ICTs, Social Connectivity, and Collective Action: A Cultural-Political Perspective

Abstract

In recent years, information and communication technologies (ICTs) have significantly affected the outcomes of large-scale collective actions. In addition, there is a well-known theoretical proposition that ICTs can fuel collective action by increasing individuals’ social connectivity that is closely related to recruitment capacity. This study aims to test this proposition by examining two moderating factors: the cultural context (i.e., online communication patterns) and the political context (i.e., the distribution of political preferences). By utilizing agent-based modeling, we find that ICT-improved connectivity not only scales down collective action if the distribution of political preference is insufficiently dispersed, but it also slows the diffusion speed if the overall propensity to participate is not strong. Moreover, the effects of ICT-improved connectivity on the scale and speed of collective action are similar under different cultural contexts. However, the theoretical implications suggest that ICTs are more effective in the collectivistic culture than in the individualistic culture.

Keywords:
ICTs, Social Connectivity, Collective Action, Cultural Difference, Political Preference Distribution, Agent-Based Modeling

Introduction

1.1 Large-scale protests, such as those in response to election fraud in Moldova and Iran in 2009, the uprisings and revolutions in the Arab world since 2011, Occupy Wall Street in the United States in 2011, and Los Indignados in Spain in 2012, have produced serious consequences on relevant sociopolitical systems. Although these protests were driven by distinct political agendas under different social and economic circumstances, these demonstrations share the same morphological feature: the use of information and communication technologies (ICTs), such as mobile phones, the Internet, and Internet-based social networking sites (e.g., Facebook and Twitter), to help protesters self-organize and recruit participants.

1.2 Numerous scholars and policy makers believe that ICTs can be an important catalyst for large-scale collective actions in term of such technologies’ advantage on social connectivity (Farrell 2012; Van Laer 2010). Empirical evidence shows that social networks are the main channel of recruitment—that is, people tend to participate in collective actions when they are invited by someone with whom they have a personal connection (e.g., Gould 1991; Lohmann 1994; McAdam 1986; Opp & Gern 1993), which is also true for online activism (e.g., Bennett et al. 2008; Gonzalez-Bailon et al. 2011). Moreover, ICTs provide a new context for social networking through which individuals can maintain greater digital connections (e.g., Cardon et al. 2009; Choi et al. 2011; Ling 2008; Wang & Wellman 2010). Thus, it is relatively easy for individuals to find and invite those who share their beliefs (Bennett et al. 2008; Tufekci & Wilson 2012; Walgrave et al. 2011).

1.3 However, the role of ICTs should be reconsidered since it may be complicated by the cultural context (i.e., the communication patterns) and the political context (i.e., the distribution of political preferences toward a particular action).

1.4 Cultural contexts, individualism vs. collectivism, in particular, differentiate how individuals create their social networks. Cross-cultural studies on online networks show that individualists tend to create “larger but looser networks with a far greater portion of weak ties,” whereas the collectivists tend to maintain “smaller and denser networks with the roughly even ratio of strong and weak ties” (Choi et al. 2011, p. 107). Such difference of social network composition has considerable implications for collective actions. As is well-known, weak ties are effective in information diffusion (Granovetter 1973), whereas strong ties are the primary source of recruitment (Granovetter 1978; McAdam 1986). That is, individuals are more likely to accept invitations from recruiters linked by strong ties (such as close friends) rather than weak ties (such as acquaintances). In this regard, the role of ICTs may be seriously overvalued under an individualistic context, due to the fact that the majority of ICT-based connections are weak (Diani 2000; Gladwell 2010). Beyond the dyadic relationship, collective actions are identified as complex contagions in which the outcomes highly depend on the amount and proportion of strong and weak ties (Centola and Macy 2007; Siegel 2009). This also suggests that the role of ICTs is contingent on cultural settings.

1.5 Furthermore, the role of ICTs may depend on the political context, i.e., the political preferences of all individuals involved in the action. In this case, the higher the connectivity, the more likely people are to encounter those with heterogeneous information, opinions or ideologies that might not be available in the local community. This has significant implications regarding ICT-improved connectivity. If the actions are politically popular, then ICTs will facilitate collective action by making “preference falsification” (Kuran 1995) of potential participants less likely. Simply put, the use of ICTs makes it easier for individuals to find like-minded persons, which facilitates their confidence to participate in a certain event (Farrell 2012). However, in unpopular actions, ICTs make it more possible for potential participants to encounter political disagreements. Hence, they realize that they are in the minority, even if they are popular in the local community (Farrell 2012; Mutz 2006). In regard to the present argument, ICTs can hinder collective action by making dissenters more preference-falsified to avoid punishment.

