# Communication Technology and Protest

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Recent antiregime protests throughout the world have been publicized, and arguably facilitated, by social media and other communication technologies. I develop formal models that examine the implications of communication technology generating information about two distinct factors: (1) the level of dissatisfaction with the regime and (2) logistical information about when, where, and how potential protests will occur. Making grievances against the regime more public has an ambiguous effect on protest levels as citizens can learn that it is more or less popular than expected. Even when publicizing more complaints about the regime does increase average protest levels, some if not most of the observed correlation between antiregime content and protest is not causal. In contrast, providing information about logistics almost always lowers the effective cost of protest, leading to larger (and more cohesive) antiregime action. The models explain a wide range of empirical results linking communication technology, antiregime beliefs, protest, and censorship.

Every revolution or large-scale protest over the past decade has been accompanied by a spirited debate both within and outside academia over the role of the latest information and communication technology (ICT). The most recent iteration of this argument, inspired by the Arab Spring, the Occupy movement, antigovernment demonstrations in Russia, Turkey, and Ukraine, and protests against killings by police in the United States (among others), has largely focused on social media such as Twitter and Facebook (e.g., Aday et al. 2010, 2012; Hale 2013; Reuter and Szakonyi 2015). More broadly, these debates speak to the question of how technologies of communication—from the printing press to radio to the Internet—make antiregime action against autocrats or political action in general more likely (Acharya 2014; Bennett and Segerberg 2013; Dafoe and Lyall 2015; Farrell 2012; Tarrow 1994).

Many have viewed ICT as indispensable to these protests: for example, during the Arab Spring use of social media was so prominent that countless commentators dubbed the events some permutation of "the (Twitter/Facebook) (Uprisings/Protests/Revolutions)" (Farrell 2012). Examples abound of participants crediting social media, such as an Egyptian activist's description of the strategy to "use Facebook to schedule the protests, Twitter to *coordinate*, and YouTube to tell the world" (Howard 2011; emphasis added).

More skeptical perspectives assert that social media and older technologies get more attention from Western observers than from actual participants (Aday et al. 2012; Starbird and Palen 2012), that the spike in antiregime content during protests simply reflects the underlying discontent with the regime that is the true cause of mobilization (Comunello and Anzera 2012; Tufekci 2014), or that better ICT may be more effective as a tool for regimes to monitor, influence, or control their citizens than the other way around (Aday et al. 2010; Gehlbach and Sonin 2014; Guriev and Treisman 2015; Morozov 2009; Shadmehr and Bernhardt 2015; Siegal and Shapiro 2013).

Further, the empirical record on the question of how better ICT affects political behavior is mixed. Some studies find that better ICT—or exposure to new political information more generally—leads to more antiregime (or anti–status quo) beliefs and action (Enikolopov, Petrova, and Zhuravskaya 2011; Pierskalla and Hollenbach 2013; Reuter and Szakonyi 2015; Yanagizawa-Drott 2014), while others find the opposite (Kern and Hainmueller 2009; Shapiro and Weidmann 2015).[1]

This article reconciles the bulk of these theoretical arguments and empirical findings in a simple formal framework. In short, I find that better technology generally increases average levels of antiregime action (which I generically call

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1. Others have used social media to analyze conflict dynamics (Zeitzoff 2011, 2014), polarization, or ideological networks (Barberá and Rivero 2014).

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"protest"), though not through the channels that receive the most attention. The models also provide an explanation for why better political information can have the opposite effect on political beliefs and action in different contexts, and predicting the direction of these effects is ex ante difficult if not impossible.

The main theoretical contribution of the article is to distinguish between two coordination problems that citizens considering antiregime action face under two different types of uncertainty. First, citizens must decide whether to take antiregime action in the first place without knowing how many others dislike the regime enough to join. I call this the *political coordination* problem.[2] Second, conditional on participating, citizens must decide when, where, and how to protest against the regime, again, with uncertainty about what tactics their fellow protesters will select. I call this the *tactical coordination* problem.[3] ICT can provide information about both the degree to which other citizens dislike the regime and what tactics protesters will choose, which affects both of these coordination problems.[4]

Formalizing this distinction highlights how the answer to whether better information from ICT helps citizens coordinate depends on the kind of information learned and the kind of coordination problem. Making it easier to air grievances against the regime with better ICT has an ambiguous effect on the beliefs about the regime's popularity. The reason is that better information must sometimes reveal that the regime is more popular than expected, though most (international) focus will be on the attention-grabbing cases in which protests are spurred by revelation of the regime's unpopularity. In contrast, better ICT (almost) always has a positive causal effect of mobilization through improving tactical coordination.

The theoretical results explain a wide range of recent empirical findings linking ICT, antiregime beliefs and action, and censorship, as well as suggesting new directions for future empirical research.

First, the model provides an explanation for the mixed results of studies that examine how better exposure to political information affects attitudes and behavior (e.g., Enikolopov et al. 2011; Kern and Hainmueller 2009; Peisakhin and Rozenas 2015; Pierskalla and Hollenbach 2013; Reuter and Szakonyi 2015; Yanagizawa-Drott 2014). I argue that this indeterminacy results from the fact that this relationship is conditional on two potentially unobservable variables: whether the regime is more or less popular than commonly known and whether the source of information has more or less proregime bias than commonly thought.

Second, the relative importance of tactical coordination compared to learning about the regime's popularity provides an explanation for a recent prominent empirical finding that contemporary China does not censor criticism of the regime but does heavily censor references to and calls for collective action (King, Pan, and Roberts 2013, 2014). As the model highlights, information that can improve tactical coordination (e.g., references to collective action) is generally more dangerous to the regime than allowing information about its (un)popularity (e.g., criticism).

Finally, the model sheds light on the challenge of making causal claims about the effect of ICT of political beliefs and behavior from observational data. For example, what can we infer from the fact that major protests tend to be concurrent with spikes of antiregime content on social media (Barberá and Metzger 2014)? Even those amenable toward the idea that technology and political action share important links often dither on the question of whether this relationship is causal. A striking example of the fear of causal language comes from Shirky (2008, 67), who writes that "two things are true about the remaking of the European intellectual landscape during the Protestant Reformation: first, it was not caused by the invention of movable type, and second, it was possible only after the invention of movable type."[5]

Formalizing this relationship demonstrates a unique challenge for empirical work on the topic, as the fact that the regime's popularity and citizens' propensity to protest are correlated (i.e., the "confound") is precisely what causes

2. I thank Milan Svolik for suggesting this terminology.

3. Petrova and Zudenkova (2015) make a related distinction between two ways the regime can censor information, one of which makes participation in protest more costly (which they call "tactical censorship") and one that downwardly biases a signal of the regime's unpopularity (which they term "content censorship").

4. As elaborated when the models are presented, this argument brings together two branches of the "global games" literature on coordination under uncertainty. The political coordination problem draws on binary action in which the actors either "participate" or do not with uncertainty about others' propensity to join, which has been frequently applied to participation in protests and revolutions (e.g., Acharya 2014; Boix and Svolik 2013; Bueno de Mesquita 2010; Edmond 2013; Hollyer, Rosendorff, and Vreeland 2013; Little 2012; Petrova and Zudenkova 2015; Shadmehr and Bernhardt 2015; Tyson and Smith 2013). The tactical coordination problem draws on models in which the actors make a continuous choice that they want to be "close" to the choices of others; inspired by Keynes's (1936) famous example of a newspaper contest in which participants guess which women are rated as the most attractive by others, these are often called "beauty contests" (e.g., Angeletos and Pavan 2007; Dewan and Myatt 2008; Morris and Shin 2002).

5. "This is not to say that access to social media is *causing* revolts" (Kendall-Taylor and Frantz 2014, 40). "The major challenge in understanding the relationship between democracy and the Internet . . . has been to distinguish cause and effect" (Morozov 2009).

citizens to be more apt to protest when observing antiregime content. So, this relationship can never be entirely causal. However, the results highlight conditions under which the correlation between antiregime content and action is more or less causal, providing a guide for how we should interpret the rapidly increasing amount of observational data linking social media and political behavior.

