A Model of Protests, Revolution, and Information

Salvador Barbera and Matthew O. Jackson *

March 2016

Abstract

A population considering a revolt must participate in sufficient numbers to succeed. We study how their ability to coordinate is affected by their information. The effects of information are non-monotone: the population may coordinate on a revolt if there is very little information or if they know a lot about each other's preferences for change, but having each agent know about the the willingness of a few others to revolt can actually make non-participation by all the unique equilibrium. We also show that holding mass protests before a revolution can be an essential step in mobilizing a population. Protests provide costly signals of how many agents are willing to participate, while easier forms of communication (e.g., via social media) may fail to signal willingness to actively participate. Thus, although social media can enhance coordination, it may still be necessary to hold a protest before a revolution in order to measure the size of the population willing to revolt. We also examine how having competing groups involved in a revolution can change its feasibility, as well as other extensions, such as what the minimal redistribution on the part of the government is in order to avoid a revolution, and the role of propaganda.

Keywords: Revolution, demonstration, protests, strikes, Arab Spring
JEL Classification Codes: D74, D72, D71, D83, C72

*Barbera is at MOVE, Universitat Autnoma de Barcelna and Barcelona GSE. He acknowledges financial support under grants ECO2014-53051-P, 2014SGR-515 and the Severo Ochoa Programme. Jackson is at the Department of Economics, Stanford University, Stanford, California 94305-6072 USA, and is an external faculty member at the Santa Fe Institute and a member of CIFAR. Emails: and jacksonm@stanford.edu. He gratefully acknowledges financial support under ARO MURI Award No. W911NF-12-1-0509 . We thank Avi Acharya and Steve Callendar for helpful comments.

1 Introduction

In human societies, there exist individuals who are dissatisfied with the status quo and would prefer a change. When enough people agree on the direction of desirable change, there may be room to force it, generally at a cost. But prior to acting for change, those agents who want it need tolearn about the strength of their group and even to let others, who are also dissatisfied but maybe not for the same reasons, know that they have sufficient forces and a common ground upon which to act. Demonstrations, strikes, and other more spontaneous forms of mass protests, provide such information. A successful mass protest informs dissenters about the size and commitment of their group, and signals to potential allies the possibility to gather a larger segment of society into a common movement.

In this paper, we provide a simple model of collective action, focusing on the informational role of mass protests. We study how the incentives to participate in them, and their eventual success, depends on the information that is available to agents at the beginning of a process of revolt, and also during the process itself. We also discuss how, in spite of the improvements in social media and communication, demonstrations remain as a differentiated and particularly revealing method to learn about the willingness, the intensity of preferences, and the conditions under which agents are willing to take risks in favor of change.

The final result of protests, if successful, will be called a revolution, but it must be understood that our model is general enough to encompass different types of events under this generic name. In some extreme cases, success is the overthrow of a government; but in others, it may be a significant change in the political scenario, enough to produce a desired change in policy. In some cases, the "revolution" will involve violence while in others it may remain peaceful. And the success of a revolution today, as we have seen in many cases, may turn into a failure tomorrow, especially if the protesters are themselves a heterogeneous group whose interests may conflict right after they achieve their initial common goal.

Although there may be instances where the strength of a single mass mobilization, coupled with the weakness of the status quo defenders, may bring about change instantly, a revolution is most often the result of a succession of events. Hence, we are interested in dynamics, and on the consequences of information gathering through collective action as part of multi-period processes. Protests can gain or loose momentum, they can arise in one country after observing the success of similar groups in other areas of the world, and they may also be deterred in one place when its success in others is a premonitory warning to the status-quo defenders. Some of these distinctions can be found in our paper, in which we propose a model that provides a common starting ground, to be later enriched when used to analyze specific movements, their goals and their means.

We begin the formal part of the paper in Sections 2 and 3, by describing a one-shot model in which the members of a population must simultaneously decide whether to participate in a "revolution" (demonstration, strike, etc.) in ignorance of other agents types. The revolution is successful if sufficient numbers participate, but not otherwise. We present this model first, since it is a useful benchmark and building block for our main analysis. This sort of model is standard as it is a basic coordination game among a population of players, and has been extensively studied in the global games literature (e.g., see Angeletos, Hellwig, and Pavan (2007)).

Then, in Sections 4 and 5, we move to our main analysis to analyze dynamic phenomena associated with the building up of demonstrations and "revolutions".

We first examine how communication between potential protestors matters in either enabling or disabling a revolution. We consider situations in which people get to observe the type of another agent in society.[1] We show that this produces two countervailing effects. One, is that agents who meet with another person who prefers change are now more confident about the size of the potential revolution. The second is that agents who meet someone who prefers the status quo are now discouraged about the size of the potential revolution. The subtle aspect here is that even when there are many supporters of change, and so most of them are encouraged by what they see, they still know that some supporters will end up being discouraged which will reduce the participation. Thus, communication can help some become more confident, but it also can thin the numbers of those confident enough to show up for the revolution. So, we show that: (i) In some cases communication can enable a revolution, while it would not be otherwise. This happens in cases in with poor prior information about the numbers of potential revolutionaries. (ii) In some cases communication can make a revolution impossible, even though it would have been possible without communication. This happens when there is stronger prior information about the numbers of potential revolutionaries, but not an overwhelming number of them relative to the threshold number that they need. We then go on to show that if people can communicate with sufficient numbers of agents, eventually reaching full knowledge of their numbers, revolutions occur if and only if they will be successful. Thus, we find an important, and new insight regarding how small amounts of information can actually make revolutions impossible - while no information or large amounts of information would lead to successful revolutions.[2]

Next, another of our main results concerns when it is that holding demonstration before a revolution can be important in enabling the revolution. Without a demonstration, moderate and cautious supporters may have insufficient information about the probability of success to participate. If a demonstration is held, then those moderates can learn about the number of more extreme supporters, which then informs them about the probability of a successful revolution, and enables the revolution to take place. Thus, demonstrations become a critical and essential part of a successful revolution. We also point out why simple polls or cheap talk

[1] Communicating types is incentive compatible in this setting.

[2] An interesting, but very different signalling phenomenon in a voting setting is studied by Lohmann (1993). She examines costly political action prior to voting, when voters are trying to estimate a state variable about which alternative is best to vote for, and her effects are based on the fact that only agents who are extreme enough take political action, which does not provide full information about the state and may confound it. Here, our affect is ends being a strategic one: agents know that some supporters will be discouraged and hence will not participate, and then through the strategic complementarity of the revolution discourages even those with strong information from participating.

are not enough. Social media have been very critical in helping coordinate demonstrations, but they cannot substitute for demonstrations, since they are 'cheap-talk' and do not involve the costly signaling that demonstrations provide. A natural setting is one in which there are many people who would prefer change, but also in which many of them are not willing to pay the personal costs of being an active part of a revolution. They may communicate their support, but fail to turn out when action is needed. Holding a somewhat costly demonstration is a filtering device, which then signals whether there are sufficient numbers of people who are willing to act for change, not just cheer it on. Thus, holding a demonstration before a revolution can be a necessary step to enabling the revolution.