1.6 Therefore, this study tests the theoretical proposition that ICTs can fuel collective action by facilitating social connectivity, by focusing on cultural and political contexts. Agent-based modeling (ABM) is utilized in this study to consider the limitations of data collection and analysis in empirical studies. In particular, empirical studies focus primarily on the cases of successful collective action and they often apply the snowball sampling method for data collection (Tufekci & Wilson 2012). However, there are several limitations to such an approach. First, such data lacks information regarding conditions that depress participation or alternative conditions that can change outcomes. Second, respondents are likely to report homogeneous networks, which can produce a non-representative sample that limits the possibilities of in-depth examinations regarding network effects on collective action (Siegel 2009). Finally, empirical observations do not allow scholars to track collective action dynamics around certain time periods (Gonzalez-Bailon et al. 2011). Therefore, ABM, a bottom-up tool (Axelrod 1997), is the natural choice for exploring the dynamics of network-based collective action, as recommended by some social and political scientists (Centola and Macy 2007; Centola et al. 2005; Siegel 2009).
2.3 In the model, the cultural context is presented as different compositions of the social network, while the political context is shown as the distribution of individuals’ motivation towards a particular action. In fact, previous studies have focused on the independent and joint effects of these two factors on collective actions (e.g., Centola and Macy 2007; Siegel 2009; Watts 2002) and they provide the first insights into the role of ICTs. However, due to the lack of empirical data, especially the data regarding offline and online social connectivity, the role of ICTs remains unclear. More specifically, the data of online social connectivity in previous surveys (e.g., Cardon et al. 2009; Choi et al. 2011; Ling 2008; Wang & Wellman 2010) are applied in the present study. In addition, this study focuses on another measure of collective action dynamics, namely the participation diffusion speed, which is rarely used in existing studies. The findings show that ICTs have inconsistent effects on the level and speed of collective actions.

1.8 This reminder of this study is organized as follows. The Literature Review section examines pertinent literature including theoretical background and methodology. The Model section presents the agent-based model and the details of the parameter settings and simulation procedures. Then, the Results section includes the simulation results. The final section consists of the conclusion, based on the findings, and several theoretical implications.

Literature Review

ICTs, Social Connectivity, and Collective Action

2.1 Social networks have long been considered as crucial channels for recruiting participants into collective actions (McClung 2003). It is obvious that the higher the social connectivity, the more resources the activists can mobilize, which, in turn, increases the possibility that individuals will receive personal invitations to join a specific action. An eternal challenge of collective action is to recruit enough individuals to initiate an event and attract more participants to maintain it (Opp 2009). The development of ICTs could theoretically address this particular challenge since individuals can easily maintain hundreds of relationships through such technologies (Ellison et al. 2007).

2.2 Some scholars have questioned the effectiveness of ICTs on collective actions (Diani 2000; Gladwell 2010) since they believe that, due to the lack of social trust, virtual digital interactions are insufficient to convince others to participate in costly actions. However, this is not exactly the case. As is well-known, social ties have different effects on recruitment depending on “tie strength” (Granovetter 1973). Scholars generally believe that strong ties with strong interpersonal influence (e.g., intimacy and trust) are powerful in persuasion (McAdam 1986; McAdam and Paulsen 1993), whereas weak ties are important in facilitating information diffusion across far-reached individuals (Granovetter 1973). In fact, people tend to use ICTs to create and maintain both strong and weak ties, just as they do in face-to-face communication.

2.3 On the one hand, ICTs can reinforce an individual’s strong-tie network. For example, phone contacts strengthen “the favor of the intimate sphere of friends and family” (Ling 2008). Similarly, the Internet aids users to maintain such intimate relationships (Boase et al. 2006; Cardon et al. 2009; Ellison et al. 2007; Wang & Wellman 2010). On the other hand, ICTs can also significantly expand an individual’s weak-tie network. For example, Hampton and Wellman (2003) show that Internet users had three times as many weak ties as nonusers. With Internet-based social networking sites (Facebook, in particular), individuals can have hundreds of connections with whom they are acquainted with but not as close (Choi et al. 2011; Ellison et al. 2007).

