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ARTICLE

Communication, coordination, and surveillance in the shadow of repression

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Abstract

Communication technology helps protesters organize, but also allows the government to monitor and repress their actions. We study this trade-off in a model where protesters want to show up at the same time and place, but also want to avoid government forces. If leaders of a movement can send messages observed only by other protesters, they can successfully coordinate on a variety of sites and force the government to spread resources thin, helping the success of the movement. If the government always observes the messages too, protesters can do no better than always going to a "focal site" knowing that the government will send all resources there as well, and thus experience higher levels of repression for the sake of coordinating tactics. Intermediate cases where messages are partially observed generate dynamics where new technologies and media that are relatively known to other protesters and not the government are used until the government can reliably infiltrate them and the protesters move on to a new medium. When some protesters are more informed than others, the model can explain protest tactics observed in recent prominent cases like having smaller "parallel" protests at the same time but different location of the main gathering.

As we continue to progress through our networked age, accounts of collective action in modern uprisings must consider the role of information and communication technology (ICT). With its ability to horizontally connect formerly disparate dissidents, these technologies may help citizens topple bad governments via protest and other forms of collective action.

Many have noted a flaw in this line of reasoning: The government is a strategic actor as well, and can stymie mobilization by intercepting communication and infiltrating movements via ICT. For example, Larry Diamond (2010, p. 70), points out that "authoritarian states such as China, Belarus, and Iran have acquired (and shared) impressive technical capabilities… to filter and control the Internet, and to identify and punish dissenters." Empirical research on (attempted) collective action in repressive environments illustrates this logic. Autocrats may censor calls for collective action via ICT (King et al., 2013), utilize dissidents' use of the internet to surveil and repress their most vocal critics (Gohdes, 2020; Morozov, 2012; Pan & Siegel, 2020; Xu, 2021), and take advantage of the internet to identify and put down the initial sparks of a mass protest movement (Weidmann & Rod, 2019).

However, work that focuses on the ability of governments to use ICT to stop mobilization can easily run into a parallel problem, dismissing the agency of protesters who themselves are strategic actors. Indeed, accounts of mobilization have shown that protesters find these technologies helpful even if the government is also using them to stymie the very same mobilization.[1]

A more complete accounting of how technology affects protest should account for the strategic choices of both sides. We take up this challenge with a for-

[1] For instance, for accounts on this point on the Arab Spring, see Clarke and Kocak (2019), Lutscher and Ketchley (2023), and Steinert-Threlkeld (2017).

mal model of protest that captures how both activists and the government can use ICT to further their goals. Our model shows how citizens innovate creative ways to use ICT, including social media, to improve collective action even as the government uses the same technology in their pursuit of political control.

Specifically, we model an empirically documented use of communication technology among protest movements and a necessity for collective action: the coordination of *where* protesters will actually meet. The model also incorporates the government's parallel use of surveillance of ICT: using it to intercept plans of protesters to know where to send security forces.[2]

We do so by building on Powell's (2007) model of insurgents choosing which sites to attack and the government deciding how many resources to spend on each site.[3] A key idea from this model is that insurgents facing a repressive regime can do better than always attacking the "most valuable" site, since if they do this, the government can send all of their resources to that site as well. By choosing a mixed strategy over several sites, the government is forced to spread out their resources, lowering the police presence where attacks occur and improving the success of anti-government forces.

To adapt this model to our question, we add a coordination component by treating the "insurgent" as multiple protesters, who may not be able to tell each other what site they intend to go to without tipping off the government. We study versions of this model that vary in how well the protesters can communicate with each other (the *observability* of a message) and whether the government can observe what they say (its *leakage*).

Without the ability to communicate, protesters can do no better than showing up to a "focal" site where protesters expect others to go, knowing that the government will send all of their resources there. Next, we consider the case of "perfectly" private communication that the government has no chance to intercept; think face-to-face communication, phone calls, and SMS in a context where the government lacks the capability to monitor, or social media platforms that the government is not yet aware of. With perfectly private communication, the equilibrium outcome resembles Powell (2007), where the protesters always go to the same site as each other, but randomize which site that is to force the government to spread resources in multiple places. However, if the communication is public (i.e., observed by the government), citizens can no longer effectively protest multiple sites and can do no better than always protesting the focal site as in the no-communication case.

We then study intermediate cases, where both the other protesters and the government observe messages with some probability. Technologies with more observability and less leakage are more valuable in the sense of increasing the success of protests, and also tend to increase the number of sites that are used. This formalizes a common trade-off within movements, where being more secretive—for example, not posting messages in public fora, including fewer others in group chats, and using more coded language—reduces the chance of being repressed but also makes it harder for other marginal protesters to join. As a result, at any given point in time, protests will tend to rely on "new" technologies, which are relatively known to protesters but not to the government.

Next, we consider what happens as the number of protesters increases, and only some are "insiders" who can see messages from leaders while others cannot. Unsurprisingly, more protesters, and more protesters able to observe private messages, help movement success. When some protesters can observe private messages while others cannot, a pattern observed in the 2018–2019 Sudanese uprising can occur, where "outsiders" go to a focal site, while "insiders" create parallel protests that divert regime attention away from the focal site, which can help grow the movement (Hassan, 2023). A similar pattern can arise if citizens have a heterogeneous cost of facing government repression, and those with a lower cost go to a focal site while others go to smaller parallel protest with less, if any, government presence—a common tactic during the 2019 Hong Kong protests (Lee, Cheng, et al., 2022).

Our basic theoretical contribution is to provide a tractable framework to study how both the government and activists use the same communication technology. We build on a large formal literature on how ICT affects coordination and protest, which tends to focus entirely on interactions between citizens (e.g., Barbera et al., 2020; Christensen & Garfias, 2018; Enikolopov et al., 2020; Kocak & Kıbrıs, 2023; Little, 2016). Existing models that study the trade-off between better technology helping both government and anti-government forces—Shapiro and Siegel (2015) and Dragu and Lupu (2021)—take the costs and benefits as exogenous, while we directly model how all actors use the information.

With this theoretical contribution in place, we also make contributions to empirical literature. We show how seemingly disparate tactics from disparate contexts follow a similar underlying logic. There is a growing body of empirical work on clever protest

[2] Of course these are not the only uses of ICT for either actor. Protesters can also share grievances, recruit members, or gain international attention to their cause. On the other side, the government can use ICT to identify and repress movement leaders.