Beyond these main analyses of the role of communication and demonstrations in enabling or disabling revolutions, we also discuss several other issues, as the model provides a base for many potential analyses. For example we also discuss how equilibria may change when agents sources of information are biased by homophily - so that agents who support change are most likely to be talking with others who feel the same, biasing the sample of communication that they receive about the society. We also discuss what happens when the potential revolutionaries are heterogeneous and distrust each other. Here, demonstrations can also signal the relative sizes of the groups, which can also enable or disable the revolution, depending on the degree of distrust. We also provide a picture of the successive steps through which mass demonstrations may build up and have different types join. Finally, we also briefly discuss what governments may do to prevent revolutions - for instance using propaganda, or redistributing income. Finally, in Section 6 we highlight the basic difference between demonstrations and polls, or other means to learn about peoples frustration and willingness to revolt.

Throughout the paper we keep the analysis simple to provide building blocks and potential first steps rather than restricting the model to analyze a single of the rich and diverse phenomena that we hope can be modeled through our basic formulation. Many of our results are easy to understand, but they are basic to understanding societal change through non-governmental means. In particular, we believe that our main results regarding the important roles of demonstrations, the non-montonicities of information, and issues of homophily and government reactions, have no precedents in theoretical literature.

There is a literature, both theoretical and empirical, on the subject of collective action and the building up of mass demonstrations. These phenomena have been analyzed from different angles, and in reference to different countries and circumstances. Indeed, there are many realities to take into account: the types of governments against which demonstrations are held, the means through which concerned agents may receive and send information, the varying objectives of agents that agree on the need to change the government, but may disagree on the alternative to set in place. The Arab Spring and the role of social networks ad cell phones have raised new important questions, activated the literature and provided opportunities for empirical tests. It is not possible to survey the literature on the subject here, but we discuss the key references (with more below, as we proceed). An early precursor on coordination games is Granovetter (1978). Other important studies of collective action and mobilization build upon the herding literature of Banerjee (1993) and Bikhchandani, Hirshleifer, and Welch (1993). Some of these papers examine sequential observations and how these affect voting, a politician's decision, or a collective action (e.g., see Chwe (1999), Lohmann (1993, 1994ab, 2000), Bueno de Mesquita (2010), and Kricheli, Livne, and Magaloni (2011)). The importance of information is central to all of these papers. At a high level, there is a common theme that there can be inefficiencies in outcomes due to imperfect information aggregation. However, the models and analyses are different from ours. The closest overlap is with Kricheli, Livne, and Magaloni (2011) who analyse a two period model in which the first period turnout informs second period activists about whether they should try a revolution. Our analysis of a first period demonstration has a similar intuition even if the models differ. The point that we make that in many cases the revolution could not take place without such a demonstration is new. In addition, our main results regarding the non-monotonicities of the amounts of information, conflicts between different types of revolutionaries, and issues of homophily as well as government propaganda and redistribution, are also new.

2 A Static Model as a Building Block

We begin by describing a one-shot model in which a population must simultaneously decide whether to participate in a strike or revolution, etc., in ignorance of other agents' types. We present an analysis of this model of collective action first, since it is a useful benchmark and building block for our main analysis. This sort of model is standard, as it is basically a coordination game among a population of players. It has been extensively studied in the global games literature (e.g., see Angeletos, Hellwig and Pavan (2007)), although we not add distributional assumptions to try to derive uniqueness of equilibrium, since the multiplicity of equilibria is important in our setting, both empirically and in the theory; especially when we expand the analysis to more than one period.

2.1 The Players

A continuum of citizens of mass 1 are indexed by $i \in [0, 1]$.

They have a choice to participate in a revolution or strike, etc.

In terms of the basic model, we will use the term 'revolt' but the model obviously has many applications.

The collective action is successful if at least a fraction $q \in (0, 1]$ of the population participates. If fewer than q participate, then the action fails.

2.2 Uncertainty

$\omega \in I\!R$ is the state of the world, which can encode information about the value of the revolution and what fraction of the population would gain from the revolution, and so forth.

There is a prior distribution over ω, denoted G - and agents do not directly observe ω.

$\theta_i \in I\!R$ is the type of agent i, which is the private information of that agent.[3]

The distribution over types depends on the state of the world and is denoted $F(\theta_i|\omega)$. We treat these as if they are independent across agents conditional upon the state, which is technically convenient but has some measurability issues that are easily handled as the limit of a finite model.[4]

We assume the standard ordering property on information:[5] conditional upon θ_i, the distribution on ω and others' types are both increasing in θ_i in the sense of first order stochastic dominance. Thus, higher types of an agent lead that agent to expect higher types of other agents.

2.3 Payoffs

An agent gets a value from the the revolution as a function of whether it is successful or not and whether the agent participates or not. All of these payoffs can be type and state dependent, and are given by the following table.

	Success	*Failure*
Participate	$a(\theta_i,\omega) + V_i(\theta_i,\omega)$	$b(\theta_i,\omega) - C_i(\theta_i,\omega)$
NotParticipate	$a(\theta_i,\omega)$	$b(\theta_i,\omega)$

Here, $a(\theta_i,\omega)$ is the value that an agent gets if the revolution is successful, regardless of whether the agent participates or not, and this can depend on the agent's type and the

[3]We could allow the states and types to be multidimensional and more complicated. The advantage of one dimension is that what we ultimately care about is whether an agent is sufficiently unhappy with the government would revolt. More dimensions would involve partial orders, but the story would basically be the same - some people are unhappy enough to revolt and others are not, and the agents are trying to learn about the relative fractions and potential for success.

[4]For a discussion of the issues of a continuum of agents having independent observations see Feldman and Gilles (1985) and Judd (1985). In our model, the independence is not really needed, and so a very easy way of formalizing the signals for our purposes is as follows. Uniformly at random, draw i_0 from $[0,1]$ - this will be the agent who gets the lowest signal in society. Then let $\theta_i = F^{-1}(i - i_0|\omega)$, where $F^{-1}(\cdot|\omega)$ is the inverse of $F(\theta_i|\omega)$, and we take $i - i_0$ modulo 1, so that if $i < i_0$, then we set $i - i_0 \equiv i + 1 - i_0$. So, we randomly pick an agent to have the lowest signal, and then just distribute the signals then in a nondecreasing way for the rest of the agents with higher labels, and then wrap around beginning again at 0. This results in the right distribution of types without any measurability issues and the independence of types is not needed for our results, as agents only care about the population behavior not any particular agent's behavior.

[5]See Milgrom (1981).

state. Similarly, $b(\theta_i, \omega)$ is the value that an agent gets if the revolution fails, regardless of whether the agent participates or not, and this can depend on the agent's type and the state. The values, $V_i(\theta_i, \omega)$ and $C_i(\theta_i, \omega)$ then are the additional value and cost that an agent gets from participating in the revolution as a function of whether it is successful or fails. Generally, C_i will be negative, but V_i could be positive or negative.

Note that this is strategically equivalent to the following payoff matrix:

$$\begin{array}{ccc} & Success & Failure \\ Participate & V_i(\theta_i,\omega) & -C_i(\theta_i,\omega) \\ NotParticipate & 0 & 0 \end{array}$$

The strategic equivalence is due to the fact that the only thing that motivates an agent to participate is the difference that they experience from participating or not, as a function of whether the revolution is successful or not.

Since V_i can already encode relevant heterogeneity in the population via θ_i, from a strategic perspective only V_i/C_i matters and so it is without loss of generality for the strategic analysis to normalize the model so that $C_i = C > 0$ for all i. We still keep C as a variable, as we wish to consider cases in which a government adjusts the penalties for participating in a failed protest/revolution.