2.4 Moreover, as in face-to-face conversations, online interpersonal communications are preferred by individuals for exchanging information during protests (Tufekci & Wilson 2012). In contrast to traditional (mainstream) media, such as television, radio, newspapers, and other printed materials, which typically cover contentious collective actions through hegemonic messages, misinformation, and negative portrayals (Downing 2001), ICT-based platforms provide a conventional and effective journalism tool for activists to diffuse and exchange timely information and accurate perspectives about an event (Van Laer 2010). In short, ICTs make collective actions more personalized (Bennett & Segerberg 2011) or loosely structured (Oberschall 1980), which can facilitate an information cascade (Lohmann 1994) across a network.

2.5 Therefore, collective actions are more likely to be initiated and maintained in the era of ICTs, which can be seen in the following examples. Wellman et al. (2003) suggests that the Internet is a new form of social infrastructure (i.e., spatially dispersed, loosely-structured personal networks) that can be easily and effectively used to mobilize a local protest. Bennett et al. (2008), based on the 2003 global anti-war demonstrations, shows that “digitally networked individuals with rich network connections are becoming increasingly central in the speed, scale, and organization of large protests.” Wagrave et al. (2011) empirically demonstrates how ICTs facilitate diverse protests and movements by enhancing the weak ties among activists. Finally, Campbell and Kwan (2012) indicates how mobile-mediated communication enhances political participation by reinforcing and expanding close personal ties. All of these studies have provided the first insights into the positive effects of ICT-improved connectivity on collective actions.

2.6 It is worth noting that participating in collective actions, such as demonstrations and protests, is a complex contagion that requires social reinforcement (Centola & Macy 2007). Thus, the composition of the social network is extremely critical for the outcome of the collective action (Siegel 2009). Experimental studies show that networks with many clustered ties (strong ties) are more effective for participation diffusion than networks with many long ties (weak ties) (Centola 2010). This implies that the role of ICTs may be complicated depending on how ICTs forge the online networks.

2.7 The preferences of individuals for creating strong or weak ties with ICTs significantly differ among nations with various cultural characteristics. For example, a 2009 survey of 11 nations reveals that the number of offline strong ties among the users of a social networking site from different nations is the same, whereas the users of collectivist-nations have significantly more online strong ties (Cardon et al. 2009). Similarly, Choi et al. (2011, p. 118) empirically show that “American college students have looser networks with about four times more weak ties than strong ties [on Facebook], whereas Korean college students have more densely linked networks with almost equal ratio of close ties and weak ties.” The underlying mechanism, as Choi et al. (2011, p. 112) suggests, is that the collectivist culture emphasizes “family integrity, in-group membership, and high sociality,” but the individualistic culture is characterized as “self-reliance, competition and distance from in-groups.” Consequently, it makes sense that the role of ICTs in collective action differs among nations with different cultural characteristics (Harlow & Harp 2012).

2.8 Moreover, the need of social reinforcement implies that political contexts could influence the role of ICTs. However, what others believe about a certain political issue, to a large extent, determines one's decision (Granovetter 1978; Kitsch 2003; Kurian 1995). Individuals do not encounter global opinion distribution directly, but instead, they acquire knowledge through a personal network. Greater network connections provide more opportunities for individuals to learn about global preferences more precisely. On the one hand, if more people are inclined to participate in the activity, then ICTs make it easier for potential participants to find like-minded individuals. These homogeneous encounters then reinforce their confidence of the action (Centola et al. 2005). In this case, ICTs can facilitate participation by lowering the costs of potential participants to express their true preferences (Farrell 2012). As in the Tunisian uprising, the use of ICTs, such as Facebook and Twitter, generated an information cascade regarding the opposition to the regime, which led to more online and offline protests (Lynch 2011). On the other hand, ICTs can make it more costly for individuals to engage in collective actions that are deemed unpopular. This is because individuals are more likely to falsify their political preferences in order to avoid social friction or political repression (Kuran 1995; Mutz 2006). In sum, the role of ICTs in collective actions can be positive or negative, to some extent, depending on whether ICTs make preference falsification less or more likely.

Analytical Models of Collective Action

2.9 Many researchers have attempted to explain why people participate in collective actions. Olson (1965) proposes a formal model of a collective action where individuals are rational and act based on a cost-benefit calculation from the theory of public goods. This model sheds light on the free-riding problem and
suggests that selective incentives, such as punishments and rewards, are necessary for triggering collective action. However, empirical evidence shows that collective actions are a critical mass system (Granovetter 1978; Schelling 1978) "in which participation by a small fraction of the population can trigger a snowball of activity" without any selective incentive (Centola 2013, p. 238).

