

Dynamics of Political Polarization

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This article accounts for two puzzling paradoxes. The first paradox is the simultaneous absence and presence of attitude polarization—the fact that global attitude polarization is relatively rare, even though pundits describe it as common. The second paradox is the simultaneous presence and absence of social polarization—the fact that while individuals experience attitude homogeneity in their interpersonal networks, their networks are characterized by attitude heterogeneity. These paradoxes give rise to numerous scholarly arguments. By developing a formal model of interpersonal influence over attitudes in a context where individuals hold simultaneous positions on multiple issues, we show why these arguments are not mutually exclusive and how they meaningfully refer to the same social setting. The results from this model provide a single parsimonious account for both paradoxes. The framework we develop may be generalized to a wider array of problems, including classic problems in collective action.

INTRODUCTION

In this article we provide a parsimonious account for two puzzling empirical outcomes. The first is the simultaneous presence and absence of political polarization—the fact that attitudes rarely polarize, even though people believe polarization to be common. The second is the simultaneous presence and absence of social polarization—the fact that while individuals experience attitude homogeneity in their

interpersonal networks, these networks retain attitude heterogeneity overall. We do this by investigating the joint effects of personal influence on attitudes and social relations.

The first paradox emerges most crisply in the contrast between the observations of pundits and expert knowledge. For example, lay observers routinely assume that the United States is increasingly politically polarized, but this belief contrasts rather sharply with the scholarly evidence on political polarization (DiMaggio, Evans, and Bryson 1996; Evans 2003; Fiorina, Abrams, and Pope 2005). The evidence suggests that, aside from a small set of takeoff issues, “the policy preferences of different social groupings generally move in parallel with each other” (Page and Shapiro 1992:288). In general, on moral, social, economic, and foreign-policy issues, there is little evidence of increasing polarization.

Against this background, why do pundits believe that attitudes are increasingly polarized? One answer is trivial: people attend to the wrong population, focusing only on the attitudes of political elites. The second answer is more substantial: sometimes, typically for very short periods, some issues become the focus of intense attention and consequently appear to radically polarize Americans—for example, attitudes toward abortion, gays in the military, or the Iraq war. We call these takeoff issues.

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Collective attention to the takeoff issues can distract from the larger number of issues in which attitudes remain parallel. Individuals thus perceive the macrostructure as polarized despite the fact that in the context of a population of issues, polarization is absent.

The second paradox emerges most crisply in the contrast between everyday experience and expert knowledge. The everyday experience of Americans is consistent with the idea that their social world is polarized. Here as well, one observes a complex duality. On one hand, our ordinary experience is that the people we talk to about issues salient to us have beliefs similar to ours on those issues. Sociologists account for this phenomenon by noting the macrolevel dynamics that lead to persistent race, ethnic, and social class segregation, thereby enhancing the probability of contact with categorically similar individuals (Abramson and Tobin 1995; Jargowsky 1996; Massey 1996). Since there is some relationship between attitudes and social background, the fact that socially similar individuals are more likely to interact is seen to yield segregated social and ideational communities. On the other hand, there has been no real change in the relationship between attitudes and attributes (DiMaggio et al. 1996; Evans 2003; Fiorina et al. 2005)—that is, the social background determinants of attitudes are as weak today as they were 50 years ago. These dual views give rise to an asymmetry between lived experience and “sociological reality.” This asymmetry is a consequence of the fact that people interact with a limited number of others and talk to far fewer about political issues important to them. Thus, while individuals experience attitude homogeneity, the larger group in which they are embedded retains attitude heterogeneity.

To study the simultaneous evolution of political views and patterns of social interaction, and thus observe the ideational and structural conditions that underpin those rare moments in which political and social polarization occur, we develop a formal model of interpersonal influence over attitudes in a context where individuals hold simultaneous positions on multiple issues—for example, abortion, highway construction, campaign reform, and pollution abatement—just as real people do. In our model, social-structural dynamics operate to enhance the probability that people with similar atti-

tudes will interact with others with similar attitudes, but actors also interact with those whose positions on attitudes are different. Actors are most likely to interact around the issue that is most salient to them, choosing that topic over topics they have little interest in. These conversations provide the foundation for personal influence, which may operate to bring individuals closer together or induce greater distance.

To anticipate the main results—obtained by studying the model through computer simulation—we observe that the simultaneous presence and absence of political polarization may be accounted for by the fact that most attitudes are not polarized, while some attitudes at some times attract disproportionate attention and become polarized. The simultaneous presence and absence of social polarization arises from the fact that people discuss important issues selectively. They thus experience homogeneous environments, although the actual attitude distribution of those around them is heterogeneous.

In more general terms, we show that simple mechanisms of social interaction and personal influence can lead to both social segregation and ideological polarization. Along the way, we identify the social dynamics that underlay issue takeoff and describe one of the structural determinants of ideational change. Because the model operates on attitudes that individuals hold in the context of “tangible” social relations within an observable network structure, the framework we develop is amenable to generalization to a diverse set of problems, including classic problems in collective action.

The structure for this article is straightforward. We first consider the literature(s) on ideological and social polarization. Building on empirical findings arising from public opinion research and studies of group dynamics, as well as previous models of social influence, we describe a model for political influence in the context of interpersonal relations. We then describe simulation results from this model, first for exemplary cases as illustration and subsequently for the entire population of observed outcomes. In the discussion we relate these results back to our empirical puzzles. Finally, we generalize the model to a wide array of contexts, including those relevant for collective action.

POLITICAL AND SOCIAL POLARIZATION IN CONTEMPORARY AMERICA

Scholars who engage the political polarization debate tend to argue that while political elites and party activists are increasingly polarized, ordinary citizens are not. Fiorina and colleagues (2005:ix), for example, suggest that

Americans are closely divided, but we are not deeply divided, and we are closely divided because many of us are ambivalent and uncertain, and consequently reluctant to make firm commitments to parties, politicians, or policies. We divide evenly in elections or sit them out entirely because we instinctively seek the center while the parties and candidates hang out on the extremes.

While scholars tend to agree that elite and activist polarization has increased,¹ they also suggest that public opinion polarization has not followed suit, even though elite polarization has been accompanied by a parallel rise in wealth disparity in the population (McCarty, Poole, and Rosenthal 2006). Whether or not one looks for polarization across all Americans or tracks changes within population subgroups, empirical data suggest that there is no evidence for polarization, overall, except for some take-off issues. Considering the population as a whole, DiMaggio and colleagues (1996:715) show that

Americans have become more united in their views on women's role in the public sphere, in their acceptance of racial integration and in their opinions on matters related to crime and justice. These trends represent movement toward consensus on

liberal views and racial integration and gender and on tougher positions on crime. By contrast, Americans have become more divided in their attitudes toward abortion and, less dramatically, in their feelings towards the poor.

Evans (2003) concurs, although he finds new evidence of increasing polarization on attitudes toward sexuality. In considering changes within population subgroups, most empirical work shows that intergroup polarization is mild. Specifically, with respect to age, gender, education, region, and religious affiliation we observe stability or even instances of depolarization in intergroup differences. In fact, the evidence suggests that variance and bimodality (two measures commonly used for assessing polarization) have not increased for most attitudes. Likewise, attitudes are not now more constrained by categorical group memberships—the attitudes of high school graduates and college graduates, men and women, the old and the young, and so on are not increasingly dissimilar.

In the same vein, Fiorina and colleagues (2005) dispute “The Myth of a Polarized America” and suggest that the “culture war” commonly conjured up in the media is a fictive construction. According to their analysis, there is no *popular* polarization, but simply *partisan* polarization—“those who affiliate with a party are more likely to affiliate with the ‘correct’ party today than they were in earlier periods” (p. 25).² It is the political elite and a small number of party activists that are polarized.³

Without getting lost in the details, we can summarize the three main findings upon which scholars agree. First, while American public opinion since 1990 is increasingly divided on abortion, and more recently on sexual morality and the war in Iraq (Baker 2005; DiMaggio

¹ This may be more true for the right than for the left. For the right, a soft ideological realignment of the party elite, initiated under Reagan as a consequence of his economic and social programs, was radically accelerated by a new cohort of strongly conservative Republicans from the South who replaced the moderate wing of the Republican Party (Wilcox 1995). The collapse of the Democratic Party in the South led the party as a whole to appear more liberal, even as it was pursuing traditional, centrist policy agendas. These dynamics led to a decline of bipartisanship in Congress (Poole and Rosenthal 1997) and contributed to the further polarization of party activists through both persuasion and mechanisms of selective recruitment and deroruitment (Saunders and Abramowitz 2004).

² Likewise, Bartels (2000) shows that the impact of partisanship on voting behavior has grown over time.

³ Of course, others disagree. For example, Abramowitz and Saunders (2005, abstract) argue that divisions between red states and blue states, religious voters and secular voters, and Democrats and Republicans “are not confined to a small minority of elected officials and activists—they involve a large segment of the public and they are likely to increase in the future as a result of long-term trends affecting American society.”

et al. 1996; Evans 2003; Shapiro and Bloch-Elkon 2006), we observe stability and even depolarization on all the remaining issues. Second, we do observe some growth in *partisan* polarization: those who are politically active, who identify with a party or place themselves on the liberal/conservative continuum, tend to have more extreme positions than the rest of the population. Third, we do not observe *popular* polarization along the lines of gender, age, education, race, region, or religious denomination (although church attendance is associated with polarized attitudes). With respect to these demographic and social categories, the parallel public still holds for the vast majority of issues.

Despite these findings, people experience the world as more polarized than it really is. This leads pundits to claim increasing polarization, inducing the asymmetry between lay and expert opinions (Abramowitz and Saunders 2005; Greenberg 2004; Kohut et al. 2000). As indicated earlier, making sense of this asymmetry is one contribution of this article. Our account hinges on the fact that one or two issues, for very short periods of time, monopolize debate and emerge as highly polarized.

While it is a cultural invariant of all societies that people tend to interact with those who are similar to them (McPherson, Smith-Lovin, and Cook 2001), changes in the overall level of social segregation—and the lines along which segregation is organized—are relevant to understanding the dynamics of everyday interaction and personal influence. Social structural changes that give rise to segregation or integration shape interaction dynamics by shaping the probability of encounters. Against this background, recent studies on social inequality and segregation provide a detailed picture of the trends in spatial segregation with respect to class, life course, race, and ethnicity that have characterized American society during the second half of the twentieth century (Logan, Stults, and Parley 2004; Massey 1996). From the 1970s on, we observe a rise in residential segregation by income and social class (Abramson and Tobin 1995; Jargowsky 1996), and in some cases the spatial structuring of affluence and poverty has been magnified by race and ethnic differences (Massey and Denton 1989). In addition to the persistence or even amplification of traditional patterns of segregation, in the last decades scholars have reported new forms of

segregation arising from choices and lifestyles. For example, young single adults increasingly concentrate in center cities, and homosexuals have disproportionately relocated to a handful of large cities.

As spatial segregation has remained stable or even increased, there is also evidence that the integrative role of voluntary associations is less salient today than in the relatively recent past. First, there is a general sense that membership in such associations is declining. More importantly, even when not in decline, voluntary associations are more homogeneous with respect to social class, race, ethnicity, and religious orientation today than in the past. Skocpol (2003), for example, argues that voluntary groups have been largely transformed into advocacy groups and nonprofit organizations, which are directed by professionals oriented to lobbying activities. One of the byproducts of a rich associational life—the possibility of building social relations with a broad, heterogeneous set of other people—is therefore reduced (Putnam 2000).