We presume that V_i is symmetric across agents and nondecreasing in θ_i, ω, and increasing in at least one of the two arguments.

Thus, we consider games of the form:

$$\begin{array}{ccc} & Success & Failure \\ Participate & V(\theta_i,\omega) & -C \\ NotParticipate & 0 & 0 \end{array}$$

Let us mention two canonical cases:

2.3.1 (Correlated) Private Values

One case of interest is that of "private-values" so that $V(\theta_i, \omega)$ depends only on θ_i. In this case it is without loss of generality (adjusting distributions) to set $V(\theta_i, \omega) = \theta_i$, and so payoffs are

$$\begin{array}{ccc} & Success & Failure \\ Participate & \theta_i & -C \\ NotParticipate & 0 & 0 \end{array}$$

An interpretation of this case is that each citizen knows how unhappy he or she is with the government - which is the θ_i. Here, the state of the world ω captures how unhappy the overall population is via the distribution of θ_i's. Agents, via Bayes' rule, can infer how unhappy the rest of the world is by inference given that higher states, ω's, lead to a higher distribution over θ_i's. So, if an agent is very unhappy, then she infers that it is likely that ω is high and so it is then likely that other agents are unhappy too.

2.3.2 Common Values

Another case of interest is where $V(\theta_i, \omega)$ depends only on ω. In this case, if preferences are symmetric, then it is without loss of generality (adjusting distributions) to set $V(\theta_i, \omega) = \omega$, and so payoffs are

	$Success$	$Failure$
$Participate$	ω	$-C$
$NotParticipate$	0	0

This case is one in which agents do not really know whether they would like to have a successful revolution – that is governed by a state ω. For instance, agents might not know how competent or corrupt the government really is, or what might replace it. Each agent has a signal θ_i which is some noisy information about the state, and so they must infer ω via Bayes' rule from their own types.

For our purposes, it is not really important which formulation we use as they all have similar effects: agents with higher θ_i's are more optimistic that there is a high payoff from participation and that other agents feel the same. So, they all have the same basic structure of equilibria: agents with types or signals (θ_is) above some threshold participate, and others do not. Thus, we first state that general result, and then we specialize to the model with private values, for a clean and intuitive analysis.

2.4 Strategies and Best Responses

A strategy for player i is a function $\sigma_i : I\!R \rightarrow \Delta(\{0, 1\})$, which specifies a probability of participating, $\sigma_i(\theta_i) \in [0, 1]$, as a (Lebesgue measurable) function of an agent's type.[6]

Let $p_\sigma(\theta_i)$ denote i's beliefs that at least a fraction q of the other agents will participate, conditional on other players playing according to σ and the agent seeing θ_i.

Given the continuum, an agent is never pivotal in determining whether there is a fraction of at least q of the population who participate, and so this is a straightforward calculation.

Then expected payoff to participation is then

$$p_\sigma(\theta_i)E[V_i(\theta_i, \omega)|\theta_i] - (1 - p_\sigma(\theta_i))C,$$

and the payoff from non-participation is 0, and so it is a best response to participate if and only if

$$\frac{E[V_i(\theta_i, \omega)|\theta_i]}{C} \geq \frac{1 - p_\sigma(\theta_i)}{p_\sigma(\theta_i)}. \tag{1}$$

Note that, given the ordering of types and preferences, $\frac{E[V_i(\theta_i,\omega)|\theta_i]}{C}$ is strictly increasing in θ_i.

[6]We work with strategies that are also Lebesgue measurable as a function of the agents' labels. Generally the equilibria will naturally depend only on agents' types and not their labels, and so this is not really a restriction.

2.5 Equilibria

We examine Bayesian equilibria of the game. Later in the paper, when we consider dynamic versions of model, we examine weak perfect Bayesian equilibria, which reduce to Bayesian equilibria in a one-shot game. So, whenever we say 'equilibria' we are referring to weak perfect Bayesian equilibria.

2.6 Existence

As this is a coordination game, there often exist multiple equilibria. For instance, nobody participating is always a strict equilibrium: if none of the other agents participate then the revolution will surely fail and so it is a best response not to participate. However, for non-trivial cases (in which there is enough weight on high types agents that they believe there is a large enough chance that they can be successful), there also exist participatory equilibria.

In particular, we focus on the class of equilibria in which agents play monotone strategies: their probability of participating is non-decreasing in θ_i. Given the increasing preferences and ordering on information, such equilibria always exist. Nonetheless, there do exist other equilibria, although for generic distributions these will be the only equilibria.[7]

Proposition 1 *Symmetric and monotone equilibria exist. Each monotone equilibria can be described by a single threshold t (the same for all agents), such that an agent participates if $\theta_i > t$ and not if $\theta_i < t$. Monotone equilibria are all symmetric up to the possible mixing that occurs at t. Monotone equilibria can be ordered by their thresholds, with ∞ always being an equilibrium threshold.*

This follows from an application of Tarski's fixed point theorem, which establishes that equilibria form a complete lattice, which here is just ordered in terms of the thresholds. Given that the proof is standard, we omit it.

So, we can represent monotone equilibria by thresholds t, such that an agent participates if $\theta_i > t$ and not if $\theta_i < t$. In cases with atoms in the distribution it is possible to have mixing at t.

In what follows, when we say 'equilibrium', we refer to a symmetric monotone equilibrium.

We focus on the most participatory equilibrium, that is with the lowest t.

[7]For an example of a non-monotone equilibrium consider a common values setting with $\omega = 2, 3$ with equal probability and $C = 1$; and such that $\theta_i = \omega$ so that all agents know the state. In this case, there is always a 'best' equilibrium in which all agents participate, and there is a worst equilibrium in which no agents participate. However, there is also a non-monotone equilibrium: There is an equilibrium in which all agents participate if $\theta_i = \omega = 2$ and none participate if $\theta_i = \omega = 3$.

3 A Discrete Private Values World

As we stated above, the main any insights and the workings of equilibria are broadly similar for the private and common values worlds, so we focus on the private values version of the model that captures the most essential features.

Consider a simplified version of the model in which types are either $\theta_H > 0$ or $\theta_L < 0$.

In particular, suppose that either $z > q \geq 1/2$ of the population are θ_H which happens with probability π, which we call the "High" state; or $1 - z < q$ of the population are θ_H, which happens with probability $1 - \pi$, and we call the "Low" state.[8]

If a player is of type θ_H, by Bayes' Rule her conditional probability on the "High" state is

$$\frac{\pi z}{\pi z + (1-\pi)(1-z)}$$

Thus, by (1) there exists an equilibrium where the high types all show up if and only if:[9]

$$\theta_H / C \geq \frac{(1-\pi)(1-z)}{\pi z}. \tag{2}$$

The existence of an equilibrium in which the high types have a high enough belief that they expect a positive payoff from showing up is pictured in Figure 1, as a function of π and z.

We emphasize that there are two requirements in order for there to exist an equilibrium in which high types all participate:

- it must be that $z \geq q$, as otherwise even in the high state there would not be enough high types to be successful, and

- it must be that beliefs of the high types put a large enough weight on the chance of success so that they are willing to participate which is true if and only if $\theta_H/C \geq \frac{(1-\pi)(1-z)}{\pi z}$.