2.10 Several models focus on the cascading dynamics of collective actions. For example, Granovetter (1978) proposes a threshold model in which one joins an activity if the proportion of the ones who have already engaged in the event exceed a certain threshold. Schelling (1978) presents a similar model assuming that an individual becomes involved if there are enough participants. In other words, the decision of an individual depends on the expected participation level. Kuran (1991) pushes the threshold model further by a dynamic threshold and assumes that the participation cost (threshold) decreases as the size of the collective action increases. Similarly, Lohmann (1994) proposes a model of information cascade to explain the mass protests in Leipzig (1989–91) where people observed the actions of others to acquire previously hidden information before revising their beliefs. In all of these models, people are so-called boundedly rational, thus implying that the dynamics of collective actions are mainly affected by two factors: internal motivation (indicated as "participation threshold") and external motivation (stemmed from the social network).

2.11 Granovetter (1978, p. 1422) defines threshold as the "point where the perceived benefits to an individual of doing the thing in question exceed the perceived costs." Clearly, individual threshold can be seen as the epitome of one's "goal and preference, and perception of [political] situation" (Granovetter 1978, p. 1422). Granovetter also posits that slight shifts in individual thresholds can significantly change the outcomes of collective actions, which has led many scholars to focus on heterogeneity in threshold distribution (Macy 1991; Siegel 2009; Watts 2002; Watts & Dodds 2007). Conversely, a social network is also extremely important to the outcome of collective actions due to the interdependence of individuals' decisions (Centola et al. 2005; Siegel 2009). In this regard, some researchers have begun studying the role of size (Manwell et al. 1998; Oliver and Manwell 1988), leader (Siegel 2009), and the composition of strong versus weak ties (Centola & Macy 2007; Siegel 2009).

2.12 The present study focuses on two works that utilize ABM and threshold models. ABM has become a major bottom-up tool and a "third way" to complement the traditional inductive and deductive approaches (Axelrod 1997). ABM consists of autonomous and goal-oriented agents embedded in a dynamic environment. In general, agents perform a task in response to changes in other agents and the environment, based on a set of defined rules derived from the real world (Lustick & Miodownik 2009). In the threshold model, since individuals are represented as networked "agents" with identical or diverse thresholds, their choices of participating are set as a decision rule, and the overall participation level is measured at the network level.

2.13 The first work by Centola and Macy (2007) tests the argument of Granovetter (1973) about the strength of weak ties. Agents are arranged on small-world topology (Watts & Strogatz 1998) in which those local and clustered relationships are strong ties, whereas those long ties that connect two individuals in different communities are weak ties. In contrast to other works, the authors characterize social behavior as "complex contagion" in which a single information resource is insufficient to make an agent participate. In other words, information regarding participation costs needs to be reinforced by several sources. In such cases, less clustered weak ties are not enough to spur an individual to participate. Instead, the redundancy of strong ties is necessary for the diffusion of collective actions.

2.14 In another study, Siegel (2009) focuses on the effect of various structures of a social network on collective actions. He defines the following typologies that mirror common empirical social networks: small-world, opinion-leader, village, and hierarchical networks. Unlike Centola and Macy (2007), who assume that all individuals have an identical threshold, Siegel believes that the thresholds of individuals are heterogeneous with normal distribution. He also shows that the effects of network structure and threshold distribution on collective actions are mediated by network size, the composition of strong and weak ties, and the role of leaders. For example, the results drawn from small-world and village networks indicate that additional strong or weak ties are sometimes detrimental for collective actions. More importantly, Siegel shows that excessive social connections may depress participation, especially in the case of individuals with weak motivation to participate.

2.15 These two studies have influenced the present study in two aspects. First, ICT-enhanced connectivity can have mixed effects, depending on the political context. The effects of network structure and threshold distribution on collective actions are mediated by network size, the composition of strong and weak ties, and the role of leaders. For example, the results drawn from small-world and village networks indicate that additional strong or weak ties are sometimes detrimental for collective actions. More importantly, Siegel shows that excessive social connections may depress participation, especially in the case of individuals with weak motivation to participate.