Persistent spatial segregation and increased associational segregation provide the sociological foundation for the idea that today, more than in the past, people talk to others who are categorically more similar to themselves. This lays the structural foundation for the everyday experience in which the people we talk to share our attitudes. At the same time, it is also true that the relationship between categorical attributes and attitudes is no stronger today than in the past; people hold contradictory and inconsistent attitudes, and, on many issues, people have only weak opinions at best. While our conversations tend toward homogeneity (because we discuss only a subset of possible political issues with a subset of possible interlocutors), the networks we are embedded in retain heterogeneity of interest on diverse attitudes.

In sum, with respect to ideational dynamics, polarization on one issue need not lead to polarization on all issues. With respect to social segregation, there may not be a mapping between social and attitudinal polarization. In fact, as we will suggest, such a mapping is unlikely. The same dynamic that leads to an intense focus on a single issue—and consequent social, structural, and attitudinal polarization—maintains attitude heterogeneity on others. These twin dynamics make possible the experience of

homogeneity in individual discussion networks within heterogeneous social structures.

MODEL FRAMEWORK

Empirical research has greatly contributed to our understanding of interpersonal influence (Katz and Lazarsfeld 1955). This research has shown that social proximity and frequent interaction usually lead to attitude conformity: from acquaintances to intimates, individuals' opinions are shaped by seemingly minor interactions arising from diverse social contexts (Huckfeldt and Sprague 1995; Zuckerman 2005). While small-scale interactions are believed to cumulate into macrolevel outcomes, empirical studies focusing on the microsphere of personal contacts provide a fragile foundation for a direct appreciation of any macro effect. We develop a formal model of social influence that allows us to link patterns of microinteraction with macrostructural outcomes.

We build on the substantial contributions of previous scholars who have studied processes of social influence and opinion change through analytical and simulation models. Mainly focused on the generation of group consensus, the earliest models of interpersonal influence led to universal agreement (De Groot 1974; French 1956; see also Abelson 1964), while subsequent models reached equilibrium outcomes different from full consensus (Abelson 1979; Hegselmann and Krause 2002; Marsden 1981; Nowak, Szamrej, and Latané 1990). In this vein, Friedkin and Johnsen (1990; Friedkin 1999) integrate previous work on opinion formation with recent developments in network analysis in a general framework—social influence network theory—which is consistent with theories of both social conformity and social conflict and can thus account for patterns of disagreement in a group.

Models that involve dynamics of interpersonal influence differ broadly in their scope, ranging from the study of dynamics of ideological polarization (Hegselmann and Krause 2002; Macy et al. 2003; Nowak et al. 1990), collective action (Kim and Bearman 1997), and collective decision-making (Marsden 1981) to the persistence of cultural differences (Axelrod 1997) and political disagreement (Huckfeldt, Johnson, and Sprague 2004).

Our goal has been to deploy a model of interpersonal influence sensitive to dynamics of political discussion, where actors hold multiple opinions on diverse issues, interact with others relative to the intensity and orientation of their political preferences, and through evolving discussion networks shape their own and others' political contexts. In the model, opinion change depends on two factors: the selection of interaction partners, which determines the aggregate structure of the discussion network, and the process of interpersonal influence, which determines the dynamics of opinion change. In the next section, we organize the description of the model around these two elements. Table 1 summarizes the simulation algorithm.

STRUCTURE AND CHOICE IN INTERACTION

In general, people interact with people who are similar to them. Rich women marry rich men proportionally more often than poor women do. Republicans are more likely to know Republicans than Democrats. Overweight individuals are more likely to eat at fast-food restaurants than thin people and are therefore more likely to meet other overweight individuals. There are strong pressures toward homophily in social relations. At the same time, it happens that overweight persons meet slim ones, Democrats know Republicans, and rich people fall in love with not so wealthy ones. Despite a clear tendency toward homophily, people are also in touch with people different from them. Social similarities affect patterns of interaction, but they do not completely determine them. Accordingly, in our model, actors can accommodate their preferences and enforce homogeneity in the process, but room for casual encounters with new and different actors is always present.

Previous scholars have been sensitive to the role of social structure in shaping social influence. Most often, the intensity of influence is seen to be a function of actors' structural proximity, modeled as a matrix of influence coefficients that vary across pairs of actors. An actor's opinion is then adjusted to other actors' opinions proportional to these influence coefficients (DeGroot 1974; French 1956). In this approach, every actor is potentially affected, albeit with different intensity, by the opinion of all other actors

Table 1. Outline of the Simulation Algorithm**Initial Conditions:**

100 actors
 4 issues; issue interest \sim normal ($\mu = 0$, $\sigma = 33.3$); interest range (-100; +100)
 Initialize perceived ideological distance $\lambda =$ mean Euclidean distance among actors

Iteration Flow:*Selection of interaction partners*

At each iteration for each actor:
 Random sample of potential interlocutors \sim to the overall level of interest
 Draw from the sample the actual interlocutors with $p = 1 - \lambda$

Process of interpersonal influence

For each pair of actors previously selected:
 Select the issue for discussion
 Compute the change for each actor based on their interest on the issue
 Determine the direction of change according to the sign of the issue
 Update actors' level of interest
 Update actors' perceived ideological distance with the current/actual distance
 Save all necessary information
 (Repeat 500 times)

(Friedkin and Johnsen 1990; Marsden 1981) or by a subgroup of similar people (Hegselmann and Krause 2002).

Other models instead explicitly consider the presence of a spatial context (Axelrod 1997; Nowak et al. 1990) or a tangible relational structure (Kim and Bearman 1997; Marsden 1981) within which individuals are embedded and discuss the relation between structural dynamics and attitude change. In both cases, individuals are influenced exclusively by those to whom they are connected in a relational structure or context that remains stable over time. In a similar model, Huckfeldt and colleagues (2004) introduce some freedom in the choice of interactants by allowing actors to have multiple contexts and to search for the more agreeable discussants.

To make our model more sensitive to empirical evidence arising from studies of public opinion and political discussion networks, we allow actors to select their discussion partners on the basis of their ideological similarity and interact more or less often according to their overall interest in political matters. Instead of fixing actors into a predetermined, stable network structure, we induce actors' discussion networks from the dynamics of local interactions in which they are involved. The political network

structure is thus shaped through patterns of interaction and evolves over time.⁴

An extremely fruitful distinction in the basic features of the system responsible for homophily is between "the individual level propensity to choose similar others (choice homophily) and the composition of the groups in the system, which dictate the possibilities for friendship choice (induced homophily)" (McPherson and Smith-Lovin 1987:371). Empirical studies suggest that a focus on choice homophily is warranted, as individuals exert significant freedom in selecting among the members of their social groups those with whom they want to talk about important matters and political issues (Huckfeldt and Sprague 1995). In our model, actors learn about other actors' attitudes through interaction. This enables actors to map their ideological distance with respect to others. Actors then adjust their future interactions in order to reduce conflict and maximize exposure to actors more similar to themselves. While ideological affinity does not drive all encounters—since actors

⁴ Similarly, Carley (1991) proposed a dynamic model in which the probability of interaction changes over time and is the function of the amount of information shared by the actors.

are not stuck in fixed relationships—it does affect the unfolding of personal relations.

In sum, the likelihood of actors getting into a discussion with others depends both on their personal level of political commitment and on the level of ideological affinity they have with other people. First, the more one is committed to a cause, the more likely one is to start a conversation. Second, actors tend to interact with others who are ideologically similar to them. Third, actors have some degree of freedom in deciding with whom they discuss their ideas and thus change interlocutors from time to time. Fourth, through interaction, actors acquire information about the ideological positions of others and adjust their future behavior accordingly.

Despite the necessary simplification that any analytical formalization imposes, the model deployed here retains the multiple and sometimes contradictory dynamics described above. Specifically, the model operates with 100 actors ($N = 100$), each of whom holds an opinion on four different issue-domains (hereafter referred to simply as issues). In this framework, actors may be in favor of or against a social policy associated with each issue. We capture intensity of sentiment, either positive or negative, by values that are allowed to range from -100 to 100 .⁵ An interest of 0 indicates that the actor has no interest on the issue. Interest increases as values move toward either 100 or -100 . The overall interest distribution follows a normal distribution centered on 0, with a standard deviation of 33. The four issues are independent.⁶

In this way, we model issue interest and extremity of opinion with a unique parameter. Although analytically distinct, these two aspects are empirically related: the more interest people have in an issue, the more people tend to have extreme views (Baldassarri 2007). There are cognitive and motivational reasons for this.

⁵ Algebraically, it is the same as modeling two qualitatively different features of interest, its arithmetic *sign* (+ or $-$) and its *strength* (ranging from 0 to 100).

⁶ We investigated a wide range of alternative models in which we allowed for correlations between issues. With respect to the argument and the main results presented in the article, there is no difference between a model in which issues are independent and one in which issues are correlated.

Attitude involvement induces biased information-gathering strategies that are likely to reinforce one's opinion and make it more extreme. In turn, attitude extremity makes it more accessible, thus important to individuals (Lavine, Borgida, and Sullivan 2000). On this ground, extremity of opinion can be regarded as a good proxy for issue interest and vice versa.

We now describe the process of social selection that guides the dynamic formation of discussion dyads. As indicated earlier, two aspects are relevant here. On one hand, actors' overall levels of interest affect their frequency of interaction; on the other hand, ideological affinity shapes the selection of specific discussants. With respect to ideological similarity, actors are not universally knowledgeable about the attitudes of those around them. Their knowledge about other actors' opinions depends on the history of their personal interactions (Huckfeldt et al. 2004). For each pair of actors, we therefore distinguish between their real ideological distance ($d_{ab}^{(t)}$) and their perceived ideological distance ($\lambda_{ab}^{(t)}$). The latter is updated to the former when actors interact. Specifically, we define the ideological distance $d_{ab}^{(t)}$ between actor a and actor b at time t as the Euclidean distance in the four-dimensional space of the four issues i , normalized to a range 0 to 1 by dividing for the maximum of all pairs:

$$d_{ab}^{(t)} = \frac{\sqrt{\sum_{i=1}^4 (a_i^{(t)} - b_i^{(t)})^2}}{\max_{\{a,b\} \in N} \left[\sqrt{\sum_{i=1}^4 (a_i^{(t)} - b_i^{(t)})^2} \right]} \quad (1)$$

The perceived ideological $\lambda_{ab}^{(t)}$ distance is initialized as the average distance at time 0 (t_0) over all a - b dyads. When actors interact, they acquire information about each other's ideological positions and update their perceived ideological distance to match the actual ideological distance between them. Formally,

$$\lambda_{ab}^{(t)} = \begin{cases} d^{(t_0)} & \text{if actors } a \text{ and } b \\ & \text{never interacted before} \\ d_{ab}^{(t-c)} & \text{if actors } a \text{ and } b \text{ last} \\ & \text{interacted at time } t - c \end{cases} \quad (2)$$

For any pair of actors a and b , the probability of interaction is proportional to their interest and an inverse function of the perceived ideological distance between the two. Combining these two elements, actor a 's chance to interact with actor

b at time t ($P_{ab}^{(t)}$) is proportional to the overall interest of actor a to the overall interest of actor b , and inversely related to the perceived ideological distance ($\lambda_{ab}^{(t)}$) between the two. Formally,

$$P_{ab}^{(t)} = \frac{\eta \times \left[\left(\frac{\sum_{i=1}^4 |a_i^{(t)}|}{4} \right)^2 + \left(\frac{\sum_{i=1}^4 |b_i^{(t)}|}{4} \right)^2 \right] \times (1 - \lambda_{ab}^{(t)})}{100} \quad (3)$$

where $P_{ab}^{(t)} \sim 1$ if both actors strongly agree ($\lambda_{ab}^{(t)} \sim 0$) and all four issues are maximally salient to them, while $P_{ab}^{(t)} \sim 0$ if they strongly disagree ($\lambda_{ab}^{(t)} \sim 1$) or have no interest on the four issues.⁷

While actors a and b have the same probability to interact with each other—interaction is reciprocal!—their respective total number of interactions might differ, due to differences in their overall levels of interest. By conditioning the probability of interaction on actors' overall levels of interest, we create a context in which a few people almost never engage in political matters, some discuss politics sometimes, and others do so more often, thus introducing a realistic feature of population heterogeneity into the model (Delli Carpini and Keeter 1996; Eliasoph 1998).