The first constraint is that z lies to the right of the vertical segment at $z = q$ and the second constraint is that π and z are above the level curve at which $\theta_H/C = \frac{(1-\pi)(1-z)}{\pi z}$. If and only if both of these are satisfied does there exists an equilibrium in which high types participate. There always exists an equilibrium in which nobody participates.

[8]The symmetry between the fraction being z and $1 - z$ simplifies calculations, but does not alter the intuition behind any of the results.

[9]At exactly this value, depending on how one models what happens when exactly q people show up, there also exists a mixed strategy equilibria where the high types mix, but it is unstable to slight changes in the preferences as well as mixing, whereas the two pure strategy equilibria of all high types and no high types participating are each stable.

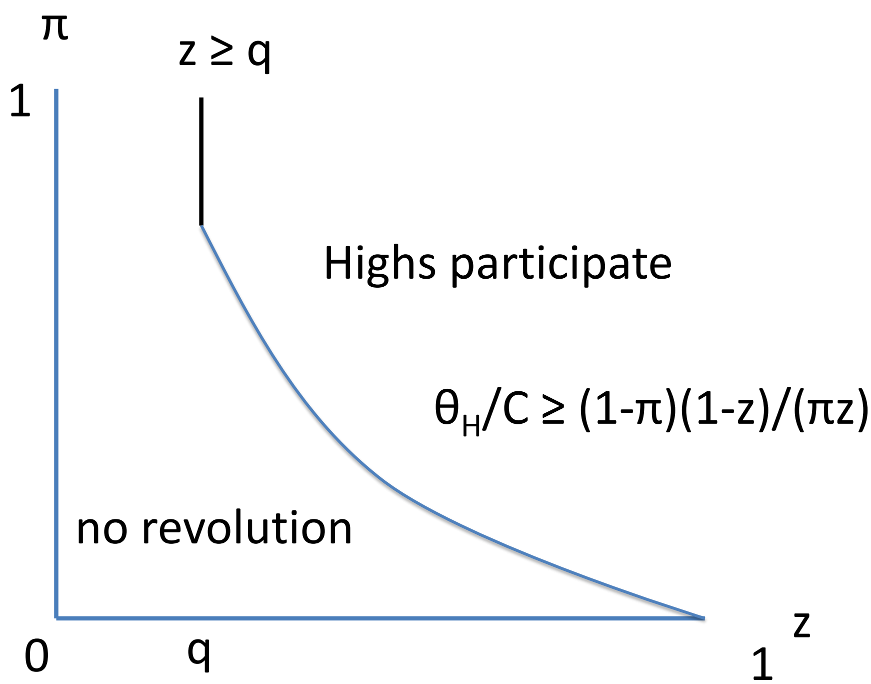

Figure 1: There is an equilibrium in which the high types participate if and only if the prior π and the correlation z are high enough.

The model produces some intuitive comparative statics, that follow directly from equation 2 and are pictured in Figure 2. We see that the range of values of π and z for which there is a revolutionary equilibrium shrinks as we decrease θ_H and/or increase C.[10]

There are high types in either state, and they act based on their beliefs conditional on the fact that they are a high type. So, they know that they still face a chance of failure as it is possible that it will be the low state and there are just not enough high types to succeed.[11] So, high types participate but the revolution still fails whenever it happens to be the low state; and thus the likelihood of success increases as the likelihood of the high state, π, increases. Also, as z increases there is a higher correlation of the high types with the state: there are more high types who show up in the high state when the revolution is successful, and fewer who show up in the low state when the revolution fails.

[10]See Kricheli, Livne, and Magaloni (2013) for evidence that increased costs lead to fewer protests, but ones that are more likely to be successful when they occur.

[11]This is provided $z < 1$, as otherwise (if $z = 1$) types are fully correlated with the state and fully revealing and the analysis becomes trivial.

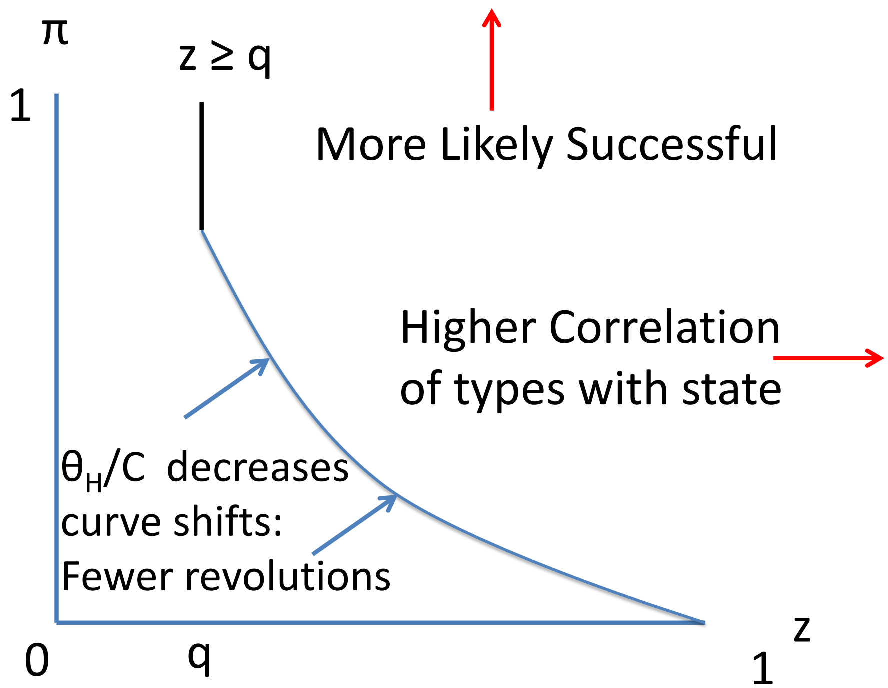

Figure 2: The range of values of the prior belief on the high state, π, and the correlation between types and the state, z, shrinks as the cost of the revolution increases or the value to highs from participating decreases. Also, as π increases, the likelihood of success increases, and as z increases there is a better match of the high types with the state.

4 Dynamics and Information

With the basic model in hand, we now expand to analyze how information affects the possibility of having revolutions.

We begin with the question of what happens when people get to see some information about how others feel about the regime.

4.1 Each Agent See One Other Agent's Type

We first consider what happens if each agent get to see one other agent's type, where that agent is chosen uniformly at random. So, each agent gets to talk to one other agent in the society and learn that agent's type.[12] This provides additional information to the agents, since now they have two signals about the state rather than just one.

[12] Note that it is incentive compatible for agents to tell each other their types, and so it is without loss of generality to simply assume that types are observed when two agents meet.

First note, again, that since $\theta_L < 0$, we only have to analyze the high type's incentives in order to characterize equilibria, since low types never participate.

If a high type sees another agent of a high type, then by Bayes' Rule, the agent's belief that the state is 'High' is

$$\frac{\pi z^2}{\pi z^2 + (1-\pi)(1-z)^2}.$$

If a high type sees that the other agent is a low type, then by Bayes' Rule, the agent's belief that the state is 'High' is

$$\frac{\pi z(1-z)}{\pi z(1-z) + (1-\pi) z(1-z)} = \pi.$$

First, let us consider the case in which the prior belief is so high that even if a high agent meets a low agent, the high agent is still convinced enough of the high state that the agent is willing to go to the revolution. By (1) there exists an equilibrium where the high types show up *regardless of signals* if and only if:

$$\theta_H / C \geq \frac{(1-\pi)}{\pi}. \tag{3}$$

The above condition is more demanding than our previous equilibrium in the absence of any signals, since it is asking whether high types go even when getting another signal which is a low one. Another possibility is that only some of the high types are now willing to show up - those who get to see another high type.

