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Takacs, K

Published in:
Journal of Conflict Resolution

DOI:
[10.1177/0022002701045006003](https://doi.org/10.1177/0022002701045006003)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2001

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Takacs, K. (2001). Structural embeddedness and intergroup conflict. *Journal of Conflict Resolution*, 45(6), 743-769. <https://doi.org/10.1177/0022002701045006003>

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Structural Embeddedness and Intergroup Conflict

KÁROLY TAKÁCS

*ICS/Department of Sociology
University of Groningen, the Netherlands*

Social structure affects the likelihood of group conflicts, although it has been disregarded by previous explanations. This study extends the intergroup public goods game model and integrates the influence of structural embeddedness and social incentives in the analysis of harmful group conflict. The integrated model explains why intergroup conflicts are often promoted by segregation and describes conditions under which this effect does not occur. The model predicts that a relationship between segregation and the likelihood of conflict can be characterized by an S-shape function. The segregation effect is stronger if local selective incentives are relatively important compared to confirmation from neighbors. Results show that under certain structural conditions, rational individuals are more likely to be trapped in harmful conflict than less rational actors, and rigid assumptions about individual rationality strengthen the effect of clustering on intergroup conflict.

Situations in which a possible collective action of one group hurts the collective interests of another group are the focus of this study. Examples are supporter behavior in stadiums, competition between pupil groups, and violent conflicts between ethnic groups in neighborhoods or in villages. Collective action of equal strength by both parties in such situations results in a mutually harmful outcome. In this study, a theoretical model is presented that predicts under what structural conditions such harmful outcomes are likely to occur and when peaceful coexistence might be expected. I focus on a factor that has been surprisingly neglected in previous research: the effect of structural embeddedness (cf. Granovetter 1985). Although it is well documented that social networks play an important role in mobilization in collective action (e.g., Oberschall 1973, 1994; McAdam 1986; Chong 1991; Gould 1991; McAdam and Paulsen 1993; Opp and Gern 1993; Sandell and Stern 1998), previous models have not taken into account the fact that individual network ties within *and* between the groups transmit social and cognitive rewards that influence participation in intergroup-related collective action. In particular, although it is widely believed that dense in-group relations help the establishment of collective action (Marwell, Oliver, and Pahl 1988; Marwell

AUTHOR'S NOTE: Address correspondence to the Interuniversity Center for Social Science Theory and Methodology, 9712 TG Groningen, Grote Rozenstraat 31, the Netherlands. Phone: +31-50-363 6208; fax: +31-50-363 6226; e-mail: k.takacs@ppsw.rug.nl. I thank Frans Stokman, Roel Popping, Wim Liebrand, and Andreas Flache for their valuable and thorough advice, comments, and criticisms. I also thank Thomas Gautschi, Henk Flap, Harry Ganzeboom, and Wolfgang Balzer for their comments.

JOURNAL OF CONFLICT RESOLUTION, Vol. 45 No. 6, December 2001 743-769
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and Oliver 1993; Gould 1993a, 1993b), in the intergroup context not much is known about why and under what conditions dense in-group and scarce out-group relations (segregation, clustering) support harmful collective action. I will investigate this question, considering competition situations between two distinct groups. A subsequent analysis should include history effects that are quite crucial in many empirical examples but, as a first step, in this study the focus is single-shot situations only.

If individual contributions are costly, group beneficial collective action is difficult to achieve. This is consistent with why lethal conflicts are more exceptions than regularities (Fearon and Laitin 1996; Gould 1999). However, the existence of an out-group could provide an explanation for higher contribution rates, especially if the relation between the groups is competitive. Cognitive incentives for cooperation can be derived from the principles of ethnocentrism or social identity theory (Lewin 1948; Sherif 1966; Tajfel et al. 1971; Tajfel and Turner 1986). Experiments also confirmed that individuals were more inclined to make sacrifices for their group in an intergroup game than for themselves in a two-person game in otherwise identical social dilemma situations (Kramer and Brewer 1984; Bornstein, Erev, and Rosen 1990; Schopler and Insko 1992; Insko et al. 1994; Bornstein and Ben-Yossef 1994). These results implied the conclusion that intergroup competition can be considered as a possible structural solution to social dilemmas (Bornstein, Erev, and Rosen 1990; Erev, Bornstein, and Galili 1993). From another perspective, Caporael et al. (1989) have argued that the solution within the groups creates a social dilemma between the groups. Similarly, Olson (1982) has shown that it is precisely the "self-sacrificial" loyalty to subgroups that can create conflicts between the subgroups.

Until now, however, theories of group conflict hardly made a connection to collective action problems within the groups (see Gould 1999), and theories of collective action also overlooked intergroup aspects. In many situations, collective action is harmful for the out-group and can be considered as defection in the intergroup context. Joining armed bands voluntarily in a tribal war certainly hurts the interests of the other group. If there is a violent outburst, the group that can mobilize more participants wins benefits, such as nationalistic pride, territory, or social identity, and the other group suffers heavy loss of these. Equal strength of violent action leaves no "results" behind, only casualties and expenses for both sides. Since there is no rivalry and no group member can be excluded from consumption, these rewards can be considered as public goods and "bads." The intergroup public goods (IPG) game (Rapoport and Bornstein 1987; Bornstein 1992) gives a comprehensive model for situations in which groups compete for such public good benefits. In the IPG model, intergroup competition is based on the number of contributors.¹ Groups are not considered as unitary entities as in realistic conflict theory. They consist of many consciously acting individuals who care primarily about their own gains and losses.

However, the original IPG model disregards the structural embeddedness of individual actions. Everyone's behavior is to a large extent constrained and influenced by

1. The model simplifies individual decisions to a binary choice, although in many situations it is continuous (for instance, how accurately a warrior shoots).

neighbors, friends, and family, regardless of group membership. In what follows, I will demonstrate the underlying mechanisms behind these network constraints and influences. First, the close social environment is a source of distribution of selective incentives, including social norms (Sandell and Stern 1998). Selective incentives from group members aid the establishment of collective action (Olson 1965), but friends from another group provide incentives that suppress contribution. Second, behavioral confirmation (conformity) that accompanies almost every kind of human interaction (Lindenberg 1986) is also transmitted by network ties. Conformity is an incentive received after an action that is identical to the behavior of others. In collective action that involves many individuals, people are not likely to conform to everyone's behavior or to be fair to everyone (in both a positive and negative sense; cf. Camerer 1997). Conformity is distributed in the social network environment, which appraises expectations about the behavior of friends and neighbors. People do not participate in collective actions in isolation but together with friends and neighbors (for empirical evidence, see McAdam 1986; Gould 1991; Opp and Gern 1993). When they decide to do so, they are assured of the other's participation (Chong 1991; Oberschall 1994). If friends and neighbors do not participate, neither do they. This way, each dyadic relation is subject to playing local coordination games (cf. Ellison 1993; Morris 2000), but in a form that is inseparable from participation choice in collective action. If surrounded by extremists, people are highly constrained to participate. On the other hand, peaceful friends or many friends from a rival group provide enough confirmation pressure to avoid contributing to the harmful collective action. Such a mobilization process is also called "block recruitment" (Oberschall 1973) and can provide the micro foundation for collective actions such as demonstrations, urban gang fights, or civil war.

