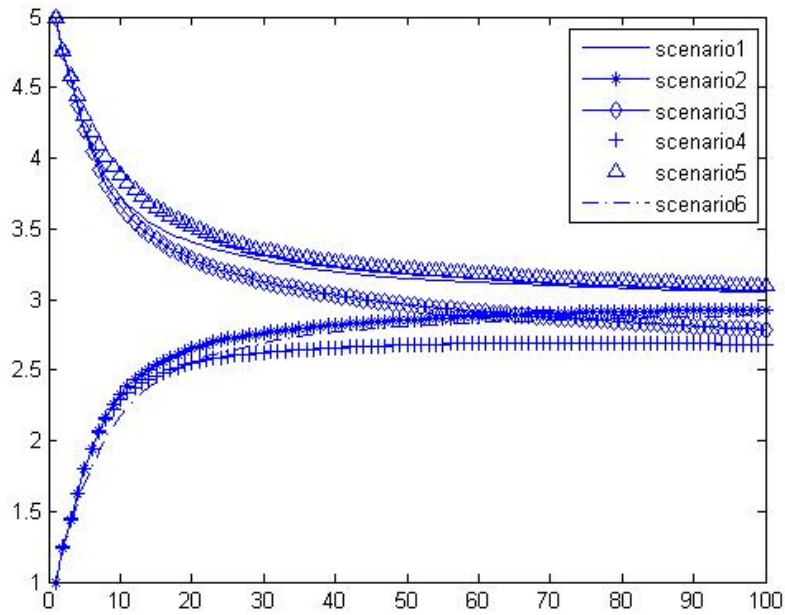


Figure 4. Trend of activity level

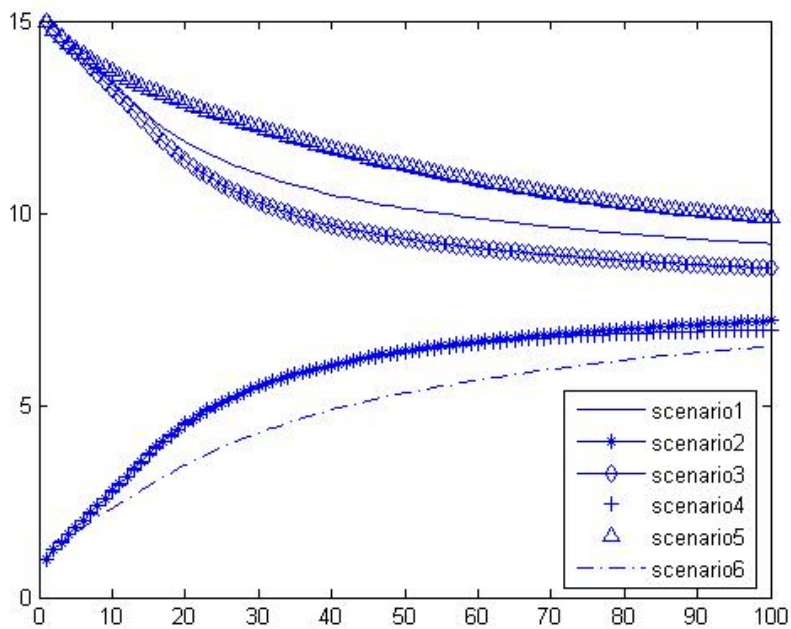


Figure 5. Trend of standard deviation of tolerance level

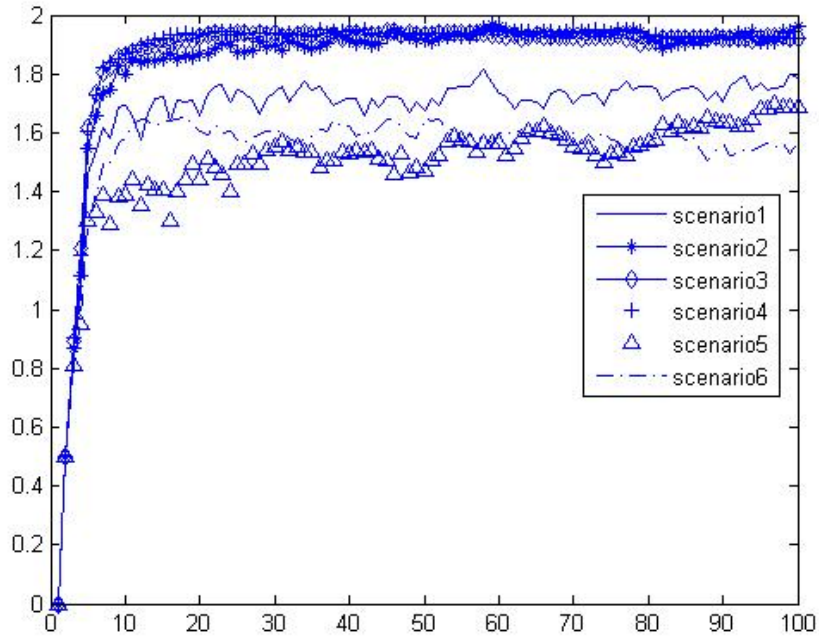


Figure 6. Trend of standard deviation of activity level