Finally, with respect to the selection process, note that the process of information updating, by which, after their first, casual encounter, actors a and b 's perceived ideological distance matches their real ideological distance, has a key role in introducing relational historicity into

the selection dynamic. In fact, further interactions are affected by this change in the perceived distance λ_{ab} : positive interactions increase the probability of future (positive) political discussions, while disagreement or conflict reduces the chances of future encounters.

While actors will not pursue disagreement, there are situations in which people happen to have an alternative perspective on relevant aspects of social life. Dog owners are more likely to become friends with neighbors who own dogs, but owning a dog also increases one's probability of contact with neighbors who intensely dislike dogs (after all, even good dogs bark frequently enough to induce complaints from dog-haters). Likewise, community groups mobilize around specific issues that are promoted by other groups, individuals, or local institutions. Those with intense opinions on these issues are more likely to interact than are those without, and so on. It follows that not only similarities but also strong differences can induce social interaction. In fact, the persistence of attitude heterogeneity in discussion networks is well documented empirically. For example, Huckfeldt and colleagues (2004) show that "political disagreement was a common event among citizens . . . even within closely held networks of political communication" (p. 63). Looking at respondent agreement with discussants who support Bush or Gore by respondents' partisanship, they find that "more than one-third of the two party voters report at least one discussant who voted for the opposite party's candidate" (p. 37).

Consequently, in our model, discussions are about the topic in which both actors are most interested. This is true even if they do not share the same view. When actors interact, they select from the portfolio of issues available the issue with the highest joint relevance, defined as the issue for which the sum of a and b 's absolute values is maximum. Specifically:

$$\text{Relevant issue} = i \text{ such that } \max (|a_i^{(t)}| + |b_i^{(t)}|) \text{ for } i = (1, \dots, 4) \text{ at time } t \quad (4)$$

While issue selection is based on the level of interest, actors need not hold the same position. Actors might discuss a certain topic because they have either strongly complementary or strongly competing views on the same issue. Baseball fans, if they sit at the same din-

⁷ Operationally, for each actor at each time period t , we randomly selected from the population a number of potential interlocutors as a function of the actor's overall level of interest. The number of people selected is proportional to the sum of the squared mean of interest over the four issues. Given this set of potential interlocutors, the probability of a discussion taking place is inversely proportional to the perceived ideological distance. The interaction between actors a and b is defined as the outcome of a random draw from a Bernoulli distribution with probability equal to 1 minus the perceived ideological distance between a and b . η is a scaling factor (.005) that limits the number of interactions to a reasonable range. In general, at time 1, actors have between 0 and 6 conversations, while at time 500, 0 to 12.

ner table, will talk about baseball whatever team they root for. Those who care deeply about an issue—the death penalty, global warming, threats to world peace—will also talk about those issues among friends and kin, certainly when they share the same opinion, but also when they disagree. Overall, in our model, actors are more likely to discuss issues they agree on, following from the mechanisms of social selection and information updating previously described. Nonetheless, by selecting discussion issues on the basis of their salience and independently from actors' respective positions, we allow some room for disagreement.

MECHANISMS OF SOCIAL INFLUENCE

Discussion with others about views important to oneself may amplify, reinforce, or reduce commitment to one's beliefs. In fact, most empirical studies of group dynamics and persuasive communication, as shown by Kitts (2006), suggest that while interaction with similar (or liked) others reduces distance, interaction with dissimilar others may increase distance, leading to group polarization. Experimental studies in social psychology suggest three complementary explanations for the "group polarization phenomenon." The *persuasive arguments* explanation suggests that while actors do not originally hold the entire set of arguments in support of their perspective, through conversation, they come to share a broader set of arguments that favor their initial attitudes and thus move toward more extreme positions. The *social comparison* explanation suggests that polarization occurs when group members, through interaction, become aware of the fact that their attitude is shared by a larger group of people than expected, thereby enhancing commitment (Myers and Lamm 1976). Lastly, individuals' attitudes become more

extreme in cases of *repeated attitude expression*, an effect augmented by social interaction (Brauer, Gliner, and Judd 1995). These three mechanisms are consistent with the model deployed here.

Specifically, when interlocutors share the same view, interaction leads to a *reinforcement* of their beliefs. Where discussants differ, either *compromise* or *conflict* can result (Hovland, Harvey, and Sherif 1957). In the case of disagreement, a simple mechanism of dissonance reduction (Festinger 1957; Hedström 2005) shapes whether or not the two parties will move toward a compromise or exacerbate their differences. In real life, conversations usually unfold around a variety of subjects, and this gives one the opportunity to evaluate others' positions on a broad set of issues. If actors have opposite attitudes on a salient issue, their interaction will lead to compromise when compromising reduces dissonance. Likewise, actors will commit to their beliefs when commitment (amplification of conflict) reduces dissonance.

In general, the direction of opinion change depends on interactants' relative positions. Table 2 shows, for a pair of actors *a* and *b*, the four possible combinations of interest orientation (+ +, + −, − −, and − +) and the consequent direction of their opinion change. If actors share the same orientation, interactions reinforce their respective commitments and they end up closer to each other (the distance between them is reduced since actors with lower absolute levels of interest move more than those with higher levels of interest). If they have contrasting views on the focal issue, but share similar opinions on the remaining issues, they compromise by reducing their commitment on the salient issue, thus moving closer to each other. In contrast, if they disagree on other issues, their commitment to the focal issue is reinforced and their opinions diverge further.

Table 2. Directionality of Opinion Change

	a b		a b		a b	
	++	--	+-	-+	+-	-+
			conflict	compromise	conflict	compromise
Change for a	+ Δa_i	- Δa_i	+ Δa_i	- Δa_i	- Δa_i	+ Δa_i
Change for b	+ Δb_i	- Δb_i	- Δb_i	+ Δb_i	+ Δb_i	- Δb_i
Relative Movement	→ ←	→ ←	← →	→ ←	← →	→ ←

We now consider intensity of opinion change. In one modeling tradition, single interactions can radically change individuals' opinions; attitudes are seen as categorical and interpersonal influence induces categorical changes in individuals' opinions, that is, a change in states (Axelrod 1997; Huckfeldt et al. 2004; Watts and Dodds 2007). In contrast, other models—and the model deployed here—assume that opinions are continuous and actors change position by some constant fraction of the distance between actors (Abelson 1964; Marsden 1981). Of course, people may recall conversations in which a sharp argument was enough to change their (or others') mind, but the fact that they remember such events tells us that they are quite exceptional. While people usually do not keep track of the myriad of unperceivable, small attitudinal changes that occur in their everyday lives, it is from this crevice unfolding of incremental tiny modifications in people's attitudes that both stability and change in mass opinions arise.

We model interpersonal influence as bidirectional—both interlocutors change their opinion as a consequence of the interaction—but the magnitude of attitude change depends on their personal level of commitment. Group dynamics and political opinion research both suggest that those least susceptible to influence either hold strong beliefs or are indifferent to the issue at hand. It follows that individuals with moderate interest in an issue are most susceptible to influence (Brauer et al. 1995; Converse 1964; Zaller 1992). Accordingly, in our model people have a low probability of discussing issues of low interest to them, and consequently their opinion on such issues is rarely modified. In contrast, while highly committed people interact frequently with others, their opinions rarely change dramatically. In fact, we model opinion change as inversely proportional to one's level of interest. In sum, changes in people's opinions are incremental and sensitive to their level of interest—the magnitude of change decreases as actors' interest (positive or negative) increases. Formally,

$$\Delta a_i^{(t)} = \mu \times \frac{\|a_i^{(t)} - b_i^{(t)}\|}{|a_i^{(t)}|} \text{ for } a_i^{(t)} \neq 0 \quad (5)$$

Where μ is a scaling factor (.1) that restricts the range of attitude change given an interaction. For

instance, the maximum change is 19.9 points, when a_i is ± 1 and b_i is ± 100 .

In sum, we represent opinion change as an interpersonal process, where the intensity and direction of the change depend on the relative positions of discussion partners. Intensity is a function of the difference in the level of interest of the two interlocutors. Direction is determined by the signs of their preferences. It may strengthen or weaken an actor's interest in a specific issue.

To exemplify the process of interpersonal influence captured in our model, we consider three simple scenarios. In Scenario 1, actor a 's interest in the four issues is respectively (50, -23, 6, 11) while b 's interest is (20, 30, -50, 4). Following Condition 4, actors will discuss Issue 1, since it is the issue for which the sum of the absolute values is greatest. Following Equation 5, the change for actor a is .6 while the change for b is 1.5. Since actors a and b share the same sign on Issue 1, the conversation reinforces their respective commitments, shifting their new values to $a_1 = 50.6$ and $b_1 = 21.5$, thus reducing their relative distance.

In Scenario 2, actors a and b have the same absolute values, but they now have different signs on the most salient issue: a has a negative interest on Issue 1 (-50, -23, 6, 11) while b remains positive (20, 30, -50, 4). In this context, both the discussion issue and the attitude change for each actor remain the same. Note that the actors in this scenario hold alternative views on the discussion issue and have contrasting opinions on most of the remaining issues. This is a conflict situation, which reinforces actors' commitments to the focal issue and thus their opinions diverge further: a will move more strongly negative, while b becomes more positive. The new values will be $a_1 = -50.6$ and $b_1 = 21.5$.

Lastly, in Scenario 3 actors still have the same absolute values and alternative signs on the discussion issue, but they agree on the remaining issues: a now has values (-50, 23, -6, 11) while b remains the same (20, 30, -50, 4). In this case, since the actors share similar opinions on the remaining issues, they compromise by reducing their commitment on the salient issue. The new values will thus be $a_1 = -49.4$ and $b_1 = 18.5$.

RESULTS

Computer simulations allow us to study the functioning of specific mechanisms in simplified social settings and to investigate the range of outcomes they generate. We run 1,000 simulations of the model. To get to polarization, we first consider issues. Figure 1 reports graphs for eight different simulation outcomes. For each simulation, we plot the selection frequency for each issue over time. The outcomes differ qualitatively; in some instances, multiple issues are discussed at comparable rates, while in other cases a single issue takes off. To summarize the range of outcomes into a synthetic index we compute a Herfindahl and Hirschman index of concentration (hereafter, the HH index):

$$HH = \sum_{i=1}^4 P_i^2 \quad (6)$$

where P_i represents the probability of discussion of issue i at time 500. P_i^2 can be interpreted as the probability that two actors, randomly selected from the population, will speak about issue i . The HH index is the sum of these values, and it increases according to the relative popularity of some issues. The histogram at the center of Figure 1 shows the HH distribution for the entire set of simulation outcomes. Reading from bottom-left to bottom-right the simulation outcomes are ordered by the HH index, reported inside the box.

While our interest naturally draws us to consider the unusual cases where takeoff occurs, it is important to also understand what happens most often. Throughout, we distinguish between two qualitatively different outcomes: *takeoff* ($HH > .4$), in which the debate polarizes around a single issue (13 percent of the outcomes) and *non-takeoff* ($HH < .4$), in which issues are more evenly discussed. Note that in over 90 percent of the cases in which the HH index is greater than .4, the most popular issue is discussed at least twice as often as the second most popular issue. While we distinguish between takeoff and non-takeoff outcomes in order to stress qualitative differences, the model generates a continuous distribution of outcomes.⁸

⁸ We use a cutoff value of .4 to distinguish between takeoff and non-takeoff contexts. The differences we highlight between these two contexts are robust. Cutoff values between .35 and .45 reveal the same substantive dynamics. Analyses available on request.