This study incorporates these different mechanisms to a model of intergroup conflict. Intergroup competition, structural embeddedness, local selective incentives, and behavioral confirmation (the assurance process) are all factors that foster collective action. As a consequence, a social trap of a different kind might arise. If both groups are engaged in collective action, it results in a harmful outcome that should be avoided from the community's point of view. I will demonstrate how the relative size of selective incentives and conformity (normative pressure versus confirmation pressure) influence the effect of segregation on the likelihood of conflict and, hence, the chance that a residential policy can help conflict resolution. Furthermore, for exact model predictions, it is necessary to specify assumptions on individual consciousness and access to information. I introduce four behavioral models and compare the effect of network structure on conflict under the different specifications. Different behavioral models can also be considered as robustness tests to check whether normative pressure in general strengthens the segregation effect on intergroup conflict more than conformity pressure. Examples of typical structures will demonstrate how the success of local mobilization can be dependent on the behavioral assumptions on individual "rationality." Contrary to the common belief, it will be shown that, under certain structural conditions, "rational" individuals are more willing to contribute to collective action.

THE STRUCTURALLY EMBEDDED INTERGROUP PUBLIC GOODS GAME: A MODEL FOR CONFLICTS BETWEEN GROUPS

There are two exclusive groups A and B of size n_A and n_B ($n_A \geq 2$ and $n_B \geq 2$) with contradictory collective interests. Inside both groups, members face a dilemma of provision of a step-level public good (cf. Bornstein 1992). A public good is a step-level good if it is not provided unless a certain level of contribution has been reached. Besides an endogenous threshold (the number of contributors in the other group), I introduce a minimal contributing set (cf. van de Kragt, Orbell, and Dawes 1983) in the game. It means that no provision of the public good that is associated with victory is possible in group A under a specified number of k_A^* contributors ($0 \leq k_A^* \leq n_A$).²

It is assumed that group members are anonymous and can gain (lose) the same rewards from the intergroup context with identical action. For instance, it can be supposed that everyone is equally proud after a victory and equally ashamed after a defeat.³ If the number of contributors in group A exceeds the number of contributors in group B and is also larger than k_A^* , then each member in A receives a reward v (a piece of a victory cake, temptation reward), and members of B receive a negative reward of d (defeat, the sucker's payoff). If the number of contributors is equal and both groups are above the minimal contributing set, then everyone receives a negative reward c (clash, punishment payoff). It can also be supposed that the clash of collective actions is worse than the outcome of peace.⁴ Peace is the collective outcome in which no collective action is established in the groups. For the sake of simplicity, the reward for peace p is a reference value and assumed to be 0. Hence, the relation between the different payoffs is $v > p = 0 > c > d$. If groups were unitary entities and they could choose between collective action and no action, collective action would be their dominant strategy. Following the dominant strategy by both sides would lead to a suboptimal outcome. Throughout this study, all outcomes are called *conflict* if a collective action is established at least in one of the groups.

I assume that a free-riding action results in an extra individual reward of e (endowment, $v > e > 0$). As an example, consider that a group of Republican voters are all happy if a Republican president is elected, but those who refrain from voting gain more because they could do something else instead of going to the polls (opportunity cost of voting). Table 1 represents the possible outcomes of the intergroup game and payoffs for player $i \in A$.⁵

2. For group B , the minimal contributing set is specified by k_B^* ($0 \leq k_B^* \leq n_B$). It is a generalization of the intergroup public goods model of Rapoport and Bornstein (1987) that considers the minimal contributing set to be 0.

3. More precisely, since we do not make any interindividual comparison, it is enough to assume that everyone perceives (the utility of) his or her share in the same way compared to other rewards and costs.

4. In the payoff structure specified by Rapoport and Bornstein (1987), these rewards are equal. In their original intergroup public goods model, a public good is distributed among the members of the group in which the number of contributors is higher. In the other group, no public good is distributed. In case of a tie, all players receive a positive reward that is smaller than the share of the public good. There is no exogenous threshold; one contributor can already establish the provision of the public good. Besides, there is no difference between a tie (clash) and no provision (peace).

5. State (5) is the exceptional case and only relevant if $k_A^* > k_B^*$. In this state, there is an equal number of contributors in both groups. Collective action is established only in group B , but the contribution of player

TABLE 1
Possible Payoffs from the Intergroup Game

	(1) <i>Peace</i>	(2) <i>Unconditional Defeat</i>	(3) <i>One for the Clash</i>	(4) <i>One for Minimal Contribution</i>	(5) <i>From Defeat to Victory</i>	(6) <i>One for the Victory</i>	(7) <i>Unconditional Victory</i>
Conditions	$k_{A-i} < k_A^* - 1$ and $k_B < k_B^*$	$(k_{A-i} < k_B - 1$ or $k_{A-i} < k_A^* - 1)$ and $k_B \geq k_B^*$	$k_{A-i} = k_B - 1$ and $k_B \geq k_B^*$ and $k_{A-i} + 1 \geq k_A^*$	$k_{A-i} = k_A^* - 1$ and $k_B < k_B^*$	$k_{A-i} = k_A^* - 1 \geq$ $k_B \geq k_B^*$	$k_A^* \leq k_{A-i} =$ $k_B \geq k_B^*$	$(k_{A-i} > k_B$ or $k_B < k_B^*)$ and $k_{A-i} \geq k_A^*$
Contribution	0	d	c	v	v	v	v
No contribution	e	$d + e$	$d + e$	e	$d + e$	$c + e$	$v + e$

NOTE: k_{A-i} = the number of contributors in group A (excluding player i); k_B = the number of contributors in group B.

Figure 1: Graphical Representation of an Example and Nash Equilibria (bullets)

A specific example of the game is represented graphically on Figure 1. In this example, group sizes and the minimal contributing sets are equal. Nash equilibria are indicated by bullets. In general (if minimal contributing sets are larger than 1), pure strategy Nash equilibria are the situations in which there are $\{0; 0\}$, $\{k_A^*; 0\}$, or $\{0; k_B^*\}$ contributors. Clash with an overall participation is also a Nash equilibrium if group sizes are equal and $d + e < c$. This equilibrium is never Pareto-optimal.