For there to exist an equilibrium in which the high types only show up when they see a high other type, two things are necessary: one is that they are sufficiently convinced of the high state that they are willing to show up: by (1) this requires that

$$\frac{\theta_H}{C} \geq \frac{(1-\pi)(1-z)^2}{\pi z^2}. \tag{4}$$

The second requirement is that there have to be enough of these high types who also see other highs (in the high state) for the revolution to be successful. This requires that

$$z^2 \geq q,$$

since z^2 of high types will see another high type in the High state.

These two different sorts of equilibria are pictured in Figure 3.

Comparing this to the no information case, Figure 4 shows the equilibrium structures for the two settings:

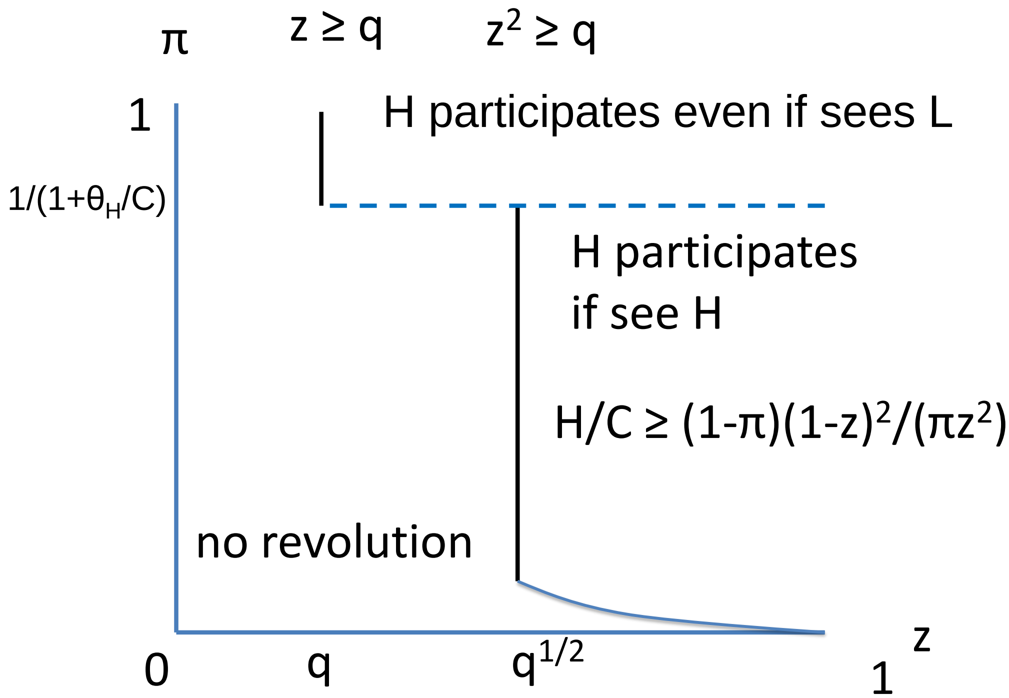

Figure 3: There are two regions of equilibria.

In Figure 5 we see that information helps the revolution when π (the prior prob of the High state) is low and when types are sufficiently correlated with the state and so seeing another high type is very informative. In contrast it hurts the revolution when the correlation between types and the state is lower and so many people can see others that have low signals and become discouraged and so that even types who see others who are high know that too few people will show up for it to be successful.

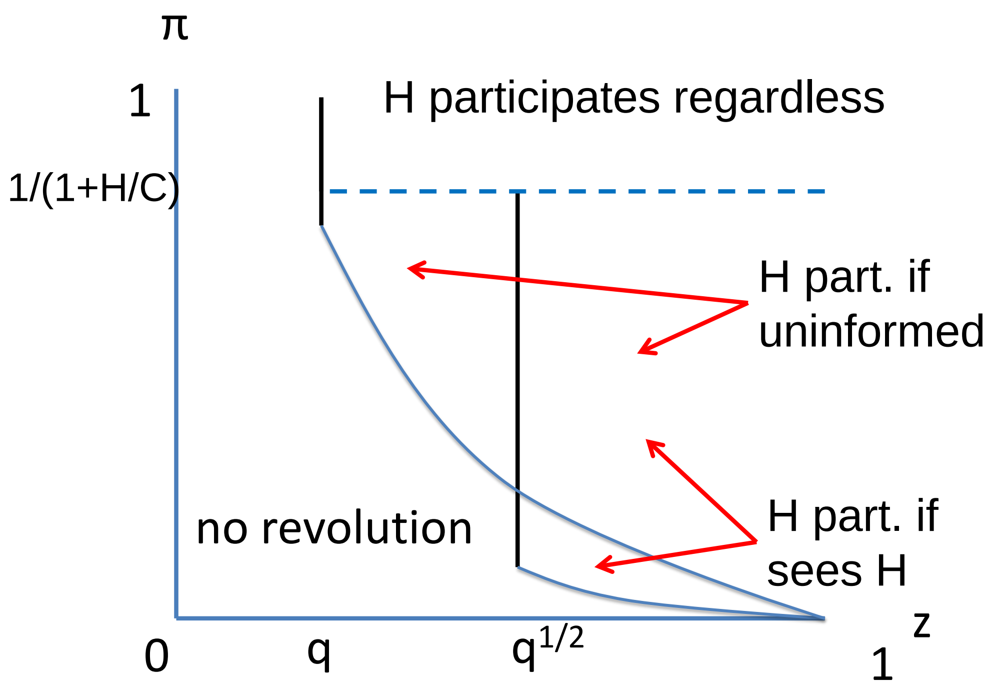

Figure 4: Five different regions: no revolution, always a revolution regardless of what info is, only a revolution if don't see signals, only a revolution if see signals and both are high, revolution if see signals or not - but only high types that see another high show

So, to summarize, we see four different possibilities:

- With a high enough prior on the high state, there exists an equilibrium in which the high types to show up regardless of what they observe from the other type, in which case it would have been an equilibrium for them to show up without seeing another agent's type. Here the equilibrium is the same as not observing anything, as the prior is strong enough so that information does not influence the agents' decisions. This happens if (3) holds (and $z \geq q$). In this case, it also would have been an equilibrium for all high types to show up without any information, and so there is no change in equilibrium structure in this parameter region.