The presentation of the results unfolds as follows: we first consider two case studies by reporting results from a non-takeoff and a takeoff situation. We then provide a more systematic analysis of the entire set of outcomes, which basically confirms the case study findings. Focusing on the ideological conditions for issue takeoff, we show that in takeoff situations the most popular issue is highly polarized, relative to the other issues. We then consider the structural properties that arise from people's patterns of interaction. We model the network structure by tracing the observed social relations actors engage in over time, and we show that network structures in takeoff situations are significantly more polarized than in non-takeoff situations. We consider the relationship between ideational and structural polarization and the level of asymmetry in issue popularity; in simple terms, takeoff arises when the dynamics that induce ideological and structural polarization intersect. We show that the rise of a single issue is associated with an oversimplified social structure, characterized by a single dominant cleavage. In contrast, where there are multiple foci of discussion, social structure appears more complex and nuanced.

CASE STUDIES

The model generates qualitatively different outcomes with respect to the level of asymmetry in issue popularity. We describe the ideological and structural characteristics that distinguish takeoff and non-takeoff situations by portraying in detail two simulation outcomes, which can be regarded as "virtual" case studies.

ROUTINE OUTCOMES: THE NON-TAKEOFF CONTEXT. We start with the more frequent outcome, non-takeoff. Specifically, we consider simulation #997, the second from the bottom-left in Figure 1. We first assess the extent of attitude polarization on two dimensions, dispersion and bimodality. Following DiMaggio and colleagues (1996), we use variance to measure the level of issue dispersion and kurtosis to measure bimodality. Dispersion refers to the average distance between two people randomly chosen from a population and it captures the intensity of opinion divergence. The more a population is polarized, the greater the average distance

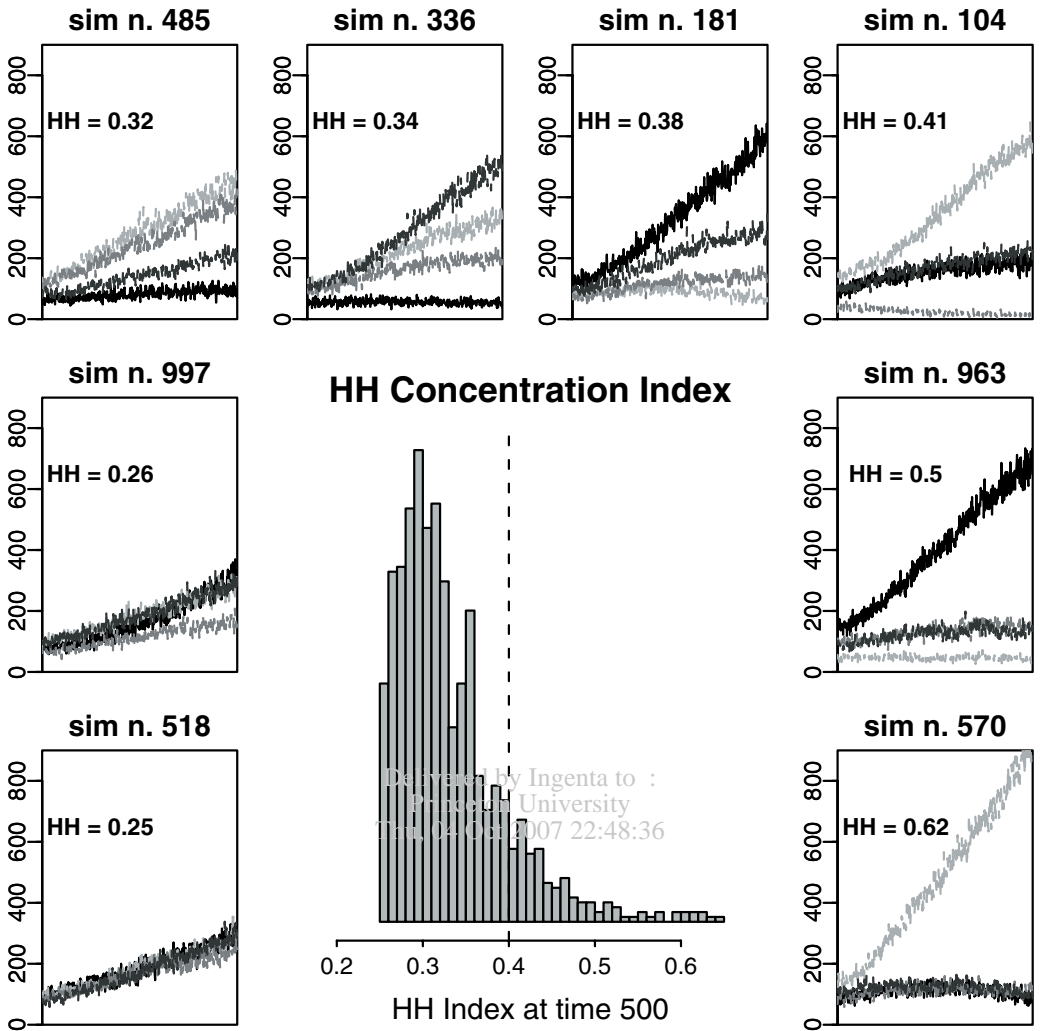


Figure 1. Frequency of Issue Discussion Over Time

Notes: The histogram in the center shows the distribution of the HH index of concentration at time 500. The dashed line indicates the .4 cut point that distinguishes between non-takeoff and takeoff outcomes. Reading from bottom-left to bottom-right we display eight simulation outcomes that are ordered by the HH index, reported inside the box. For each simulation outcome, the graph shows the frequency of discussion of each issue over time. x-axis: time (from 1 to 500); y-axis: frequency of discussion.

between its members. Kurtosis⁹ measures the extent to which the population splits evenly into

⁹ For each issue i , we compute kurtosis as:

$$kurtosis_i = \frac{\sum_{a=1}^N (i_a - \bar{i})^4}{N \times sd(i)^4} - 3$$

where \bar{i} is the average opinion on issue i , $sd(i)$ is the standard deviation, and N is the number of actors.

two groups. Kurtosis increases as attitudes radicalize and reaches its maximum value when moderation gives way to extremist views on either side of the issue. While variance captures the strength of opinion divergence, kurtosis refers to the shape of attitude distribution and allows us to distinguish between cases in which actors' opinions organize around two alternative positions and cases in which the distribution of opinion is unimodal.

Figure 2 reports the attitude distributions (as histograms) of the four issues at times 1, 100, 200, 350, and 500. For each issue at each time we report kurtosis and variance. Initially, all issue distributions are essentially normal. As time passes, the number of actors with a modest commitment to issues decreases and attitudes

become stronger, either positive or negative. Across the whole set of issues and times, both dispersion and bimodality increase, leading toward a more polarized, or at least flat, attitude distribution.

We now consider the structure of interpersonal relations. We induce discussion networks

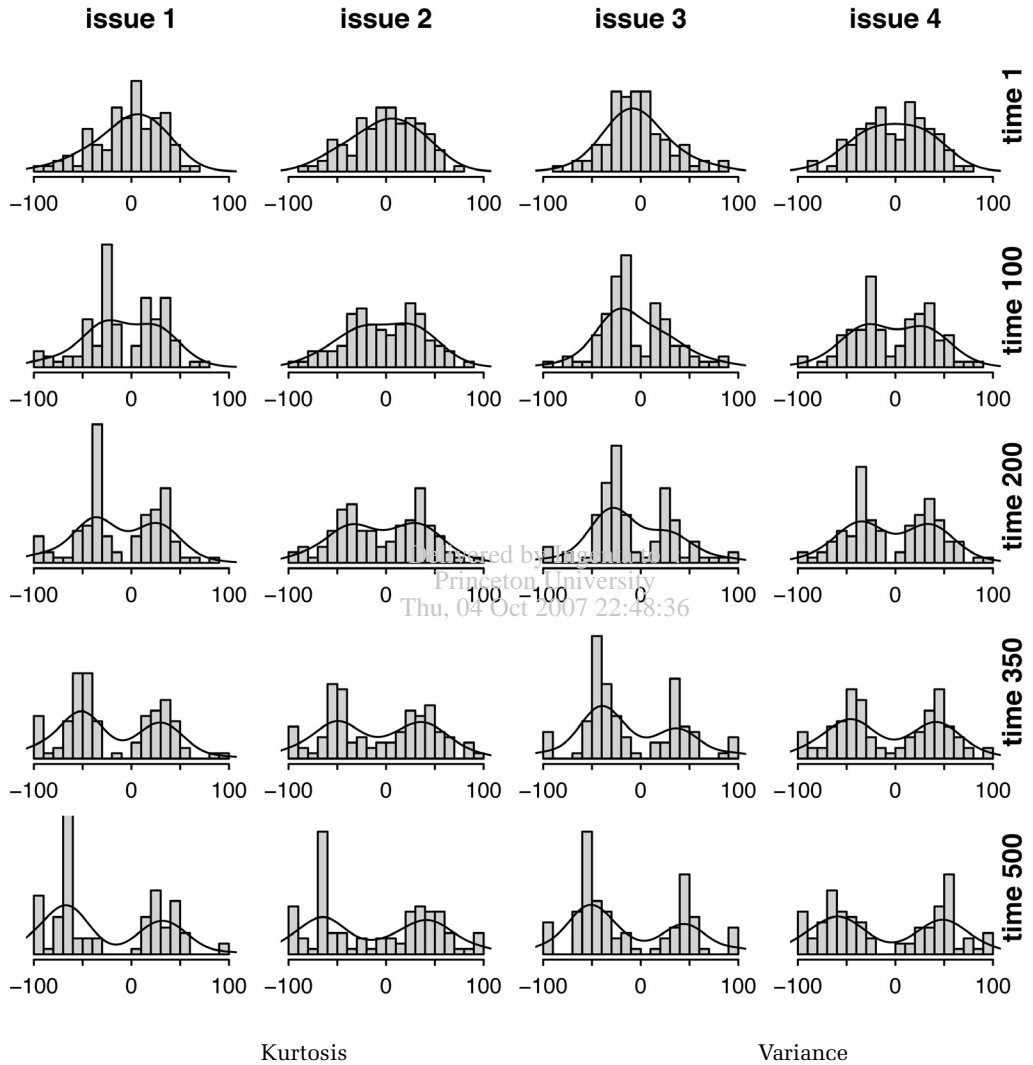


Figure 2. Issue Interest Over Time in a Non-takeoff Case (#997)

Notes: Columns display the interest distribution of the four issues at times 1, 100, 200, 350, and 500. The table shows the values of kurtosis and variance associated with different points in time. The case is simulation #997, an instance where takeoff does not occur.

from patterns of social interaction. Sociologists have defined relations in numerous ways, however there is virtually full agreement on the fact that sustained interaction is a relevant part of what constitutes a social tie. At different points in time, we consider the number of interactions each pair of actors has previously had, and we draw a link between actors *a* and *b* when their number of interactions is significantly higher than would be expected if they were to select their discussion partners at random. Specifically, we define a measure of preferential association between actors *a* and *b* at time *t* ($A_{ab}^{(t)}$) as the difference between the observed ($Obs_{ab}^{(t)}$) and expected ($Exp_{ab}^{(t)}$) number of interactions (*x*) divided by the expected number of interactions.¹⁰

$$A_{ab}^{(t)} = \frac{Obs_{ab}^{(t)} - Exp_{ab}^{(t)}}{Exp_{ab}^{(t)}} \quad (7)$$

The logic here is similar to that used to compute models of independence,¹¹ and it allows us to take into account and control for actors' different interaction frequencies (degrees). For each dyad *a* and *b*, $A_{ab}^{(t)}$ values close to zero indicate that they interact at chance levels, while deviations from zero indicate that social selection is operating. Negative values indicate that actor *a* avoids interaction with *b*, while positive values indicate that *a* disproportionately selects *b* as a discussion partner. This measure is not affected by frequency of interaction since we control for degree. Consequently, *A* captures a pure tendency for selection and avoidance of

specific discussion partners. Technically, to distinguish between repeated interactions and more occasional ones, we draw a link between actors *a* and *b* if their propensity of association is at least two standard deviations greater than the average propensity of association for actor *a*. Relations are then treated as symmetric.

$$a \rightarrow b \text{ if } A_{ab}^{(t)} > 2s.d. (A_{a+}^{(t)}) \quad (10)$$

The derived discussion network can thus be considered an indicator of social structure in which only recurrent patterns of interaction constitute social ties.