[3] Other related theoretical work uses "Colonel Blotto"-like games to study how governments allocate resources to defend sites that some actor may want to attack (Blair et al., 2022; Powell, 2007, 2009; Sonin & Wright, 2022). Our key innovation with respect to these models is to incorporate communication among protesters and the interaction between this communication and what the government learns.

tactics that circumvent traditional coordination challenges against a repressive government—from disguised collective action (Fu, 2017, 2018) to mobilization from scratch (Pearlman, 2021) to butterfly protests (Ketchley, 2017) to extended, multisite actions (Bishara, 2021) to coordinated dis-coordination (Hassan, 2023). A key strength of this line of work is inductively describing innovations in protest tactics in a particular setting and providing scope conditions as to when that tactic might be observed elsewhere. Our contribution, in a sense, is the opposite: to build on past work to deductively draw out the underlying logics of dissident innovation and regime adaptation in contexts with imperfect information whereby the possibility of government interception of communication compels protesters to pivot away from tactics they would undertake in contexts of purely private communication. That we illustrate elements of the model from empirical contexts across the range of scope conditions identified in past work speaks to the model's ability to generalize and show a common thread that has been missed in considering singular episodes of protest.

Our analysis also provides future directions for empirical work. The model suggests that important variables to understand the dynamics of protest are the dispersion of protests on a given day as well as whether protesters tend to go to different sites on different days. Further, the observability and leakage parameters are akin to variation in affordances across ICT platforms, drawing a connection to research on the conditions under which different platforms are useful at different stages in a protest movement or for different movements given different political arenas (Bennett & Segerberg, 2012; Clarke & Kocak, 2019; Lee, Liang, et al., 2022; Tufekci, 2017).

EXAMPLES OF COMMUNICATION TACTICS

We draw on tactics used during the Sudanese Uprising and the Hong Kong Anti-Extradition Bill Movement—episodes of contention that vary starkly—to motivate elements of this model. Particulars of the two cases make them well suited for comparison in light of the model. Both cases saw sustained, multi-month protests against an autocratic regime in cities of similar sizes. At the same time, they vary in key parameters of our model—in the regime's repressive capacity (r), the observability of a message between protesters (o), and the probability of that message leaking to the government (l).

Online Appendix D includes background on these episodes of collective action. For the Sudan case, we draw on interviews with protesters who were active in the movement. Fieldwork procedures are outlined in Online Appendix E.[4]

THE MODEL

Consider government G, protesters indexed by $i \in \{1, \dots, P\}$. We can think of the protesters as individuals or a group of individuals who are well-coordinated enough to be a unitary actor. As will be apparent from our analysis, one way to think about being "well-coordinated" is that the group (1) has homogeneous preferences and (2) can communicate privately without interference from the government.

Choices

The key ideas the model aims to capture are that the protest movement will be more successful if (1) the protesters can solve the "tactical coordination problem" of showing up at the same time and place with unified goals and (2) the protests face less repression from the government. To simplify, we focus on the choice of what sites to protest, and the government allocation of resources across sites where the protest may happen.

Formally, there are N possible sites for protest; $j \in \{1, \dots, N\}$ is a generic site. This set includes sites equated with collective action in a given place, such as in front of historically important political buildings and outside the funerals of movement martyrs. It may also include "ecologically conducive" sites (Zhao, 1998)—well-trafficked areas that are amenable to protests but may not have been common sites of collective action in the past, such as centrally located city parks, busy cross-streets, and town squares.

The protesters' choice is discrete, each choosing a site to protest or staying home. Let s_i be the site chosen by protester i, with $s_i \in \{0, 1, \dots, N\}$, where $s_i = 0$ means staying home. Say a site is *protested* if at least one of the protesters chooses it with strictly positive probability.

The government has resources $R > 0$ to allocate across sites. We can think of R as capturing both personnel (e.g., the number and capacity of the police and security officers) as well as the capital that state personnel has at their disposal (e.g., the amount and quality of police wagons, weapons). Let r_j be the amount dedicated to site j. Since the budget is fixed, if the government allocates the full budget, $\sum_{j=1}^{n} r_j = R$. Say a site is *defended* if $r_j > 0$ and not defended if $r_j = 0$.

[4] This research is covered by IRB application HUM00171824.

The value of protest

Define S_j as the number of protesters who go to site j, and let $v_j(S_j, r_j)$ be the value of the protest at site j if there are S_j protesters and the government spends resources r_j. This value is common across protesters.

Broadly speaking, a successful (higher value) protest is one where larger numbers of participants send a clear message that they are committed to their goals (Lohmann, 1993). Larger protests also generally make participation safer for a fixed government presence (we explicitly model this in section "Due to heterogeneous tolerance for repression")—both because of a lower likelihood of any one individual being repressed and due to the odds that security officers seeing a larger crowd shy away from using repression. On the flipside, a protest will be seen as less successful if there are more government forces who can arrest protesters and potentially drive some participants away.

This value of protest also depends on intrinsic characteristics of the sites. Some sites can have higher value for practical reasons—such as being centrally located and easy to get to for a variety of participants—or for symbolic reasons (see Beissinger, 2022; Gieryn, 2000; Schwedler, 2022; Zhao, 1998, for examples). Sites may also be more appropriate for large crowds or easier for the government to defend, which will mean the v_j function is more or less sensitive to changes in S_j or r_j, respectively.

Formally, assume v_j is continuous, decreasing, and convex in r_j, and, when $v_j > 0$, both derivatives are strict. We also assume $v_j(0, r_j) = 0$ and v_j is weakly increasing in S_j. This general formulation is sufficient for many results but we make stronger assumptions about these functions for some parts of the analysis. To capture the assumption that some places have higher intrinsic value for protest, order them such that those with lower indices are better targets, in the sense that they provide more value if all protesters show up there ($S_j = P$) for any level of government presence r:

$$v_1(P, r) > v_2(P, r) > \dots > v_N(P, r).$$

A functional form that meets all assumptions we eventually make and is used for illustrations is:

$$v_j(S_j, r_j) = \frac{a_j b(S_J)}{c + r_j}, \tag{1}$$

where $a_1 > a_2 > \dots > a_N > 0$ is the general value of protest at each site, in descending order of site value. $b(S_J) \geq 0$ is a weakly increasing function capturing how adding more protesters affects success, and $c > 0$ is a constant.

Payoffs

Let the utility for each protester be the sum of the value of protest at all sites—or the *success of the movement*—minus a cost $k_i \geq 0$ if they protest. That is, one protester may pay a higher cost, though the cost does not depend on the site chosen. Writing the utility as a function of the chosen sites $s = (s_1, \dots, s_P)$ and resource allocation $r = (r_1, \dots, r_n)$:

$$u_i(s, r) = \underbrace{\sum_{j=1}^{n} v_j(S_j, r_j)}_{\text{success of movement}} - \underbrace{k_i \mathbf{1}_{s_i > 0}}_{\text{cost}}.$$

That is, protesters weigh the success of protests across all sites at a particular point in time equally. However, they may vary in the personal costs they pay to protest.