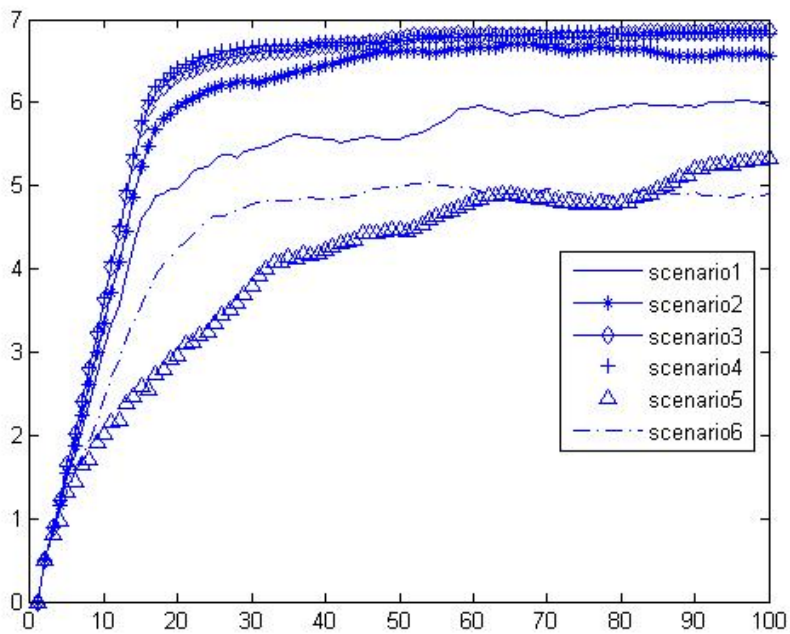


Figure 7. Trend of the number of coalitions

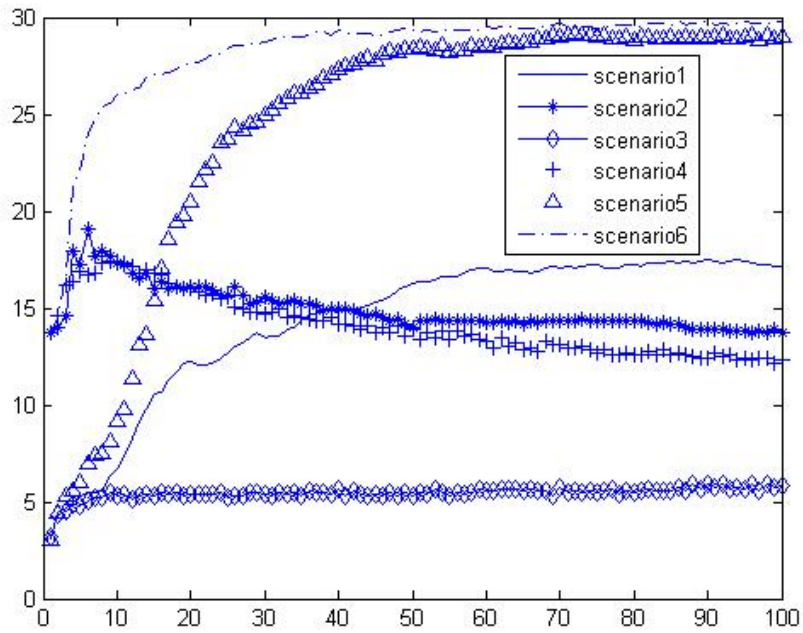


Figure 8. Trend of the size of the biggest coalitions

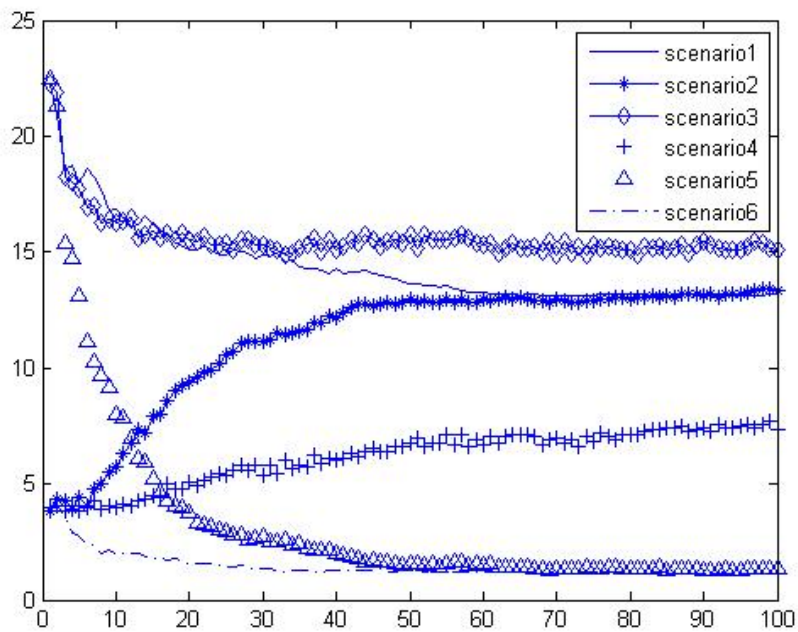


Figure 9. Trend of the standard deviation of the size of coalitions (biggest one excluded)

