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Ethnic conflict goes mobile: Mobile technology's effect on the opportunities and motivations for violent collective action

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Abstract

This analysis contributes to the body of research testing the effect of mobile phone availability on the probability of violent conflict by shifting the unit of analysis to that of distinct ethnic groups. This approach provides two important advantages. First, it tests the robustness of this relationship by determining whether this effect maintains when shifted to a more rigorous and theoretically appropriate level of analysis. Second, shifting the analysis to the group level also enables tests of specific characteristics that may condition the effect of mobile phone availability on violent collective action. The first set of characteristics test whether mobile phone availability primarily increases a group's opportunities to engage in violent collective action as a result of decreased organizational costs due to diminished communication costs. The second set of characteristics explore whether mobile phone availability makes violent collective action more likely as a result of increasing a group's motivation to organize, thanks to enabling more efficient communication about shared grievances between group members. The results yield mixed support for both of these potential mechanisms, providing needed insight into the dynamics at play in this relationship – a matter that very much remains in the 'black box' at this point in time.

Keywords

collective action, conflict, information and communication technology, mobile telephony

This analysis contributes to the line of research testing the effect of mobile phone availability on the probability of violent conflict by shifting the unit of analysis to that of distinct ethnic groups. Previous research employed geographic information systems (GIS) data to show that the probability of violent conflict in a given location increases significantly when a mobile phone signal is present in that location (Pierskalla & Hollenbach, 2013). However, although these researchers offered a plausible theoretical framework – that mobile phones reduce communication costs associated with collective action – they were unable to test this framework due to the units employed in their analysis.

By shifting the unit of analysis to that of distinct ethnic groups, this analysis makes several important contributions to this burgeoning line of research. First, it tests the robustness of previous findings by determining whether this effect is maintained when shifted to a more robust and theoretically appropriate level of analysis. I also expand the range of countries tested to include 599 distinct ethnic groups living across 121 countries. More importantly, shifting the analysis to the group level also enables tests of specific factors that may condition the effect of mobile phones on violent collective action, thus providing insight into the mechanisms that are potentially at play in this relationship. In other words, these tests will provide insight into whether specific group or national characteristics magnify or diminish the degree to which mobile phones reduce communication costs that facilitate organization for violent collective action. This will provide needed insight into the theoretical framework undergirding the potential for reduced

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communication costs provided by new information and communication technologies (ICTs) to precipitate meaningful changes in political behavior and outcomes.

In the following sections, I briefly revisit components of the theory of collective action relevant to communication costs, with particular attention to how new ICTs update this discussion. I then turn to a summary review of the literature of a specific and special type of collective action – violent ethnic conflict – during which I pay particular attention to two specific sets of explanations regarding the causes of ethnic conflict. The first set focuses on opportunities as catalysts for violent conflict, whereas the second set emphasizes motivations.

Then, employing a mixed effects logistic model of time-series cross-sectional data over a three-year period, from 2007 to 2009, I test the effect of the percentage of a group's geographic territory (weighted by population density) that is covered by a mobile phone signal on the probability of violent conflict between that ethnic group and its government. This is followed by several tests of whether specific group or national factors condition this effect. Specifically, I first determine whether the effect of mobile phones is distinct in nations with limited access to landline telephone connections. Next, I test for conditioning effects of specific characteristics to investigate whether mobile phones increase the probability of engaging in violent collective action as a result of increased *opportunities* provided by the reduced communication costs yielded by mobile phones. The second set of characteristics test whether reduced communication costs via mobile phones make violent collective action more likely to occur as a result of increasing a group's *motivation* to organize by enabling more efficient communication between aggrieved group members.

The findings of this analysis substantiate a distinct effect of mobile phones in nations with limited access to landline telephones. The findings also demonstrate mixed support for both opportunities-based and motivation-based mechanisms. The size of an ethnic group's population, the geographic concentration of the population, and how rural a group's territory is each condition the effect of mobile phones on the probability those groups will engage in conflict with their government, suggesting that mobile phones reduce certain organizational barriers and thereby increase opportunities for collective action. The results also reveal, however, that political status of the ethnic group and strength of national democratic practices also condition this effect, suggesting that mobile phones may also enable group members to better communicate about shared grievances with one another, potentially increasing their motivation to organize for violence.

Communication costs in collective action theory

In Olson's classic work, *The Logic of Collective Action* (1965), a group's likelihood of organizing toward collective ends hinges on a number of factors that determine the costs and benefits that group members expect as a result of participation in that collective action. One central determinant of these factors is how easily and cost-effectively a group can communicate and exchange information between its members. Thus, 'traditional collective action theory is correct in recognizing the necessity of information, communication, and coordination to collective actions of every kind' (Bimber, Flanagin & Stohl, 2005: 374).

The most evident of these communication costs are associated with coordination: how effectively can groups inform their members of the logistics – the who, what, where, and when – of participation? These types of costs are typically referred to as organizational costs. Another prominent type of communication cost that groups incur is costs associated with learning about, locating, and punishing free-riders who opt out of collective action, but who still seek to enjoy the public goods associated with a group's efforts. Conversely, more efficient communication also helps groups to better reward participation via selective benefits, through which groups can use individualized incentives that are rewarded selectively to individuals to encourage their participation.

Finally, less costly communication also facilitates secondary processes that are often integral to collective action. These can loosely be thought of as the 'whys' of participation. For example, the likelihood of organization increases when group members (or group factions) can better bargain with one another in order to arrive at a mutually beneficial course and mutually satisfactory goal of collective action. Collective action is also more likely to occur when group members better identify with one another and believe that they, in fact, have common interests that are at stake, justifying that collective action.

New information and communication technologies have drastically reduced the costs of communication, fundamentally reshaping contemporary information environments and ushering in what Bruce Bimber (2003) terms the fourth information regime. This information regime is characterized by information abundance, which has profoundly altered the structure of political institutions to favor new, post-bureaucratic forms of politics. This drastic reduction in communication costs also has profound consequences for collective action more generally. By 'lowering the costs of coordinating group action' (Shirky, 2008: 31),

the expected goods of collective action will exceed the expected costs of that organization more often than in the past, which Shirky predicts will result in a surge in group activity toward a broader range of ends.