The rest of the article proceeds as follows. First, I present a single-actor model that derives many of the main results. Next, I show that these results hold in models with multiple citizens that more fully capture the political and tactical coordination problems. Further extensions to the model show that the main findings hold when (1) the signals are biased—potentially as a strategic choice by the regime—and (2) citizens are not fully Bayesian in forming their beliefs. Finally, I informally consider other effects that ICT could have on the dynamics of protest and conclude.

## SINGLE-ACTOR MODEL

While the main conceptual goal of the article is to examine how better ICT affects political and tactical coordination problems—which inherently involves strategic interactions among potential participants—the central results can be derived in a reduced-form model with a single actor. Consider a citizen (pronoun "she") who first chooses whether to take an antiregime action $a$. This action is binary, where $a = 1$ means choosing the antiregime action (e.g., taking to the streets, joining a rebel movement) and $a = 0$ means not participating. The model is meant to describe antiregime action at a high level of abstraction, capturing any activity that citizens are more apt to participate in when the regime is weak or unpopular (and, in the following section, when other citizens participate as well). For concreteness, I usually refer to the antiregime action as "protesting" and not taking the action as "staying home."

If the citizen chooses to protest, she also chooses a tactic $t$. The tactics are meant to capture a variety of logistical details, such as when and where to protest, what concessions to demand, whether to use violence, or how to respond to the police. While these examples highlight the multidimensional nature that I lump into "tactics," to save on notation let this choice be unidimensional on the real line: $t \in \mathbb{R}$; that is, the tactical choice is unidimensional on the real line. That is, a "high" $t$ could represent protesting later in the day, in a location further north, demanding more from the government, and so forth. (The analysis can be easily extended to the case in which here the tactical choice is discrete or multidimensional.)

The citizen payoff as a function of these choices is

$$u(a, t) = a[\omega - k(t - \theta)^2].$$

If the citizen does not protest ($a = 0$), she gets a payoff normalized to zero. The payoff to protest (i.e., when $a = 1$) is increasing in the unpopularity or weakness of the regime $\omega$, capturing the idea that the citizen is more apt to protest against a "bad" regime, or because she expects the protests to be larger if others are unhappy as well.[6] The $k(t - \theta)^2$ term is the cost of protest, where $\theta$ represents the "average" tactics chosen by other protesters. So, the cost to protest is increasing in $k$—or the general costliness of protest—and in how unusual the citizen's chosen tactic is.

The citizen is uncertain about the level of dissatisfaction with the regime ($\omega$) and the tactics chosen by others ($\theta$). Let the prior belief about $\omega$ be normally distributed with mean $\mu_\omega$ and precision $\alpha_0$ (i.e., variance $1/\alpha_0$). The prior on $\theta$ is normally distributed with a mean normalized to zero and precision $\beta_0$. The normality assumption is merely to streamline exposition and interpretation; as demonstrated in the appendix (available online), the central results hold with much weaker distributional assumptions.

Before taking her action, the citizen observes a noisy signal of both parameters of uncertainty. The tactical signal is given by

$$s_\theta = \theta + \epsilon_\theta,$$

where $\epsilon_\theta$ is normally distributed with mean zero and precision $\beta_s$. When interpreting the model, I assume that one effect of better ICT is increasing $\beta_s$, that is, giving the citizen more information about how others will protest. That is, I treat the information learned from social media and other sources as exogenous and take it as a given that better technology leads to better-informed citizens. If social media or another technology renders citizens less informed—perhaps by confusing them, providing false information, or causing them to substitute away from more informative sources—it will have the exact opposite effect as the one analyzed here.

For now the regime takes no actions, either to affect the signals (which will be modeled in an extension) or to use the information they generate to combat antiregime activity (see Siegal and Shapiro [2013] for a model with this effect).

The signal of the regime's (un)popularity is also exogenous and has two components. First, it contains a $\rho\omega$ term, where $\rho \in [0, 1]$. So, a high $\rho$ means that citizens observe

6. The fact that the citizen payoff is linear in $\omega$ (and later, the size of protest) implies they are not generally more apt to protest when more certain about this parameter. If the citizen payoff were concave in $\omega$ (loosely speaking, they are risk averse in the protest payoff), then better information about this parameter would generally make protest more likely through this channel, though results analogous to proposition 2 would still hold.

more of the opinions of others, whether positive or negative. Since the main focus here is on cases in which the incumbent is unpopular enough for citizens to take costly antiregime actions (i.e., $\omega$ is positive), I often refer to $\rho$ as the proportion of aired grievances against the regime or ease of criticism. Second, there is a noise term $\epsilon_\omega$ that is normally distributed with mean zero and precision $\alpha_s$. (This implies that the signal is unbiased;[7] the section on biased and endogenous signals considers the case in which the signal may be biased.) These components are additive, so the signal is

$$s_\omega = \rho\omega + \epsilon_\omega. \tag{1}$$

The closest analog to the assumption that better ICT makes the tactical signal more informative would be to assume that new technology increases the precision of $s_\omega$ as well, that is, $\alpha_s$. However, I primarily interpret the effect of better ICT on this signal as increasing $\rho$, that is, making it easier to complain about (or compliment) the regime. As demonstrated below, increasing $\alpha_\omega$ has the same effect on the probability of protest as increasing $\rho$, and conceptualizing better ICT as making it easier to complain about the regime generates additional appealing interpretations.

Upon observing $s_\theta$ and $s_\omega$, the citizen updates her beliefs about $\theta$ and $\omega$ via Bayes's rule and protests if and only if her expected payoff from protesting when choosing the optimal tactic is greater than zero.

The optimal tactic minimizes the expected cost of protest $\mathbb{E}[k(t-\theta)^2]$. The citizen's belief about $\theta$ upon observing $s_\theta$ is normally distributed with mean and precision

$$\bar{\mu}_\theta = s_\theta \frac{\beta_s}{\beta_s + \beta_0} \quad \text{and} \quad \bar{\beta} = \beta_s + \beta_0.$$

The expected cost is minimized at $t = \bar{\mu}_\theta$; that is, the citizen chooses the tactic equal to her average belief about what others will do. Regardless of the specific value of $s_\theta$, the expected value of $(\bar{\mu}_\theta - \theta)^2$ is the variance of the posterior belief about $\theta$, which is $1/\bar{\beta}$. So, the expected cost of protest when choosing the optimal tactic is $k/\bar{\beta}$.

The citizen's interpretation of the signal of the regime's popularity ($s_\omega$) depends on the proportion of aired grievances $\rho$. A convenient way to represent this mathematically is to divide both sides of equation (1) by $\rho$, giving

$$s_\omega/\rho = \omega + \epsilon_\omega/\rho. \tag{2}$$

That is, $s_\omega/\rho$ represents the signal of regime grievances adjusted for the ease of criticism. Since $s_\omega/\rho$ is equal to $\omega$ plus a random variable with mean zero, it is an unbiased signal of the regime's unpopularity. When making this normalization, the noise term is divided by $\rho$ as well. So, when $\rho$ is high—corresponding to a greater proportion of grievances against the regime being aired—the citizen is able to form a more precise belief about the regime's popularity.

Formally, the citizen posterior belief about $\omega$ after observing $s_\omega$ is normally distributed with mean

$$\bar{\mu}_\omega(s_\omega) = \lambda\mu_\omega + (1-\lambda)(s_\omega/\rho), \tag{3}$$

where $\lambda = \alpha_0/(\alpha_0 + \rho^2\alpha_s)$, and precision $\alpha_0 + \rho^2\alpha_s$.

Combining the information given by the signals $s_\omega$ and $s_\theta$, the citizen protests if and only if

$$\bar{\mu}_\omega(s_\omega) \geq k/\bar{\beta}. \tag{4}$$

A consequence of equations (3) and (4) is that the citizen protests when the signal of grievances is sufficiently high. So, when fixing the communication technology (i.e., $\rho$), the citizen is always more apt to take to the streets when she sees more antiregime information. In this sense, spikes in antiregime content on social media and the like do have a positive impact on protests, though as elaborated below the analogous effect is not entirely causal when explicitly modeling coordination among citizens.

More immediately, the fact that antiregime content (i.e., higher $s_\omega$) can have a causal effect on protest does not mean that making it easier to air grievances against the government (higher $\rho$) makes antiregime action ex ante more likely. In particular, while increasing $\rho$ increases $s_\omega$ when the regime is unpopular (i.e., $\omega > 0$), it also changes how citizens interpret the information they receive. When it is easier to complain about the regime, more criticism of the regime is made public, but since citizens are aware of this fact, they need to see a higher level of antiregime content to believe the regime is actually less popular than expected.