To predict which outcome will be realized, assumptions must be made about how individuals decide in the game. In some states of a step-level public good game, contribution is a better choice (cf. Frohlich and Oppenheimer 1978). In this intergroup game, these states are 3, 4, 5, and 6 in Table 1. The likelihood that the action of i has an influence on the overall outcome is the sum of critical probabilities (cf. Caporael et al. 1989) that are subjectively ordered to these outcomes by i . If group sizes are large and the minimal contributing sets are relatively high, then based on realistic calculations, critical probabilities are extremely small, and the game is close to being a pure in-group social dilemma (cf. Bornstein and Rapoport 1988, 127). Consequently, peace is a very likely outcome of intergroup opposition (for empirical evidence, see Fearon and Laitin 1996). However, collective action can be established if effective social control, norms, or selective incentives exist in the group (Olson 1965; Heckathorn 1990). Accordingly, in the next paragraphs I will incorporate three different forms of social control that are transmitted by network ties in the model of intergroup conflict. These are traitor rewards, behavioral confirmation, and social selective incentives. As a consequence of dyadic social control, under certain network structures, harmful collective action might emerge.

$i \in A$ turns the outcome to the victory of group A. State (1) is not relevant if less than two contributors can establish group collective action, and state (4) is not relevant if the minimal contributing sets are 0. This holds for the original Rapoport and Bornstein (1987) model. In that model, only states (2), (3), (6), and (7) are relevant, with the assumptions of $0 = d < c < v$. States (6) and (7) are irrelevant if $k_A^* = n_A$.

TABLE 2
Local Coordination Game between Fellow Neighbors

	<i>Neighbor from the Same Group</i>	
	<i>Contribute</i>	<i>Do Not Contribute</i>
Individual <i>i</i>		
Contribute	$b + s, b + s$	$s, 0$
Do not contribute	$0, s$	b, b

Individuals are rewarded for not participating in the collective action if their neighbors or friends are from the other group. It is assumed that everyone receives a $t > 0$ traitor reward in case of no contribution for each tie that connects this person to members of the opposite group. Hence, the traitor payoff is a selective incentive rewarding defection and distributed locally conditionally on the number of ties to the other group. The traitor reward provides an additional incentive to people who live close to members of the opposite group and refrain from participation in the collective action. For instance, supporters surrounded by fans of the other club are rewarded for remaining silent in a stadium.

Ties connecting members of the same group transmit different social incentives. People receive behavioral confirmation ($b > 0$) from each relation by acting the same way as a friend does. This reward is a mutual positive externality, which drives toward uniform action. Regardless of behavioral confirmation, contribution is rewarded by neighbors or friends who appreciate group-beneficial action by social selective incentives. It can be assumed that all contributors receive a selective incentive $s > 0$ from each neighbor. The provision of these incentives does not require separate decisions; they always accompany choices made in the intergroup game. This assumption is plausible for certain social rewards, such as respect or status, that can be by-products of intergroup relations. The relationship between neighbors or friends can be represented as a local coordination game (see Table 2).⁶ All three types of social incentives are received unconditionally on the outcome of the intergroup competition, unlike the public goods ("bads") v , c , and d .

The structurally embedded IPG game is the extension of the IPG game (Table 1 and Figure 1) with the incentives (t , b , and s) from the network environment. Individuals must choose a single action (contribution or no contribution) and cannot tailor their behavior for each neighbor.⁷ In the structurally embedded IPG game, contribution can even be the dominant strategy. For this, selective incentives have to exceed rewards for defection in the worst case scenario, when no neighbors are contributing and a single contribution does not change the outcome. That is, contribution is a dominant strategy of player $i \in A$ if

6. For the sake of simplicity, it is assumed that selective incentives and confirmation payoffs are held constant through all pairwise games. However, it is sufficient to assume that all individuals relate social rewards to other rewards and costs in the same way.

7. It is also the assumption of the literature on local interaction games (see Morris 2000, n. 1).

$$g_i t + e < f_i(s - b), \quad (1)$$

where f_i denotes the number of neighbors of i from group A, and g_i stands for the number of neighbors from group B. Although the decision of i is not likely to be critical, contribution can be highly beneficial because of social incentives. For instance, many individuals join tribal wars, although the gains from these conflicts are only symbolic, and single contributions do not make any difference. One reason is that warriors can attain high status in the group and become “heroes” easily. A similar argument can be made to explain a redundant contribution choice (Caporael et al. 1989). People seek social rewards when they sacrifice their contribution to the production of a public good that has already been established.

On the other extreme, no contribution is the dominant strategy of i if defection provides higher rewards than contribution even if all neighbors are contributing and a single additional contribution would change the outcome of the game. That is, defection is a dominant strategy of player $i \in A$ if⁸

$$g_i t + e > f_i(s + b) + v - d. \quad (2)$$

Nash equilibria in the structurally embedded game can be very different from the original IPG game, depending on the exact network structure. Social networks decisively shape conditions under which social incentives can generate solutions for the in-group collective action problem. In a highly segregated network with dense in-group and scarce out-group relations, overall participation is likely to be an equilibrium. Full contribution can be a dominant strategy equilibrium and a suboptimal outcome in which every individual payoff is smaller than in overall peace. The unusual social dilemma that traps groups in harmful contribution emerges if

$$|c| > f_i s - g_i t - e > f_i b \quad (3)$$

holds for every individual.

MODEL PREDICTIONS UNDER DIFFERENT INDIVIDUAL DECISION RULES

To derive exact model predictions, further assumptions about individual behavior are needed. Since there is no generally accepted view about what level of rationality can be assigned to individual action and what kind of information people use for their

8. If $k_B^* \geq k_A^*$, then the less strict conditions

$$g_i t + e > f_i(s + b) + c - d$$

and

$$g_i t + e > f_i(s + b) + v - c$$

are sufficient to hold for no contribution to be a dominant strategy.

decisions,⁹ four models will be considered with different levels of consciousness and access to information. In this section, I introduce these models and describe the effect of segregation on intergroup conflict under the different assumptions. None of these models are claimed to reflect the appropriate view on the logic of individual action. I believe there is no such view: the level of rational consciousness in individual action varies depending on the framing and importance of situations (Lindenberg and Frey 1993). However, in all four models, I assume a certain level of rationality. I also bring strategic thinking back into consideration, which would not be present if I had assumed that people order expected values for actions and maximize this value (cf. Rapoport and Bornstein 1987). On the other hand, the models also deviate from classical game theory by skipping the assumptions of complete information and perfect rationality. I agree with Macy (1991b, 810) that game theory is ideally suited for sociological concerns, not because of its key assumption of rationality but because it provides an adequate model for the interdependence of actions.

By considering four decision models, it becomes possible to analyze the effect of rational consciousness and access to information on the likelihood of contribution and the interaction effect of behavioral assumptions and segregation on intergroup conflict. In model 1, it is assumed that individuals choose their dominant strategy if they have one. In model 2, local information is introduced into the analysis by assuming that individuals are also able to recognize dominant replies to the dominant strategies of their neighbors. In model 3, it is assumed that such obvious actions are common knowledge between neighbors, and optimal replies are chosen accordingly. In model 4, an expected value element is added to all these assumptions. This model still assumes bounded rationality, since the tendency of overestimation of criticalness (Kerr 1989) is controlled. The most rigid assumptions about individual behavior are used in model 4 and the least rigid ones in model 1. All the assumptions will be discussed in detail in this section. I will show that rigid assumptions strengthen the predicted relationship between segregation and the likelihood of intergroup conflict.