Bimber, Flanagin & Stohl (2005) articulate three specific ways in which reduced information costs provided by new technology will facilitate collective action: 'The need to accumulate resources in order to bear the costs of acquiring information about interests, the costs of distributing messages, and the labor and material costs of coordination are diminished substantially under certain circumstances by the availability of new technology' (Bimber, Flanagin & Stohl, 2005: 374). Thus, it is not surprising that scholars are revisiting the classic Olsonian logic of collective action in light of new technology (Lupia & Sin, 2003). As a result, a large portion of the prominent work on new technology and collective action considers the potential for digital networks to increase political participation and civic engagement in developed countries (Earl & Kimport, 2011; Kenski & Stroud, 2006; Mossberger, Tolbert & McNeal, 2008; Xenos & Moy, 2007).

While this is an important line of inquiry, the technology that is presently exerting the most profound impact in developing countries is that of mobile telephony. It should be stipulated at this point, however, that differentiating between the effects of Internet and mobile phones is already difficult and will only grow increasingly so, thanks to the convergence of these technologies. As Bimber and colleagues explain, 'many people – a majority of those online in Japan, for example – use the Web through cellular phones. Similarly voice calls are increasingly made over the Internet. For these reasons, attempting to maintain a distinction between the Internet and telephony [. . .] is not always fruitful' (Bimber, Flanagin & Stohl, 2005: 369).

While it is necessary to acknowledge convergence, this does not preclude a consideration of the unique contributions made by mobile phones, particularly in developing regions. This is because in many developing countries access to traditional landline telephones was limited or nearly non-existent as recently as 15 years ago. According to the International Telecommunications Union (2011), whereas there were 57 landlines per 100 individuals living in developed countries in 2000, in this same year there were only nine landlines per 100 inhabitants living in developing countries. This meant that, for the vast majority of individuals in developing countries, exchanging information over any sort of geographic distance meant that information had to be physically transported by a person, carried either in written form or verbally. Thus, the rapid expansion of mobile phones in developing countries decentralized the capacity for individuals to share information over geographic distances at breakneck speeds.

As a result, the costs of communication – in terms of the time, effort, and money required to exchange information over geographic distances – have decreased exponentially in the past decade in these regions and, with it, so have the communication costs associated with collective action. As Livingston (2011: 12) observes, 'Mobile telephony allows nongovernmental organizations (NGOs) and other groups to organize disparate and often marginalized populations into new kinds of organizations and types of group activity.' Accordingly, a growing body of literature has begun unpacking the potential economic and political effects of this unprecedented expansion of communication capacity (Aker & Mbiti, 2010; Bailard, 2009; Diamond, 2012; Jensen, 2007).

Ethnic conflict as collective action

Violent conflict is a significant and special type of collective action – thanks to the particularly high risks and potential rewards that characterize this type of organization. A primary (although not mutually exclusive) cleavage within this literature considers the relative effect of a group's opportunities versus motivations to engage in conflict. Whereas opportunity theories emphasize factors that make organization more or less costly, motivation theories focus on the expected costs and benefits derived from conflict that may encourage groups to act.

Weidmann (2009) articulates both sides of the organization versus motivation divide in his consideration of two potential mechanisms to explain the positive effect of the concentration of group members on that group's likelihood of engaging in conflict (Toft, 2002): 'Two competing mechanisms have been proposed: first, a motivation-driven mechanism, where the existence of a well-defined territory makes the group more likely to fight for it; and second, an opportunity-driven link, where concentration facilitates group coordination for collective action' (Weidmann, 2009: 536). Through an analysis of the relative effect of territorial concentration versus population concentration, Weidmann concludes that it is reduced organizational costs (i.e. reduced communication costs via living in closer proximity) that drive the positive relationship shared by a group's physical concentration and its propensity to engage in conflict (Laitin, 2004).

Continuing along this divide, Cederman, Wimmer & Min (2010) consider both motivational and organizational factors as potential predictors of violent ethnonationalist

conflict. On the organizational side, contrary to Olsonian logic, they argue that large ethnic groups are actually more likely to organize for violence, 'While neoclassical collective action theory in the Olsonian tradition expects free riding in large groups, nationalists may overcome such dilemmas through intragroup monitoring, by relying on preexisting social networks, and by mobilizing identity-related cooperation norms' (Cederman, Wimmer & Min, 2010: 96). Additionally, they suggest that larger groups can better draw on their larger numbers to recruit fighters and have a greater potential resource pool to sustain their organization and activity. However, they also explore a motivational-side explanation for the effect of group size on violence propensity, drawing on Cederman, Buhaug & Rød (2009) to suggest that 'larger groups also enjoy more legitimacy: given the principles of representativity that underlie the nation-state, the exclusion of large sections of the population from power is more scandalous than the exclusion of smaller groups' (Cederman, Wimmer & Min, 2010: 96). Their findings that large groups that have recently experienced a downgrade in status are particularly likely to engage in violent conflict provide support to both of these mechanisms as precipitators of violent conflict.

Wucherpfennig et al. (2011) also consider both approaches to explain their finding that groups located at greater geographic distances from the capital are particularly likely to engage in territorial conflict. On the opportunity side, citing Fearon & Laitin (2003), they suggest that 'state capacity, that is, the ability of the state to effectively control territory, is particularly low in the periphery, making rebellion feasible' (Wucherpfennig et al., 2011: 432). However, on the motivation side, these same authors suggest that it may also be true that peripheral groups are 'less likely to be involved in the process of nation building and therefore most likely to disidentify with the state' (Wucherpfennig et al., 2011: 432).

Hypotheses

If mobile phones decrease the communication costs associated with collective action, what role might mobile phones play in organizing for violent conflict? Should we expect to see an increase in violent collective action as mobile signal coverage spreads across groups' territories, reducing communication costs that may have previously limited a group's capacity to organize? This is the question that Pierskalla & Hollenbach (2013) set out to test using spatially disaggregated data of mobile signal availability and violent conflict on the African continent. They operationalize their dependent variable as grid cells of approximately 55 km by 55 km in size, which take on binary values indicating whether or not a conflict occurred in that geographic location in that year. Using multiple models, Pierskalla & Hollenbach demonstrate a consistent positive effect of mobile signal availability on the probability of violent conflict.

These findings offer an important first step in testing the full range of potential implications of expanding mobile phone coverage in developing countries. However, although the authors conclude that their findings provide 'evidence that cell phone technology can increase the ability of rebel groups to overcome collective action problems' (Pierskalla & Hollenbach, 2013: 31), their analysis does not actually test this relationship. Although their theoretical framework is specific to the manner in which mobile phones reduce communication costs faced by *groups* when organizing for conflict, their analysis is unable to test for this effect on actual groups' likelihood of engaging in conflict.