Since the mean of the posterior belief is a function of a random variable ($s_\omega$; see eq. [3]), it is itself a random variable. In particular, the ex ante distribution of $\bar{\mu}_\omega(s_\omega)$ is normal with mean $\mu_\omega$ and precision

$$(1-\lambda)^{-2}\frac{\alpha_0\alpha_s\rho^{-2}}{\alpha_0 + \alpha_s\rho^{-2}} \equiv \tau_\mu.$$

So, the probability of protest can be written

$$\Pr(\bar{\mu}_\omega(s_\omega) \geq k/\bar{\beta}) = \Phi(\tau_\mu^{1/2}(\mu_\omega - k/\bar{\beta})), \tag{5}$$

7. More precisely, $s_\omega$ is an unbiased signal of $\rho\omega$.

where $\Phi(\cdot)$ is the cumulative density function of a standard normal random variable.[8] The result about the precision of the tactical signal is straightforward: by giving a better sense of how others will protest, the effective cost of participation is lower and hence protest is more likely.

**Proposition 1.** The probability of protest is increasing in the prior precision on the average tactic ($\beta_0$) and the precision of the tactical signal ($\beta_s$).

*Proof.* Equation (5) implies that the probability of protest is decreasing in $k/\bar{\beta}$. Since $\bar{\beta} = \beta_0 + \beta_s$, the probability of protest is increasing in both of these terms. QED

The likelihood of protest is increasing in both the prior precision of where the protest will be and the precision of the tactical signal. A precise prior on the location of protest could be driven by a history of past protest or an obvious location that is commonly known to have "prominence and conspicuousness" (Schelling 1960, 57). This prior precision could reflect information about tactics that succeeded recently in similar countries, which many have argued played a central role in the Arab Spring (e.g., Patel and Bunce 2012). More central to the topic of this article, better ICT (though the channel of increasing $\beta_s$) improves tactical coordination and unambiguously increases protest through this channel.

In contrast to the unambiguous effect of improved tactical information, the effect of increasing the proportion of aired grievances on the expected protest size is not always positive. However, there are two ways to express conditions under which higher $\rho$ leads to more protest, first on average and second as a function of the true regime popularity.

**Proposition 2.** The probability of protest is increasing in the ease of airing grievances ($\rho$) if and only if

i. the prior mean on $\omega$ is less than the expected cost of participation: $\mu_\omega < k/\bar{\beta}$, and

ii. the difference between the true regime popularity and the prior is sufficiently high:

$$\omega - \mu_\omega > (k/\bar{\beta} - \mu_\omega)\left(1 - \frac{\alpha_0}{\rho^2 \alpha_s}\right).$$

*Proof.* See the appendix.

To see the intuition behind part i, consider the limiting case as $\rho \to 0$, which means that $s_\omega$ provides no information about the regime's popularity. If so, the citizen's posterior belief about $\omega$ is always equal to the prior, and hence she always protests if $\mu_\omega > k/\bar{\beta}$ and never protests if $\mu_\omega < k/\bar{\beta}$. So, making the signal informative can make protest more likely only if $\mu_\omega < k/\bar{\beta}$ and can make protest less likely only if $\mu_\omega > k/\bar{\beta}$. More generally, when protest is ex ante unlikely, a high level of new information revealing that the incumbent is unpopular is required to get the citizen to protest, which is more feasible when the signal is informative. Conversely, when protest is ex ante likely, it takes a high degree of information that the regime is more popular to prevent protest, so protest is more likely when the public signal is uninformative.

The conditional relationship between $\rho$ and the probability of protest depends on some particularities of the assumptions: for example, that protest is a binary decision, and the prior and signal have a jointly normal information structure. The important conclusion from part i of proposition 2 is less the specific conditions under which making it easier to criticize the regime does or does not make protest more likely, but the broader fact that this relationship is not straightforward. So, while one can concoct models in which better information about the popularity of the regime increases (or decreases) protest, we should be wary of any clear-cut theoretical predictions about the direction of this relationship.

Part ii of proposition 2 highlights a set of cases in which better communication technology leads to more protest by making it easier to complain about the regime: when the government is less popular than is commonly known. However, this cannot always be the case: by construction it is ex ante unknowable—at least to the actor in the model—whether the regime is more or less popular than expected. Sometimes the regime is more popular than is commonly known, in which case better communication technology makes protest less likely. Outside observers are drawn to the cases in which new technology is flushed with antiregime (and, in some contexts, progressive and liberal) content, but should they "dig a bit deeper, they might find ample material to run articles with headlines like 'Iranian bloggers: major challenge to democratic change' and 'Saudi Arabia: bloggers hate women's rights'" (Morozov 2009).

8. This relies on the symmetry of the normal distribution, in particular, that

$$\begin{aligned}\Pr(\bar{\mu}_\omega(s_\omega) \geq x) &= 1 - \Pr(\bar{\mu}_\omega(s_\omega) < x)\\ &= 1 - \Phi(\tau_\mu^{1/2}(x - \mu_\omega))\\ &= \Phi(\tau_\mu^{1/2}(\mu_\omega - x)).\end{aligned}$$

In other words, the general intuition that ICT helps protest by generating common knowledge that others are unhappy with the regime as well—or by reducing the uncertainty about whether others are angry enough to protest—is sometimes correct but incomplete because the opposite is true in another set of cases. Further, it is not too surprising that many observers expect ICT to protest through this channel because the cases in which it does not hold—again, when the regime is more popular than is commonly known—are precisely the cases that garner the least attention (see Tufekci [2014] for a related argument).

This indeterminacy extends to the question of how any new politically relevant information affects beliefs and resulting actions. For example, proposition 2 provides a potential explanation of why Kern and Hainmueller (2009) find that exposure to Western German television did not make Eastern Germans more pessimistic about their own regime. While it may be intuitive to think that providing more information about life outside a repressive regime would make citizens less satisfied with their government, the model would predict such a relationship only if such television portrayed the regime as worse than commonly thought. On the other hand, Reuter and Szakonyi (2015) show that in the wake of the 2011 Russian parliamentary elections—plausibly more fraudulent than expected—citizens who actively used Facebook and Twitter had higher beliefs about the degree of fraud.[9] While not directly related to antiregime beliefs, the model is also consistent with that of Yanagizawa-Drott (2014), who finds that areas in Rwanda with better radio signals experienced more intense conflict during the 1993 genocide, a case in which media broadcasts were encouraging the most violent actions imaginable. In terms of the model, this corresponds to a case in which $\nu_\omega$ is extremely high, and hence higher $\rho$ leads to more participation—here, in genocide. However, we cannot infer from this that radio leads to more violence in general, as most of the time what citizens learn from better access to information is orders of magnitude less incendiary.

In general, an important implication of part ii of proposition 2 for empirical work is that unless outside observers have better information than those being studied, prediction about how introducing better information affects their beliefs and actions may be impossible. That is, the effects of better information on beliefs about the popularity of the regime are conditional on the difference between the actors' prior and the truth, which without better outsider information is fundamentally unknowable. Once we know the content of the new information—for example, we know that Rwandan radio stations were broadcasting extremely proviolence messages—it is possible to explore how it affected beliefs and actions; but if the content of the new information was known beforehand, it would not be new information in the first place.

However, the model does make an unambiguous prediction that better tactical information leads to more antiregime action. This contrast also provides insight into what kinds of information regimes benefit from censoring. Recall that the two variables interpreted as measuring the effectiveness of communication technology are $\rho$—which is the ease of expressing antiregime beliefs—and $\beta_s$—which captures the amount of public information about protest tactics. All things equal, the model predicts that reducing $\beta_s$ is an effective way to reduce protest, but reducing $\rho$ only sometimes depresses protest levels. In principal, regimes should be able to affect $\rho$ and $\beta_s$ separately if they have the technology to selectively censor certain kinds of information.