Figure 3 reports the evolution over time of the emergent structure of political discussion in a non-takeoff situation. Nodes are shaded with respect to actor position on the most popular issue—black indicates a positive attitude, white negative. The structure of the graph remains remarkably stable over time. Most striking is the absence of subgroup formation. In fact, there is no indication that a leading logic of association between actors emerges. If actors are increasingly committed to their ideas, (which they are), this commitment—in a non-takeoff situation—carries few implications for social structure.

It is possible that the population is not polarized on the most salient issue and that Figure 3 represses nascent conflict on other issues. We consider this idea in Figure 4, which reproduces the discussion network at time 500—shown at the bottom-right in Figure 3—and reports the issue discussed most frequently by each actor. While actors tend to associate with others who share their viewpoint, the macro structure is integrated with respect to attitudes.

In sum, the normal outcome is that issues will not takeoff, that is, attention is devoted relatively evenly to all four issues over time. On each issue, as time elapses, opinions diverge slightly and the distribution of attitudes becomes increasingly flat. With respect to social structure, there is little change. This does not mean that people do not associate with others who share the same opinions. More often than not, they do.¹² But the

¹⁰ Where $Obs_{ab}^{(t)}$ is the total number of interactions actors *a* and *b* had until time *t*:

$$Obs_{ab}^{(t)} = \sum_{i=1}^T x_{ab} \quad (8)$$

and $Exp_{ab}^{(t)}$ is the product of each actor's total number of interactions divided by the total number of interactions among all the actors.

$$Exp_a^{(t)} = \left(\frac{\sum_{i=1}^T x_{a+} \times \sum_{i=1}^T x_{b+}}{\sum_{i=1}^T x_{++}} \right) \quad (9)$$

¹¹ While this strategy might be problematic for relational data in which there are triadic tendencies and more complex forms of interaction, it is appropriate when networks are built starting from dyadic interactions.

¹² One reader suggested that the most efficient test of this assertion would be to assess dyadic autocorrelation. We note that the autocorrelation between dyadic relations and each of the four issues is significant, with Moran's I statistic of autocorrelation ranging between .77 and .86 (Cliff and Ord 1973). It

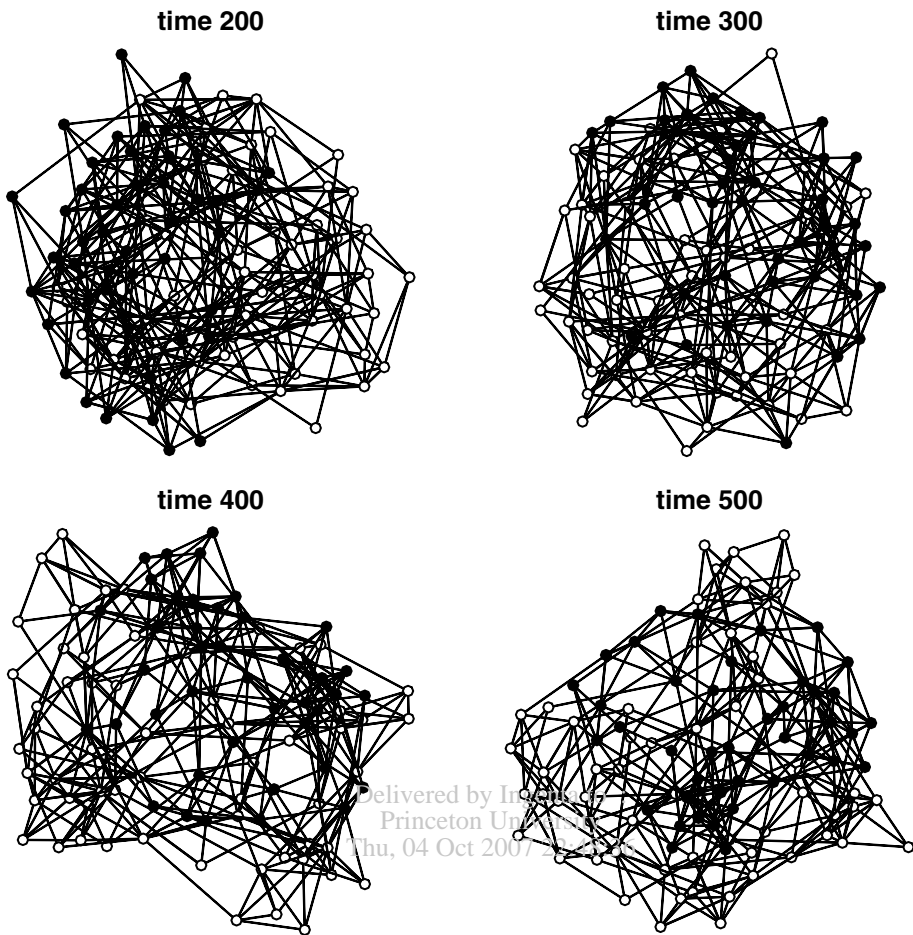


Figure 3. Discussion Networks Over Time in a Non-takeoff Case (#997)

Notes: Actors (circles or nodes) are connected (by arcs) if their frequency of interaction is higher than expected by chance. Nodes are colored according to the sign of the most frequently discussed issue. Black is positive, white is negative. Simulation #997, non-takeoff. The layout of the graph is a variant of Fruchterman and Reingold's force-directed placement algorithm implemented in R by Carter Butts. All graphs in the article are visualized using this algorithm.

structure of interactions is not polarized, giving rise to the second puzzle we started with—while individuals experience attitude homogeneity in their interpersonal networks, these networks retain attitude heterogeneity overall.

NON-ROUTINE OUTCOMES: THE TAKEOFF CONTEXT. We now consider a takeoff situation, specifically simulation #963, the second from the bottom-right in Figure 1. Recall that take-

off is relatively rare, occurring only 13 percent of the time. From a quick glance at our case study, we can see that one issue (Issue 1) takes off; that is, becomes the focus of intense discussion. In this instance, Issue 1 is three times more frequently discussed than the other issues.

As before, we first consider attitude dispersion and bimodality for each issue. Figure 5 reports attitude distributions of the four issues over time. A direct comparison between Figure 5 (takeoff) and Figure 2 (non-takeoff) reveals a different pattern. The takeoff issue (Issue 1) polarizes rapidly; by time 200 the middle of the distribution is largely absent. By time 500,

has to be this way, given the underlying selection model.

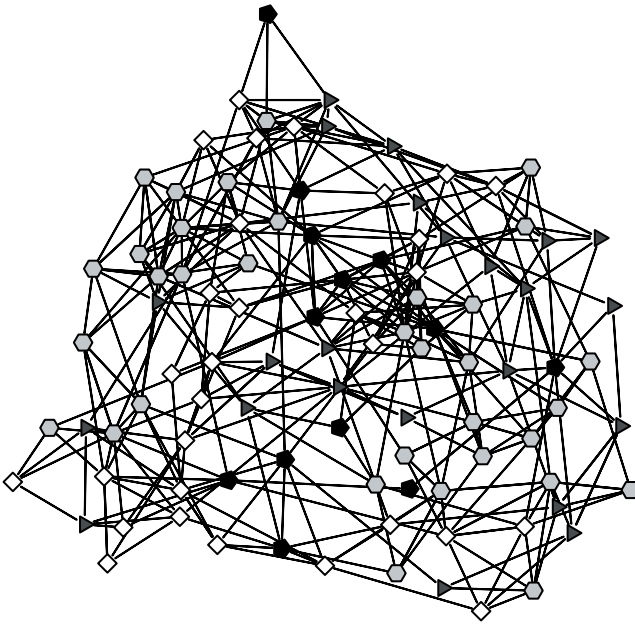


Figure 4. Discussion Network at Time 500 in a Non-takeoff Case (#997)

Notes: Nodes represent the issue discussed most frequently by each actor. Color and shape distinguish different issues: dark gray triangles symbolize Issue 1, white squares refer to Issue 2, black pentagons Issue 3, and light grey hexagons Issue 4. Simulation #997, non-takeoff.

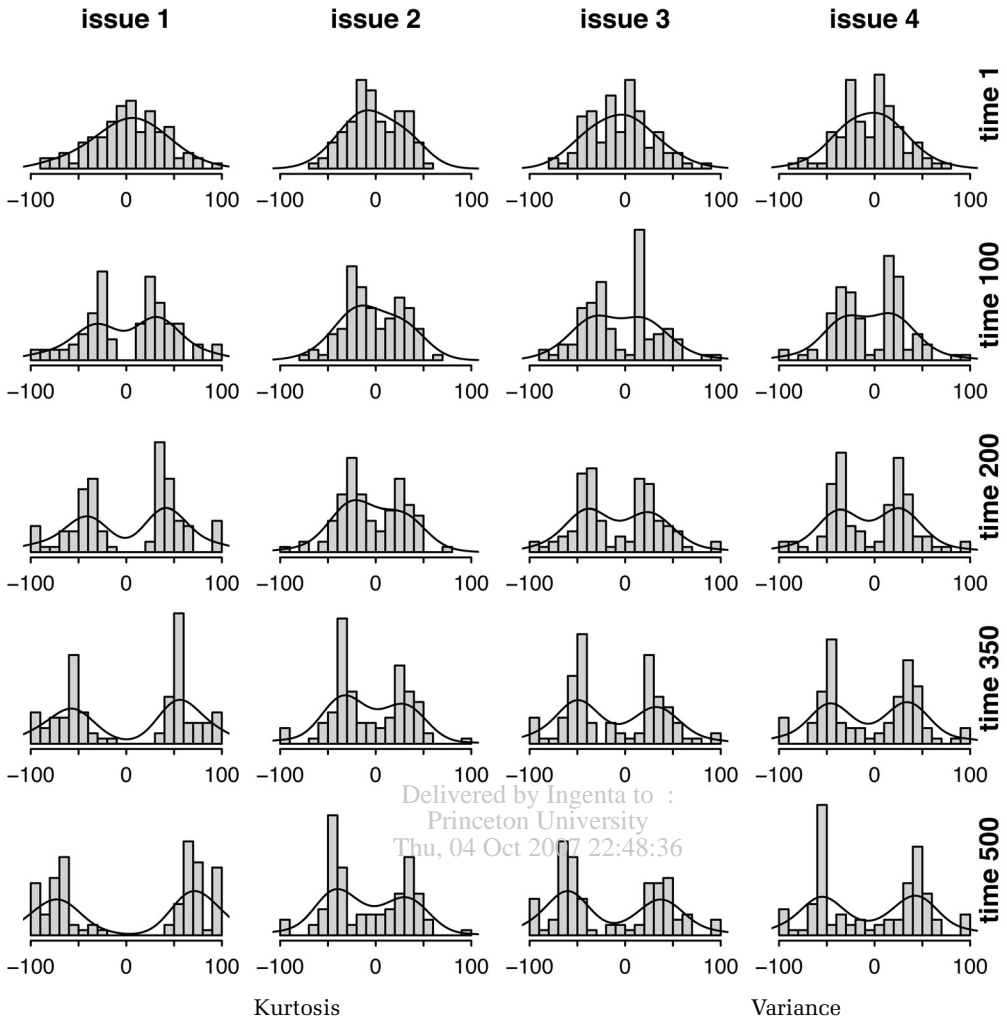
the distribution is bimodal; everyone is radicalized—almost all of the actors have interest values higher than 50 or lower than -50. This is not the case for the other issues, on which the majority of actors have positions between -50 and 50. The values of kurtosis and variance provide more detailed quantitative evidence for this clear qualitative finding.