Accordingly, the present analysis expands this seminal work by shifting the unit of analysis to a more theoretically appropriate and rigorous level – that of distinct ethnic groups (Wucherpfennig et al., 2011).[1] This will first demonstrate whether the relationship uncovered by earlier research is maintained when tested at a more appropriate level of analysis and in countries that span well beyond the African continent. (Table A1 in the online appendix provides a list of included countries.) More importantly, shifting to this level of analysis enables a consideration of whether specific group and national characteristics condition the effect of mobile signal coverage on violent collective action, permitting insight into the mechanisms that potentially drive this relationship. This will provide needed insight into the mechanisms potentially at play in this relationship – a matter that remains very much in the 'black box' at this point in time.

Before turning to the hypotheses, a somewhat obvious but necessary aside: this analysis does not suggest that mobile phones alone increase violence – one does not pick up a phone and instantly and invariably grow more prone to violence. In the words of Earl & Kimport

[1] Ethnic groups are defined in the GROWup data collection as those with 'any subjectively experienced sense of commonality based on the belief in common ancestry and shared culture' (Hunziker, 2013: 6). Each group must also be classified as politically relevant within its state, defined as such if at least one political organization claims to represent it in national politics or if its members are subjected to state-led political discrimination (Hunziker, 2013).

(2011: 31), 'technologies don't inevitably lead to specific social or political changes. Instead, people's uses of technologies – sometimes mundane, and sometimes widely innovative – lead to (different kinds of) social and political changes'. Accordingly, the present analysis assumes that groups already possess some varying underlying propensity toward violent collective action; however, these groups also face various barriers that, in some cases, limit their capacity to act on that underlying propensity. Thus, this analysis tests the various avenues through which the reduced costs of communication provided by mobile phones might enable groups to better surmount barriers that would otherwise have limited their ability to organize for conflict.

The first hypothesis tested in this analysis posits a distinct effect of mobile phones in countries with fewer landline telephones. Specifically, I test the prediction that mobile phones have a pronounced effect in regions that previously had less access to telephonic communication of any sort. It is true that, relative to landline telephones, mobile phones offer unique advantages that are integral to collective action. For example, mobile phones are particularly useful to organizations for political protest due to their capacity to reduce reliance on 'brittle planning'. Brittle planning characterizes the types of plans that rely on traditional landline telephones (Rheingold, 2003). This is because, once protestors leave the house, they are wholly dependent on word-of-mouth to learn of changes in protest venues, tactics, or timing – giving protestors limited capacity to adjust plans in response to changing circumstances once the participants take to the streets. Mobile phones have greatly diminished this limitation – protestors can now use mobile phones to send texts and messages through social media to change protest plans on-the-fly – a capacity well demonstrated by the Arab Spring uprisings (Howard & Hussain, 2011). Thus, even in countries already well connected through landline telephones, the expansion of mobile phones uniquely reduces communication and, thus, organizational costs integral to protest and violent conflict.

Nevertheless, I argue that the effect of mobile phones on the probability of organizing for conflict will be significantly distinct and more positive in nations with fewer landlines (Hypothesis 1). This is because it is in these countries where the recent and rapid adoption of mobile phones represents a more massive decentralization of the capacity to exchange information quickly and at low cost over geographic spaces. Previous to this decentralization, in nations with few landline telephones, elites have long enjoyed access to communication technology whereas the masses tended to be excluded from this capacity. Thus, it is here that the expansion of mobile phones has most profoundly redistributed the capacity to communicate and share information over geographic distances.

Thanks to this profound 'shock' to these information environments, it is here that we are likely to see a larger effect of mobile phones on the probability that groups will organize for conflict. This is for two reasons. First, recall that this analysis assumes that all groups harbor some underlying propensity toward organizing for collective violence. However, all groups also face certain constraints and costs associated with organization, which determine the threshold point at which the perceived benefits of violence outweigh the likely costs. And, in many cases, these costs set this threshold point high enough to preclude organization.

In nations with fewer landlines, where the introduction of mobile phones presented a larger shock to the information landscape by decentralizing communication capacity, the reduced communication costs provided by mobile phones will more drastically lower the threshold point (relative to nations with abundant landlines) at which the expected benefits of violence outweigh the costs. Essentially, with the expansion of mobile phones, the cost–benefit calculus determining whether groups successfully organize for violent conflict was altered to a greater degree in nations with fewer landlines than in nations that already enjoyed widespread telephonic access. Thus, we should see mobile phones have a larger impact on organization for conflict in nations with fewer landlines.

Second, political scientists tend to view conflict as the result of strategic interactions. A multitude of models predict that as the violence-producing capability of the citizenry increases, the choices and behavior of political leaders will change accordingly (Acemoglu & Robinson, 2001; Besley & Persson, 2010). Thus, leaders in nations with widespread access to landline telephones are more likely to have already adjusted their strategic calculations to take into account the assumption of decentralized and widespread communication capacity of disaffected groups. However, the introduction of mobile phones in nations previously without widespread access to landline telephones meant that these leaders were less likely to have updated their strategic calculations to account for the effects of disaffected group members now being able to communicate widely, quickly, efficiently, and cheaply with one another. Therefore, in the initial years of the expansion of mobile phones, leaders in these nations have been more likely to take for granted the implications of decentralized communication capacity, making

them more likely to commit strategic miscalculations that may catalyze disaffected groups to action. The failure of leaders to update their calculus and take into account how reduced communication costs differently enable their population – and the implications of this for violent conflict – is also well-demonstrated by the Arab Spring uprising (Howard & Hussain, 2011). It is for these reasons I expect to find a larger effect of mobile phones in nations with fewer landlines.

Turning to the next portion of the analysis, I test two specific avenues through which mobile phones may increase the likelihood that groups will be able to successfully organize for violent collective action. The first of these hypotheses predicts that mobile phones increase the probability that a group will organize for violent collective action as a result of the increased opportunities that reduced communication costs provide. For example, whereas a very rural territory made it difficult for group members to communicate in order to strategize and then mobilize persons and resources without telephones because individuals had to physically transport these messages over relatively difficult geographic spaces to traverse, mobile phones enable these messages to be sent instantly and at low cost, without anyone having to physically carry those messages. Accordingly, Hypothesis 2 predicts that factors that represent traditional barriers to organization – such as having a very rural territory, a large population, or a thinly concentrated population – will significantly and positively condition the effect of mobile phones on the probability of organizing for violent conflict.