This distinction is consistent with the main empirical results of King et al. (2013, 2014), who find that China aggressively censors references to planned or ongoing collective action, which is best interpreted as decreasing $\beta_s$, but does not censor complaints about the regime, which would correspond to reducing $\rho$.[10] However, the model also warns against extrapolating from the contemporary Chinese case to general theories of what types of communication are censored. For regimes in a different part of the parameter space, reducing the ability for citizens to air grievances could make citizens less apt to protest.[11] (See Guriev and Treisman [2015] and Petrova and Zudenkova [2015] for related models that make more nuanced predictions about when dictators prefer to use different technologies of censorship and propaganda.)

## COORDINATION WITH HETEROGENEOUS REGIME ASSESSMENTS

While the model in the previous section highlights many of the central arguments and empirical predictions of the ar-

9. See also Enikolopov et al. (2011) for evidence that access to independent television increased vote shares for parties other than Putin's in Russia's 1999 parliamentary election.

10. This analysis focuses only on the benefits of censoring complaints versus tactic information. It is also plausible that it is costlier to censor more commonplace criticism rather than rarer specific calls to action. Calls to action centered on specific events may also be easier to automatically detect with keywords.

11. In addition, censoring complaints against the regime can have effects outside of those modeled here, such as signaling the ability to do so (Huang 2014) and making it more difficult to gather information about the performance of local officials (Egorov, Guriev, and Sonin 2009; Lorentzen 2013).

ticle, the focus on a single actor means that it cannot explicitly address how public information generated by ICT affects political and tactical coordination. This section develops a model in which a large number of citizens decide whether and how to protest with heterogeneous assessments of the regime, that is, with a focus on political coordination. In the next section I describe a model that endogenizes the tactical coordination problem as well. Doing so demonstrates that the conclusions from the single-actor model require only minor caveats when endogenizing these coordination problems while also generating additional results relevant to empirical work on ICT and political behavior.

The setup and solution to the first coordination model are closely related to many papers on how public information affects coordination in "bank run" style incomplete information coordination models (Hellwig 2002; Morris and Shin 2003), including a focus on political protest (e.g., Acharya 2014; Bueno de Mesquita 2010; Hollyer et al. 2013; Little 2012; Tyson and Smith 2013), so most of the details are relegated to the appendix. The emphasis in the main text is on the more empirically relevant results on whether better ICT—or more antiregime content on ICT—does or does not cause more protest.

The actors in the political coordination model are a continuum of citizens of mass 1. Rather than assuming a fixed benefit to protest ($\omega$ in the previous section), each citizen is characterized by a personal level of dissatisfaction with the regime $\omega_i$, given by

$$\omega_i = \omega + \epsilon_i,$$

where $\omega$ is now the average level of dissatisfaction with the regime and the $\epsilon_i$'s are independent and normally distributed with mean zero and precision $\alpha_\omega$.[12] Citizens know their own views of the regime ($\omega_i$) but are uncertain about the average assessment of the regime ($\omega$). Assume that the citizens share a common prior on $\omega$ that is again normally distributed with mean $\mu_\omega$ and precision $\alpha_0$.

To model the level of communication technology, I assume that an exogenously chosen $n \geq 1$ citizens' opinions of the regime (i.e., their $\omega_i$'s) are commonly observed, denoted $s_{1,\omega}, \ldots, s_{n,\omega}$. This technical structure best captures public communication technology such as television and social media, but not private communication facilitated by cell phones, e-mail, and the like. Let $\bar{s} = \sum_{j=1}^{n} s_{j,\omega}/n$ be the average of the public signals. This average—which could represent the amount of antiregime content on the Internet and social media—is a sufficient statistic for the citizens' belief about $\omega$ before observing their private signal.[13] Comparing the model in the previous section, $n$ is analogous to $\rho$, and citizens are making the normalization that accounts for the ease of observing other signals (eq. [2]) when making the average calculation that divides the sum of these signals by $n$.

Citizens also observe a common tactical signal $s_\theta = \theta + \epsilon_s$ with the distributional assumptions used above. In this section I interpret $\theta$ not as the average tactic chosen by others (which will be common knowledge in equilibrium) but as an "objectively optimal" tactic that all are uncertain about.

The citizen payoff in this section is

$$u(a_i, t_i; \omega_i) = a_i[\omega_i + \nu_A A - k(t_i - \theta)^2],$$

where $A$ is the proportion of citizens who protest and $\nu_A > 0$. The strategy for a citizen is a mapping from her view of the regime ($\omega_i$) and the public signals to a decision whether or not to protest, and the tactic to choose if protesting conditional on these signals. By sequential rationality, citizens all choose tactic $t_i^* = s_\theta[\beta_s/(\beta_0 + \beta_s)]$, giving an expected cost of protest $k/\bar{\beta}$. Further, given this tactical choice, citizens with $\omega_i > k/\bar{\beta}$ have a dominant strategy to protest (i.e., regardless of $A$), and citizens with $\omega_i < k/\bar{\beta} - \nu_A$ have a dominant strategy to stay home. So, it is natural to search for equilibria of the form "protest if and only if $\omega_i > \hat{\omega}(\bar{s})$," where the critical $\hat{\omega}$ may be a function of the public signals.

The intuition behind the solution is to find a critical level of dissatisfaction with the regime for each average public signal $\hat{\omega}(\bar{s})$ such that citizens protest if and only if their individual distaste for the regime is above this threshold (i.e., $\omega_i > \hat{\omega}(\bar{s})$). The key equilibrium condition is that for every possible public signal, the marginal citizen—that is, the citizen observing exactly the cutoff strategy—is indifferent between protesting and not given that all other citizens use this strategy. By a standard calculation, an equilibrium $\hat{\omega}(\bar{s})$ solves

$$\hat{\omega}(\bar{s}) + \nu_A \Phi(\tilde{\alpha}(\bar{\mu}_\omega - \hat{\omega}(\bar{s}))) = k/\bar{\beta}, \tag{6}$$

for all $\bar{s}$, where $\bar{\mu}_\omega \equiv (\alpha_0\mu_\omega + \alpha_s\bar{s})/(\alpha_0 + \alpha_s)$ is the average posterior belief about the incumbent unpopularity condi-

12. Of course citizens' views of the regime may be more closely correlated with those of citizens who are "close" to them socially or geographically. The conditional independence assumption substantially simplifies the analysis.

13. Citizens with the private signals that are made public have a different posterior belief about $\omega$ because they do not learn anything new from their own signal; but since the number of such citizens is finite, their behavior does not affect the protest size in equilibrium and hence the calculations of others.

tional on the public information, and $\tilde{\alpha}$ is a function of the primitive $\alpha$ parameters. Two main characteristics of the equilibrium (which are standard in related models) are as follows.

**Proposition 3.**

i. If $\nu_A$ is sufficiently small, there is a unique solution to equation (6) for all $\bar{s}$ and hence a unique equilibrium to the model in this section.
ii. When there is a unique equilibrium, $\hat{\omega}(\bar{s})$ is decreasing in $\bar{s}$.

*Proof.* See the appendix.

Part ii states that when the public signals indicate more dissatisfaction with the regime ($\bar{s}$ is higher), the equilibrium threshold goes down. This means that citizens are more apt to protest because they expect the size to be larger, increasing the value of participating. Even when there is not a unique equilibrium, this comparative static holds within the equilibria with the highest and lowest levels of protest.

This result captures a causal effect of increasing the amount of complaints about the regime (more on this below), not the causal effect of improving the amount of information about how many citizens dislike the regime. As in the single-actor model, when the public signal reveals that the regime is less popular than the citizens previously thought, increasing the precision of this information leads to more protest, while the opposite is true when the regime is more popular than expected. The average effect is found by computing the ex ante effect of increasing the amount of public information on the expected size of protest, giving a similar result.

**Proposition 4.** The expected size of protest is

i. decreasing in $k$,
ii. increasing in $\bar{\beta}$,
iii. increasing in $\bar{s}$, and
iv. can be increasing or decreasing in $n$.

*Proof.* See the appendix.

The first two comparative statics are straightforward: when protest is more costly, fewer participate; and when the tactical information is more precise, citizens are more apt to protest. The third part is analyzed in more detail below.