Takeoff issues are more likely to be salient issues, and consequently, attitudes on them are more likely to be polarized. It is not clear, though, if ideational polarization induces social polarization. We will now consider this problem. Figure 6 reports the emergent structure of political discussion over time. We observe dramatic structural polarization visible by time 300 and deeply encoded by time 500. Patterns of political discussion in takeoff situations thus induce polarized structures of interaction. Actors' opinions on the most popular issue divide them into alternative camps.

Takeoff contexts are contexts in which salient issues emerge, but they do not completely dominate political discourse. As shown in Figure 7, for over 25 percent of the actors some issue other than Issue 1 is the most salient. Moreover,

these actors are not marginalized; they serve as bridges between the two otherwise disconnected areas of the polarized graph. This leads to an interesting irony—marginal issues serve as the glue for social structure. Actors who focus on marginal issues integrate what would otherwise be increasingly disjointed worlds.

These results shed some light on the first puzzle we started with—that attitudes rarely polarize, even though people experience polarization as common. When an issue becomes the focus of intense attention and consequently radically polarizes actors, individuals experience polarization in their discussion networks. With respect to the population of issues, though, polarization is largely absent. The fact that one issue is polarized carries few implications for polarization on other issues. This is observed empirically as well; when people change their opinion on pollution abatement (for example) there is no reason to expect a corresponding change in attitude on other issues, such as abortion, gay marriage, or education vouchers. If we surveyed actors in our takeoff context, we would discover that their opinions are usually parallel and only diverge on one issue. This, of



Time	Issue 1	Issue 2	Issue 3	Issue 4	Issue 1	Issue 2	Issue 3	Issue 4
1	-.15	-.79	-.39	-.02	1396	768	1025	957
100	-.68	-.71	-.43	-.10	2034	896	1361	1300
200	-1.12	-.44	-.63	-.52	2863	1099	1765	1727
350	-1.61	-.46	-1.10	-1.00	4192	1449	2417	2401
500	-1.80	-.88	-1.37	-1.34	5752	1695	3045	3019

Figure 5. Issue Interest Over Time in a Takeoff Case (#963)

Notes: Columns display the interest distribution of the four issues at times 1, 100, 200, 350, and 500. The table shows the values of kurtosis and variance associated with different points in time. The case is simulation #963, an instance where takeoff does occur.

course, is what many opinion surveys reveal. Since takeoff issues come and go, different actors at different times serve as the glue for the social system; their roles change even if their attitudes do not. This simple fact provides an unanticipated foundation for social stability.

GENERAL FINDINGS

We now generalize the qualitative findings from the case studies to the entire population of 1,000 simulations; this requires a change in focus—and measurement. We first focus on ideological polarization and show that takeoff issues are distinguished by their relative polarization—

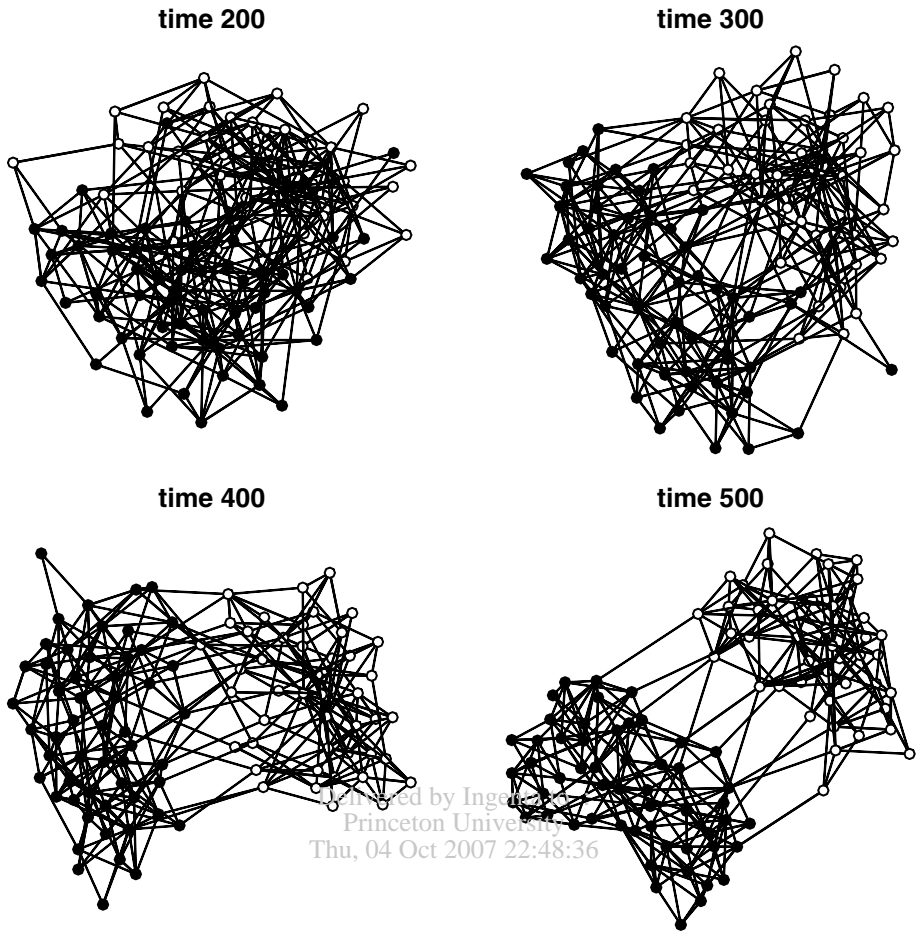


Figure 6. Discussion Network Over Time in a Takeoff Case (#963)

Notes: Actors (circles) are connected (by arcs) if their frequency of interaction is higher than expected by chance. Nodes are colored according to the sign of the most popular issue. Black is positive, white is negative. Simulation #963, takeoff.

that is, their polarization with respect to other issues. We then turn to the intercalation of structural and ideological polarization and next to the consequences that more or less segregated patterns of discussion have on the aggregate level of issues closure and individuals' experience.

IDEOLOGICAL POLARIZATION

To gain analytic leverage, we compute an index of polarization that combines dispersion and bimodality (the product of variance and kurtosis) such that the level of ideological polarization increases when the index increases. We then plot the level of polarization of the most popular issue against the average level of polar-

ization of the other issues. Figure 8 shows the dynamic of attitude polarization distinguishing between non-takeoff (black dots) and takeoff (white xs) cases. The x-axis reports polarization of the most popular issue; the y-axis reports polarization of the other issues. Each point represents the coordinates for one simulation. The goal is to reveal relative levels of polarization.

At time 1 (the small box in the bottom-left corner of Figure 8) takeoff and non-takeoff contexts cannot be distinguished with respect to relative polarization, across all issues, whether popular or not. At time 200 (the center box) one can already see a dense cloud of takeoff outcomes in the lower-right side, signifying that the popular issue in takeoff outcomes is relatively

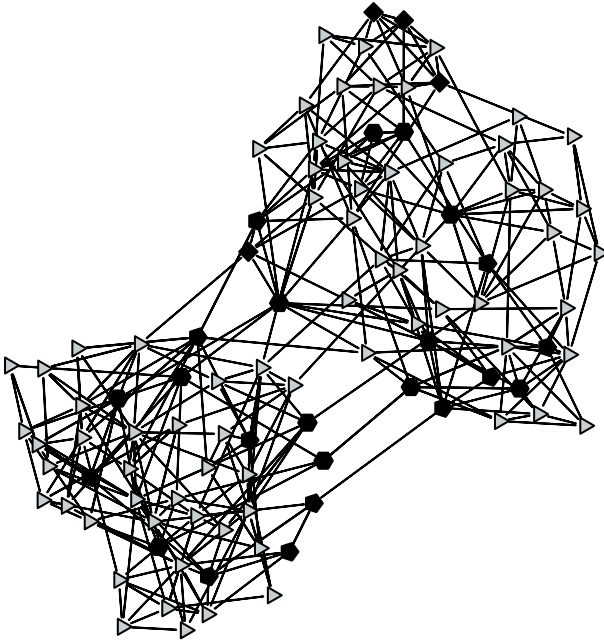


Figure 7. Discussion Network at Time 500 in a Takeoff Case (#963)

Notes: Nodes represent the issue that has been discussed most frequently by each actor. The color distinguishes between the most popular issue (grey) and all the other issues (black). Simulation #963, takeoff.

more polarized than the other issues. The relationship appears even stronger at time 500. Lines show the respective trajectories of the two case studies. Figure 8 reveals that while the absolute level of polarization of the most popular issue tends to be higher in takeoff than in non-takeoff outcomes, takeoff outcomes are distinguished by their relative level of polarization. Although the level of polarization of the most popular issue makes a difference, more critical is the level of polarization with respect to the polarization of the other issues. It follows that a polarized public discourse emerges from attitude polarization on a specific topic, while attitudes on the remaining issues do not lean toward extreme values.

STRUCTURAL AND IDEOLOGICAL POLARIZATION

From the case studies, we observe that asymmetries in discussion frequency are responsible both for dynamics of ideological polarization and for crystallization of patterns of social interaction. This suggests that issue popularity is at the origin of emergent processes of polarization of interpersonal relations. To test this hypothe-

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sis, we partition the social networks into subgroups and compute a measure of structural polarization.¹³ To accomplish this for different time periods, we first run CONCOR on the actor by actor cumulative discussion network to induce a two-group solution such that groups are relatively even in size.¹⁴ To identify the best fit to a two-group solution, in the second stage we iteratively assess whether or not node out-degree is disproportionately within group. If so, the assignment is retained. We continue the procedure until convergence. Second, we use a measure of modularity, which is often used to assess the performance of a graph partition, to evaluate the level of polarization of the two-group (module) partition. A good partition is one that maximizes the number of within-module links (or minimizes between-module links). In a two-module solution, the lower the relative number

¹³ We thank James Moody for providing the partitioning solution.

¹⁴ We opt for a two-group solution on empirical grounds, since this is the most appropriate (and often the only feasible) partitioning solution for most of the cases.