- Next, there is a region in which there was an equilibrium for high types to show up without any information, but with information it is no longer an equilibrium for the high types to show up *even if they see another high type*. Here the equilibrium fails not because those who see two high signals are not convinced enough about the High state, but instead because they know that they are too small a fraction of the society to be successful. Here information is damaging for the high types as it would have been an equilibrium for them to show up if they did not see another agent! In this region

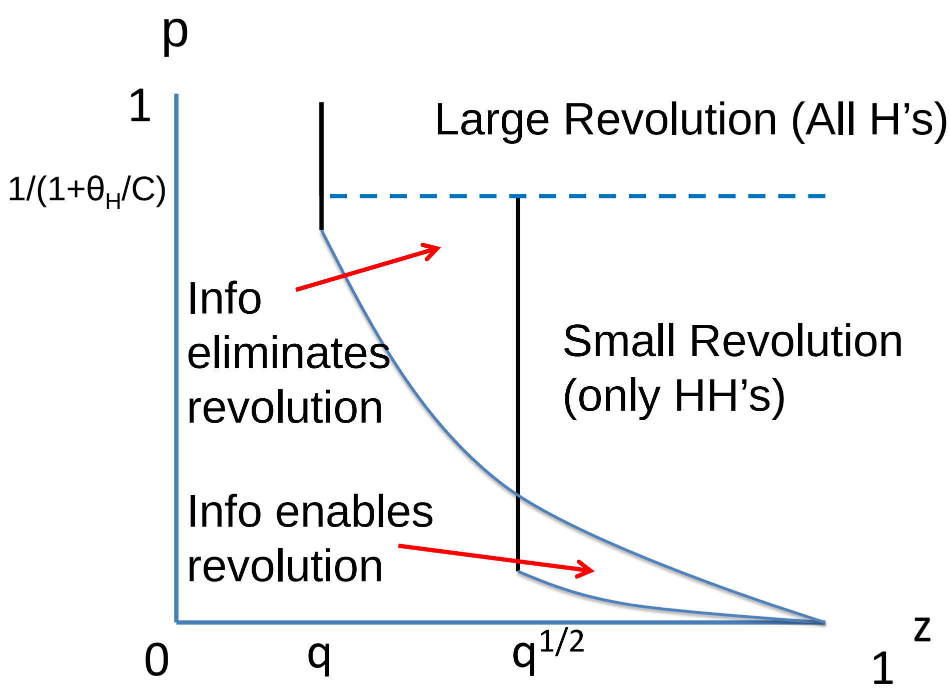

Figure 5: Sometimes information aids the revolution and other times it blocks it

the high types are ex ante worse off and the low types are better off. This happens if $z^2 < q < z$ while (2) holds.

- Next, there is a region in which there is an equilibrium in which the high types show up if and only if they see that the other agent is of the high type. This breaks into two pieces.
  - One part of this region is where it would also have been an equilibrium for them to show up without seeing anything. Here the equilibrium is now changed, as fewer high types show up in the High state and also in the low state, but the revolution is still successful in the high state and not the low. The High types are better off ex ante, and the low types are indifferent. Ex post, some high types are better off and others worse off in this setting than in the no information case, and overall they are better off ex ante. This happens if $z^2 > q$ and (4) holds, as does (2), while (3) do not.
  - The other part of this region in where it is an equilibrium for the high types to show up if and only if they see that the other agent is of the high type, but it would not have been an equilibrium for them to show up without seeing anything. Here the equilibrium is now changed, as seeing the other type enables high types to show up as they are now surer of the state, while without the information they

would not have been able to have a revolution. Again, the High types are better off ex ante, and the low types are worse off. This happens if $z^2 > q$ and (4) holds, while (2) does not.

4.2 Homophily

The previous analysis considers a case in which an individual meets another person chosen uniformly at random from the population. However, as we know, in many contexts people are more likely to interact with others who are similar to each other, not only in some base characteristic, but also in preferences and political views.[13]

To capture this, let us consider a variation on the above setting in which we allow for homophily. A very easy way to adjust the model to include a bias in meetings, is to allow that a fraction $h \in [0,1]$ of matches that would be have been between highs and lows under uniform random are instead with highs matched to highs and lows to lows.

If $h = 0$ then there is no homophily and matching is uniformly random, while if $h = 1$ then highs always meet highs and lows always meet lows.

In terms of information, when $h = 1$, there is no information in a partner's type as it is then the same as the agent's own type regardless of the agent's type. The informativeness of the signal is highest when $h = 0$. However, given the non-monotonicities in equilibrium, the effect of homophily on equilibrium can be ambiguous, as we now show.

In particular, the probability of a θ_H type seeing another θ_H type with homophily $h \in [0,1]$ is $z^2 + z(1-z)h$ in the high state and $(1-z)^2 + z(1-z)h$ in the low state.

This leads to a new constraint for the equilibrium in which a high type is willing to participate if and only if seeing another high type. These are straightforward variations on the previous analysis, just using Bayes' rule. The necessary conditions for an equilibrium (presuming that a θ_H meeting a θ_L type would not participate) are then:

$$\frac{\theta_H}{C} \geq \frac{(1-\pi)[(1-z)^2 + z(1-z)h]}{\pi[z^2 + z(1-z)h]},$$

and

$$z^2 + z(1-z)h \geq q.$$

Note that the second inequality gets easier to satisfy as h increases, while the first one gets harder to satisfy as h increases: this is the tradeoff as homophily is increased. Homophily decreases information, making the individual incentive to participate harder to satisfy, but also leads to fewer agents who are discouraged by meeting low types. Which effect dominates depends, again, on the relative prior and correlation of types with the sate.

This leads to the adjustment in the equilibrium structure as pictured in Figure 6:

[13] For background on this empirical observation, termed "homophily", see McPherson, Smith-Lovin and Cook (2001) and Jackson (2008).

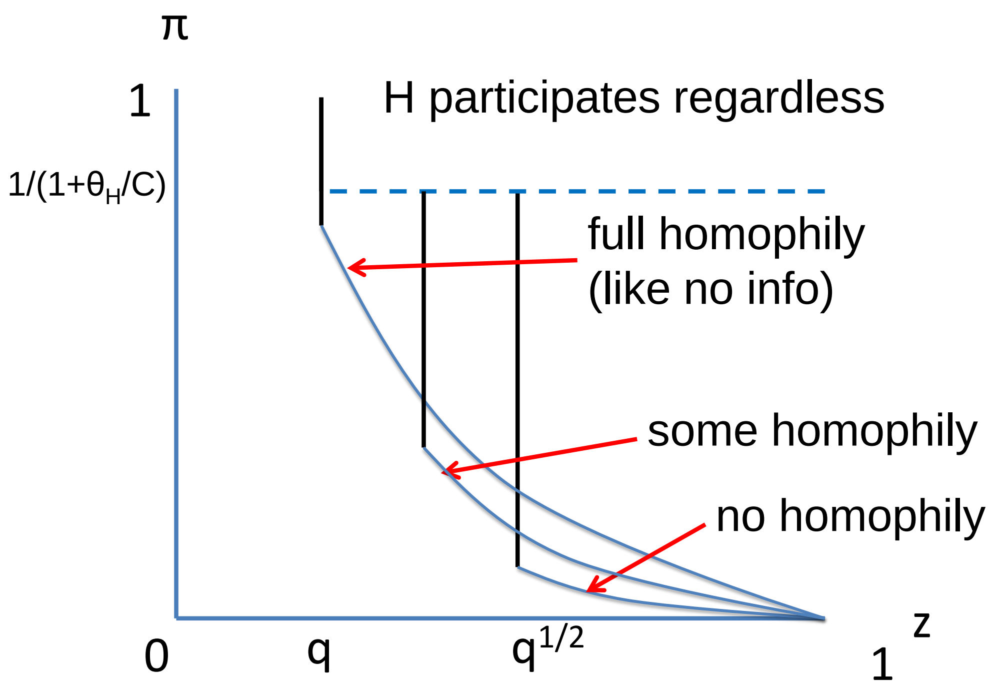

Figure 6: Homophily (assortativity in meetings) changes the equilibrium structure.