The comparative static on the number of public signals revealed (and the amount of public information about the regime's popularity) is difficult to sign, though extensive numerical analysis indicates that as in the first section, the expected size of protest is increasing in $\alpha_s$ when the probability of protest is low and decreasing in $\alpha_s$ when the probability of protest is high.[14]

The most important empirical lesson from the model in this section that does not arise in the single-actor model is the relationship between the intensity of antiregime content in the public signal and protest size. The expected size of protest given the realization of the public signals is

$$\begin{aligned}\mathbb{E}[A|\bar{s}] &= \Pr(\omega_i > \hat{\omega}(\bar{s})|\bar{s}) = \Pr(\omega + \nu_j > \hat{\omega}(\bar{s})|\bar{s}) \\ &= \Phi(\alpha_A^{1/2}(\bar{\mu}_\omega - \hat{\omega}(\bar{s}))),\end{aligned}$$

where $\alpha_A = (\alpha_0 + \alpha_s)\alpha_\omega/(\alpha_0 + \alpha_s + \alpha_\omega)$. Differentiating with respect to $\bar{s}$ gives that the effect of the average public signal on the expected level of protest is proportional to[15]

$$\frac{\partial \mathbb{E}[A|\bar{s}]}{\partial \bar{s}} \propto \underbrace{\frac{\partial \bar{\mu}_\omega}{\partial \bar{s}}}_{\text{Confounding}} - \underbrace{\frac{\partial \hat{\omega}(\bar{s})}{\partial \bar{s}}}_{\text{Strategic}}. \tag{7}$$

The $\partial\bar{\mu}_\omega/\partial\bar{s}$ term is positive and $\partial\hat{\omega}(\bar{s})/\partial\bar{s}$ is negative, so the expected protest size is increasing in the public signal. This is consistent with the fact that recent antiregime movements have been accompanied by spikes in social media activity and in particular antiregime content (e.g., Barberá and Metzger 2014).

However, equation (7) highlights how the relationship between the signal of grievances and the size of protest can be decomposed into two parts. The $\partial\bar{\mu}_\omega/\partial\bar{s}$ term captures the fact that for a fixed citizen strategy, a higher public signal means that the average citizen dislikes the regime more, and hence more citizens are willing to protest. The $\partial\hat{\omega}(\bar{s})/\partial\bar{s}$ term captures the fact that a higher public signal lowers the citizen threshold to protest; that is, for a fixed distaste for the regime, citizens are more apt to protest if they think others will join.[16]

Notably, the first effect is not causal, in the sense that if an outside observer could control for the true unpopularity of the incumbent, observing the public signal would not provide any new information and hence would have no

14. See proposition 2 in Little (2012) for a similar result in a related model, and corollary 1 in Shadmehr and Bernhardt (2011) for results about when better private information leads to more rebellion in a coordination model.

15. This is a slight abuse of the term "proportional to" as the "constant" these terms are multiplied by is $\alpha_A^{1/2}\,\phi(\alpha_A^{1/2}\,(\bar{\mu}_\omega - \hat{\omega}(\bar{s}))$, which is also a function of $\bar{s}$.

16. This term being negative relies on the strategic complementarities inherent in the payoffs. If participation decisions were strategic substitutes—as in some public goods games—the opposite could hold.

effect through this channel. However, even when controlling for the true $\omega$, the public signal still changes the citizen strategy, so the second effect is causal. Unless an outsider can perfect control for the average popularity of the regime, some of the observed association between antiregime media and protest levels is not causal. Further, the confounding effect is given by

$$\frac{\partial \bar{\mu}_\omega}{\partial \bar{s}} = \frac{\alpha_s}{\alpha_s + \alpha_0 + \alpha_\omega},$$

and the strategic effect is obtained by implicitly differentiating equation (6):

$$\frac{\partial \hat{\omega}}{\partial \bar{s}} = \frac{-\nu_A \tilde{\alpha} \phi(\bar{\mu}_\omega - \hat{\omega}(\bar{s}))}{1 - \nu_A \tilde{\alpha} \phi(\bar{\mu}_\omega - \hat{\omega}(\bar{s}))} \frac{\partial \bar{\mu}_\omega}{\partial \bar{s}}. \tag{8}$$

The central insight from examining these equations is that the causal effect includes a $\partial \bar{\mu}_\omega / \partial \bar{s}$ term, that is, the confounding effect. So, it is not possible for the relationship between the public signals and protest to be entirely causal: anything that makes $\partial \bar{\mu}_\omega / \partial \bar{s} \to 0$ will also make $\partial \hat{\omega} / \partial \bar{s} \to 0$. The reason is that the driving force behind the confounding effect—that the public signals are correlated with the regime's popularity—is required for the strategic effect to exist: if it did not, citizens would not condition their strategy on the signal.

On the other hand, it is possible that the confounding effect explains all of the relationship between publicized complaints about the regime and protest size: for example, if $\nu_A \to 0$, then $\partial \hat{\omega}(\bar{s}) / \partial \bar{s} \to 0$, but $\partial \bar{\mu}_\omega / \partial \bar{s}$ is unaffected, meaning that there is no causal effect but still a positive relationship between $\bar{s}$ and $A$. Similarly, if citizens have access to better information about the regime's popularity (through their private signals or other sources) than outsiders, they pay little if any attention to the public signals, and the strategic effect vanishes.

In the case of social media, there are several reasons to believe this relationship is mostly not causal. First, much of what is observed by outsiders is written in a language that most participants cannot read. Second, most of the activity on social media is outsiders communicating with outsiders: Starbird and Palen (2012) find that only 30% of the most-retweeted accounts during the height of the Tahrir Square protests originated in Cairo, and Aday et al. (2012) find that most of those following links posted on social media in Egypt and other Arab Spring protests were foreigners. Finally, much information available to outsiders is censored by the regime being attacked or simply replicates information already available to participants in the protest. So, unless social media provide distinct information to the actual participants of the protest they cannot access elsewhere, it does not have a causal effect on mobilization.[17]

The next three sections describe further extensions that are formalized in the appendix and discuss several other aspects of ICT and protest that are not included in the models.

## COORDINATION WITH HETEROGENEOUS PREFERRED TACTICS

Both the single-actor model and the model in the previous section treat the tactical coordination problem in a very reduced-form fashion. This section considers whether the result that improved public information about tactics leads to more protest holds when citizens have different tactical preferences and choose different tactics in equilibrium.

This question is related to a prominent literature on the welfare effects of public information in "beauty contest" style global games (Angeletos and Pavan 2007; Morris and Shin 2002; Svensson 2006). In the context here, these papers ask "if participation in the protest is taken as exogenous but participants choose their tactics with a motivation to choose a tactic close to others, does better public information about the optimal tactics increase the average payoff of protesters?" Morris and Shin (2002) spurred this literature with a provocative result that the answer to the question may be "no": better public information can lower aggregate welfare (here, the average payoff to protest). However, subsequent work has demonstrated that the conditions under which this occurs are quite restrictive (e.g., Angeletos and Pavan 2007; Svensson 2006).[18] Thus this strand of literature is broadly consistent with the claim that better ICT makes protest more likely through the tactical channel.

However, there are two major shortcomings in directly applying these results to the question at hand. First, they assume that the actors in the model are differentiated only by the information they have about the "fundamental," which

17. An implicit assumption in the above discussion is that outside attention does not embolden protesters, in which case social media could have a causal effect on protest levels even through this channel. In the interest of space I do not explicitly consider this possibility, though see Zeitzoff (2014) for evidence that "outsider" social media activity affected the dynamics of the 2012 Gaza conflict.

18. Using the specific payoffs in Morris and Shin (2002), better public information leads to higher welfare unless the coordination motives are very strong and the precision of public information is low (Svensson 2006). Using a broader payoff structure, Angeletos and Pavan (2007) show that better public information is beneficial unless citizens "overreact" to public information relative to what would be socially optimal or choose suboptimal actions even under complete information.

here is the optimal tactical choice. This assumption is natural for some applications—say, when investors have different information about the profitability of a company. However, citizens certainly have heterogeneous preferences over protest tactics; if nothing else, the most convenient time and place to protest vary across potential participants. Second, these models ignore what this article calls the political coordination problem by not considering whether potential protesters actually want to participate. In most of these models, citizens with "extreme" signals get arbitrarily low equilibrium payoffs. So, if there is an option to not participate, some, if not many, would choose not to.

To address these issues, I develop a model that endogenizes both the political and tactical coordination problems. In the interest of space, I verbally describe the main results in the main text, with the formalization placed in the appendix.