Model

Decision Rule

3.1 In line with the threshold model, it is assumed that an individual will participate in collective action if:

\[ S_{i,t-1} > \tau_{i} \] (1)

where \( S_{i,t-1} \) denotes the social influence that individual \( i \) receives from neighbors at time \( t-1 \), and \( \tau_{i} \) is the threshold of the individual \( i \) that is independent of time. Strong and weak ties are differentiated by structural difference (Centola & Macy 2007; Siegel 2009) and tie strength. In particular, the structural difference between strong and weak ties is that strong ties are more likely to cluster or overlap than weak ties. Moreover, strong ties have a greater interpersonal influence than weak ties, which can be formulated as:

\[ s_{i,t-1} = \frac{\alpha + \tau_{i} \cdot n_{i,t-1} + (1 - \alpha) \cdot n_{i,t-1} \cdot \alpha}{1 + \tau_{i} + n_{i,t-1} \cdot (1 - \alpha) \cdot \alpha} \] (2)

where \( n_{i,t-1} \) and \( n_{i,t-1} \) are the number of strong and weak ties in individual \( i \)'s network, respectively, and \( n_{i,t-1} \) and \( n_{i,t-1} \) express the numbers of participated neighbors linked by strong and weak ties, respectively.

3.2 The influences of strong and weak ties are differentiated on individual decision by \( \alpha \). A large \( \alpha \) simplifies that the influence of strong ties is much higher than that of weak ties. Furthermore, when \( \alpha = 0 \), the interpersonal influence of strong and weak ties is identical, which is the same for the threshold model. However, when \( \alpha = 1 \), individuals make decisions based only on strong ties.

Social Network

3.3 This study utilizes a network model based on several important properties of real social networks. First, empirical observations show that the distributions of social ties in both offline and online networks are skewed. That is, a small number of individuals hold ties that greatly exceed the average, which is called the "scale-free" property in complex network theory (Barabasi & Albert 1999; Shirky 2003). Second, social networks are small-world (Watts & Strogatz 1998)—that is, on the one hand, individuals tend to be clustered into communities based on aspects such as geographical location, political interest, and occupation (McPherson et al. 2001). On the other hand, the distance between any two individuals can be dramatically short due to some inter-community ties. Generally, the intra-
community networks are dense, but inter-community networks are sparse in comparison. By this logic, it is assumed that intra-community connections are strong ties; whereas inter-community connections are weak ties (see Figure 1).

![Schematic of a social network with two communities (dashed circles) and 20 agents (bold dots). The solid links signify strong ties, whereas the dashed links signify weak ties.](http://jasss.soc.surrey.ac.uk/17/2/7.html)

3.4 Technically, \( N \) individuals are equally allocated into \( M \) communities. For simplification, each individual belongs to only one community. Each individual is characterized by \( p^s_i \) and \( p^w_i \), drawn from a power-law distribution with an exponent \( \gamma \). Larger \( p^s_i / (p^w_i) \) denotes that the individual has more strong (weak) ties. The average number of strong and weak ties is labeled as \( m \) and \( n \), respectively. In this study, only those online ties with the same strength as offline strong ties are defined as online strong ties, while the offline and online strong (weak, respectively) ties have the same influence on the participation of an action. See Table 2.

Parameter Settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (if constant)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N )</td>
<td>5000</td>
<td>Population size</td>
</tr>
<tr>
<td>( M )</td>
<td>20</td>
<td>Number of communities</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>3</td>
<td>Power-law index</td>
</tr>
<tr>
<td>( m )</td>
<td>See Table 2</td>
<td>Average number of strong ties</td>
</tr>
<tr>
<td>( n )</td>
<td>See Table 2</td>
<td>Average number of weak ties</td>
</tr>
<tr>
<td>( \alpha )</td>
<td>0.33 or 0.5</td>
<td>Advantage of strong ties vs. weak ties on interpersonal influence (0.33 for individualistic culture and 0.5 for collectivistic culture)</td>
</tr>
<tr>
<td>( \tau_{\text{mean}} )</td>
<td>0.4, 0.5, or 0.6</td>
<td>Mean value of threshold distribution</td>
</tr>
<tr>
<td>( \tau_{\text{std}} )</td>
<td>[0,1]</td>
<td>Standard deviation of threshold distribution</td>
</tr>
</tbody>
</table>

3.5 All parameter settings are given in Table 1. The simulations are performed with \( N = 5000 \) agents in \( M = 20 \) communities. The degree distribution follows a power-law distribution with \( \gamma = 3 \). The average number of strong and weak ties \((m \) and \( n)\) are drawn from empirical studies (see Table 2).