So, we see that higher homophily increases the region of having a revolution if the prior is high enough, since more highs will see high signals and be willing to join, but higher homophily reduces the region for low priors and high z since it decreases the information contained in a meeting.

4.3 Seeing Many Other Agents' Types

Next, we consider what happens in the same setting when agents get to see many other randomly chosen agents' types.

PROPOSITION **2** *For any $z \geq q$, π, and θ_H/C, there exists a number of signals above which there is an equilibrium which involves protests conditional upon sufficient fraction of high types being observed. Moreover, as the number of others observed increases, the fraction of high types participating in the 'High state goes to 1 and the fraction of high types participating in the 'Low state goes to 0: the protest is perfectly effective in the limit.*

In the proposition, by the law of large numbers agents will eventually be sure of the state, and so there exists an equilibrium in which agents who are high types show up whenever their posterior is above a threshold, and in the limit they are almost always successful.

The interesting aspect, putting this result together with our analysis of just seeing one other agent's type, is that information can be non-monotonic: small amounts of information can be disruptive, while large enough amounts of information are always enhancing.

As such, we might expect that technological advances that allow agents to learn about the opinions of greater numbers of others to eventually lead to more accurate demonstrations. As people learn about greater number of others the correlation of the size of the demonstration with the state will increase. This is consistent with empirical background on this sort of effect, as in Breuer, Landman and Farquhar (2012) and Farrell (2012), as well as Manacorda and Tesei (2016), Pierskalla and Hollenback (2013), and Steinert-Threlkeld, Mocanu, Vespignani and Fowler (2015).

Demonstrations of nontrivial size may become more or less frequent depending on the parameter region, but then much more likely to be successful when of large size. We can solve for some aspects of the equilibrium in more detail.

An individual now gets to see m random other individuals' types. We now can see how many signals they must see before they are willing to participate.

Let t be the threshold so that if at least t other high types observed, then they are willing to participate.

There are two constraints that need to be satisfied in order to have an equilibrium where some people participate. One is that some agents end up with high enough beliefs that it is the high state. The other is that enough of them participate to be successful. So, collective action is feasible only if these threshold intervals overlap.

Let us examine first the lower bound $\underline{t}(m)$ on the threshold that can convince an agent to participate.

If a player is of type θ_H and sees t out of m other high types, then the conditional probability on the state that z of the population are of the high type is

$$\frac{\pi b(t+1,m+1,z)}{\pi b(t+1,m+1,z)+(1-\pi)b(t+1,m+1,1-z)}$$

where $b(t,m,z)$ is the binomial probability of seeing t positives out of m trials that are positive with probability z. So to get an agent to act (presuming the agent expects success conditional upon the high state) requires:

$$\theta_H/C \geq \frac{1-p_i}{p_i} = \frac{(1-\pi)b(t+1,m+1,1-z)}{\pi b(t+1,m+1,z)} = \frac{(1-\pi)(1-z)^{2t+1-m}}{\pi z^{2t+1-m}}.$$

Solving this with equality allows us to deduce $\underline{t}(m)$

$$\underline{t}(m) = \frac{m-1}{2} + \frac{\log\left(\frac{\theta_H \pi}{1-\pi}\right)}{2C\log\left(\frac{1-z}{z}\right)}.$$

Next, we solve for $\overline{t}(m)$. In order to have the fraction of agents who show up be at least q conditional upon the high state it must be that

$$(1-B(t-1,m,z))z \geq q,$$

where $B(t-1,m,z)$ is the cdf of the binomial distribution (so the probability that there are $t-1$ or fewer other high types out of the m observed when drawn with probability z).

Thus,[14]

$$\bar{t}(m) = B^{-1}_{m,z}\left(1 - \frac{q}{z}\right) + 1.$$

Note that in the limit, $\bar{t}(m) \to zm$, while $\underline{t}(m) \to m/2$, and so eventually $\bar{t}(m) > \underline{t}(m)$.

As a numerical example, let $z = 2/3$ and $q = 1/2$ $\theta_H\pi/[C(1-\pi)] = .8$. Here the non-montonicity of information is clear: we have an equilibrium with high types participating if $m = 0$ or if $m = 2$, but *not* if $m = 1$.

4.4 Extremists

The result from Proposition 2 – that sufficiently many observations of other agents' types eventually enables revolutions and their success – depends on what people expect to happen after the revolution.[15]

To explore the potential conflict after a revolution, and its potential effect on the revolution, let us consider the following variation on our previous setting.

Suppose that there are now three types: θ_L support the government and never want to participate, θ_M are moderates who will support a revolution, but only if they are the majority of the revolutionaries and get to impose a moderate government after a successful revolution; and extreme types θ_E, who want a revolution whenever it would be successful regardless of the next government.[16] In particular, participating moderate agents get θ_M if the revolution is successful and there are more moderates than extremists, and get $-C$ otherwise. Extremists get θ_E if the revolution is successful and they outnumber moderates, $\alpha\theta_E$ if the revolution is successful and moderates outnumber extremists, and $-C$ if it fails.

In particular, moderate types prefer to participate in the revolution only if the fraction of moderate and extreme types exceeds q, but *also* only if the fraction of moderates exceeds the fraction of extreme types.

The state ω is a list, $\omega(\theta_L), \omega(\theta_M), \omega(\theta_E)$, of the fractions of the population that are of the corresponding types.

There are three states $\omega \in \{\omega^L, \omega^M, \omega^E\}$:

- Low state: $\omega^L(\theta_M) + \omega^L(\theta_E) < q$, so the revolution will fail even if moderates and extremists participate.

[14] Here, the inverse of B is rounded downwards, so it is the largest value of t for which $B(t-1,m,z) < 1-\frac{q}{z}$, which then assures that t is the smallest values for which the chance that at least t high types are observed is at least q/z.

[15] See Shadmehr (2015) for an analysis of an endogenous agenda as part of a revolution. Our example here presumes that there is no ability to commit to what will happen after the revolution.

[16] See Acemoglu, Hassan, and Tahoun (2015) for a description of conflicts between different revolutionary groups during the Arab Spring.

- Moderate state: $\omega^M(\theta_M)+\omega^M(\theta_E)$, but $\omega^M(\theta_M) < q$ and $\omega^M(\theta_E) < q$ (so the revolution will succeed if and only if both moderates and extremists participate), and moderates outnumber extremists, $\omega^M(\theta_M) > \omega^M(\theta_E)$.

- Extreme state: $\omega^E(\theta_M) + \omega^E(\theta_E) \geq q$, but $\omega^E(\theta_M) < q$ and $\omega^E(\theta_E) < q$ (so the revolution will succeed if and only if both moderates and extremists participate), and extremists outnumber moderates $\omega^E(\theta_M) < \omega^E(\theta_E)$.

There are different equilibrium possibilities depending on the prior probabilities of the states, π^L, π^M, π^E. Here we focus on the case without communication, although the extension to communication is straightforward and parallels that above.