In this model, citizens are uncertain about the objectively optimal tactic $\theta$ and also have an individual preferred tactic $x_i$. The payoff to protest is increasing in (1) the unpopularity of the regime, (2) how close the chosen tactic is to the preferred ($t_i - x_i$) and objectively optimal tactics ($t_i - \theta$), (3) the size of the protest, and (4) the cohesion of the protest, which is a decreasing function of the range of chosen tactics.[19] Participants want to take an action that is a weighted average of their preferred tactic and an objectively optimal tactic (or, equivalently, the average preferred tactic of others).[20] This allows for a straightforward characterization of the tactical choice of participants, and hence the expected cost to protest, which is a function of the citizen's preferred tactic. Protest is more attractive for those who think their preferred tactic is similar to the preferred tactics of others.

The first main insight of this model is that when considering both the tactical and political coordination problems, the question of whether better public information about tactics increases protest size depends not on whether it makes the *average* citizen more apt to protest but whether the *marginal* citizen on the fence between participating and not benefits from better information from ICT. This generates an important caveat with respect to the results from the models described, as better tactical information can decrease protest sizes when they are already very large. The reason is that when protests are already massive, the marginal citizen indifferent between participating and not has a relatively "extreme" preferred tactic, and better tactical information tends to make such citizens even more aware that their preferences are extreme. On the other hand, when protests are relatively small, the marginal citizen has a more "typical" preferred tactic and is more likely to protest with better information.

However, as demonstrated in the formal analysis, the marginal citizen faces a lower expected cost of participation unless the size of protest is above a critical threshold, which is quite high: typically over two-thirds of the citizens. This potential negative effect of more public information could be interesting in some contexts: say, where there are a finite number of actors who must make unanimous decisions for coordination to succeed. However, when applied to antiregime protest—where much lower levels of participation are required for success—better information about the preferred tactics of others generally makes it cheaper for those who are on the fence about joining.

The model also highlights another positive benefit of better public information on protest effectiveness. When citizens have better information about the preferences of others, they place less weight on their individual preferred tactic and more on what they expect others to do. This makes the protest more cohesive and hence participation more attractive. So, even if better information means that fewer citizens participate, the increase in cohesion may make the protest more effective.

In sum, the model of tactical coordination largely reinforces a central conclusion from the single-actor model: creating common knowledge of when, where, and how other citizens are apt to protest makes participation cheaper and more effective even with more complex tactical coordination.

## BIASED AND ENDOGENOUS SIGNALS

Another problematic aspect of the models is that the public signals about the regime popularity and optimal tactics are exogenous and unbiased. The next set of extensions generalizes the information structure to loosen these assumptions.

First, consider a variant of the single-actor model in which both the regime popularity and tactical signal can be biased. In particular, suppose the signals are given by

$$s_\omega = \rho\omega + b_\omega + \epsilon_\omega \quad \text{and} \quad s_\theta = \theta + b_\theta + \epsilon_\theta,$$

where $\rho$, $\omega$, $\theta$, $\epsilon_\omega$, and $\epsilon_\theta$ are defined and interpreted as in the first section. The new terms, $b_\omega \in \mathbb{R}$ and $b_\theta \in \mathbb{R}$, represent the bias in the regime's popularity and tactical signals, respectively. That is, when $b_\omega$ is negative, the signal of the

19. The fact that less cohesive protests are worse leads to a strategic substitution effect in protest participation, as adding those with more extreme tactics will make protest less effective through this channel. See Myatt (2015) for a model of protest voting with stronger strategic substitutes in participation.

20. It would arguably be more natural to have citizens want to pick a tactic close to the average choice of others, though as described in the appendix, this formulation has no equilibrium with linear strategies, making straightforward conclusions much more difficult.

regime's popularity is lower than it would be otherwise, and when $b_\omega$ is positive, the signal of the regime's unpopularity is higher.

If the bias is exogenously given and known by the citizen, then she simply subtracts the bias out when forming posterior beliefs about $\omega$ and $\theta$ and propositions 1–3 remain unchanged.[21]

Next, assume the bias is exogenous but the citizen is uncertain about how distorted the signals are. In particular, suppose $b_\omega$ and $b_\theta$ are independent from each other and the other primitive random variables and normally distributed with means $m_\omega$ and $m_\theta$ and precisions $\gamma_\omega$ and $\gamma_\theta$, respectively.

Analogous to the case in which the bias is known, the citizen subtracts the expected level of bias from the signals to form an unbiased signal of both $\omega$ and $\theta$. However, since she is uncertain about the exact level of bias, both signals become less informative. That is, the precision of her posterior belief about both parameters of uncertainty is decreasing in how uncertain she is about the magnitude of bias. So, the central results from the first section hold with additional results about how uncertain the citizen is about the level of bias.

**Proposition 5.** In the extension with uncertainty about the bias of the signals, the probability of protest is

i. increasing in $\beta_0$, $\beta_s$, and $\gamma_\theta$;
ii. increasing in $\gamma_\omega$ and $\rho$ if and only if $\mu_\omega < k/\bar{\beta}'$, where $\bar{\beta}' = \beta_0 + [\beta_s\gamma_\theta/(\beta_s + \gamma_\theta)]$; and
iii. unaffected by $m_\theta$ and $m_\omega$.

*Proof.* See the appendix.

As before, better tactical information always leads to more protest, and making it easier to air grievances against the regime increases the probability of protest when it is ex ante unlikely.

The effect of the bias in both signals, on average, is simply to make them noisier. So, less uncertainty about the bias in the tactical signal leads to more protest, and less uncertainty about the bias in the signal about the regime's popularity leads to more protest under the exact same condition that making it easier to complain about the regime leads to more protest.

More relevant to empirical work, just as better information about the popularity of the regime leads to more protest when it is less popular than expected, there is less protest when the bias is more proregime than expected. On the other hand, when the bias is less proregime than expected, the presence of bias leads to more protest. For example, Ukrainians exposed to Russian media with a slant against pro-Western parties (perhaps more than realized) voted less often for these parties in the 2014 elections (Peisakhin and Rozenas 2015), while Enikolopov et al. (2011) find that exposure to independent television in Russia led to higher opposition vote shares, perhaps because of an antiregime bias or by providing information without a proregime bias.

This provides a second reason why in some cases we should expect to see better ICT lead to more protest (when the bias is more proregime than expected) and in other cases we should expect the opposite effect (less proregime bias than expected). If we pay attention only to cases in which outside observers know that the media have a stronger proregime bias than citizens think, then the presence of bias in those cases decreases protest. However, unless people systematically underestimate how much proregime bias is in the media they consume, this will not always be the case.

Next, the appendix formalizes an extension in which the regime is a strategic actor and can choose a level of bias in the signal of its popularity. If the level of bias were observed by the citizen, she would subtract it out as in the case of known exogenous bias; and hence the incumbent would have no incentive to distort the signal in a way that would be immediately reversed. However, if the bias decision is unobserved, then the regime always has an incentive to choose a higher bias level than is expected, and hence bias can happen in equilibrium for "career concerns" type incentives (see Bueno de Mesquita [2010] and Little [2012] for related models).

So in equilibrium, the inferences made by the citizen are analogous to the case of exogenous bias. When the regime plays a pure strategy choosing bias level $b^*_\omega$, the citizen subtracts this from the signal when making her inference and none of the main results change. The case of mixed strategies is somewhat more complex but unlikely to change the central conclusions. (Though see Edmond [2013] for a model in which the regime knows its strength and can benefit from manipulating private signals observed by citizens.)

Similar dynamics could arise if citizens could manipulate the public information available to others. In particular, suppose that the citizens who publicly report their opinion of the regime in the model in the second section can choose whatever signal they like. If citizens can report their opinions of the regime costlessly, there is unlikely to be an informative equilibrium: those who plan to participate in the protest always want to increase participation and hence have an

21. More precisely, define $s'_\omega \equiv s_\omega - b_\omega$ and $s'_\theta = s_\theta - b_\theta$. Then $s'_\omega$ and $s'_\theta$ have the same distribution as $s_\omega$ and $s_\theta$ in the first section, respectively. So all the results derived in that section hold with the primed variables replacing their counterparts.

incentive to lie and say they dislike the regime more than they truly do. However, if misreporting is costly for some reason—perhaps psychological or because of reputation effects—there may be an informative equilibrium in which citizens exaggerate their distaste for (or happiness with) the regime to the point where the benefit of lying more than expected to affect the protest size in the desired direction is equal to the cost of additional exaggeration. As long as there is a one-to-one mapping between the true antiregime sentiment and reported signals, citizens will be able to back out the "true" public signals, hence not changing any of the central results derived above.