Hypothesis 3 predicts that factors traditionally associated with increasing a group's motivation to organize for conflict – such as a recent downgrade in status, being excluded from political power, living in a less democratic nation, or having lower living standards – will significantly condition the effect of mobile phones on violent collective action. In this view, the effect of mobile phones travels through their capacity to better connect disaffected group members, enabling broader and more frequent communication about their shared injustices, potentially increasing their motivation to organize for conflict to push the state to redress those grievances.

Taken together, I predict that this analysis will yield stronger support for Hypothesis 2 than for Hypothesis 3. This is because mobile phones still primarily facilitate one-to-one communication (with the exception of using phones to access the Internet and/or send out mass texts). And, the information exchanged in one-to-one interactions tends not to exist at the level of abstraction that is necessary for individuals not to morselize their personal suffering at the hands of the state. In more detail, work by political scientist Robert E Lane (1962), argues that people tend to morselize their private experience: 'the events and details of daily life are typically not interpreted as instances of broader themes, political or otherwise ... Such morselization is an enormous obstacle to the politicization of private experience' (Kinder & Kiewiet, 1981: 158). Thus, information communicated one-to-one through mobile phones tends not to exist at the level of abstraction necessary for personal experiences to be linked to broader, aggregate- or national-level evaluations – the types of evaluations that are arguably more likely to motivate a group to organize in response to injustices or suffering.

On the other hand, the capacity for mobile phones to reduce coordination and organization costs that may have otherwise precluded violent collective action is much more straightforward. Coordination requires that strategies and goals be discussed and decided upon and organization requires that people and resources be marshaled and deployed – all of which requires communication between group members. Thus, more efficient communication makes it easier to successfully coordinate and organize for collective action. Therefore, I predict that there will be a larger effect of mobile phones on organization for violent collective action among groups that traditionally faced larger barriers to organization compared with groups whose experiences in their host country may magnify their motivation to organize for conflict.

In summary, the following analysis tests three specific hypotheses:

Hypothesis 1: Mobile phone availability will have a pronounced effect on the probability of conflict in nations with fewer fixed landline telephones.

Hypothesis 2: Mobile phone availability will have a pronounced effect on the probability of conflict among ethnic groups that traditionally faced higher organizational barriers to collective action.

Hypothesis 3: Mobile phone availability will have a pronounced effect on the probability of conflict among ethnic groups that have greater motivations to organize for collective action.

Data and model

The binary dependent variable in this analysis represents the onset or continuation of violent conflict between an ethnic group and its government, provided by the GROWup data collection (ETH Zurich, 2014). This

dataset includes any politically relevant ethnic group with a population of at least one million and whose territory covers at least 50,000 square kilometers as of 2005. The definition of conflict used by GROWup accords with the parameters specified in the UCDP/PRIO Armed Conflict Dataset (Gleditsch et al., 2002; Themnér & Wallensteen, 2014): 'a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths'. In more detail, the binary variable employed in this analysis is provided by the EPR-ETH 2.0 dataset (Cederman, Wimmer & Min, 2010), and it represents the incidence of conflict involving a specific ethnic group or rebel organization associated with that group. The EPR-ETH 2.0 dataset draws from three distinct sources to build these variables – the ACD2EPR dataset (Wucherpfennig et al., 2012), the NSA dataset (Cunningham, Gleditsch & Salehyan, 2009), and the UCDP/PRIO Armed Conflict Dataset (Gleditsch et al., 2002).

The primary explanatory variable measures the percentage of an ethnic group's territory that had mobile phone coverage in each year from 2007 to 2009 (Wucherpfennig et al., 2011), weighted according to population density (LandScan, 2009).[2] A population density-weighted measure of the percentage of an ethnic group's territory that is covered by a mobile signal is preferable to an unweighted measure since there are often sizeable portions of territories that are sparsely inhabited or entirely uninhabited. Therefore, the population density-weighted measure adjusts for these regions and provides a more valid measure of the percentage of the actual size of the population living in geographic spaces that can receive a mobile phone signal.

I also include a number of variables to control for group- and country-level factors that the literature suggests are strongly correlated with mobile signal coverage and intrastate conflict. At the country level, I include variables controlling for GDP per capita (UNDP, 2013a; see also Cederman, Wimmer & Min, 2010), as well as the country's human development index (HDI) (UNDP 2013a; see also Fearon & Laitin, 2003), which is a quality of life metric. As for governance measures, I control for the strength of the democratic practices in that nation, how effectively the government provisions public goods, and the strength of rule of law (World Bank, 2013; see also Fearon & Laitin, 2003; Saideman et al., 2002). In order to focus on the effect of mobile phones specifically, I also include a measure of the number of landline telephones in each nation per 100 inhabitants (International Telecommunications Union, 2013).

At the group level, I control for the geographic size of the group's territory, the percentage of that group's territory that is rural (CIESIN, 2011; see also Buhaug & Gates, 2002; Buhaug & Rød, 2006; Fearon & Laitin, 2003), and the size of the ethnic population (UNDP, 2013b; see also Cederman, Wimmer & Min, 2010; Fearon & Laitin, 2003). Additionally, since a group's propensity to engage in conflict is influenced by past engagement in conflict (Kalyvas, 2008), I include a measure of how many years it has been since that group last engaged in conflict (i.e. peace years). In order to avoid the hazards associated with time dependence in binary data, I also include variables representing the squared and cubed number of years since conflict (Carter & Signorino, 2010).

The primary model used in this analysis is a mixed effects logistic model of time-series cross-sectional data. A mixed effects model permits the analysis of repeated measures (i.e. longitudinal data) that also have a hierarchy of meaningful levels (i.e. nested data). Mixed effects models are particularly useful for this type of dataset because they estimate both random and fixed effects. The random effects component of the model estimates variance parameters that represent the spread (i.e. standard deviation) of the random intercepts around the common intercept of each level of interest – such as the country and region within which each ethnic group lives. The fixed effects portion of the model produces estimates of the effect of mobile phones specific to the level of analysis of the observations – in this case, that of the specific ethnic groups – over a specific period of time (Seltman, 2014). The ability to test a relationship over time permits a much more robust test than static tests of that relationship at a single point in time (Stimson, 1985).