MODEL 1: DOMINANT STRATEGY RULE

In the first model, only a limited rationality of players is assumed. It is presumed that actors choose their dominant strategy, if they have one. Everyone who lacks a dominant strategy contributes with a fixed probability. These behavioral assumptions allow for a derivation of hypotheses from inequalities 1 and 2. As far as the main payoff parameters are concerned, a smaller difference between victory and defeat and a smaller reward for free riding will increase the likelihood of intergroup clash. With regard to structural effects, extensive connections (larger f_i s) support contribution; therefore, collective action will be more likely in a clustered population.

9. Assumptions in the relevant literature contain perfect rationality (e.g., Chwe 1999) as well as considerations of motivations that are beyond egoistic incentives (cf. Caporael et al. 1989). There are various models that assume bounded rationality or limited access to information in different forms (e.g., Ellison 1993; Morris 2000; Fearon and Laitin 1996; Gould 1993a; Rapoport and Bornstein 1987; Macy 1991a).

Already this simple model generates empirically plausible implications. However, there are empirical examples that contradict the predictions and show that isolation can sometimes be an effective way to avoid intergroup clash. Isolation in these cases could mean a termination of the interdependent situation (e.g., building a wall in Belfast, destruction of a bridge in Mostar, or blocking a bridge in Kosovska Mitrovica). These are external or artificial solutions of intergroup conflict that might require the deployment of armed forces for monitoring. When there are no external solutions and interdependencies are unavoidable, the model predicts a strong effect of segregation on the likelihood of conflict between groups if selective incentives are relatively more important than behavioral confirmation (see equation [1]).

The model has interesting implications for group size effects. In a physical clash or battle, larger groups can obtain success easily. If the minimal contributing sets are equal in the groups, the larger group has a higher chance to win from the intergroup opposition. The lower the minimal contributing set, the more likely it is that collective action emerges. In this case, a small amount of noise can break down the peaceful equilibrium. Empirical examples of noise are mistakes, misinterpretations, drunkenness, or sudden passions (Fearon and Laitin 1996). It is more remarkable that even if minimal contributing sets are given proportionally to group size, the larger group still has an advantage. It follows from the fact that if group *A* is larger than group *B*, the expected proportion of ties in group *A* is higher than the relative size of group *A*. Hence, the chance of being in a neighborhood in which normative pressure restricts the individual to contributing action is exponentially higher by increasing group proportion. For instance, there is evidence that voting participation (and votes) increases nonlinearly with higher levels of residential segregation (Butler and Stokes 1974). In other cases, this prediction may contradict real life experience. Larger groups tend to be more sparse and less organized (Olson 1965). Furthermore, if there is a big inequality in group strength, the minority may try to avoid intergroup opposition by assimilation (fading group borders), and the majority can reward this process by forms of positive discrimination.

MODEL 2: DOMINANT REPLY RULE

In the second model, more rigid assumptions are formulated about individual behavior by introducing access to local information. Every actor follows his or her dominant strategy, if there is one. Furthermore, since people know their neighbors to some extent, they can also attain information about their possible actions. Let us assume that people can recognize if some of their neighbors have a dominant strategy and can give an unconditionally best (dominant) reply if there is one.¹⁰ Denote the number of neighbors of *i* who are members of the same group and have a dominant strategy of contribution by f_{ic} and the number of neighbors from the same group who have a dominant strategy of defection by f_{id} . From Table 1 and equations (1) and (2), it can be derived that contribution is the unconditionally best (dominant) reply of *i* if

10. We call a strategy an unconditionally best (dominant) reply if it is a pure best reply against all pure strategy profiles that contain the dominant strategies of neighbors. It involves the assumption that every actor is capable of assessing information about the number of ties and about the relative value of social rewards *b* and *s* for all fellow neighbors.

$$g_i t + e < f_{ic}(s + b) + (f_i - f_{ic})(s - b) \quad (4)$$

holds, and defection (no contribution) is the dominant reply if

$$g_i t + e > (f_i - f_{id})(s + b) + f_{id}(s - b) + v - d \quad (5)$$

is satisfied.¹¹ Everyone who has no dominant strategy or dominant reply is assumed to contribute with a fixed probability.

Model 2 generates further insights into structural effects. Compared to model 1, the existence of relatively closed “ghettos” increases the likelihood of conflict. The periphery of these network segments acts together with the initiators, because they have dominant reactions. The higher the relative size of social incentives ($s + b$), the more likely it is that the periphery will also be encouraged to contribute. A large relative difference between selective incentives and behavioral confirmation ($s - b$) helps key contributors to arise (see model 1), but their additive value ($s + b$) is important for the mobilization of the periphery (model 2). On the other hand, if confirmation rewards are relatively important, peaceful behavior might spread around radical defectors. Hence, in model 2, centralized networks are efficient in spreading both behavioral patterns (cf. Marwell, Oliver, and Pahl 1988; Gould 1993a).

Consider, for instance, the following example. An imaginary map of a small village is represented in Figure 2. Five members of group A (white houses) and seven members of group B (black houses) inhabit the village. In this example, members of group A live at the periphery of the village. Assume that groups are involved in a competition situation that can be described by the structurally embedded IPG game. Suppose that everyone is in close connection only with neighbors to the east, west, south, and north. Group B has the advantage of size but also has a structural advantage, because its members are located mainly in the center of the village. Consequently, collective action is more likely in this group. One player has a dominant strategy of contribution in group B if $e + 3b < 3s$. Three other members living in black houses have a dominant reply of contribution in this case if $e + t < 2s$. If a stronger condition of $e + t + 2b < 2s$ is satisfied, then five members of group B have contribution as a dominant strategy. If the condition of $e + t < s + b$ is also met, then the remaining two members of group B may contribute to the collective action, since it is their dominant reply. In none of these cases does anyone in group A have a dominant strategy of contribution or a dominant reply of contribution. In this village, only high opportunity costs of contribution (high rewards for free riding) and low importance of selective incentives can help to avoid conflict and the exploitation of group A.

11. If $k_B^* \geq k_A^*$, then the less strict conditions

$$g_i t + e > (f_i - f_{id})(s + b) + f_{id}(s - b) + c - d$$

and

$$g_i t + e > (f_i - f_{id})(s + b) + f_{id}(s - b) + v - c$$

are sufficient to hold for defection to be a dominant strategy of $i \in A$.