The utility to the government is:

$$u_G(s, r) = -\sum_{j=1}^{n} w_j v_j(S_j, r_j),$$

where w_j is *relative* weight the government places on protest at site j. If w_j is constant, then the government weights the importance of the site the same as the protesters.

Our solution concept is subgame perfect Nash equilibrium (SPNE). All variants of the model can have multiple equilibria; we focus on the equilibria that give the highest protesters payoff.

Communication

Assume the choices made by all actors are simultaneous after a "communication phase" where protester 1 sends a message $m \in \{0, 1, \dots, N\}$, potentially observed by some other actors. In the equilibria we study, interpret message m as "the protest is at site m." In the next two sections, we show how different communication protocols affect the optimal protest strategy.

In particular, assume that this message is observed by the other protester(s) with probability $o \in [0, 1]$, and is observed by the government ("leaked") with probability $l \in [0, 1]$. Figure 1 summarizes the cases we will study based on the value of these variables.

In section "Corner cases," we study three "corner" cases. Call the $o = l = 0$ case "no communication" as no actor observes the message. Next, we study "(perfect) private communication," where $o = 1$ and $l = 0$. Then, we consider public communication where $o = l = 1$. In section "Edge and interior cases," we consider "interior" cases where

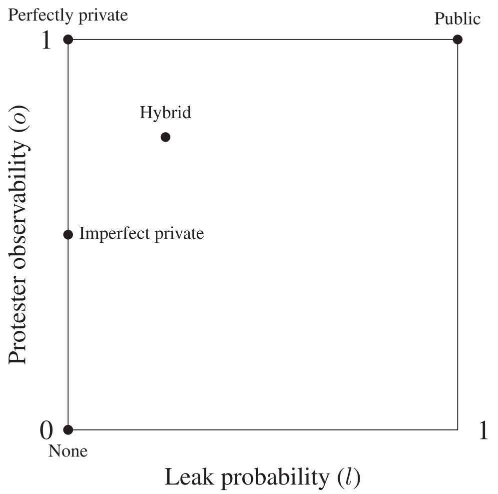

FIGURE 1 Illustration of communication cases.

some actors sometimes but not always observe the message.

While there are more cases and subtle insights along the way, the big picture is that communication is more valuable to protesters when it is more likely to be observed by other protesters and less likely to be observed by the government.

Main parameterization and scope conditions

For the next two sections, we focus on the case where there are two protesters ($P = 2$), the protest is not costly ($k_i = 0$), and the protest only has value if both show up to the same site ($v_j(1, r_j) = 0$ for all j). The first two restrictions allow us to isolate the key forces of the model, and will be loosened. The third is a more substantive assumption that there are strong strategic complementarities in protest; that is, it is much more successful when participants are more concentrated in one (or a few) sites rather than dispersed across many. We make the extreme assumption that protest only has value if both go to the same site for simplicity. As discussed below, the dynamics of the model are quite different if there are no strategic complementarities; that is, the value of adding a protester to a site is independent of how many are already there. In other words, the existence of some strategic complementarities among protesters is a key scope condition for many results.

Our key motivating cases in the paper are primarily nonviolent protests, while the model we build on was designed to provide insight into violent insurgencies. Our model can apply to cases where (1) a key strategic dynamic is that the anti-government actors are trying to attack sites not well-defended by the government, and (2) anti-government actors need to coordinate their activity without tipping off the government. In other words, whether a movement is using violence is not directly relevant for whether our analysis applies, though the strategic complementary inherent to feature (2) is likely more common in nonviolent movements. Insurgencies may also have higher organization, which may mean more developed lines of communication that are unlikely to leak.

Feature (1) also highlights why the dynamics are more likely to arise in repressive environments. In less repressive settings where government forces are relatively unlikely to violently crack down on protest (e.g., as is often the case in democracies), there is no reason for protesters to try and be secretive about where protests will be.

CORNER CASES

No communication

First, consider the "no communication" case, where no one observes the message m from protester 1. Since no one else can condition their behavior on the message, the message is meaningless and we solve the model as if there is a no-communication phase.

Even if protesters cannot explicitly communicate with each other, tacit knowledge of which locations and times are "focal" can allow successful communication. This was the dynamic in Assad's Syria during the Arab Spring where pre-existing organization was lacking and private communication across large groups was not possible. After protests broke out following Friday prayers on March 18, those opposed to the regime began to congregate at mosques during subsequent Fridays, expecting protests to break out again (Pearlman, 2021, pp. 1798–1789). However, if citizens know that a site is focal, then the government does too. So, showing up at the focal site means confronting the full resources of the government.

More generally, the assumptions that protest is not costly and requires both protesters at the same site to succeed imply that for any site j, there is a pure strategy equilibrium where both protesters choose j and the government sends all resources to this site ($s_1 = s_2 = j$ and $r_j = R$).

There are also equilibria in mixed strategies where the government does not know where protesters will be. However, if citizens mix without communication, they often end up at different sites, creating a "miscoordination cost."

The core result in this section is that, under the scope conditions codified by our main parameterization, the costs of mixing always outweigh the benefits. So, the best equilibrium for protesters involves no mixing and all go to the *focal site*. Given our assumptions, this is site 1.

The key intuition is that from either citizen's perspective, the miscoordination cost scales linearly in the probability that the other citizen will go to a different site. By contrast, the benefit of getting the government to send fewer resources to a site has diminishing returns. For example, the protester would rather know the other protester will show up to the focal site along with all of the government resources to knowing the other protester will show up half of the time along with half of the government forces. The following proposition formalizes and generalizes this observation:

Proposition 1. *In main parameterization with no communication, in any optimal equilibrium for protesters,* $s_1^* = s_2^* = 1$ *and* $r_1^* = R$.

Proof. All proofs are in Online Appendix B. □

In summary, the "no communication" scenario captures a situation where, absent the ability to coordinate, the best citizens can do is just go to the focal site and hope for the best knowing it will be heavily defended by the government.

Private communication

Now suppose that before the protest/resource allocation decisions, citizen 1 sends a cheap talk message $m \in \mathbb{R}$, which is observed by citizen 2 but not the government. This represents an ideal type where protesters' communication is capable of evading state surveillance. The private communication assumption approximates cases such as within weak states, among highly evasive protest movements that have escaped infiltration, or later in the course of a movement as protesters build effective mobilizing structures (Bishara, 2021; Pearlman, 2021). It can also represent protesters having recently identified a new technology or new ways to use an existing technology before the government catches on.

Formally, a pure strategy for citizen 1 is to send a message m and to protest as a function of m, $s_1(m)$. A pure strategy for citizen 2 is the site to go to as a function of m, $s_2(m)$.

Since the message is cheap talk, any equilibrium without communication (s_1^*, s_2^*, r^*) has a corresponding set of equilibria where any message is sent and the actors play (s_1^*, s_2^*, r^*) for any message. That is, since the message is not directly payoff relevant, it can be ignored.