Mixed effects models are preferable in this case to random effects or fixed effects models because this model flexibly estimates fixed effects at the observation level in the presence of the correlated errors that accompany nested (i.e. hierarchical) data (Seltman, 2014). In other words, it will estimate the fixed effect of mobile phones at the ethnic group level over repeated measures over time while simultaneously accounting for country- or region-level variance. Moreover, mixed effects models estimate both within-group and across-group effects,

[2] One major concern is potential endogeneity between the presence of mobile phones and reports of conflict. For a discussion of this, please refer to Discussion 1A in the online appendix.

whereas a fixed effects model is limited to only within-group estimation and a random effects model considers only across-group effects. Most simply, a mixed effects model is preferable in this regard because the across-group effect of mobile phones is a key component of the research question driving this analysis – what are the factors that account for the fact that some groups are more likely to organize for violent conflict when communication costs via mobile phones are reduced, but this will not have the same effect on other groups? Additionally, fixed effects models do not generate estimates for factors that do not vary over the course of the analysis, such as the ruralness of a group's territory. Thus, a fixed effects model would prevent (or, at least, unnecessarily complicate) exploration of whether a set of potentially meaningful group and country characteristics condition the effect of mobile phones on the probability of organizing for violence.

More generally, fixed effects models are not preferred for longitudinal data that is collected over a relatively short period of time when the change in the independent variables tends to be incremental (as is the case for this dataset). This is because '[i]f predictor variables vary greatly across individuals but have little variation over time for each individual, then fixed effects estimates will be imprecise and have large standard errors' (Williams, 2013a). On the other hand, a random effects model would be problematic because this model assumes that the variation across the ethnic groups is uncorrelated with the independent variables included in the model – which is clearly not the case. This means that a random effects model would produce biased estimates of the coefficients. Random effects models are also more likely to suffer from omitted variable bias, since they do not control for time-invariant factors associated with residing in a specific country or region (Williams, 2013b).

For these reasons, a mixed effects model that estimates both fixed and random effects is the preferred model for the present analysis. First, a mixed effects model is well suited to the analysis of a large number of units that are measured over a small set of points in time (Lindstrom & Bates, 1990), such as is the case in the present analysis. Additionally, by estimating random effects at the country and/or region level, the model is able to account for unobserved or unmeasurable variance that derives from residing in a particular country or region, while the fixed effects component permits the model to estimate coefficients of the effect of access to a mobile phone signal over time specific to the meaningful level of analysis: the ethnic group.

Findings

A mixed effects logistic regression of groups' mobile signal coverage (weighted by population) on the probability of conflict between an ethnic group and its government over a three-year period, from 2007 to 2009, corroborates the findings uncovered by Pierskalla & Hollenbach (2013). Even after shifting the level of analysis and expanding the range of inquiry well beyond the African continent, increased mobile signal coverage significantly increases the probability that a group will engage in conflict with its government in a given year (see Table I). Specifically, with each unit increase in the percentage of an ethnic group's territory that is covered by a mobile signal (weighted by population density), the odds that group will engage in violent conflict against its government increases by .02.

It is worthwhile to note here that the regression including region-level random effects reveals that the region within which an ethnic group resides does not exert much of an effect on the relationship shared by mobile phones and violent conflict, evidenced by the standard deviation of the region-level variance approximating zero. Therefore, from this point forward, the models employed in this analysis will only generate random effects parameters for the country level.

Having demonstrated the continuing robustness of the effect of mobile phones on organized political violence – even when the unit of analysis is shifted to the group level and the range of countries is expanded well beyond Africa – I now turn to the test of Hypothesis 1. Before commencing, it is important to note that interpretation of the significance and substantive size of interaction effects in nonlinear models is not straightforward, due to the fact that the direction and size of the effects often vary at different levels of the interacted variables. It is also the case that the coefficients of the variables constituting interaction terms sometimes exhibit different significance levels when viewed in a regression results table than in practice (i.e. the components of interaction terms that appear significant in a results table may not actually represent a significant interactive effect in calculations of predicted probabilities and marginal effects, and vice versa) (Norton, Wang & Ai, 2004). Therefore, to determine whether there are significant conditioning effects of the variables tested in this analysis, I map the average marginal effect of a one-unit increase in mobile signal coverage over a range of meaningful values for each of the interacted variables, also known as marginal effects at representative values (Wiggins, 2013; Williams, 2013c). (Note that these

Table I. Mixed effects logit regression of the effect of mobile signal coverage on the probability of violent conflict (odds-ratio), 2007–09

Fixed effects estimates	*Mixed effects logit, country random effects*	*Mixed effects logit, country and region random effects*	*Mixed effects logit if landlines less than 34, country random effects*
Mobile signal coverage	1.019† (.010)	1.019† (.010)	1.021* (.010)
Fixed landlines per 100 inhabitants	1.152† (.091)	1.152† (.091)	1.249** (.109)
GDP per capita (x100, 2005 USD)	.994 (.012)	.995 (.012)	1.009 (.009)
Human development index	.958 (.055)	.958 (.055)	.889† (.059)
Voice and accountability	.694 (.653)	.694 (.653)	1.145 (.951)
Rule of law	1.089 (1.859)	1.089 (1.859)	.890 (1.456)
Governmental effectiveness	.817 (1.383)	.817 (1.383)	1.292 (2.122)
Peace years	.276** (.056)	.276** (.056)	.292** (.06)
Peace years squared	1.043** (.008)	1.043** (.008)	1.041** (.008)
Peace years cubed	.999** (<.001)	.999** (<.001)	.999** (<.001)
Rural percentage of territory	1.063 (.059)	1.063 (.059)	1.115 (.088)
Group population size (100,000s)	.998 (.003)	.998 (.003)	.987 (.003)
Size of territory (1,000,000 km^2)	.999 (<.001)	.999 (<.001)	.999 (<.001)
Intercept	.024 (.151)	.024 (.151)	.005 (.047)
Random effects parameters			
Region variance (s.d.)	1.821 (.528)	<.001 (.459)	1.421 (.532)
Country variance (s.d.)		1.821 (.528)	
Number of regions		6	
Number of countries	121	121	103
Number of ethnic groups	599	599	540
Number of observations	1,765	1,765	1,576

Dependent variable (binary) is the incidence of violent conflict between an ethnic group and their host nation's government in a given year. All summary statistics are included in the online appendix. $^{\dagger}p \leq .1$, $^{*}p \leq .05$, $^{**}p \leq .01$.

marginal effects are estimated for only the fixed effects portion of the mixed effects models.)