Figure 2: An Imaginary Map of a Small Village with Mixed Population**MODEL 3: LOCAL COMMON KNOWLEDGE**

If extensive contacts in the neighborhood are assumed, it can also be supposed that individuals are not only capable of recognizing dominant strategies of their neighbors but also dominant replies, best replies to dominant replies, and so forth. In model 3, it is assumed that people can anticipate obvious actions of their neighbors but also the neighbors' perceptions about their own behavior and the neighbors' perceptions about their own perceptions. This means that having a dominant strategy or reply of any order is common knowledge between the neighbors. Under this decision rule, it is also assumed that everyone who has a dominant strategy or reply of any order acts in accordance with this strategy. In the lack of such a strategy, individuals are assumed to contribute with a fixed probability. Model 3 goes far beyond the previous models in the sense that it also takes indirect network influence into consideration. In this model, hesitating people can be influenced by neighbors who have been convinced by other neighbors. At high levels of clustering, contribution spreads easier, and at low levels defection does; consequently, in this model, a stronger effect of segregation is expected on the likelihood of conflict. The stronger relationship originates in the more exhaustive recruitment of peripheral areas next to initiators of collective action. Completely isolated individuals are not assured by the action of fellow group members and not rewarded for traitor action. Therefore, they are still indifferent in the intergroup game (their decision is probabilistic).

MODEL 4: EXPECTED VALUE CALCULATION

Decision models 1, 2, and 3 allowed individuals to make strategic calculations but involved a purely probabilistic element in the case of the absence of a dominant strategy or a dominant reply. However, under certain circumstances, it is reasonable to presume calculative choice for these individuals. In model 4, it is assumed that everyone who has a dominant strategy or reply of any order acts in accordance with this strategy,

just as in model 3. Those who do not have such a strategy will base their decision on an expected value calculation that involves an estimation of the number of contributing neighbors and attaches subjective probabilities to possible outcomes (similar to Rapoport and Bornstein 1987).¹²

To make the model more realistic, I incorporated a certain tendency in the model that is found in experiments and is in accordance with bounded rationality. Social psychologists often claim that people usually overestimate the severity of their own decisions (e.g., Kerr 1989). Even if their beliefs about critical probabilities are correct, they contribute to the collective action more likely than would follow from expected value calculations based on these probabilities (Rapoport, Bornstein, and Erev 1989). This striking gap is also present in experimental conditions in which confirmation incentives can be excluded (cf. Caporael et al. 1989). Such a positive error can originate in people's preferences about being responsible in a negative sense for a group decision and can be labeled responsibility aversion. This tendency was incorporated in model 4.¹³

In Model 4, collective action might be established in a segregated setup even if rewards of intergroup opposition are not salient. In less segregated settings, not only direct neighborhoods but also fellows at a larger network distance can be enforced to contribute because they might forecast contribution in the close neighborhood of

12. The estimation can be based on the following calculation. Denote the subjective probabilities for i of the seven states by P_z s

$$\left(\sum_{z=1}^{z=7} P_z = 1 \right)$$

and the estimated number of neighbors who will contribute by $\hat{f}_{ic}$. For the sake of simplicity, assume that rewards are numerical and individual utility is a linear function of rewards. Contribution is a better choice if

$$P_3(c - d) + P_4v + P_5(v - d) + P_6(v - c) + \hat{f}_{ic}(b + s) + (f_i - \hat{f}_{ic})(s - b) > g_i t + e.$$

We have to make further assumptions about how individuals determine critical probabilities. The calculation could be based on an approximation from the binomial distribution. People are, however, unlikely to make calculations in this sophisticated way (cf. experimental results of Rapoport, Bornstein, and Erev 1989), especially if it is problematic to translate rewards into utilities. However, people certainly consider in their decisions what the probable outcome of the intergroup opposition can be and how their neighbors behave. Hence, results are only aimed to highlight tendencies: how the "vision of rational man" can change the predicted likelihood of group conflict and the predicted relationship between clustering and conflict.

13. The decision rule is constructed as follows: all individuals are assumed to choose their dominant strategy or dominant reply of any order if they have any (local common knowledge is assumed about obvious reactions of neighbors). If they do not have such a strategy, they use an expected value calculation based on the formula in footnote 12. Critical probabilities P_3 , P_4 , P_5 , and P_6 are obtained from a binomial calculation that sums the probabilities of all possible events for the given outcome:

$$P_3 = \sum_{j=\max(k_A^*, k_B^*)}^{\min(n_A, n_B)} \binom{n_A-1}{j-1} P_A^{*j-1} (1-P_A^*)^{n_A-j} \cdot \binom{n_B}{j} P_B^{*j} (1-P_B^*)^{n_B-j},$$

$$P_4 = \binom{n_A-1}{k_A^*-1} P_A^{*k_A^*-1} (1-P_A^*)^{n_A-k_A^*} \cdot \sum_{j=0}^{k_B^*-1} \binom{n_B}{j} P_B^{*j} (1-P_B^*)^{n_B-j},$$

$$P_5 = \binom{n_A-1}{k_A^*-1} P_A^{*k_A^*-1} (1-P_A^*)^{n_A-k_A^*} \cdot \sum_{j=k_B^*}^{k_A^*-1} \binom{n_B}{j} P_B^{*j} (1-P_B^*)^{n_B-j},$$

initiators. On the other hand, highly mixed networks are still likely to be saved from conflict.

It is also possible to derive predictions about the effect of a certain type of cognitive interdependency between the players. If in at least one group there is a widespread belief that the local area is a leader in the establishment of group collective action (for instance, in many districts of the city, Serbs believe that only “good” Serbs live in that district), then collective action will be more likely. The more people who expect a high level of contribution (conflict), the more likely it is that conflict will happen. On the other hand, expectations of peace will help the occurrence of a peaceful outcome. Hence, cognitive beliefs have an inflating effect in both directions.

SIMULATION RESULTS

SIMULATION DESIGN

In the previous section, four models of individual behavior were introduced, and general model predictions under the different assumptions were discussed. It was noticed that segregation increases the likelihood of intergroup conflict in all models, especially in the presence of strong selective incentives. Besides the derivation of transparent analytical results, simulations can be used to derive precise predictions and provide comparative statics for all possible networks in specific settings. In the simulations, network ties represent relations between neighbors.¹⁴ People are seldom able to escape interacting with neighbors and being influenced by them. The empirical relevance lies in the fact that, unlike other ties, neighboring connections are symmetrical (undirected) and easily mapped. Residential structures are visible, and therefore results can be interpreted easily. Furthermore, it is known that residential segregation often goes together with other forms of segregation (e.g., Whyte 1986).

In the simulations, a rectangular grid modeled residential locations. Every location in the grid (each cell) could be in three different states: occupied by a member of group *A*, occupied by a member of group *B*, or empty. No restrictions were applied about the location of the empty cells. For instance, corner areas of the rectangle could be empty. In this way, the model could resemble a cross-shape or amorphous settlements as well. However, simulation could provide only a simplification of residential configurations observed in reality. Simplification was also made with respect to a ceiling on neighbor-

and

$$P_6 = \sum_{j=\max(k_A^*, k_B^*)}^{\min(n_A-1, n_B)} \binom{n_A-1}{j} p_A^{*j} (1-p_A^*)^{n_A-j-1} \cdot \binom{n_B}{j} p_B^{*j} (1-p_B^*)^{n_B-j},$$

where p_A^* and p_B^* denote the subjective probability that a representative individual contributes to the group collective action in group *A* and *B*, respectively. It is assumed that people think both groups are homogeneous in the sense that they order the same subjective probability to each actor's action in the given group (cf. Rapoport and Bornstein 1987). Responsibility aversion is incorporated into the decision rule in the form that, if the procedure described does not result in contribution, then people are still allowed to contribute with a fixed probability.

hood size. The usual assumptions of cellular automata-based research were embraced and, at most, four (south, west, north, east) or eight (also SW, NW, NE, SE) adjacent cells were considered to represent neighbors (Von Neumann or Moore neighbors). As in reality, at the edges of the grid the neighborhood was smaller in size. Empty, adjacent cells at central locations could represent uninhabited buildings, squares, parks, and so on.