However, we focus on equilibria that are best for citizens, and citizens may do better by conditioning their strategy on the message. Further, in this section, there is no loss to focusing on equilibria where both protesters go to whichever site is indicated by the message:

Definition 1. An equilibrium has *direct messaging* if and only if the citizens always go to the site corresponding to the message, that is, $s_1^*(m) = s_2^*(m)$.

Fortunately, these two refinements end up having a close relationship; as shown in Online Appendix A, the direct messaging equilibrium (which as we will show is unique) gives the highest possible payoff to protesters.

For this class of equilibria, we can effectively treat the protesters as a unitary actor, since they have the same preferences and take the same action in equilibrium. As a result, the dynamics of protest resemble the model developed in Powell (2007), and our analysis closely parallels that paper.

Unlike the case with no communication, protesters can now play a strategy where the government is not sure what site they will go to, but because of the ability to communicate, they always show up at the same site as each other and pay no miscoordinatinon cost.

For there to be an equilibrium with such mixing, the protesters must be indifferent between protesting at all sites they go to with positive probability. Further, the government only expends resources at sites that are protested with strictly positive probability. These observations also imply that if the site j is protested, then $1, \ldots, j-1$ must also be protested. So, one condition for an SPNE where sites $1, \ldots, n$ are protested and defended for some $n < N$ is that there must exist a resource allocation $(r_1^*, \ldots, r_n^*)$ such that $\sum_{j=1}^{h} r_j^* = R$ and:

$$v_1(2, r_1^*) = v_2(2, r_2^*) = \cdots = v_n(2, r_n^*) \geq v_{n+1}(2, 0).$$

The condition for an equilibrium where all sites are protested $(n = N)$ is the same except there is no inequality at the end.

To get intuition about how many sites are protested in equilibrium, start with the case where the government has few resources. If so, they cannot defend site 1 enough to prevent it from being the most attractive site to protest. Formally, let $\hat{R}_1$ be the resource level implicitly defined by:

$$v_1(2, \hat{R}_1) = v_2(2, 0). \quad (2)$$

If $R \leq \hat{R}_1$ and the government were to dedicate any resources to another site, then the protesters would have a strict preference to go to site 1, and hence in the direct messaging equilibrium, only site 1 is protested and defended.

Once $R > \hat{R}_1$, if the government dedicated all resources to site 1, then protesters would strictly prefer site 2. So, this serves as a threshold where the government goes from only defending site 1 to defending sites 1 and 2, and the protesters start going to site 2 as well. (The government must begin defending site

2 before any other site because $v_2(2,0) > v_j(2,0)$ for $j > 2$.)

For some range of resources, the government just defends sites 1 and 2, and picks an allocation that makes the citizen indifferent between the sites: $v_1(2, r_1^*) = v_2(2, R - r_1^*)$. By the assumptions placed on the v_js, such an allocation exists and is unique. If this allocation makes the protesters strictly prefer protesting site 1 or 2 to protesting an undefended site 3, then there is a unique equilibrium where just 1 and 2 are protested and defended.

Continuing this line of reasoning, as R increases, the government starts defending more sites, and the protesters also protest more sites because the most attractive targets are well defended.

The last thing to characterize is the protest probability within the set of sites where this is nonzero. Similar to the government strategy, the protester strategy must leave the government indifferent between increasing the allocation to any site. As derived in Online Appendix B, this gives:

$$\sigma_j^* = \frac{\left(w_j \left. \frac{\partial v_j(2, r_j)}{\partial r_j} \right|_{r = r_j^*} \right)^{-1}}{\sum_{k \in S} \left(w_k \left. \frac{\partial v_j(2, r_k)}{\partial r_k} \right|_{r = r_j^*} \right)^{-1}}, \tag{3}$$

where S is the set of sites protested with positive probability.

If the government and protesters give each site the same relative value as each other (constant w_j), then how often a site is protested is proportional to the inverse of the marginal gain from defending it more. It is not clear whether these are the ex ante more valuable sites (lower j) because these are generally defended more, lowering this marginal gain, but also can be more valuable in general, which may increase the marginal gain.

We can make a clearer claim with respect to w_j. Recall that this scales the v_j function, which determines how much protesters value the site, and so w_j captures how much the government values the site relative to the protesters. This result implies that the sites the government values relatively more must have *less* protest. The result follows from the logic of mixing: If the government relatively values a site, they would deviate and defend it more unless the protesters do not go there as often, and if they deviate to defend it more, that breaks the protester indifference.

Summarizing:

Proposition 2. *In the main parameterization with perfect private communication, there is a unique direct messaging equilibrium, which gives the highest possible utility to the protesters. In this equilibrium:*

1. *there exists an $n^* \in \{1, \ldots, N\}$ such that sites $\{1, \ldots, n^*\}$ are protested and defended while sites $j > n^*$ are not;*
2. *as R increases, the number of sites protested is weakly increasing and the protester equilibrium utility is strictly decreasing;*
3. *if site j is protested, then the probability of protest at site j is strictly decreasing in w_j.*

While other results will provide a different perspective, this version of the model highlights one sense in which protesters attacking multiple sites is a sign of strong regimes. If the regime had few resources, there would be nothing to stop the protesters from going to the focal site.

One interpretation of R is not the actual budget of the government, but how much their presence harms protesters. For example, one key difference between countries with repressive governments and more free societies is that, in the latter, protesters care much less if the police show up where they do. If v_1 is not sharply decreasing in R, then even with private communications, citizens can still go to the focal site. Intuitively, there is not much downside to the government sending all of their resources there.

Our motivating cases are consistent with the result that the number of sites protested is increasing in R.

First, while protests occurred at multiple sites in both cases, the degree of dispersion across sites was much higher in Hong Kong than that in Sudan—consistent with the model's expectation of the effect of the much higher repressive capacity (R) of the regime in Hong Kong. At its peak, Hong Kong saw over two dozen parallel protests occurring at the same time (*ANTIELAB Research Data Archive*, 2020; Teo & Fu, 2021).[5] On the other hand, and in spite of Khartoum's larger size, there were often only around half a dozen parallel protests to any one focal event. While it is difficult to compare repressive capacity in a systematic manner, Hong Kong's higher income, high number of police officers per capita (twice that of the United States), and the fragmentation of Sudan's security apparatus (Hassan & Kodouda, 2019), all point to a significantly stronger policing force in Hong Kong.