Interacting mobile phone coverage with the number of landline telephones per 100 inhabitants in that country reveals that the effect of mobile phones does vary across the range of the number of fixed telephone lines in a nation. Whereas the average marginal effect of mobile phone signal coverage on the probability of conflict is positive and borders significance (at the $p < .10$ level) among nations with fewer than 34 landlines per 100 inhabitants, among groups living in nations above this threshold the average effect of mobile phone availability on the probability of conflict becomes non-significant and highly variable (as evidenced by the broad confidence intervals above this threshold; see Figure 1 here and Table A5 in the online appendix). In part, this result could be a product of the use of *average* marginal effects, which can obscure important differences across cases. Accordingly, I also compute the predictive margins of the effect of specific levels of mobile signal coverage on the probability of conflict across the range of levels of fixed landline availability (i.e. adjusted predictions at representative values), which reveals a similar relationship – a significant ($p < .05$ level) and positive effect of all levels of mobile phone availability on the probability of conflict among nations with fewer than 34 landlines, but a non-significant and widely variable relationship above this threshold (see Figure 2).[3]

Finally, an additional regression including only countries with fewer than 34 landlines per 100 inhabitants reveals a significant (at the $p < .05$ level) and positive effect of mobile signal availability on the probability of conflict (see Table I) – an effect that is not replicated in a test of this relationship among nations with 34 or more landlines per 100 inhabitants. This set of findings provides tentative support for Hypothesis 1, suggesting that the size and consistency of the effect of mobile phone availability is distinct in nations with fewer landlines relative to nations with widespread landline availability. Future research should

[3] Regression results tables for each of the margins plots included in this article are available in the online appendix.

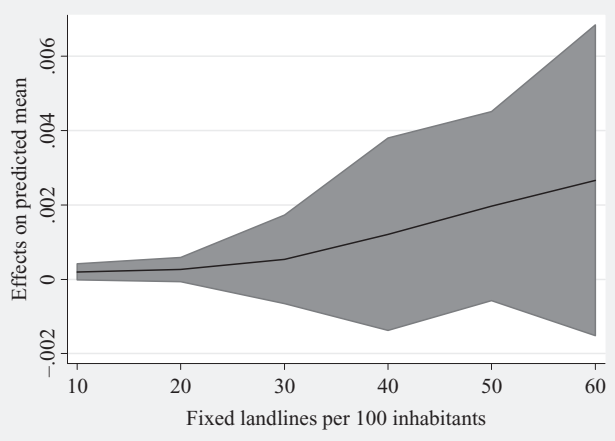

Figure 1. Average marginal effect of mobile phone signal coverage across range of number of landline telephones in country

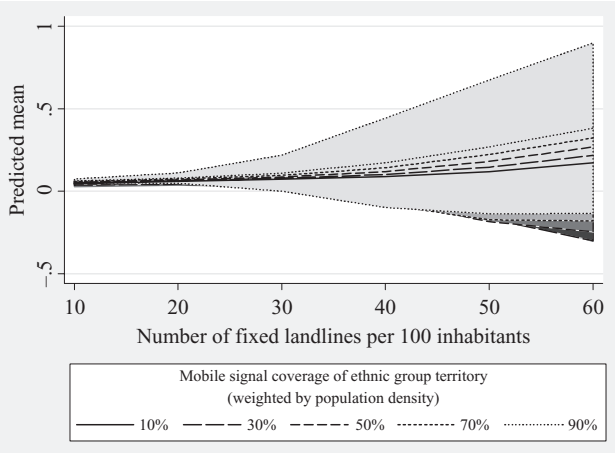

Figure 2. Predictive margins of different levels of mobile signal coverage across range of number of landline telephones in country

seek to further unpack the specific contextual factors that contribute to the distinct effects of the introduction of mobile phones across these different information environments.

The next set of findings explore whether specific national and group characteristics condition the effect of mobile phones on the probability of violent conflict to provide insight into whether reduced communication costs via mobile phones increase the likelihood that a group will organize for violent collective action as a result of reducing organizational barriers (as posited by Hypothesis 2) or by increasing a group's motivation (as posited by Hypothesis 3). In order to keep the presentation of the findings straightforward and consistent, I run

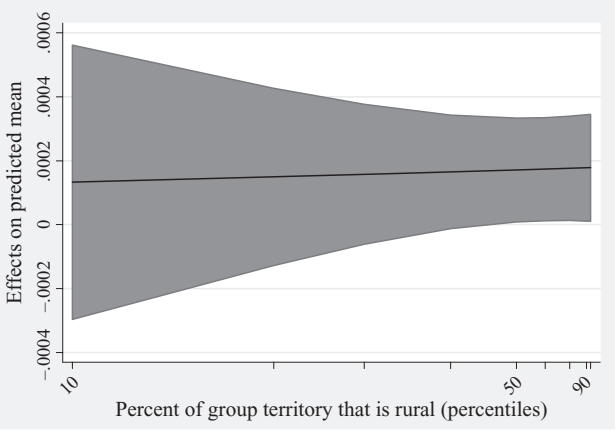

Figure 3. Average marginal effect of mobile phone signal coverage on conflict across range of ruralness of group territory

separate mixed effects regressions for each of the interactions (with the same set of controls), and then I plot the average marginal effects of mobile signal coverage at the deciles of each of the interacted variables in each regression (with 90% confidence intervals). In other words, I map the average marginal effect of mobile signal coverage on the predicted probability of conflict for the values of the interacted variables at each decile between the 10th and 90th percentiles of their ranges. (For the sake of brevity, I only include the average marginal effects plots here. The regression results are included in the online appendix.)

Beginning with Hypothesis 2, I test various factors that may impede a group's ability to organize for collective action, which seem particularly likely to be offset by the reduced communication costs yielded by the introduction of mobile phones. The first is how rural a group's territory is, which the analysis reveals does positively condition the effect of mobile phones on the probability of conflict – specifically, the more rural a group's territory is, the larger the effect of mobile signal coverage on the probability of conflict with the government. Moreover, among groups living in the least rural territories, increased mobile signal coverage does not significantly increase the probability of conflict. (See Figure 3 here and Table A6 in the online appendix.) This provides tentative support for Hypothesis 1.