Table 2: The average number of strong and weak ties

<table>
<thead>
<tr>
<th></th>
<th>Individualistic Culture</th>
<th>Collectivistic Culture</th>
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<tbody>
<tr>
<td></td>
<td>Strong Ties</td>
<td>Weak Ties</td>
</tr>
<tr>
<td>Offline</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>Online</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>55</td>
</tr>
</tbody>
</table>

3.6 Based on the 2009 cross-national survey by Cardon et al. (2009), individuals from individualistic nations (e.g., United States, France, Sweden, and Israel) have approximately 10 offline strong ties on average, which is also confirmed by several other national surveys (Lizardo 2006; Wang & Wellman 2010). Cardon et al. (2009) identifies a slight difference in the number of offline strong ties between individualistic and collectivistic individuals (roughly nine on average from China, Egypt, India, Korea, and Macao). According to this survey, individualistic respondents have nearly eight online strong ties, whereas collectivistic individuals have approximately 13. Based on the data from Lizardo (2006), it is assumed that individualistic individuals have an average of approximately 23 offline weak ties. According to the findings by Choi et al. (2011, p. 118) in which “Americans … had looser networks with about four times more weak ties than strong ties [online], whereas Koreans have more densely linked networks with the almost equal ratio of close ties to weak ties,” it is assumed that individuals from individualistic nations have 32 online weak ties, whereas collectivists have nine offline and 13 online weak ties on average.

3.7 To further distinguish the tension between the influences of strong versus weak ties under different cultural settings, \( \alpha = 0.5 \) is assigned to the collectivistic setting, thus implying that one strong tie has three times as much influence than one weak tie. Conversely, in individualistic settings, \( \alpha \) is set to 0.33, that is, the influence of a strong tie is approximately one time more than that of a weak tie. Notably, such settings emphasize that strong ties are more important than weak ties regardless of cultural characteristics, but individuals with a collectivistic culture rely more on strong ties than their individualistic counterparts. Furthermore, additional sensitivity analyses are performed to test other configurations of \( \alpha \) (see Appendix).

3.8 As mentioned earlier, the threshold distribution, to a large extent, mirrors the political context. Following earlier scholars of collective action (Centola 2013; Granovetter 1978; Siegel 2009), the present study assumes that thresholds of individuals follow a normalized distribution with mean value \( \tau_{\text{mean}} \) and standard deviation \( \tau_{\text{std}} \). Without loss of generality, \( \tau_{\text{mean}} \) is set to 0.4, 0.5, and 0.6 denotes “strong,” “intermediate,” and “weak” classes of overall political preference towards particular actions, respectively. Apparently, the smaller the \( \tau_{\text{mean}} \) the more inclined the individuals are to engage in a contention. Thus, more focus is placed on \( \tau_{\text{std}} \). Within each class of \( \tau_{\text{mean}} \), \( \tau_{\text{std}} \) varies from 0 to 1.
Since the threshold is normally distributed, agents can be roughly divided into three segments: rabble-rousers \( (\tau_i < 0) \) triggers participation in collective actions; wet blankets \( (\tau_i > 1) \) never engages in collective actions; and speculators \( (\tau_i \in [0, 1]) \), remains inactive until participation conditions are satisfied. Once one becomes active, he/she remains in this state across the duration of the experiment. The pseudocode is presented as follows:

```plaintext
1. for each event do
2.    generate network
3.    assign threshold to each agent
4.    set all agents as inactive
5.    trigger the event by rabble-rousers
6.    while there exist new participants at the last step do
7.        for each inactive agent do
8.            if social influence exceeds participation threshold
9.                become active
10.           else
11.                keep inactive
12.           end if
13.        end for
14.    end while
15.    calculate level
16.    calculate speed
17.    end for
```

The model, implemented in Matlab (2009a), is available for viewing at: http://www.openabm.org/model/3900/version/1/view. Each combination of the different values of parameters constitutes a single simulation run. In addition, a total of 1,000 simulations are conducted for each unique combination. The two measures of collective actions include: level (the maximal participation rate in equilibrium) and speed (the average number of new participants (excluding rabble-rousers) per time period prior to stability). All of the results are averaged over the 1,000 simulations.

Preliminary results of the effects of ICTs (combined with the cultural and political contexts) on collective actions are presented in Figure 2. Since the functions of \( t_{act} \) in different combinations of culture and ICTs are similar, only the results for the collectivistic culture with ICTs are shown. Moreover, in each plot, different
values of $\tau_{\text{mean}}$ are indicated by different lines.