Second, substantial *inter-temporal* variation within cases also illustrates this result. In the early stages of each protest movement, Hong Kong saw no parallel protests and Khartoum saw very few. However, as each government began to repress protests as the movement persisted, some protesters increasingly began to

[5] As discussed in the concluding section "Closing points," it may be valuable to distinguish between the number of sites that get protested on a given day and how many get protested across different days.

shy away from focal sites and instead mobilize across local neighborhoods.[6]

Value of communication

It will also be useful to define how much a particular communication protocol increases the payoff of the protester in the optimal equilibrium relative to the equilibrium where all go to the focal site. Let $u^*(o, l)$ be the citizen payoff in the optimal equilibrium with a communication protocol observed by other protesters with probability o and by the government with probability l.

Definition 2. The *value of communication* with observation probabilities (o, l) is:

$$V^*(o, l) = u^*(o, l) - u^*(0, 0).$$

In the case of no cost to protest, the value of communication is also equal to the increase in the success of the movement.

By definition, there is no value in the no-communication case. In the private information case, since the protesters must be indifferent between all sites, this takes a simple form, which compares the value of protesting the focal site with less government presence to what they would get going to the focal site with all government resources spent there:

$$V^*(1, 0) = v_1(2, r_1^*) - v_1(2, R).$$

Intuitively, this captures the idea that the value of private communication is that it forces the regime to spread their resources thin, making protests more effective.

This has the following properties:

Proposition 3. *In the main parameterization, the value of private communication has the following properties*

- $V^*(1, 0) = 0$ *if* $R \leq \hat{R}_1$
- $V^*(1, 0) > 0$ *if* $R > \hat{R}_1$
- $\lim_{R\to\infty} V^*(1, 0) \to 0$

When the regime has so few resources (or their presence has such a small deterrent effect) that the protest will all happen at the focal site anyways, there is no value to private communication. At the other extreme, when the regime can police all sites so intensely that the value of going anywhere is low, there is also little value to private communication. It is for the in-between cases where the value of spreading the government resources thin is highest.

Public communication

Now suppose that both protester 2 and the government observe the message sent by protester 1: $o = l = 1$. The protesters could use a strategy where protester 1 chooses the message according to a mixed strategy and both protesters go to the site indicated. However, now that the government can also condition its allocation of resources on the message, it is clearly a best response for them to also send all resources to the site m. But if the government is going to send all resources to whatever site the protesters go to, then they might as well go to the focal site.[7]

If we keep the restriction to direct messaging equilibria, there is now a unique equilibrium of this form where all $m = 1$, and all go to the focal site.

However, there are also other equilibria, and in fact a site selection/resource allocation can be a part of an equilibrium of the model with public communication if and only if it is an equilibrium to the model with no communication. This follows immediately from the fact that the message is payoff irrelevant, and the subgame following all observing the message is identical to the no-communication game.

Proposition 4. *In the model with the main parameterization and public communication:*

(i) in any optimal equilibrium for protesters, the focal site is the only one protested and defended on the equilibrium path,
(ii) there is a unique direct messaging equilibrium where $m^* = 1$*, and*
(iii) the value of communication is zero ($V^*(1, 1) = 0$*)*

So, there is a sense in which public communication is irrelevant. However, informally, it can help solve the equilibrium selection problem if it is not clear to protesters what the focal site is. While there are some examples where a focal protest time/place is known, in other settings, individuals may be unsure of when and where protests will be, absent some kind of public communication. Consider Khartoum, which has numerous places that could be considered focal points for protest: some for political reasons (e.g., in front of Parliament), others for symbolic purposes (e.g., by the University of Khartoum, where two prior historic uprisings erupted), and still others due to their practicality (e.g., within the open-air

[6] See Teo and Fu (2021) for this dynamic in Hong Kong, and for Sudan, phone interview, October 31, 2019; interview November 30, 2019, Khartoum, Sudan; focus group, December 9, 2019, Khartoum, Sudan.

[7] This is similar to the dynamics described in Carter and Carter (2020), in which protesters follow a focal calendar.

souk). The public calendar of events helped coordinate protesters at a different focal point in Khartoum for each specific event.

EDGE AND INTERIOR CASES

In this section, we consider variants to the model where messages are sometimes observed. In the visualization of Figure 1, we first consider an "edge" case where the government never observes the message and the other protester sometimes (but not always) does, and then add the possibility of the message leaking to the government.

Imperfect citizen observation

First, consider the case where the government never observes the message ($l = 0$) but protester 2 only sometimes observes the message ($o \in (0,1)$). Protester 1 must make their site choice before they know whether 2 observes the message. Think of this as a case where protest leaders are very secretive and err on the side of not having their message seen by many potential followers in order to be sure the government does not learn their plans.

We again focus on a direct messaging equilibrium in which protester 1 sends message m with probability σ_m and always goes to the site corresponding to the message. When protester 2 observes message m, which occurs with probability o, they will also go to site m.

If protester 2 does not observe the message, they could in principle play a mixed strategy or default to one site. We focus on equilibria where protester 2 goes to the focal site if not observing the message; call this a direct messaging/focal default equilibrium. In Online Appendix A, we prove that no other equilibrium can give a higher payoff than the direct messaging/focal default equilibrium when the observation probability (o) is sufficiently high and when the leak probability (l) is sufficiently low (as well as several other special cases), and discuss why it likely holds for any (o, l) pair.

The indifference condition for protester 1 in an equilibrium where sites $\{1, \ldots n\}$ are protested is then:

$$v_1(2, r_1^*) = ov_2(2, r_2^*) = \cdots ov_n(2, r_n^*) \geq ov_{n+1}(2, 0).$$

The logic of the solution here is similar. If the government resources are low, protesters just go to the focal site. The critical resource level for an equilibrium where protesters go to site 2 as well is:

$$v_1(2, R) = ov_2(2, 0). \tag{4}$$

As $o \to 1$, this approaches the perfect private communication case, and as $o \to 0$, the condition cannot hold as the other protester is never tipped off to the alternative location. Rearranging, if

$$o \leq \underline{o}(R) \equiv v_1(2, R)/v_2(2, 0),$$

then the direct messaging equilibrium is only at the focal site, and there is no value to communication. If $o > \underline{o}(R)$, then the direct messaging equilibrium will involve multiple sites and the technology will have strictly positive value.

To fully characterize the equilibrium, in this section, write the solution to this equation as $\hat{R}_1(o)$. Since the right-hand side (RHS) is increasing in o and the left-hand side (LHS) is decreasing in o, $\hat{R}_1(o)$ is strictly decreasing in o. That is, the easier it is for protester 2 to observe the message, the wider the range of resources where multisite protests are valuable.

By a similar logic, as the government resources increase, the protest spreads to more and more sites, though each threshold $\hat{R}_j(o)$ is strictly decreasing in o.

The last key aspect of this equilibrium is that since the value of all protests at all sites beyond 1 is scaled by o, as o decreases, the government must spend more resources at site 1 (even keeping fixed the set of sites protested). As a result, the equilibrium protester utility, which is again $v_1(2, r_1^*(o))$, increases in o, and increases strictly in any equilibrium with multiple protest sites.