MEASURES OF SEGREGATION

Because the central interest of the study is the relationship between structural configurations and the likelihood of conflict, it is important to describe the network structure with appropriate measures under the model settings. Therefore, I briefly summarize the measurements used in computer simulation.

In the limited scope of simulations, ties connect two adjacent cells. Density was measured by the proportion of ties connecting two nonempty cells. This measure of density approaches being a simple quadratic function of the proportion of nonempty cells as grid size increases to infinity, regardless of the definition of neighborhood.¹⁵

There are two (groups of) widely accepted indexes to measure the relative density of in-group and out-group relations in the empirical literature. The first type measures the extent to which members of one group are exposed only to each other and thus isolated from members of the complementary group. This index is called isolation (or simply clustering) (*I*: Willms and Paterson 1995; ${}_aP_a^*$: Lieberson 1980). The second index measures the extent to which members of one group are exposed to members of the other. This index is called exposure (${}_aP_b^*$: Lieberson 1980) or interaction. In empirical research, these indexes are computed from meso-level data (e.g., group proportions in census tracts). As Grannis (1998) stressed, in this way the indexes provide a biased measure of neighborhood compositions. Individual behavior is influenced mainly by contacts embedded in smaller units of residential structure; hence, tertiary residential-type streets or merely the closest neighbors have to receive explanatory focus. Because the simulations include individual-level data, it is possible to rely on

14. Simulation programs were written in Delphi 3 and are available by request from the author.

15. Denote the grid size by S . The proportion of nonempty cells (population density) is $\pi = (n_A + n_B)/S$. The probability of one cell's being empty is $1 - \pi$, and the same holds for the adjacent cell. Since the two events are not independent (the locations are filled without replacement), in the calculation of the probability that at least one of the cells that the given tie connects is empty it is necessary to subtract the joint probability of the two events, which is

$$(1 - \pi) \frac{(1 - \pi)S - 1}{S - 1}.$$

The probability that a tie connects two nonempty cells is 1 minus the above probability. Therefore, regardless of the definition of neighborhood (Von Neumann or Moore neighbors), the expected density of network relations $E(\delta)$ is obtained as

$$E(\delta) = 2\pi - 1 + (1 - \pi) \frac{(1 - \pi)S - 1}{S - 1}.$$

micro-level indexes that are close in interpretation to the empirical isolation and exposure measures.

The proportion of fellow ties (from all nonempty relations) will be used as an index of segregation (clustering). This measure is closely related to the individual f_i values. As in the empirical isolation index, high values indicate high levels of clustering. As grid size increases to infinity, the expected proportion of fellow ties approaches the sum of squares of the group proportions.¹⁶ If a grid is more clustered than another one under the Von Neumann neighborhood definition, it does not mean that this grid is also more clustered under the Moore neighborhood definition. A striking example is a chessboard-like settlement in which black and white fields represent members of the two groups. In such a residential structure, the segregation index is 0 if neighborhood is defined by Von Neumann neighbors, but it is close to the average level if neighborhood is defined by Moore neighbors.

Similarly, the proportion of opposite ties connecting two individuals from the competing groups could be used as an index of exposure. This measure is closely related to the individual g_i values. High values of exposure indicate high levels of mixing. It is important to note that extreme mixing is not equivalent to a random residential structure. The proportion of fellow and opposite ties (segregation and exposure) always sums to 1. The constructed segregation and exposure indexes fulfill the proposed criteria and are appropriate for the simulation analysis based on complete information. In the next examples, clustering will be indicated by the value of the segregation index.

THE EFFECT OF SEGREGATION UNDER DIFFERENT NEIGHBORHOOD DEFINITIONS AND DECISION RULES

This section aims to provide precise predictions about the effect of segregation on the expected likelihood of conflict under different models of individual decision making. In the simulations, structurally embedded IPG games were played between two groups of equal size. A 10×10 grid was considered, in which 90% of the cells were inhabited; hence, there were 450 members in both groups. In each decision model, population was assumed to be homogeneous in the sense that every player used the selected decision rule. The probability element of each decision rule was fixed to 25% of contribution.

The larger the grid size S , the closer the expected value is to π^2 .

16. The proportion of ties connecting members of the same group will be used as an index of segregation (clustering). For the calculation of the expected proportion of ties connecting two members of the same group, the same argument can be used as for the calculation of the expected proportion of nonempty ties (see footnote 14). Applying this to both groups, it is obtained that regardless of the neighborhood definition, the expected proportion of ties $E(\phi)$ from all nonempty relations is

$$E(\phi) = \frac{\alpha(n_A - 1) + \beta(n_B - 1)}{n_{A+B} - 1}.$$

By enlarging the grid, the expected value gets closer to $\alpha^2 + \beta^2$.

The proportion of opposite ties γ can be used as an index of exposure. The index of segregation (clustering) and the index of exposure sums up to 1. As grid size increases towards infinity, the expected value of exposure gets closer to $2\alpha\beta$.

Figure 3: The Effect of Segregation on the Expected Likelihood of Conflict If Neighborhoods Are Defined Differently

NOTE: In confirmation pressure condition, $b = 2$, $s = 1$. In normative pressure condition, $b = 1$, $s = 2$. Other parameter values are $v = 5$, $e = 2$, $c = -1$, $d = -5$, $t = 2$. The minimal contributing set is 113 members (25%) in both groups.

Before discussing the effects of segregation and individual decision rules, I will briefly summarize how the definition of neighborhood influences the expected likelihood of conflict. If the same levels of clustering are considered, the expected likelihood of conflict is usually higher in the Von Neumann neighborhood. Figure 3 shows two comparisons in decision model 1. The examples demonstrate that when considering a sparse and a dense network with the same proportion of intergroup contacts, contributions and intergroup conflict will be more likely in the sparse network. The reasons can be found in the structural conditions of having a dominant strategy. In the confirmation pressure condition, only defection can be a dominant strategy. Furthermore, it can be a dominant strategy only under the Moore neighborhood definition, which means a higher likelihood of peace for this case. If local selective incentives are important, then contribution is more likely to be a dominant strategy in dense networks (cf. equations [1] and [2]).