Figure 2. Preliminary results of the effects of culture and ICTs on collective actions. (a) results for participation level; and (b) results for participation speed

4.2 Several points are worth noting in Figure 2. First, increasing $\tau_{\text{mean}}$ always increases the participation level and speed, which is not surprising since people who are more willing to participate generally become involved more frequently and at a faster rate. Second, in contrast, the effect of $\tau_{\text{std}}$ depends on $\tau_{\text{mean}}$. More specifically, this effect is monotonically positive in weak and intermediate classes, but it is non-monotonic in the strong class where there is an optimal level of dispersion that leads to the maximal level and speed in equilibrium. This is because in weak and intermediate classes, there are not enough rabble-rousers and susceptible speculators (Granovetter 1978; Siegel 2009; Watts & Dodds 2007). Clearly, the number of rabble-rousers and susceptible speculators increases with dispersion. However, in the strong class, there are a sufficient number of rabble-rousers. Thus, the number of wet blankets who can significantly block the diffusion process increases with dispersion.

4.3 Figure 3 shows the effects of ICT-increased connectivity on the level and speed of collective actions under particular cultural contexts. The impacts are described using the D-value, which is the value of the results of with-ICT connectivity minus the results of without-ICT connectivity. Each plot includes two y-axes and the remarks (“L” and “R”) after the legend denote the data set that applies to the left or the right y-axis.

4.4 The two upper plots show that increased connectivity results in mixed effects in regard to level. The effects are similar for different $\tau_{\text{mean}}$, but they can be roughly divided into two segments according to $\tau_{\text{std}}$. First, when $\tau_{\text{std}}$ is comparatively low, ICTs seemingly hinders participation. As mentioned earlier, a low $\tau_{\text{std}}$ implies that rabble-rousers and susceptible speculators are inherently insufficient. At the same time, higher connectivity shows that speculators need more reinforcements. As a result, ICTs deter rather than spur participation. Second, when dispersion is comparatively high, the effect of ICTs becomes positive. This can be explained in two ways: 1) rabble-rousers increase significantly so that they can persuade speculators collectively; and 2) there are more susceptible speculators. However, when dispersion becomes too large, the positive effect is weakened as a result of the increased number of wet blankets.

4.5 Unlike the effect on level, ICTs slow the speed of participation diffusion, except in a strong class with modest $\tau_{\text{std}}$ (see the two lower plots in Figure 3). As mentioned earlier, higher connectivity implies that it is more difficult to convince individuals to participate. In other words, exposure to more wet blankets and speculators increases individuals’ ambivalence, which delays their decisions.

4.6 Figure 4 shows how cultural contexts differentiate the role of ICTs. Collectivistic and individualistic cultures differ in regard to communication patterns and behavioral norms. With these differences, ICTs are more important in the collectivistic culture rather than in the individualistic culture. Particularly, the three upper plots in Figure 4 show that ICTs result in a more significant decrease (increase) of participation level in the collectivistic culture than in the individualistic culture when the dispersion in propensity distribution is low (high). However, the effect on participation diffusion speed is similar, as seen in the three lower plots.

http://jasss.soc.surrey.ac.uk/17/2/7.html

16/10/2015
This latter property has some implications for scholars who focus on the influence of the culture context on the relationship between ICTs and collective actions.

### Discussion and Conclusion

5.1 As ICTs are becoming increasingly important in modern-day collective actions, researchers have begun investigating how ICTs impact such actions. A well-known theoretical proposition is that ICTs can facilitate collective actions by increasing the social connectivity of individuals. Therefore, this study tested the proposition by examining two moderating factors, namely, the cultural patterns of behavior and communication norms and the distribution of political preference towards particular collective actions.

5.2 By utilizing the ABM, two interesting properties are revealed. First, providing a larger number of social contacts cannot guarantee the positive role of ICTs in both the level and speed of collective actions, which goes against conventional wisdom. In one perspective, the relationship between ICTs and participation level greatly depends on the dispersion of participation preference. More specifically, ICTs deter participation when dispersion is comparatively low; otherwise, ICTs facilitate participation. This finding echoes an interesting political dilemma in which greater cross-cutting social contacts may exacerbate or ameliorate collective actions (Farrell 2012). Moreover, the results show that ICTs only have a weak effect on participation level when preference distribution is unduly polarized. This finding is in accord with several empirical observations. For example, Lawrence, Sides and Farrell (2010) show that ICTs have an insignificant effect on political participation when individuals encounter entirely competing opinions (e.g., when right-wing individuals read left-wing blogs).