Next, the analysis reveals a significant conditioning effect of the size of a group's population. Whereas there is a positive significant effect of signal coverage on the probability of conflict for the smallest and intermediate-sized groups, the size of this effect diminishes in size and becomes non-significant among the largest groups tested

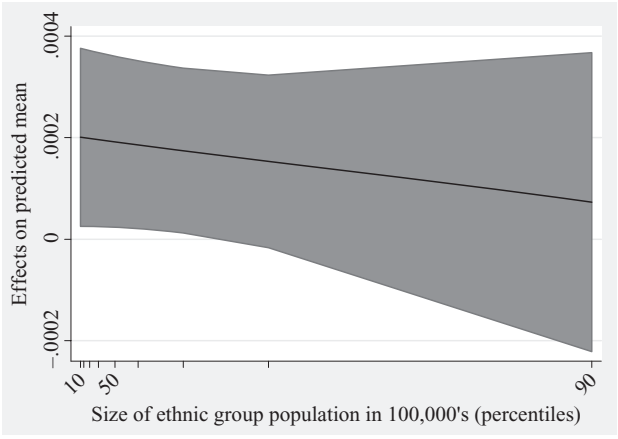

Figure 4. Average marginal effect of mobile phone signal coverage on conflict across range of group population size

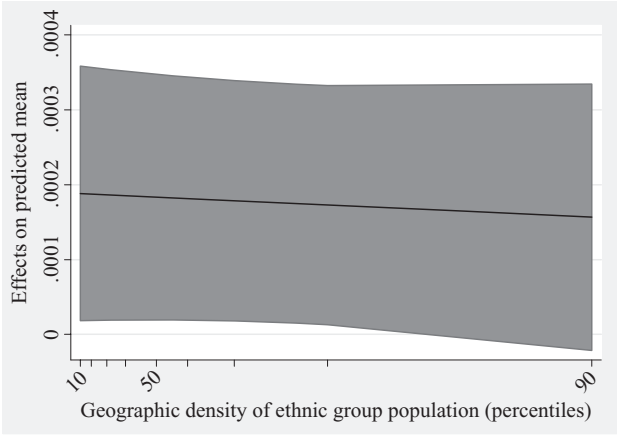

Figure 5. Average marginal effect of mobile phone signal coverage on conflict across various levels of geographic density of group population

in this analysis. (See Figure 4 here and Table A7 in the online appendix.) This finding accords with Cederman, Wimmer & Min's (2010) argument that larger groups could already use their size to their advantage by drawing on their larger numbers to recruit fighters and having a larger resource pool. Thus, it appears that it is smaller and intermediate-sized groups which benefit more from the introduction of mobile phones, potentially by enabling members of these smaller groups to better locate and marshal more scarce resources and fighters.

Finally, we turn to population density. Hypothesis 2 predicts that groups that are dispersed more thinly across their territory should particularly benefit from mobile phones thanks to the ability to now more easily communicate with one another across these sparsely populated regions. In support of this, the analysis does reveal a conditioning effect of population density. Specifically, more sparsely distributed groups see a positive effect of mobile signal coverage; however, this effect diminishes in size and becomes non-significant around the 50th percentile as the geographic density of a group's population increases. This provides further support for Hypothesis 2. (See Figure 5 here and Table A8 in the online appendix.)

In the final stage of the analysis, I test various group- and country-level characteristics that may plausibly motivate groups to organize for conflict. I begin with a test of whether the experience of a group being recently (i.e. within the past year) downgraded in political status in their host country conditions the effect of mobile phones on conflict, since 'theories of emotion suggest that negative emotions are especially likely to be aroused following the loss of prestige or power' (Cederman, Wimmer & Min, 2010: 95). So, do mobile phones enable groups to more effectively share these negative emotions, perhaps even magnifying them and thereby increasing their motivation to organize for violence? The results of this analysis suggest that this is unlikely. Being recently downgraded in status does not appear to condition the effect of mobile phones on a group's propensity to engage in conflict. (The marginal effects plot of this test is included in the online appendix.)

Next I consider a potentially distinct effect for ethnic groups that currently hold political power in their host country compared with those that are currently excluded from political power. Here we do see a very different effect of mobile phone coverage on the probability of conflict across these two groups, which travels in the direction that Hypothesis 3 predicts. Specifically, mobile signal coverage exerts no significant effect on the probability of conflict among groups that currently hold political power in their country. On the other hand, mobile phone availability significantly and substantially increases the likelihood that groups currently excluded from power will organize for violent conflict. This provides support for a motivations-based explanation of mobile phones' effect on conflict probability (Hypothesis 3). (See Figure 6 here and Table A9 in the online appendix.)

As for the country-level factors, I test whether the quality of democracy and the quality of national living standards condition the effect of mobile phones on the probability of conflict. It is plausible that less democratic governments may be more likely to abuse citizens' political rights and civil liberties, which may motivate groups to organize for conflict, particularly when mobile phones enable abused group members to communicate their shared grievances with one another. It is also plausible

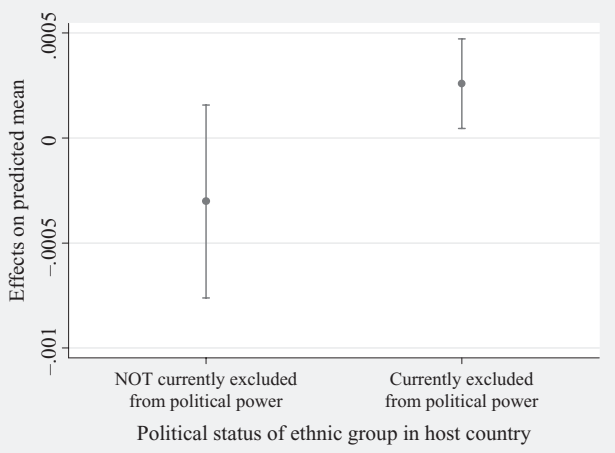

Figure 6. Average marginal effect of mobile phone signal coverage on conflict for groups by political status

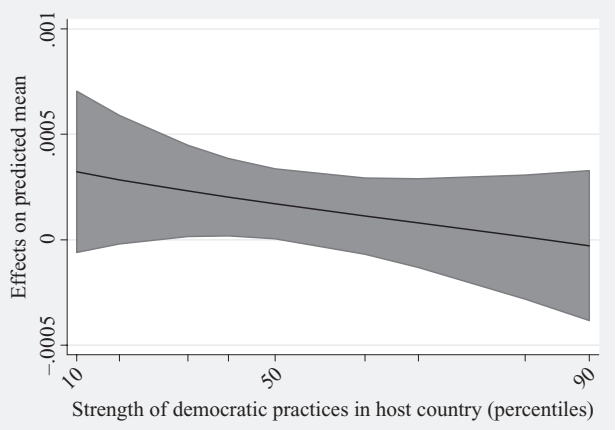

Figure 7. Average marginal effect of mobile phone signal coverage on conflict across range of strength of democracy