Curves on Figure 3 and on subsequent figures connect discrete cases of clustering levels. It is possible that when the average number of neighbors is higher, the number of people who have enough neighbors to have contribution as a dominant strategy is smaller. This causes quite a big fluctuation, especially for high and low ranges of clustering. To avoid graphic confusion, averages of expected likelihood of conflict are shown by 0.01 interval sizes in the medium range of clustering and by 0.025 interval sizes for extreme cases. However, it could be interesting to investigate what structural configurations are behind these fluctuations and what are the structural conditions that result in a high likelihood of conflict in a mixed setting or, oppositely, in a low like-

likelihood of conflict in a segregated setting. I will come back to this point in the next section.

Figures 4 and 5 illustrate how different individual decision rules (models 1-4) influence the effect of segregation on the expected likelihood of conflict. The figures demonstrate this effect for two minimal contributing sets. In these examples, Moore neighborhoods were considered.¹⁷ In both figures, the effect of behavioral models are represented separately. On each figure, curves display the expected likelihood of conflict for four combinations of parameter values: whether rewards from the intergroup opposition are *salient* ($v = 5, d = -5$) or *nonsalient* ($v = 3, d = -3$) and whether behavioral confirmation is more important than selective incentives (*confirmation pressure* condition; $b = 2, s = 1$) or not (*normative pressure* condition; $b = 1, s = 2$). Values of other parameters were fixed in all cases ($e = 2, c = -1, t = 2$).

Figures 4 and 5 show that segregation has a crucial effect on the expected likelihood of conflict in the normative pressure condition.¹⁸ Salient payoff parameters are always associated with a higher expected likelihood of conflict. This effect is never as crucial as the difference between the confirmation pressure and normative pressure conditions. This is not surprising since social incentives are originated from network relations; meanwhile, payoff parameters of the IPG game are independent from social structure. If contribution can be a dominant strategy ($s > b$), then the relationship between segregation and the expected likelihood of conflict is best described by a steep S-shape curve. In the normative pressure condition, clustering has a crucial effect on conflict in a certain critical range. This range *ceteris paribus* moves to the right (compare Figures 4 and 5) if the minimal contributing set for collective action is higher, which means that the overall likelihood of conflict is always smaller. Under certain conditions, there is no critical range. There are examples in which peace is expected with certainty even in a grid of maximum clustering (cf. confirmation pressure on Figure 5).

Within Figures 4 and 5, comparisons can be made between the effects of segregation under different decision models. The segregation effect somewhat increases and the critical range of clustering decreases as we go toward models with more rigid behavioral assumptions. In the low ranges of clustering, the expected likelihood of conflict is lower if a rigid decision rule is applied. In these cases, peace can be achieved more easily if the community consists of "rational" individuals with extensive information attainment. This success of calculative action can be explained by "negative" block recruitment. In the high ranges of clustering, the opposite process (positive block recruitment) can be traced. In the normative pressure condition, more and more people will have a dominant strategy (and a dominant reaction) of contribution in a

17. In model 4, we assumed both p_A^* and p_B^* to be 0.25 (cf. footnote 13). Responsibility aversion is incorporated in the decision rule in the form that if the procedure described does not result in contribution, then people are still allowed to contribute with a 25% chance.

18. In the confirmation pressure condition, contribution cannot be a dominant strategy (cf. equation [1]). In these cases, the expected likelihood of conflict is smaller. If $b = 1$ and $s = 2$, then contribution is a dominant strategy for individual i , if $g_i = 0$ and $f_i \geq 3$; or if $g_i = 1$ and $f_i \geq 5$. If rewards from the intergroup opposition are salient ($v = 5, d = -5$), then not to contribute is a dominant strategy for individual $i \in A$, if $f_i = 0$ and $g_i \geq 3$; or if $f_i = 1$ and $g_i \geq 4$; or if $f_i = 2$ and $g_i = 6$. For nonsalient payoffs, not to contribute is a dominant strategy for individual $i \in A$, if $f_i = 0$ and $g_i \geq 2$; or if $f_i = 1$ and $g_i \geq 3$; or if $f_i = 2$ and $g_i \geq 5$.

Figure 4: The Expected Likelihood of Conflict by Clustering If the Minimal Contributing Set Is 113 Members

NOTE: Curves *A* and *B*: salient, curves *C* and *D*: nonsalient rewards of intergroup opposition. Curves *A* and *B*: confirmation pressure condition, curves *C* and *D*: normative pressure condition. Results from decision models 1 and 2 are above, and results from decision models 3 and 4 are below.

Figure 5: The Expected Likelihood of Conflict by Clustering If the Minimal Contributing Set Is 226 Members (50% + 1)

NOTE: Curves *A* and *B*: salient, curves *C* and *D*: nonsalient rewards of intergroup opposition. Curves *A* and *B*: confirmation pressure condition, curves *C* and *D*: normative pressure condition. Results from decision models 1 and 2 are above, and results from decision models 3 and 4 are below.

segregated network. These two processes of block recruitment result in steeper curves on the figures.

However, curves get only slightly steeper. The processes discussed above are only present in some networks. In most possible network structures, very few individuals have a dominant reply of any order. This implies that assumptions on individual consciousness and local information are not crucial to determine segregation effects on conflict. However, in the next section it will be demonstrated that, in some specific structures, more rigid assumptions about rationality definitely change predictions.

ANOMALIES: WHEN SEGREGATION DOES NOT HAVE THE PREDICTED EFFECT

In this section, I use examples to illustrate when rational consciousness and access to additional information make a significant difference for our model predictions. I also provide an explanation for the fluctuations in Figures 4 and 5. These curves are constructed by connecting discrete data points. One data point shows the expected likelihood of conflict under a given level of clustering. There is a high variation of how many network configurations belong to the same level of clustering. Furthermore, the expected likelihood of conflict might be very different for two networks with the same level of clustering. Obviously, segregation is not the only network characteristic that influences the likelihood of conflict between groups. As a short illustration, I will deal with the relevance of bridges, minority hostages, and subgrouping.

Bridges are believed to be of central importance in social network analysis (Granovetter 1973). Chain reactions in collective action also require bridges that link socially distant actors (Macy 1991a). A bridge is defined as a connection between otherwise separated units or subgroups of the network. In the intergroup context, bridges connect otherwise separated portions of the same group. The analysis here shows that bridges do not always help to spread contribution or defection and sometimes play no role in intergroup conflict. Whether bridges play a brokerage depends on the importance of social rewards, the width of the bridges, and the environment of bridging ties. The size of social rewards determines which compositions of the individual neighborhood would allow dominant strategies or replies. Consider the normative pressure condition of Figures 4 and 5 with the same parameter values. The first three network segments in Figure 6 are examples of a low level of clustering. In these segments, a single bridge, a double bridge, and a double bridge with bridgeheads (perceptors) are represented in a residential setting in which network ties are assumed to exist between Moore neighbors.