5.3 Conversely, ICT-improved connectivity primarily has a negative effect on the speed of participation diffusion, unless the participation preference is strong and dispersion is modest. This is because when activists’ influence on a particular individual becomes significantly weakened, they can reach more potential targets through ICTs. Some empirical observations support this result. For example, Campbell and Kwak (2012) show that intensive utilizations of mobile phones in core discussion networks hinder open dialogue with outsiders, and hence, such usage impedes information diffusion from the local to the global level. Mutz (2006) suggests that more cross-cutting ties imply more exposure to conflicting information, which makes it more difficult for people to make a decision. This leads some individuals to make a decision later in the action. However, it can also make others remain on the sidelines until the action has been completed.

5.4 The first property implies that blocking communication may be ineffective in dealing with contentious collective actions. On the one hand, as Hassanpour (2011) suggests, individuals may contact more activists using ICTs, but dense networks can delay their participation decisions or even prevent them from participating. On the other hand, blocking communication may upset those citizens who are apolitical or unconcerned with the activity. In other words, it may reduce an individual’s participation threshold. This can increase the number of rabble-rousers and susceptible speculators but decrease the number of wet blankets, which can enlarge and accelerate participation.

5.5 The second property shows that the effect of ICTs on collective actions is greater in the collectivistic culture than in the individualistic culture. Recall that individuals in the collectivistic culture tend to hold a significant strong-tie network that trusts strong ties much more than weak ones. Some scholars suggest that such strong-tie networks are helpful for reducing ambivalence (Campbell & Kwak 2012; Eveland & Hively 2009; Huckfeldt et al. 2004). By this logic, the collectivistic setting can amplify the (either positive or negative) effects of ICTs.

5.6 This latter property has some implications for scholars who focus on the influence of the culture context on the relationship between ICTs and collective actions.
Recent empirical research has recognized that the role of ICTs in protest activists is different in nations such as China, Latin America, and the United States (Harlow and Harp 2012; Harp et al. 2012). These researchers argue that the differences are caused by digital divide, Internet penetration rate, and demographic differences. The findings of the present study suggest that the role of ICTs greatly relies on the culture context and therefore, such reliance needs to be considered in future empirical studies regarding the role of ICTs.

Appendix: Sensitivity Analysis

Here the sensitivity of the results regarding the strength difference between strong and weak ties, $\alpha$, is examined. The value of $\alpha$ varies from 0 to 1 and there are a total of 990 paired samples (3 values for $\tau_{\text{mean}}$ × 6 values for $\tau_{\text{std}}$ × 55 combinations of $\alpha_{\text{collectivism}} > \alpha_{\text{individualism}}$). Figure 5 and Table 4 show that ICTs are more influential in the collectivistic culture than in the individualistic culture and in most cases, they are not sensitive to parameter $\alpha$. For valid samples, 92.74% of samples for level and 84.93% for speed support this claim. The other results are also insensitive to parameter $\alpha$. More details are available from the authors upon request.

![Figure 5. Sensitivity analysis for $\alpha$](http://jasss.soc.surrey.ac.uk/17/2/7.html)

<table>
<thead>
<tr>
<th></th>
<th>Total Samples</th>
<th>Valid Samples</th>
<th>C&gt;I</th>
<th>%</th>
</tr>
</thead>
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<tr>
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<td>895</td>
<td>830</td>
<td>92.74</td>
</tr>
<tr>
<td>Speed</td>
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<td>836</td>
<td>710</td>
<td>84.93</td>
</tr>
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</table>

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Notes

1 The social network defined in this study is actually the influence network. In addition, during an activity, it focuses on "who can influence who" (whether a tie exists) and "how much one actually influences the other's decision" (tie strength). In this sense, the specific form of a tie (e.g., online vs. offline, emotional vs.
behavioral or life-long vs. temporary) could be negligible in this model.

2 The following example illustrates this study’s statements. Amy received three invitations from Brand (workmate), Cindy (confidante), and David (member in a same online interest group). She took these invitations into account when deciding whether or not to participate in the activity. In this case, Amy has at least three ties even though they are associated with different empirical referents. With respect to tie strength, it is likely that the online tie between Amy and David is equally as strong as the offline tie between Amy and Cindy, because Amy and David could have a strong interpersonal influence on one another due to shared interests (even though they never met in person). However, it is plausible that the online tie between Amy and David is stronger than the offline tie between Amy and Brand, especially if Amy and Brand do not care for one another (even though they meet approximately every day).

References