The case of endogenously biasing the tactical signal is more technically involved. If the incumbent has an interest in making the citizen choose a tactic far from $\theta$, he could profit from playing a mixed strategy that "jams" the tactical signal (see Munger et al. [2014] for related empirical results about how proregime Venezuelans flooded social media with tweets about unrelated topics during antiregime protests in 2014–15). If biasing the tactical signal is free, the incumbent could choose a mixed strategy that maximizes the citizen's ex post degree of uncertainty, making her choose a worse tactic on average and making protests less attractive. If biasing the signal is costly, the incumbent could still choose a mixed strategy if the citizen chooses a worse tactic on average when a more costly level of bias is chosen. Again, this extension seems unlikely to overturn any of the central conclusions drawn above.

### NONSTANDARD BELIEF FORMATION

As with most formal models with incomplete information, all of the analysis above assumes that the citizens form beliefs about the regime popularity and optimal tactics correctly, that is, by Bayes's rule. This may be particularly problematic in a model that hinges on citizens using the information presented to them correctly.

A challenge of allowing nonstandard beliefs is that there is only one way to do proper Bayesian updating but an infinite number of ways to be irrational. To limit the scope, the appendix contains extensions of the single-actor model with two types of incorrect beliefs. First, I assume there is random noise in the posterior expectation of the regime's popularity. Second, I let the citizens have an incorrect belief about how to incorporate the ease of criticism in their posterior belief.

If there is random noise in the citizen's beliefs, the implications of the model remain the same for reasons similar to those of the model with exogenous bias. As long as the citizen believes she has better tactical information when $\beta_s$ is high, she will be more apt to protest (even if misinterpreting the tactical signal). If the citizen systematically misinterprets the signal of the regime's popularity, this can make her more or less apt to protest in general, but the conditional relationship where making it easier to complain about the regime can lead to more or less protest remains.

A potentially more problematic class of incorrect belief formation is if the citizen misunderstands the role of the ease of airing grievances in the signal she observes. That is, if the citizen improperly makes the normalization of $s_\omega$ (eq. [2]), then making it easier to complain against an unpopular regime can always lead to more protest. Conversely, censorship can work if citizens underappreciate how this affects how they should interpret the criticism they do see. However, without good empirical evidence that citizens underadjust for the effect of the ease of criticism—and there is no reason to think they do not sometimes overadjust for this effect—the more standard model seems more appropriate than ones in which effects of censorship and technology rely on citizens misunderstanding their effects.

### OTHER MECHANISMS: TIME, REGIME RESPONSE, AND ORGANIZATION

Finally, I informally consider how several other notable arguments about how social media and other ICT affect protest fit into the modeling done here.

First, a common argument not captured directly in the coordination models is that social media spread information about how many citizens have already taken to the streets and what tactics they are using. In the words of a BBC correspondent, "if you follow second by second some of the accounts coming from Cairo's Tahrir Square, you can almost see when activists realized they had broken through, that it wasn't just a few hundred people turning up but tens of thousands" (Else 2012). Formally capturing this idea requires a dynamic model, which proves complex when combined with incomplete information coordination games (Angeletos, Hellwig, and Pavan 2007; Kricheli, Livne, and Magaloni 2011; Little 2015).

Still, analogous to the argument made repeatedly here, if communication technology can provide information that many people are on the streets, it will also make it more clear when they are not on the streets. For example, Twitter can help spread the word that protests are growing, but it can also spread the word that protesters are going home. So, in cases of successful revolution, we will generally see many positive messages spreading on social media; but in failed cases there generally will not be, potentially resulting in the same ambiguous average effect found in the formal analysis. On the other hand, providing better information about the tactics protesters are using should have an unambiguously positive effect on protest levels.[22]

Second, ICT may spread information about how the regime is responding to protests, either as a sign that protesting is safe or as a source of grievances. Still, the same arguments above likely apply to this kind of information too: better information about the extent to which the regime is cracking down on protests will affect future protest decisions conditional on whether the regime is being more or less repressive than expected.

Third, even the models with multiple actors treat them all as homogeneous, not differentiating with a leadership that may use ICT differently than other participants and nonparticipants. For example, better technology may allow organizers to communicate better to plan antiregime activity. This effect would seem to run parallel to improving tactical coordination, by having protest leaders converge more quickly on what tactics to encourage. So, this effect reinforces the finding that tactical coordination—perhaps more broadly defined—has an unambiguously positive effect on antiregime action.

## CONCLUSION

As communication technology continues to improve and assume a central role in politics, debates about how new technology affects political behavior are unlikely to go away. Similarly, the rapidly growing availability of information generated by social media and related technologies will almost certainly become a central source of data for political scientists and social scientists more generally. As most of this information is observational, there is an acute need to develop theories that can place structure on how we should interpret this fire hose of data. Even in the (arguably rare) instances in which it is possible to run experiments and credibly estimate treatment effects on, say, what types of communication are censored or how having one's writing censored affects future behavior (King et al. 2014; Roberts 2014), good research design alone cannot tell us what these causal effects tell us about authoritarian (and democratic) politics.

The modeling here is an early step in such theorizing, clarifying the formal logic of certain channels through which information generated by new communication technologies is associated with (and potentially causes) antiregime action. Of course the models developed here are not meant to be a definitive statement on this particular relationship, let alone the relationship between social media and political behavior more generally. For example, future research should more thoroughly consider the regime as a strategic actor that can use or manipulate the information generated by social media and consider the temporal dynamics that are central to political movements. Still, even in the static framework that abstracts from how regimes use information, the models here provide concrete insights into how new communication technology can help or hurt political mobilization, providing a starting point for what will hopefully become a fruitful communication between theorizing and empirical work on both the relationship between technology and politics and what data from new technologies can teach us about politics in general.

22. Another distinction between political and tactical coordination that may arise from a dynamic model is that while the antiregime sentiment is likely stable across short periods of time, tactics may evolve more rapidly, further increasing the importance of getting new information through this channel.

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## REFERENCES

Acharya, Avidit. 2014. "Coordination and Development in Dictatorships." Manuscript.

Aday, Sean, Henry Farrell, Marc Lynch, John Sides, and Dean Freelon. 2012. "Blogs and Bullets II: New Media and Conflict after the Arab Spring." Report, US Institute for Peace, Washington, DC.

Aday, Sean, Henry Farrell, Marc Lynch, John Sides, John Kelly, and Ethan Zukerman. 2010. "Blogs and Bullets: New Media in Contentious Politics." Report, US Institute for Peace, Washington, DC.

Angeletos, George-Marios, Christian Hellwig, and Alessandro Pavan. 2007. "Dynamic Global Games of Regime Change: Learning, Multiplicity, and Timing of Attacks." *Econometrica* 75 (3): 711–56.

Angeletos, George-Marios, and Alessandro Pavan. 2007. "Efficient Use of Information and Social Value of Information." *Econometrica* 75 (4): 1103–42.

Barberá, Pablo, and Megan Metzger. 2014. "Tweeting the Revolution: Social Media Use and the #Euromaidan Protests." *Huffington Post*, February 21.

Barberá, Pablo, and Gonzalo Rivero. 2014. "Understanding the Political Representativeness of Twitter Users." *Social Science Computer Review*. Electronically published, December 1.

Bennett, W. Lance, and Alexandra Segerberg. 2013. *The Logic of Connective Action: Digital Media and the Personalization of Contentious Politics*. Cambridge: Cambridge University Press.

Boix, Carles, and Milan Svolik. 2013. "The Foundations of Limited Authoritarian Government: Institutions and Power-Sharing in Dictatorships." *Journal of Politics* 75 (2): 300–316.

Bueno de Mesquita, Ethan. 2010. "Regime Change and Revolutionary Entrepreneurs." *American Political Science Review* 108 (3): 446–66.