Proposition 5. *In the main parameterization with imperfect private communication ($o \in (0,1)$, $l = 0$), in the direct messaging/focal default equilibrium:*

(i) if $o \leq \underline{o}(R)$, the unique direct messaging equilibrium involves going all going to the focal site, and $V^*(o, 1) = 0$.
If $o > \underline{o}(R)$, then:
(ii) the direct messaging equilibrium involves protesting more than one site, with
(iii) the number of sites $n^*(o)$ defended is weakly increasing in o,
(iv) $V^*(o, 1)$ is strictly increasing in o.

This is the first equilibrium where we will sometimes see "miscoordination" in the sense that protesters go to different sites. One protester in the Sudanese case explained what this miscoordination looked like: "when we got to the [publicly-advertised, focal] protest spot we realized that [neighborhood activists] had moved the protest. And we didn't have any direct contact with [them]… [we arrived] with the idea that we would join the protest that had been publicized [through public messages], but then we found that [neighborhood activists] had gotten together in another area, in another square."[8]

The analysis here implies that such miscoordination does not mean that protesters are failing to use technology in the best way they can. If they were always to go to the publicly announced (focal) site, it would be easier for the government to send all resources there as well. With imperfect communication technology, protesters must accept that sometimes others sympathetic with their cause will not get the message.

Leaks and interior cases

Now we allow for the government to observe the message sent by protester 1 with interior probability. A strategy for the government must now specify how resources are allocated (a) when the message is not intercepted and (b) for each message when the message is in fact intercepted. Conceptually, this can map to the scenario where protesters have to decide on where to go without knowing if the government has successfully intercepted their message. Since the protesters cannot observe the messages perfectly, messages that end up leaked but unobserved now carry an additional interpretation: messages that are censored.

We retain a focus on a direct messaging equilibrium, where the protester who does not observe the message goes to site 1. For the government, when it observes m, it is optimal to send all resources (R) to m; when it does not, its best response to the mixed strategy by player 1 follows a similar logic as the previous cases. In particular, we must find an allocation that makes protester 1 indifferent between sending a message to go to sites $1, \ldots, n$ and also not prefer to send a message to go to site $n+1$.

By the same logic of the previous iterations, when the government resources are sufficiently low, the direct messaging equilibrium involves always going to the focal site. Protester 1 will start sending the message to go to site 2 when the focal site is defended well enough that it would be better to send a message to go to site 2 if it remains undefended when the message does not leak, while also knowing the other protester will only get the message with probability o. Formally, this condition is:

$$v_1(2, R) = o[(1-l)v_2(2, 0) + lv_2(2, R)]. \tag{5}$$

Rearranging gives a simple closed-form solution for when the communication technology has some value in terms of o:

Proposition 6. *In the main parameterization with interior o and l:*

(i) the direct messaging/focal default equilibrium involves more than just the focal site and the value of the technology is strictly positive if and only if $o > \underline{o}(R, l)$, where

$$\underline{o}(R, l) = \frac{v_1(2, R)}{(1-l)v_2(2, 0) + lv_2(2, R)}; \tag{6}$$

(ii) $\underline{o}$ is strictly increasing in l; and
(iii) $\underline{o}$ is strictly decreasing in R.

Part ii captures the natural trade-off where, the more the government is likely to intercept a message, the more it needs to be visible to other protesters to have value. The intuition for part (iii) is that since stronger governments can do more to fortify the focal site, sending a message to protest elsewhere is more valuable even if it may be unheard by protesters or intercepted by the government.

The intuition behind the full equilibrium with direct messaging follows a logic similar to that in the previous cases:

Proposition 7. *In the main parameterization with interior observation and leak probabilities, there is a unique direct messaging/focal default equilibrium where:*

(i) if $o \leq \underline{o}(R, l)$, protest only occurs at the focal site.
For $o > \underline{o}(R, l)$:
(ii) the amount of repressive resources allocated to the focal site is strictly decreasing in o, and the value of technology is strictly increasing in o, and
(iii) the amount of repressive resources allocated to the focal site is strictly increasing in l, and the value of technology is strictly decreasing in l.

APPLICATIONS

In this section, we show that extensions to the baseline model can provide insight into dynamics discussed informally in past work and observed in our motivating cases.

Technological innovation

The technologies we study are (fairly) new but protest dynamics in the digital age seem to be following patterns posited by Doug McAdam (1983, p. 735) some four decades ago:

> Such innovations, however, only temporarily afford challengers increased bargaining leverage. In chess-like fashion,

[8] Phone interview, August 15, 2020.

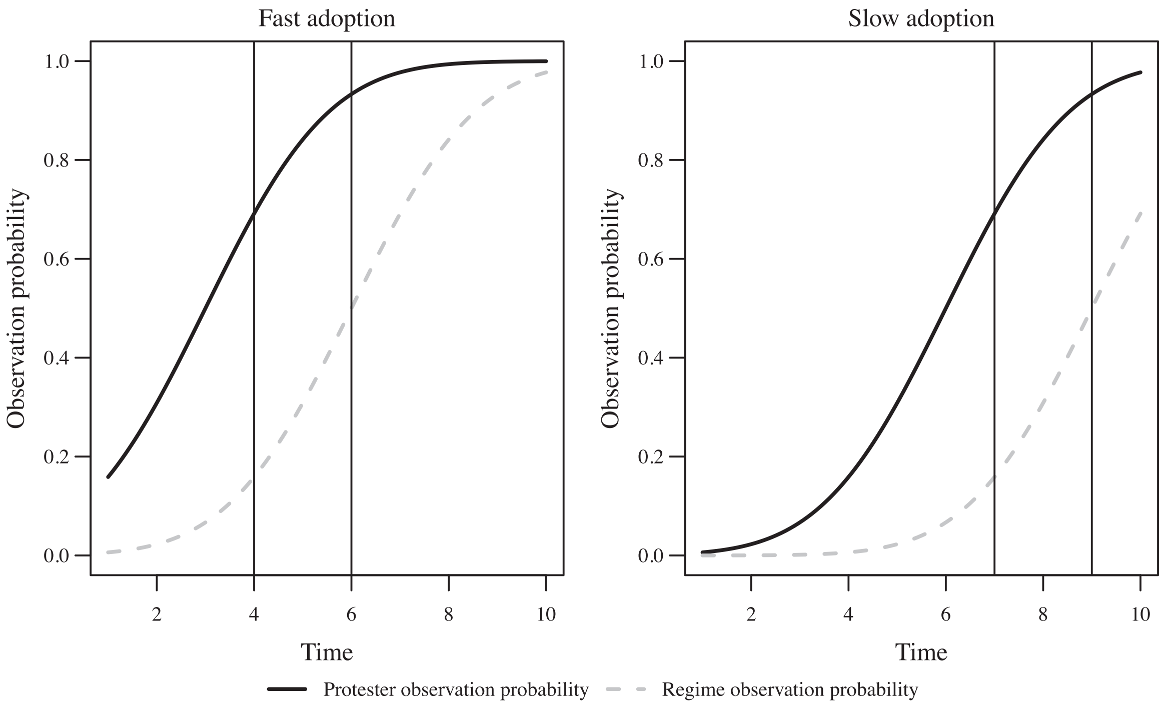

FIGURE 2 Technological adoption over time.