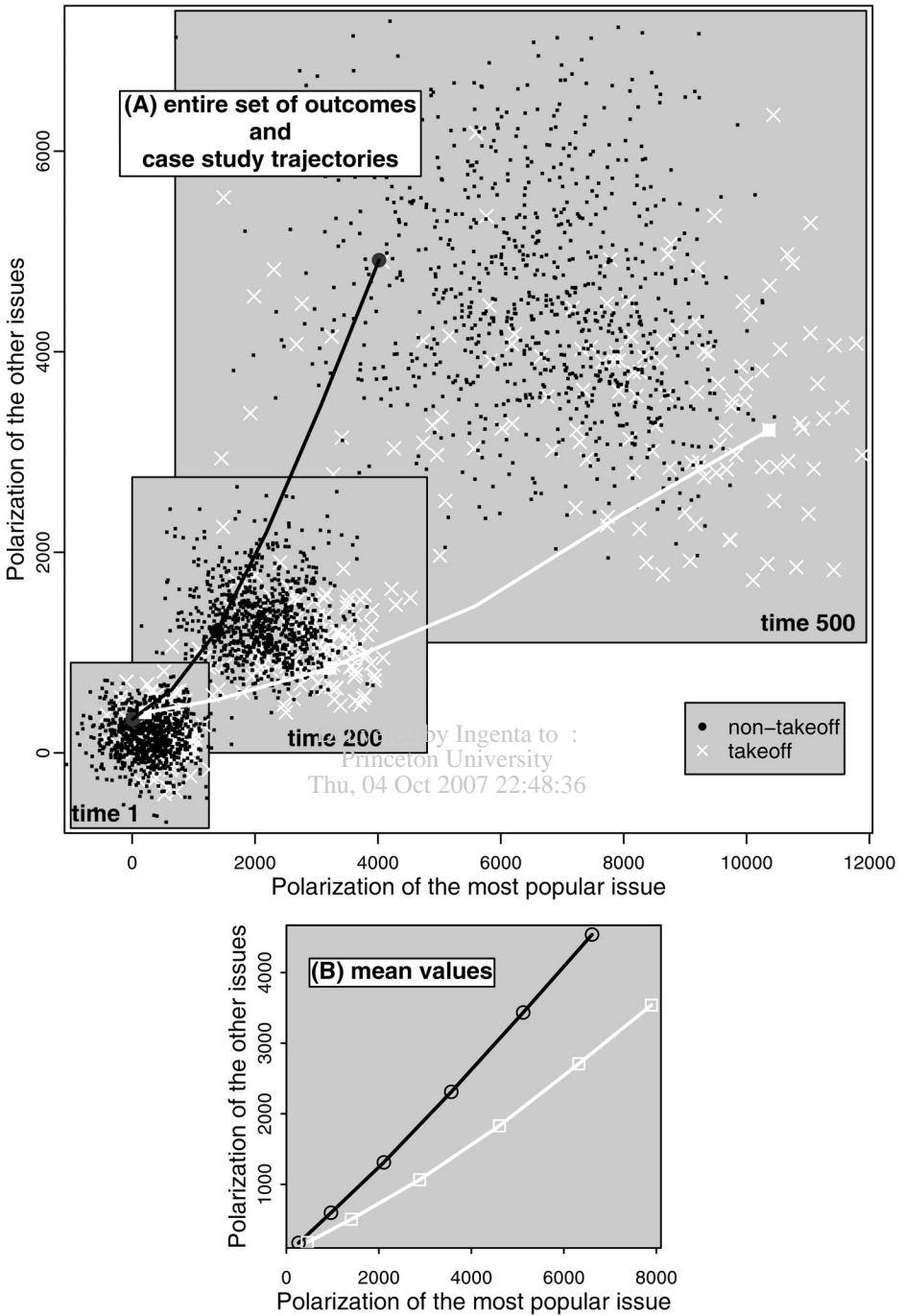


Figure 8. Relative Level of Polarization of the Issues Over Time

Notes: (A) Plot of the polarization of the most popular issue against the polarization of the other issues at times 1, 200, and 500. Takeoff outcomes (white xs) have higher levels of polarization on the most popular issue and lower levels of polarization on the other issues than non-takeoff outcomes (black dots). Lines show the trajectory of the case studies. (B) Plot of the average polarization of the most popular issue against the average polarization of the other issues in takeoff (white) and non-takeoff (black) outcomes.

of links between modules, the higher the modularity measure, and thus the level of polarization of the graph. Formally, the measure of modularity (M) for a two-group partition is:

$$M = \sum_{s=1}^2 \left[\frac{l_s}{L} - \left(\frac{d_s}{2L} \right)^2 \right] \quad (11)$$

where L is the number of links in the network, l_s is the number of links between nodes in module s , and d_s is the sum of the degrees of the nodes in module s (Guimera and Amaral 2005:899).

Figure 9 summarizes the specific relation between ideological and structural polarization. We start at time 100, when takeoff outcomes begin to be distinguished by increased levels of ideological polarization. For both takeoff and non-takeoff contexts, there is no evidence of structural polarization. Around time 200, distinctive dynamics of social polarization that characterize takeoff outcomes develop, emerge, and strengthen, amplifying attitude polarization. We see that takeoff outcomes disproportionately occur when there is an intersection of highly polarized structures and high levels of ideological polarization. Consequently, the interplay between ideological and structural polarization provides the necessary condition for issue takeoff. It follows that when public discourse polarizes around a single issue it is possible to observe the concurrent emergence of both ideological and structural polarization.

Further evidence is provided by the match between the structural partition of the graph and the attitude polarization around the most popular issue. Specifically, takeoff contexts are six times more likely than non-takeoff contexts to reveal a pure correspondence between group membership and ideological position (20 percent versus 3 percent). We observe the reverse pattern in non-takeoff contexts. In sum, in takeoff situations, actors with positive and negative attitudes on the core issue are split apart and embedded within dense ideological envelopes that prevent them from interacting with those who have alternative positions.

ISSUE CLOSURE AND ACTORS' EXPERIENCE

These patterns of segregation carry implications for issue closure—that is, the extent to

which discussion occurs disproportionately within groups in which actors share the same attitude on the issue at hand. Consequently, we measure issue closure as the share of individuals who are embedded in completely homogeneous relational networks. Figure 10 plots the level of issue closure of the most popular issue against the average level of closure of the other issues. The goal is to compare relative levels of issue closure across contexts. At time 100 issue closure is low for all issues in both contexts, and only around 20 percent of actors are embedded in completely homogenous networks. Over time, systematic differentiation between outcomes across contexts becomes increasingly evident. It is clear that takeoff outcomes are distinguished by higher closure on the most popular issue and, simultaneously, lower levels of closure on the other issues.

Figure 10 shows that when single issues dominate debate, social interactions tend to segregate actors who hold contrasting views on that issue. At the same time, the level of segregation with respect to the other issues is lower than in non-takeoff situations. Whereas conversation on the takeoff issue tends to be between actors who share the same opinion, conversation on other issues tends to be more discordant. The experience of disagreement on non-takeoff issues restricts the chance that actors' main focus of interest will drift and that eventually a new issue will take over.¹⁵

Of course, the monopolization of discussion does not take place only at the aggregate level—it also occurs in the unfolding of actors' experience. To evaluate individuals' heterogeneity of discussion topics, we compute the index of concentration (HH index) at the individual level. Panel A in Figure 11 shows the trend over time of the average HH index in takeoff and non-takeoff outcomes. Actors in non-takeoff contexts are more evenly exposed to the entire set of issues than are actors in

¹⁵ This result is consistent with Rokkan's theory of cleavage crystallization (Lipset and Rokkan 1967). Rokkan shows that the political systems that emerged after WWII were shaped by enduring territorial, religious, ethnic, and ideological divisions. Such a "freezing effect" can be understood as a consequence of the structuring of public discourse that prevents the rise of new issue-cleavages.

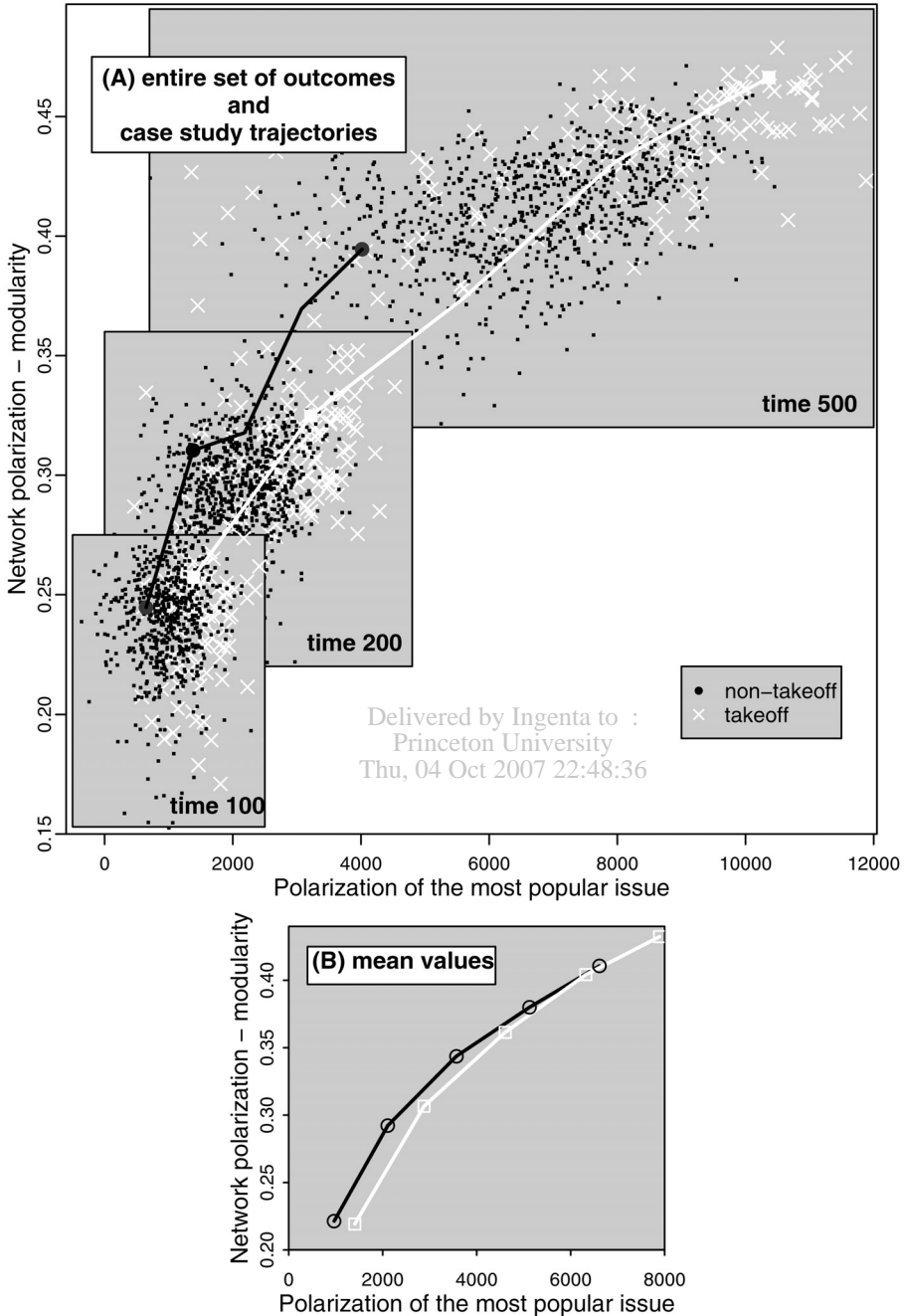


Figure 9. Ideological and Structural Polarization Over Time

Notes: (A) Plot of ideological polarization against structural polarization at times 1, 200, and 500. Takeoff outcomes (white xs) show higher values in both ideological and structural measures of polarization than non-takeoff outcomes (black dots). Lines show the trajectory of the case studies. (B) Plot of the average issue polarization against the average network polarization in takeoff (white) and non-takeoff (black) outcomes.