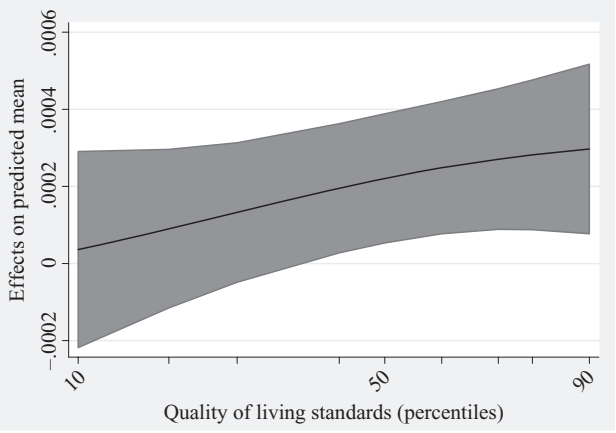

Figure 8. Average marginal effect of mobile phone signal coverage on conflict across range of quality of living standards

that groups living in nations with lower quality of life standards may be more motivated to organize for conflict when phones enable members to better communicate their dissatisfaction regarding the state's failure to provide basic living standards.

The findings reveal that mobile phones do exert different effects depending on the quality of democracy in a nation. At the highest levels of strength of democracy tested, increased mobile signal coverage does not affect the probability of conflict. However, in nations below this threshold, there is a significant and substantively large conditioning effect on the relationship between mobile phone availability and the probability of conflict. (See Figure 7 here and Table A10 in the online appendix.)

Lastly, quality of living standards exhibits an interesting effect. Here, the effect of more mobile phones on the probability of conflict is significantly positive only in nations with intermediate and high levels of living standards. In nations with the lowest quality of living standards, however, the average marginal effect of mobile signal coverage on the probability of conflict is small and insignificant – which runs contrary to what Hypothesis 3 would predict. Also interestingly, the slope of the effect of mobile phone availability on the probability of conflict tapers off toward the highest end of the scale of quality of living standards (i.e. the slope becomes somewhat flat above the 80th percentile of quality of living standards). This suggests that the most pronounced conditioning effect of mobile phones on the probability of organizing for conflict may exist in nations with intermediate levels of quality of living standards. (See Figure 8 here and Table A11 in the online appendix.) These findings have interesting implications for an opportunities-based versus motivations-based debate of the nature of the effect of reduced communication costs via mobile phones on the probability of conflict, which I will return to in the next section.

Discussion and conclusion

Although this only represents the tip of the iceberg, the factors tested in this analysis provide mixed support for both opportunity-based (Hypothesis 2) and motivation-based (Hypothesis 3) explanations of the effect of reduced communication costs via mobile phones on the probability groups will successfully organize for conflict. The significant conditioning effect of population density, the size of a group's population, and the ruralness of a group's

territory suggest that mobile phones increase the likelihood of violent collective action by decreasing specific types of barriers to organization. As for factors that may increase a group's motivation to organize for conflict, as Hypothesis 3 predicts, being currently excluded from political power and living in less democratic nations do positively condition the effect of mobile phones on the probability of conflict. However, the null effect of a recent downgrade in the group's status and the unexpected conditioning effect of quality of living standards both run contrary to Hypothesis 3.

Although the findings of this analysis yield mixed support for a motivations-based explanation of the effect of mobile phones on conflict, further consideration suggests that these latter findings may actually be equally well conceptualized as supporting opportunities-based explanations of the effect of mobile phones. Consider first that, perhaps, the effect of increased mobile signal coverage on the probability of conflict for groups currently excluded from power is a result of the tendency for these groups to also face greater obstacles to organization in their nation – such as lack of access to basic resources and public institutions – challenges which mobile phones may better enable these groups to surmount. This would plausibly lend further weight to the opportunities-based explanation of the effect of mobile phones on the probability of conflict.

As for the conditioning effect of quality of democracy, also consider that in these nations there are likely fewer formal, institutionalized, nonviolent channels for groups to petition the government to redress their grievances. So, groups in less democratic nations may not necessarily be more motivated to organize for conflict than groups in more democratic nations, but they may find themselves more often having to resort to violence due to the absence of nonviolent alternatives. If this is the case, it is likely that the positive effect of mobile phones on the probability of conflict for groups living in less democratic countries is actually better attributed to more efficient communication for the sake of organization – particularly the type of communication that would enable groups to better circumvent limitations on freedoms of speech, press, and assembly imposed by repressive regimes – than the potential for mobile phones to magnify motivations by better connecting group members to discuss shared grievances.

Finally, the seemingly counter-intuitive conditioning effect of living standards also seems relevant to this consideration. The finding that mobile phones do not increase the probability of conflict in nations with the lowest living standards may best be explained by the possibility that these groups lack access to a basic level of resources and physical well-being that would make organizing for conflict feasible. Thus, no matter how motivated a group might be, groups living in nations with very low quality of life standards may simply not have the collective health and/or resources to act on that motivation by successfully organizing for conflict.

In summary, by employing mixed effects logistic regressions of panel data over a three-year period, I demonstrate the positive effect of the percentage of a group's geographic territory that is covered by a mobile signal on the probability of conflict between that group and its government – confirming the robustness of earlier findings. I also show that the effect of mobile phones on the probability of conflict appears to exhibit a different effect in nations with fewer landlines, providing tentative support for Hypothesis 1. Then, following a common cleavage within the ethnic conflict literature, the analysis provides insight into whether mobile phones primarily facilitate violent collective action as a result of increasing the opportunities available to organize for conflict or instead by increasing groups' motivation to organize. The findings reveal mixed support for each of these potential mechanisms, contributing to the theoretical framework undergirding the emerging body of research exploring the effect of information technology on violent collective action (Warren, 2015; Weidmann, 2015). Future analyses should seek to further unpack the mechanisms through which information technology alters communication costs relevant to collective action in order to continue to build a more robust theoretical foundation predicting the political effects of new ICTs.

Replication data

Stata 13 was used for all statistical analyses in this manuscript. The dataset and do-files for the empirical analysis in this article, along with the online appendix, can be found at http://www.prio.no/jpr/datasets.

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