> movement opponents can be expected, through effective tactical adaptation, to neutralize the new tactic.

While writing a fully dynamic version of the model would add considerable complexity, we can capture this argument by considering how different technologies and ways of using them vary in our o and l parameters over time.

Consider a set of modes or types of communication $h = 1, \ldots$. Let l_t^h be the probability that a message leaks on mode h in time t. Let o_t^h be the probability that the message is heard by the other protester. It is natural to assume that both l_t^h and o_t^h are increasing in t. As derived above, the value of using mode h at time t is $V^*(o_t^h, l_t^h)$.

Figure 2 gives a sense of why this may lead to protesters shifting the technology they use over time. The left panel plots the probability of observation for the other protester (black) and the government (grey), for technology that is just starting to be adopted in period 1. At the outset, a small minority of the protesters know about the old technology, while the government almost never intercepts such messages. Initially, this advantage grows (left panel) as the technology spreads quickly among protesters, and the government is just starting to understand it. However, eventually the government "catches up", and the advantage of using this technology diminishes. For these parameters (and $R = 3$), this technology is useful in the sense of Proposition 7 for periods 4 through 6.

The right panel illustrates the same dynamic for a newer technology, which does not start to take off until around period 6. This technology is useful from periods 7 through 9.

A more general expression of this pattern is that as long as technologies "start" close to $o_t^h = 0$ and $l_t^h = 0$ and then both of these probabilities increase toward $o_t^h = 1$ and $l_t^h = 1$, technologies can only be valuable to protesters for some intermediate window of t; this follows immediately from the fact that $V^*(0, 0) = V^*(1, 1) = 0$. Not all technologies must follow this trajectory, for example, some may be persistently hidden from the government. We set aside a more comprehensive exploration of what other patterns may arise for future work.

In our two cases, we observe cat-and-mouse dynamics. In Hong Kong, police adapted to protesters' innovative ICT uses. For example, protesters developed an app that communicated real-time geolocations of police personnel (Albrecht et al., 2021), which initially stumped law enforcement. Eventually, authorities started monitoring these channels and forced protesters to switch to new ones. In Sudan, we see innovation in the use of existing technologies. The regime eventually infiltrated some relatively more open neighborhood WhatsApp groups. In response, some protesters created new, more secret, groups in which membership was selectively granted only after group administrators would improvise a "two-factor verification" process through trusted intermediaries for people who wanted to join.[9]

Costs to protest: How movements grow

In our main analysis, we set the cost of protesting k_i to zero. Now suppose it costs protester i a fixed cost of $k_i > 0$ to participate. The analysis is essentially the same, with the additional participation constraint: The protesters must be willing to protest over staying home. We can write the value of protest in any of the variants studied above as the value of going to the focal site, and so the condition to get both protesters to participate is:

$$v_1(2, r_f^*(o, l)) \geq \min\{k_1, k_2\}.$$

A natural implication of this is that increasing R may eventually make no protest tenable, as can increasing l or decreasing o. In other words, absent a sufficiently "good" communication technology (in the sense of high o and low l), it may not be possible to have any protest movement.

With more than two protesters (who all observe the message with the same probability), the equilibrium condition for an equilibrium with at least p protesters is that there are at least p protesters with $k_i \leq v_2(p, r_f^*(o, l))$.

Parallel protests

Due to information

In this section, we consider an extension where there are multiple protesters. Given the analysis so far, it is important to specify how this affects the leader's ability to communicate privately with others.

Indeed, in the Sudanese case, knowledge about parallel protests was not spread evenly across the population. Instead, only those connected to protest leaders who organized parallel events might receive private communication about them: For example, when one protester was asked how they knew the location of upcoming parallel protests, they responded, "I have a friend [who] receives information from outside of Facebook. From [local protest leaders]… people who you knew were active."[10]

In general, it could be valuable to consider various network structures of who can communicate, or a hierarchy where a smaller group higher up in the protest organization can communicate relatively freely but must worry about messages leaking as less committed members are sent messages. To start, we consider a simple case where the P total protesters can be broken into two groups: P^{ins} *insiders* who can hear the message of protester 1 (including protester 1), and P^{out} who cannot. Think of this as a case where the protest leaders have been successful in including only trusted members who will not leak to the government in planning decisions.

Of course, protesters can always go to the focal site expecting the government to send all their resources too, which gives the protest value $v_1(P, R)$.

When can the protesters do better? Building on the logic developed so far, it is possible that the insiders can coordinate on attacking multiple sites while the outsiders go to the focal site. This can work if the value of adding a group of protesters to a nonfocal site with little if any government presence outweighs the loss of these protesters from a heavily defended focal site.

The simplest form this can take is if the outsiders always go to the focal site and the insiders follow the message of a leader who plays a mixed strategy sending them to sites 1 and 2. The leader indifference condition (if site 2 is undefended) is:

$$v_1(P^{\text{out}} + P^{\text{ins}}, R) = v_1(P^{\text{out}}, R) + v_2(P^{\text{ins}}, 0). \quad (7)$$

To get a sense of when this strategy might be used at different times as a protest movement grows, we can ask how this critical threshold changes as P^{ins} and P^{out} increase. We discuss the results here informally, with more details in the Online Appendix.

When R is large, the marginal value of adding a protester to an undefended site 2 is higher than the value of adding another inside to the well-defended focal site. As a result, if early movements in repressive environments are characterized by carefully adding more insiders who can be trusted, this may be a phase when the parallel strategy is attractive. This also highlights a way in which movements can grow as the number of insiders grows. Since v_f is increasing in the number of protesters there, as there are more insiders at the focal site the value of protest increases. Hence, the "marginal" participants in the sense of facing a higher cost to join may be willing to start going to the focal site.

As for the number of outsiders, if there are increasing marginal returns to adding more protesters to the focal site, then increasing the number of outsiders makes the strategy of all going to the focal site more attractive. This dynamic may be present relatively "late" in successful protest movements, where enough citizens are getting involved that private communication becomes infeasible. However, with strength in

[9] Phone interview, July 22, 2020; phone interview, August 15, 2020.
[10] Phone interview, July 20, 2020.

numbers, they can overwhelm the government by all showing up to the focal site.