The examples demonstrate that under the given parameter conditions, a single bridge “does not make a summer” (cf. McAdam 1986; McAdam and Paulsen 1993). If mediators are not alone, at least they will be active contributors to collective action. However, they can only influence the connected subgroups if sufficient people receive their message. That is, bridges are capable of transmitting contribution incentives if they are “wide” enough and if bridgeheads are built to receive and forward these incentives. Figure 6 gives an indication of how a flow of contribution can be established

Figure 6: Examples of a Single Bridge, a Double Bridge, and Bridgeheads (above) and Suppression of Collective Action by Minority Hostages (below)

NOTE: A white X denotes a dominant strategy of contribution, a white / stands for a dominant reply of a first order, and a white \ indicates a dominant reply of a higher order.

between loosely structured subgroups that are connected by wide bridges and bridgeheads if the local common knowledge rule (model 3) is applied.

Another central issue in social network analysis is the role of structural holes (Burt 1992). In the intergroup context, structural holes are redefined as empty or minority connections in a local environment that is dominated by one group. Empty cells in a homogeneous neighborhood do not harm contribution or defection unless there are not many of them. In a dense structure, abandoning some ties and creating structural holes have low marginal influence on contribution, since dominant strategy and reply are more dependent on the homogeneity than on the size of the neighborhood. However, if structural holes are filled with minority "hostages," then they form a serious threat to contribution. If they have a central location, they can nip collective action in the bud. As an example, consider the normative pressure condition with the same parameter values as in previous figures. In this case, minority hostages have a good chance to suppress collective action if they are not standing completely alone (see the network on the bottom right of Figure 6). The network on the bottom left of Figure 6 indicates a situation in which the direct influence of a single individual is maximal (all of the neighbors have a dominant reply of contribution). The feature in the middle of the second row shows that contribution is suppressed if a structural hole is inserted at a central location.

For the discussion of anomalies, I would like to emphasize another important point: the role of subgrouping. What helps intergroup collective action more: many small, cohesive, but isolated subgroups or a few large, loosely connected subgroups? The answer depends on the behavioral assumption we apply. If people can recognize only their dominant strategies or have very limited local information (model 2), then isolated but dense subgroups are more efficient in the establishment of collective action. However, if people are capable of assessing high-quality information about their neighbors (model 3), then large, loosely connected subgroups are more effective for

Figure 7: Expected Likelihood of Conflict in Two Networks with Equal Level of Clustering

NOTE: Expected likelihood of conflict is indicated for salient intergroup rewards in the normative pressure condition with a minimal contributing set of 13 members (Moore neighborhood). Left side: network with small, cohesive subgroups; right side: network with a large, loosely connected subgroup.

mobilizing group members. Individuals at the periphery of the large group can be convinced as participating in collective action. However, key contributors are always necessary to start mobilization. Two networks with an equal level of clustering are represented in Figure 7 as an example. In the network on the left, there are two small, cohesive subgroups of black cells. In the network on the right, there is a loosely connected large subgroup. The expected likelihood of conflict is larger in the left structure under model 1 but smaller under the assumptions of other behavioral models.

DISCUSSION

The aim of this study was to construct a theoretical model of intergroup conflict that is based on the interdependency of individual decisions and that integrates sociological insight in the analysis. The latter was achieved by focusing on social incentives that influence individual decisions besides the rewards from the intergroup context. Social incentives are transmitted through social ties, and consequently the network structure has a strong impact on the emergence of group conflicts.

Previous research found that intergroup competition, the local assurance process, and the application of selective incentives are possible structural solutions to social dilemmas. By integrating these different ideas into a general model, I showed that a different social dilemma might occur in which overall contribution traps the groups in a mutually harmful outcome. Further investigation of the study concerned structural conditions that can help to avoid lethal conflicts. Particular attention was paid to the

direct and interaction effects of network segregation. Results indicate that segregation is likely to increase the likelihood of conflict, but not under all circumstances. Depending on other parameters, certain ranges of clustering are decisive in determination of the outcome of intergroup competition. This result might have implications for real conflict management, for example, residential policy. In general, the model predicts a strong positive effect of segregation if normative pressure is more important than confirmation pressure of neighbors and friends. This effect was found in all the behavioral models. It was demonstrated that, by assuming a higher consciousness of individual decisions and better access to local information, the segregation effect becomes stronger. On the other hand, more rigid assumptions about "rationality" made a difference only in certain network configurations.

Possible applications of the model include ethnic conflict in neighborhoods, villages, or cities under different residential structures; conflict between football supporters in a stadium or between pupils in a classroom under different seating patterns; or participation in voting in two-party democracies. Empirical evidence from different areas provides support for many of the model predictions. For instance, residential segregation and separate education were found to be highly responsible for repeated conflict in Northern Ireland (Whyte 1986). In studies of voting behavior, the classical work of Tingsten ([1937] 1963) has shown that socialist party choice is disproportionately more likely in working class districts. Further evidence of a nonlinearly increasing effect of segregation on voting was found by Butler and Stokes (1974) and Ragin (1986).

The model provides new insight into intergroup processes and has many important implications. On the other hand, there is valid concern about the limited applicability of the model to empirical situations. The ecological validity would be enhanced significantly if some of the parameter values could be based on empirical data. However, the measurement of payoff parameters (especially social selective incentives and behavioral confirmation) is highly problematic. Numeration of public good rewards (e.g., social identity, nationalistic pride) is also often impossible. Furthermore, the model builds on far too simple assumptions to be competent for the description of complex situations in reality. I will mention some of the limitations here. The focus on single-shot games results in a complete neglect of time. In the model, simultaneous actions of individuals are assumed, although in many empirical situations there are long-term delays, and people can obtain information about the decision of others. The introduced dominant reply and common-knowledge decision rules, however, could also be interpreted as decisions with a certain time lag. By this interpretation, the model brings new insight also to the threshold models of collective action (Granovetter 1978; Oliver, Marwell, and Teixeira 1985; Macy 1991a; Gould 1993a; Chwe 1999). More strikingly, this study did not attempt to include the history of intergroup relations, which is the root of many empirical conflict situations. The neglect of history can be relaxed in subsequent research by iterating the game over time. For instance, the effectiveness of local trigger strategies can be analyzed. Examples of such strategies are numerous in human history.

In the long run, group boundaries may also change or become less visible. Assimilation, for example, can be considered as an optimal long-run strategy to avoid the emergence of harmful conflicts between groups. Individual differences of many forms

can also be incorporated in advanced model building. Examples are the possible distinctions between leaders and followers (asymmetric neighborhood games), aggressive and peaceful players, or social and egoistic types (with different perceptions about the relations between payoff parameters). Payoff restrictions of the present model (e.g., zero reward for peace) and assumption of linear utility functions can be easily relaxed. Besides these possible developments, a major proceeding can constitute a dynamic model in which the feedback effect of conflict is incorporated on the residential structure. Despite these restrictions, the model was able to emphasize the effect of residential structure, social rewards, and individual decision procedures on the likelihood of group conflict that may help conflict resolution in empirical situations along these lines.

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