Comunello, Francesca, and Giuseppe Anzera. 2012. "Will the Revolution Be Tweeted? A Conceptual Framework for Understanding the Social Media and the Arab Spring." *Islam and Christian-Muslim Relations* 23 (4): 453–70.

Dafoe, Allan, and Jason Lyall. 2015. "From Cell Phones to Conflict? Reflections on the Emerging ICT–Political Conflict Research Agenda." *Journal of Peace Research* 52 (3): 401–13.

Dewan, Torun, and David P. Myatt. 2008. "The Qualities of Leadership: Direction, Communication, Obfuscation." *American Political Science Review* 102 (3): 351–68.

Edmond, Chris. 2013. "Information Manipulation, Coordination, and Regime Change." *Review of Economic Studies* 80 (4): 1422–58.

Egorov, Georgy, Sergei Guriev, and Konstantin Sonin. 2009. "Why Resource-Poor Dictators Allow Freer Media: A Theory and Evidence from Panel Data." *American Political Science Review* 103 (4): 645–68.

Else, Liz. 2012. "The Revolution Will Be Tweeted." *New Scientist*, February 6.

Enikolopov, Ruben, Maria Petrova, and Ekaterina Zhuravskaya. 2011. "Media and Political Persuasion: Evidence from Russia." *American Economic Review* 101 (7): 3253–85.

Farrell, Henry. 2012. "The Consequences of the Internet for Politics." *Annual Reviews of Political Science* 15:35–52.

Gehlbach, Scott, and Konstantin Sonin. 2014. "Government Control of the Media." *Journal of Public Economics* 118:163–71.

Guriev, Sergei M., and Daniel Treisman. 2015. "How Modern Dictators Survive: Cooptation, Censorship, Propaganda, and Repression." CEPR Discussion Paper no. DP10454, Centre for Economic Policy Research, London.

Hale, Henry E. 2013. "Explaining Moldova's 'Twitter Revolution That Wasn't.'" Working paper, PONARS Eurasia.

Hellwig, Christian. 2002. "Public Information, Private Information, and the Multiplicity of Equilibria in Coordination Games." *Journal of Economic Theory* 107 (2): 191–222.

Hollyer, James R., B. Peter Rosendorff, and James Raymond Vreeland. 2013. "Transparency, Protest and Political (In)Stability." Manuscript.

Howard, Philip N. 2011. "The Cascading Effects of the Arab Spring." *Miller-McCune* 23 (February).

Huang, Haifeng. 2014. "Propaganda as Signaling." *Comparative Politics* (forthcoming).

Kendall-Taylor, Andrea, and Erica Frantz. 2014. "How Autocracies Fall." *Washington Quarterly* 37 (1): 35–47.

Kern, Holger Lutz, and Jens Hainmueller. 2009. "Opium for the Masses: How Foreign Media Can Stabilize Authoritarian Regimes." *Political Analysis* 17 (4): 377–99.

Keynes, John Maynard. 1936. *The General Theory of Employment, Interest and Money*. London: Macmillan.

King, Gary, Jennifer Pan, and Margaret E. Roberts. 2013. "How Censorship in China Allows Government Criticism but Silences Collective Expression." *American Political Science Review* 107 (2): 326–43.

King, Gary, Jennifer Pan, and Margaret E. Roberts. 2014. "Reverse-Engineering Censorship in China: Randomized Experimentation and Participant Observation." *Science* 345 (6199): 1251722.

Kricheli, Ruth, Yair Livne, and Beatriz Magaloni. 2011. "Taking to the Streets: Theory and Evidence on Protests under Authoritarianism." Manuscript.

Little, Andrew T. 2012. "Elections, Fraud, and Election Monitoring in the Shadow of Revolution." *Quarterly Journal of Political Science* 7 (3): 249–83.

Little, Andrew T. 2015. "Coordination, Learning, and Coups." *Journal of Conflict Resolution*. Electronically published February 12.

Lorentzen, Peter. 2013. "China's Strategic Censorship." *American Journal of Political Science* 58 (2): 402–14.

Morozov, Evgeny. 2009. "Texting towards Utopia: Does the Internet Spread Democracy?" *Boston Review* (March).

Morris, Stephen, and Hyun Song Shin. 2002. "Social Value of Public Information." *American Economic Review* 92 (5): 1521–34.

Morris, Stephen, and Hyun Song Shin. 2003. "Global Games: Theory and Applications." In Mathias Dewatripont, Lars Peter Hansen, and Stephen J. Turnovsky, eds., *Advances in Economics and Econometrics: Theory and Applications; Eighth World Congress*. Cambridge: Cambridge University Press.

Munger, Kevin, Richard Bonneau, Jonathan T. Jost, Jonathan Nagler, and Joshua A. Tucker. 2014. "Elites Tweet to Get the Feet of the Streets: Measuring Regime Response to Protest Using Social Media." Manuscript.

Myatt, David P. 2015. "A Theory of Protest Voting." Manuscript.

Patel, David, and Valerie Bunce. 2012. "Turning Points and the Cross-National Diffusion of Popular Protest." *Comparative Democratization* 10 (1): 10–13.

Peisakhin, Leonid, and Arturas Rozenas. 2015. "Electoral Mobilization with Biased Media: The Influence of Russian Television in Ukraine." Manuscript.

Petrova, Maria, and Galina Zudenkova. 2015. "Content and Coordination Censorship in Authoritarian Regimes." Manuscript.

Pierskalla, Jan H., and Florian M. Hollenbach. 2013. "Technology and Collective Action: The Effect of Cell Phone Coverage on Political Violence in Africa." *American Political Science Review* 107 (2): 207–24.

Reuter, Ora John, and David Szakonyi. 2015. "Online Social Media and Political Awareness in Authoritarian Regimes." *British Journal of Political Science* 45 (1): 29–51.

Roberts, Margaret E. 2014. "Fear or Friction? How Censorship Slows the Spread of Information in the Digital Age." Manuscript.

Schelling, Thomas C. 1960. *The Strategy of Conflict*. Cambridge, MA: Harvard University Press.

Shadmehr, Mehdi, and Dan Bernhardt. 2011. "Collective Action with Uncertain Payoffs: Coordination, Public Signals and Punishment Dilemmas." *American Political Science Review* 105:829–51.

Shadmehr, Mehdi, and Dan Bernhardt. 2015. "State Censorship." *American Economic Journal: Microeconomics* 7 (2): 280–307.

Shapiro, Jacob, and Nils Weidmann. 2015. "Is the Phone Mightier than the Sword? Cell Phones and Insurgent Violence in Iraq." *International Organization* 69 (2): 247–74.

Shirky, Clay. 2008. *Here Comes Everybody: The Power of Organizing without Organizations*. New York: Penguin.

Siegal, David A., and Jacob N. Shapiro. 2013. "Coordination and Security: How Mobile Communications Affect Insurgency." *Journal of Peace Research* 52 (3): 312–22.

Starbird, Kate, and Leysia Palen. 2012. "(How) Will the Revolution Be Retweeted? Information Diffusion and the 2011 Egyptian Uprising." In *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work*. New York: ACM, 7–16.

Svensson, Lars E. O. 2006. "Social Value of Public Information: Morris and Shin (2002) Is Actually Pro Transparency, Not Con." *American Economic Review* 96 (1): 448–52.

Tarrow, Sidney. 1994. *Power in Movement: Social Movements, Collective Action and Politics*. Cambridge: Cambridge University Press.

Tufekci, Zeynep. 2014. "Big Questions for Social Media Big Data: Representativeness, Validity and Other Methodological Pitfalls." arXiv preprint arXiv:1403.7400.

Tyson, Scott A., and Alastair Smith. 2013. "Regime Insiders and Revolutions." Presented at the annual meeting of the Midwest Political Science Association, Chicago.

Yanagizawa-Drott, David. 2014. "Propaganda and Conflict: Theory and Evidence from the Rwandan Genocide." *Quarterly Journal of Economics* 129 (4): 1947–96.

Zeitzoff, Thomas. 2011. "Using Social Media to Measure Conflict Dynamics: An Application to the 2008–2009 Gaza Conflict." *Journal of Conflict Resolution* 55 (6): 938–69.

Zeitzoff, Thomas. 2014. "Does Social Media Influence Conflict? Evidence from the 2012 Gaza Conflict." Manuscript.