Combining, for governments without many resources or where repression has a small deterrent effect, adding anyone to the protest movement makes going to the focal site more attractive. In more repressive environments, adding insiders makes a parallel protest strategy more effective.

More generally, the analysis in this section provides a suggestive explanation for dynamics of protest movements that start small and at focal sites, then spread to a wider number of sites as insiders learn to coordinate on protesting other places that receive little defense. However, once the movement gets large enough that protest participants can overwhelm the government at the focal site, they can go back to all protesting there even if insiders in principle could coordinate on hitting other sites as well.

Due to heterogeneous tolerance for repression

Next, we develop an alternative intuition for the value of parallel protest: heterogeneous tolerance of repression. The key idea is that some protesters will go to a site that draws the government forces, allowing others to go to sites that are safe (i.e., the neighborhood protest in Hong Kong, or the “repression lightening” strategy in Sudan) (Hassan, 2023). The key is that now the cost to protester i depends on the level of repression at the site where i goes.

In particular, if one protester is less concerned about being repressed, it may be best for the movement if they always go to the focal site and “suck up” the government's resources, while the other group mixes at more lightly defended sites. This can be optimal for the government because the focal site is always protested while other sites are often empty. From the protester perspective, the group going to the focal site does not deviate because this site is valuable and they do not mind police presence as much. (Even if they would rather go elsewhere, they may want to commit to going to this site if doing so is necessary to get the other protester to join by pulling most government resources to the focal site.)

One dynamic we want to capture is where some set of protest leaders go to the focal site, while smaller groups stage simultaneous parallel protests. In the Online Appendix, we formalize two reasons why this can occur. First, some protesters may face a higher cost of being at a site with a large police presence, and hence will avoid major protests at focal site.

Second, if the strategic complementarities of protest are not too strong, it may be better for the movement to have protesters at multiple sites so the government cannot send all of their forces to the focal site. These explanations are not mutually exclusive: Parallel protests can be a way to get more individuals involved and spread out government resources.

Empirical observations

We see heterogeneous tolerance for repression among protesters in both our motivating examples, whereby individuals with a higher tolerance braved focal sites and those with a lower tolerance congregated in parallel sites.

Hong Kong

Initially, large groups of peaceful protesters gathered at focal sites like Victoria Park and the police did little to deter. However, as repression increases, the dynamics shifted and the risk of attending large gatherings increases (Chau & Wan, 2024). This also coincided with the growth of parallel protests.

Intuitively, this creates a situation in which protesters with higher tolerance for police presence specifically go to nonfocal sites to “soak up” R. According to the former Hong Kong leader, these are protesters who “have no stake in the society.”[11] During the movement, there was clear division between frontline protesters who confront the police directly, ensuring larger, less confrontational assemblies continue elsewhere (Lee et al., 2019). The protest slogan “peaceful protesters (和理非) and violent protesters (勇武) have no division (不分)” (和勇不分) elucidates the complementarity of the two groups of protesters (Lee, Cheng, et al., 2022).

Sudan

Similar dynamics emerged in Sudan. Though repression at the focal site was expected, individuals who attended these protests claimed that it was their “duty” to do so to keep the revolution alive. This is in contrast to parallel protests within neighborhoods where police presence was often lower and the environment was “more chill.”[12]

While no systematic evidence of protest attendance by site is available, qualitative observations and general narratives paint different pictures. One could find the full range of Sudanese citizens in a neighborhood protest, including older people who did not have the stamina to walk long, let alone outrun police officers. On the other hand, a certain type of protester was more likely to attend focal site protests where violence was expected: Individuals who were young, physically fit, and more middle class (and thus more

[11] Transcript of remarks, August 9, 2019, Hong Kong Government. Permanent link (via Archive.org)
[12] Phone interview, October 31, 2019.

likely to "know" someone that can get them out of detention).[13]

CLOSING POINTS

The expansion of ICT has dramatically changed protest dynamics across the world—for both protesters and the governments they are mobilizing against. Protesters often turn to ICT to communicate and coordinate collective action against bad governments. But precisely because of the gains in tactical coordination that ICT has facilitated, governments have invested in intercepting communication sent via ICT so as to hinder mobilization.

This paper speaks to this dilemma by modeling the effects of ICT on contention at varying levels of government infiltration of protester communication. Throughout, we have illustrated some of our theoretical findings with descriptions from two recent episodes of contention, the Sudanese Uprising and the Hong Kong Anti-Extradition Bill Movement as well as incorporating insights from empirical research on other episodes of collective action within repressive regimes. That our paper speaks to how protesters used ICT across very different contexts, most notably in the strength of the security apparatus, suggests the utility of our model.

A broad takeaway from the model is that an important variable for understanding the dynamics of protest is how they are dispersed across time and space. While we can never directly measure a mixed strategy used by protesters, the comparative statics in the model on the number of sites protested can be roughly measured by asking how many different sites are used for protest. The key predictions on this variable are that more sites will be protested when the government has more resources (higher R, Proposition 2), when communication is less likely to be intercepted (low l, Proposition 6), and when other protesters are more likely to see messages (high o, Proposition 6). Notably, all of these parameters broadly relate to different notions of state capacity, and so different types of "strong" regimes may experience different kinds of protest. Strong regimes in the sense of having lots of police and equipment to physically suppress protests (high R) will tend to have protests hitting many sites, while those who are strong in the sense of being able to infiltrate protest communication networks (higher l) or censor tactical information (low o) will tend to see protests occur at a small number of focal sites.

While the results about how many sites are protested in equilibrium are less concrete, a general prediction is that multisite protest will happen when there are a larger number of "outsiders" who are willing to participate in the movement but are not plugged into secure communication networks. Our analysis also suggests that multisite protest arises when there are heterogenous costs of repression, which may be more likely when protest movements draw on a wider range of demographics (e.g., young and old participants). While not examined in our model, future theoretical work might adapt our model to consider not only variation in repressive capacity, but in who that repression targets (e.g., protest leaders versus on-lookers).

A final prediction about what sites are more likely to be protested follows a standard mixed strategy logic but may be somewhat counterintuitive: The probability of going to a site (conditional on this being nonzero) is determined not by how much protesters value the site, but by how much the government values the site (Proposition 2). This result is driven by the logic of keeping other actors indifferent: If protesters value a site greatly, that will induce the government to defend it more so the site is not always hit. On the other hand, keeping the government indifferent between increasing resource allocations across sites relies on protesting more at sites that the government values *less*.

Future empirical work could test these implications, and related implications like how the improved ability to censor (lower o) affects these outcomes. The model also opens paths for future theoretical work, for example, on hierarchical communication among protesters or the impact of government censorship of ICT.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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