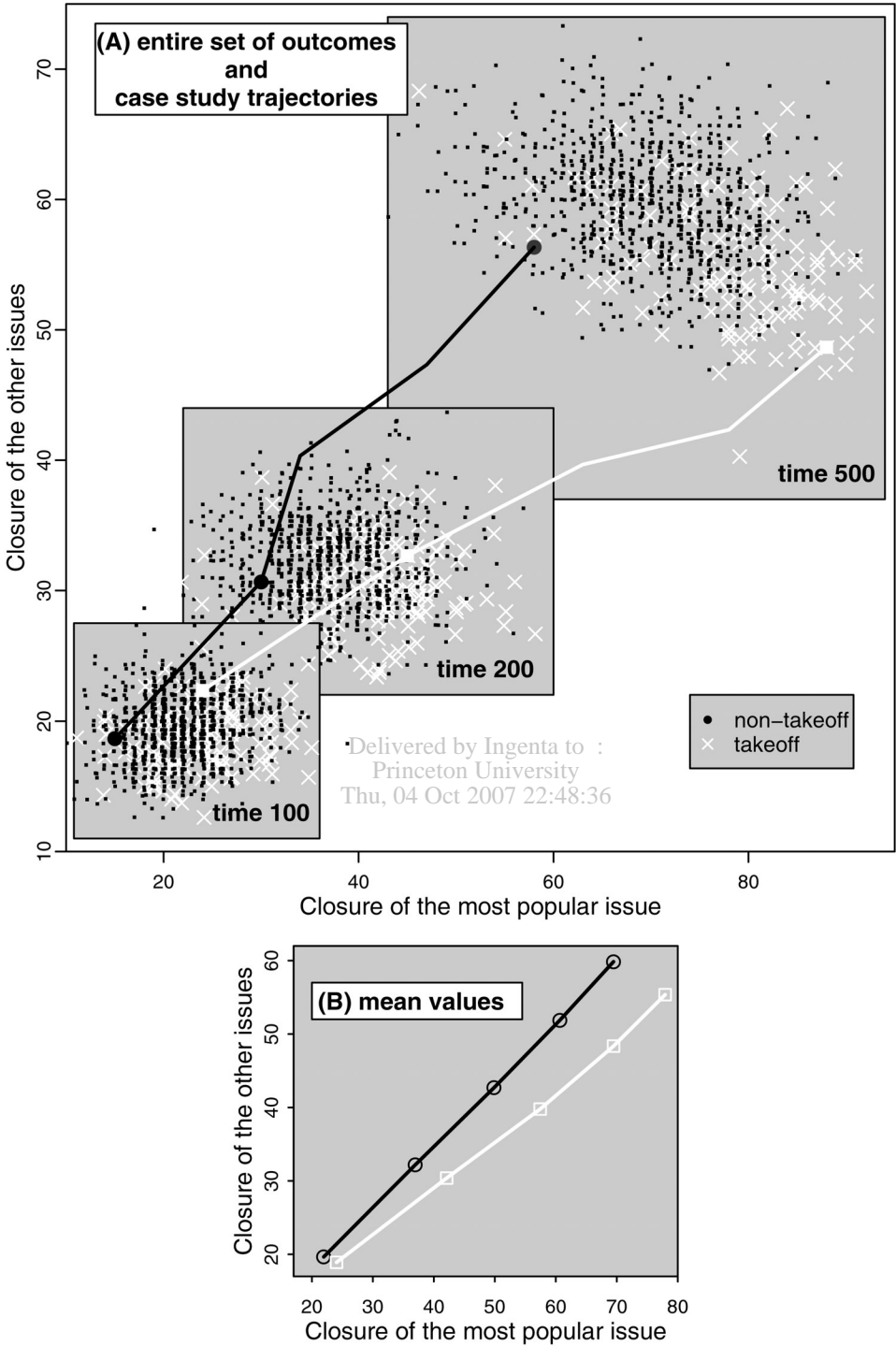


Figure 10. Relative Level of Issue Closure Over Time

Notes: (A) Plot of the level of closure of the most popular issue against the average closure of the other issues. Closure is defined as the number of individuals that are embedded in discussion networks homogeneous with respect to issue orientation. Takeoff outcomes have higher closure on the popular issue and lower closure on the other issues. Lines show the trajectory of the case studies. (B) Plot of the average closure of the most popular issue against the average closure of the other issues in takeoff (white) and non-takeoff (black) outcomes.

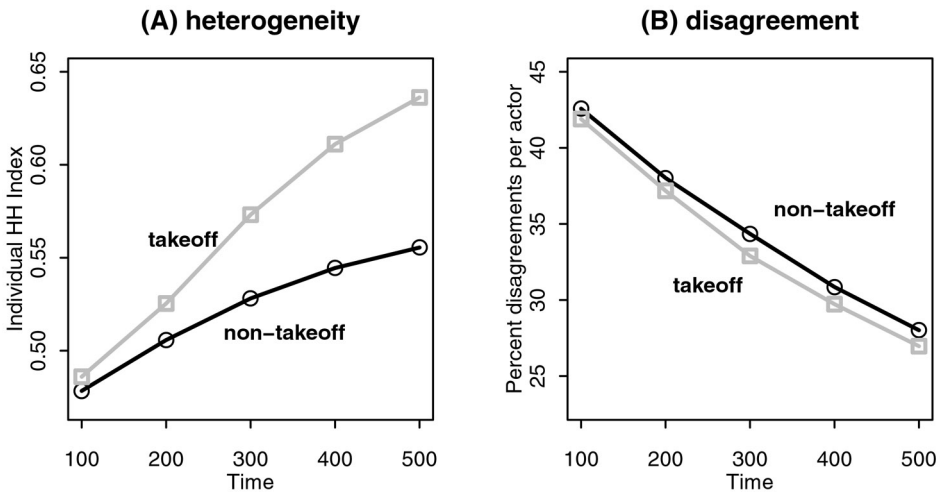


Figure 11. Discussion Patterns at the Individual Level: Heterogeneity and Disagreement

Notes: (A) Trend of the mean HH index over time in takeoff and non-takeoff outcomes. In non-takeoff outcomes actors are exposed to more heterogeneous topics of discussion than in takeoff contexts. (B) Trend of mean percentage disagreement experienced by actors in takeoff and non-takeoff outcomes. In both contexts, people experience similar, decreasing levels of disagreement.

takeoff situations.¹⁶ But this does not necessarily mean that people experience heterogeneity in interaction with respect to attitudes.

In fact, if we look at how frequently people experience disagreement, we discover that there are no differences between takeoff and non-takeoff contexts. Panel B in Figure 11 reports the trend over time of the percentage of discussions, on average, in which actors have contrasting views on the relevant issue. In both takeoff and non-takeoff contexts, the frequency of disagreement decreases as time elapses. It follows that the emergent relational patterns tend to minimize individual exposure to disagreement (and conflict), independent of the overall macrostructural features of the network of interaction. This induces, at the individual level, a misperception of the macrostructure (Kitts 2003) that may carry implications for mobilization.

¹⁶ It could be otherwise. One can imagine a non-takeoff context in which individuals are clustered in multiple small subgroups where they discuss only one issue. Consequently, their individual HH index score would be high, while the overall HH index is low—as we observe for the non-takeoff context.

DISCUSSION

We started with the observation that some scholars argue that the United States is politically polarized, although only on one issue at a time. Others, though, argue that we are not politically polarized, because public opinion is moderate (and changes are parallel) on a broad set of relevant issues. With respect to social polarization, we observe a similar debate. Some scholars argue that the country is polarized because people experience homogeneity in their everyday interactions. A second group argues that we are not socially polarized because we do not observe divergence in attitudes along classical social categories, such as age, education, income, race, and ethnicity. This article provides a simple model that suggests why these arguments are not mutually exclusive and how they meaningfully refer to the same social setting.

We first consider political polarization. Two results provide insight into the divergence of views between experts and lay observers. First, takeoff is rare; in the empirical world, only a few issues are takeoff issues. Second, for takeoff to occur one issue has to be relatively more polarized than others. It follows therefore, that we can observe ideological polarization on a single

issue at a time. The fact that the takeoff issue is disproportionately discussed leads to social structural change: actors compose themselves into new, polarized interactive sets, within which they experience increasing homogeneity. The focus on the single issue, though, means that the opinions they hold on other issues remain heterogeneous. This fact gives rise to the expert conclusion that the country is not politically polarized, because public opinion is moderate on a broad set of issues.

We now turn to the mismatch between the perceived and actual level of opinion polarization across social categories. People will talk about trivial matters—the weather or what to have for dinner—with most anyone, but for topics that are important to them, they reveal their views more selectively, disproportionately choosing people who they believe share views broadly similar to their own. Because actors tend to talk to others who share their beliefs, both in takeoff and non-takeoff contexts, the discussion of important issues will always induce, at the microlevel, the experience of a segregated discussion network. In non-takeoff contexts, actors tend to perceive that their environments are polarized, even though this is not the case. In takeoff contexts, when a single issue dominates discussion, individuals will overvalue the extent of ideational homogeneity because their contacts are disproportionately within a polarized subgroup. But even this experience is misleading with respect to issue heterogeneity, since public opinion remains heterogeneous on the broad range of other issues. It is this precise fact that provides the foundation for scholars' arguments that we do not observe increasing divergence in attitudes along classical social categories.

The relationship between single issue takeoff and polarization reported in this article provides insight into the larger debate on political and social polarization. Experts who minimize the extent of polarization because it is restricted to single takeoff issues ought to recognize that polarized interaction structures, and therefore heightened radicalism, arise from single issues. At the same time, those who see in the appearance of such issues the emergence of fundamental cultural divides (a "culture war") (Abramowitz and Saunders 2005; Greenberg 2004; Kohut et al. 2000) ought to recognize that polarization dynamics can be confined to

single attitudes. Radicalization on one dimension of the political space may carry minimal potential for "societal disruption," since opinions on other issues may maintain their heterogeneity.

EXPANSION TO COLLECTIVE ACTION

Our model has applicability to a broader array of foci. Clearly, processes of identity formation, such as the simultaneous social and ideational polarization associated with takeoff outcomes, are central to collective action dynamics. As suggested by Gould and others, identity is doubly meaningful for action when it is translated into (and transformed through) patterns of interaction such that class *in* itself becomes class *for* itself (Gould 1991; Marx [1852] 1963). Historically, collective action is made possible by the simultaneity of identity and interest. Against this background, we offer a simple model of social interaction and influence that simultaneously accounts for the emergence of a collective interest—an interest that enters and dominates the public sphere—and for the process of the formation of social identities in the form of sustained niches of social interaction. Moreover, we show that these two dimensions are interdependent. Meaningful social partitions cannot arise in the absence of salient issues. At the same time, attitude polarization is of little significance if it is not crystallized into relational patterns.

Consequently, the starting point for this analysis is the recognition that collective action involves persuasion and mobilization among actors who hold multiple and often alternative sets of preferences. To model this empirical reality, we need a model of social influence in which individuals' attitudes, social structure, and the public interest itself are not fixed, predefined aspects (exogenous to the model)—rather they are shaped in interaction sequences. This framing shifts the focus of investigation from what makes collective action possible—that is, the coordination problem or the free-rider problem (Gould 1993; Heckathorn 1990; Kim and Bearman 1997; Macy 1990; Marwell and Oliver 1993; Olson 1965)—to broader themes, specifically the mobilization of identity, structural change, and their intercalation. This focus allows us to show that the ideational and structural preconditions that trigger takeoff depend

on interaction patterns rather than on individual characteristics. Likewise, we show that only by referring to the ecology of local interactions can we simultaneously account for issue popularity and structural polarization.

Finally, our approach reveals an interesting gap between experience and reality, a gap that turns out to be particularly relevant for the nurturing of collective action. Is polarization a perception or a reality? With respect to aggregate categories and social properties, it seems that polarization is often a perception, but it is a real perception since the experiences of ordinary people are often structured so as to lead them into homogeneous and polarized environments. False perceptions can lead to real outcomes. At early stages of collective mobilization, activists are not completely aware of their real chances (they overestimate them, since they do not hold universal knowledge about the attitudes and preferences of their fellow citizens). They also perceive society as more polarized than it is. These misperceptions of the macrostructure based on inferences from their microcontext lead them to take chances they would otherwise reject as hopeless. The limited perception of the external reality—specifically the fact that the people around them share their attitudes and the fact that society splits into apparently disjoint groups—can transform, in the context of action over the long run, otherwise negligible chances into tangible achievements. This is exactly why shared identities play such a strong role in fostering actors' commitments to their political beliefs and consequent actions. Hope springs eternal not because people are hopeful, but because structures organize people into contexts where hope appears as rational inference.

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