In order for a revolution to be possible, it must be that the moderates place a high enough probability on the moderate state (conditional on being a moderate), while the extremists place a high enough probability on both the moderate and the extreme state. In particular, it is straightforward to check that the necessary conditions for having a revolution are that

$$\theta_M/C \geq \frac{\pi^L\omega^L(\theta_M) + \pi^E\omega^E(\theta_M)}{\pi^M\omega^M(\theta_M)}.$$

and

$$\theta_E/C \geq \frac{\pi^L\omega^L(\theta_E)}{\alpha\pi^M\omega^M(\theta_E) + \pi^E\omega^E(\theta_E)}.$$

This can allow a revolution to take place in both the moderate and extreme case, provided the prior on the moderate state is high enough relative to the extreme state for the moderates. However, once information becomes stronger, the moderates might no longer participate in the extreme state - or at least most of them will not, and so there is no longer a successful revolution in the extreme state. Again, information could be disruptive to the revolution.

5 Dynamics: A Two-Period Version of the Model

So far we have examined information revelation as agents meet some other people from the population. Another important informational channel is having mass demonstrations in which agents protest. These can be important precursors to a strike or revolution as they signal information in a much broader and more revealing way than people just seeing the preferences of a few friends.

5.1 The Informational Role of Demonstrations before a Revolt

To study the role of demonstrations, we enrich the model so that there are two periods and three types. The types are $\theta_L, \theta_M, \theta_H$ - but this is different from the previous example with the revolutionary extremists. Now the values are purely private, and the highest value types simply are more disadvantaged by the current government, and both the moderates types would also prefer to overthrow the government if it is possible, but are harder to convince to join the revolution since they are not as dissatisfied as the extremists.

There are two states. In the 'High' state $1-z$ of the population are θ_L and $z/2$ are θ_M and $z/2$ are θ_H, while in the 'Low' state z of the population are θ_L and $(1-z)/2$ are θ_M and $(1-z)/2$ are θ_H.

So, this is exactly the same as our first model, except that we have split the 'high' types equally into moderates and highs. This allows us to see the value of having protests before the revolution.

So, there is a first period in which the population can hold a demonstration, and the a second period in which they can hold the revolution. They can skip the first period if they wish, but it signals information about the state.

Let the cost of having participated in a protest or revolution if the revolution is not ultimately successful depend on the period, and for the first period be c and the second period be C.

Let us consider a case in which

$$\frac{\theta_M}{C} < \frac{(1-\pi)(1-z)}{\pi z},$$

but $z \geq q$.

So, without any additional information, the moderates are too frightened/pessimistic to participate in the revolution.

However, note that if

$$\frac{\theta_H}{c} \geq \frac{(1-\pi)(1-z)}{\pi z},$$

then it is possible to have the revolution.

The highs are willing to demonstrate in the first period. If $z/2$ of them show up, then the moderates learn that it is the high state and the revolution takes place in the second period. If only $(1-z)/2$ of them show up in the first period, then the demonstration is a failure and there is no revolution in the second period.

This illustrates the possibility of having successive demonstrations, where people learn about how many people are dissatisfied by observing the size of the turnout, and more extreme individuals protest earlier, enabling more moderate types to assess the state and join later if things look strong enough.

5.2 The Difference Between Polls and Demonstrations

One question that we have not yet addressed, but is important, is why one needs demonstrations at all in a world where people can hear about how others feel via polls and/or social media. In the above example, why do they still need to turn out at a demonstration in order to convince the population to revolt rather than just expressing their preferences in a poll or on some social platform?

The answer is that demonstrations involve costs - and so agents must be sufficiently willing to participate to overcome those costs. Having many agents willing to pay those costs can signal to others that there is enough of the population willing to take costly action, that the revolution has a chance of succeeding. In contrast, polls and social media may involve much lower costs, and so agents simply saying that they support change does not indicate that they would be willing to act if needed. This is illustrated in the following example.

Suppose that payoffs are of the following form:

	Success	*Failure*
Participate	θ_i	$-C$
NotParticipate	a_i	0

Here, agents who have $a_i > 0$ and $\theta_i > -C$ would like to see the revolution succeed. However, those who have $a_i > \theta_i$ have a dominant strategy not to participate. These are non-activist people who prefer to have others participate, but still would like to see change.

In this sort of setting, if one holds a poll to see who favors change, the agents who have $a_i > \theta_i > -C$ and $a_i > 0$ will say that they favor change. However these people cannot be counted upon to show up for the revolution when it is needed. Thus, the poll does not differentiate between people who favor change and those who support it enough to do something about it. In contrast, a demonstration can be costly to show up for, and so can screen out the non-activists and give a more accurate assessment of agents who are willing to act for change.

Thus, demonstrations can be essential for successful further action and change in ways that polls and other sorts of media posting and cheap-talk might not.[17]

5.3 The Arab Spring

Another variation on the above example is one in which there are not two periods, but instead two correlated countries. If one country has a large enough turnout in its revolution, then other country's population may learn about their own state and revolt as well.

Let us consider our original setting, but the only difference is that there are now two countries. The have the same probability of a high state, designated by π, but differ in the value and costs to high types, and the correlation of types with the state. We use the obvious notation: $(\theta_{H1}, C_1, z_1, q_1), (\theta_{H2}, C_2, z_2, q_2)$

The states of the two countries are correlated, with the correlation in High states being $\rho \geq 0$. In particular, the probability of the high or low states for the respective countries are

[17] Note that in a very repressive regime - that penalizes people who even say they support change - then it would be possible for that to provide a costly signal. However, that would only work if sufficiently many people are able to express their opinions, and such very repressive regimes may also censor information about any opposition.

given by:

$$\begin{array}{ccc} & High-2 & Low-2 \\ High-1 & \pi^2+\rho\pi(1-\pi) & \pi(1-\pi)(1-\rho) \\ Low-1 & \pi(1-\pi)(1-\rho) & (1-\pi)^2+\rho\pi(1-\pi) \end{array}$$

Let us suppose also that $z_1 \geq q_1$ and $z_2 \geq q_2$, so that both countries can have successful revolutions in their respective high states.

Suppose that

$$\theta_{H1}/C_1 \geq (1-\pi)(1-z_1)/(\pi z_1)$$

but

$$\theta_{H2}/C_2 \geq (1-\pi)(1-z_2)/(\pi z_2).$$

This is a world in which country 1 is sufficiently unhappy, or convinced of the high state, that a revolution is possible for that country on its own, while country 2 fails to satisfy that constraint, and so would only be willing to revolt if they are sufficiently convinced. In fact, the data on the Arab Spring collected by Brummitt, Barnett, and D'Souza (2014), who find a significant correlation between the unemployment rate in countries and the date of first protest (e.g., Tunisia had higher unemployment than Egypt than Syria, and the first date of protests occurred in that order - and they analyze fifteen countries in total).

In this case, if the country 1 holds its demonstration/revolution, then country 2 can learn about the state, provided there is sufficient correlation.

In particular, some direct calculations of the posterior conditional on success in country 1 (together with the appropriate variation of (2)) shows that if

$$\rho > (C_2(1-z_2)/(z_2\theta_{H2})\pi)/(C_2(1-z_2)/(z_2\theta_{H2})+1),$$

then there will be contagion.

6 The Government

A government can change the world from being one in which there is an equilibrium with a revolution to one in which there is not, by affecting the various parameters.[18]

6.1 Costs

Most directly, by increasing the cost to failed revolutionaries (increasing C), the government can make the conditions for a revolution harder to satisfy. For instance, in the base model,

[18] For important analyses of governments and propaganda as well as censoring and other informational distortions in models that are very different from ours, see Edmond (2013) as well as Egorov, Guriev, and Sonin (2009), Little (2012), and King, Pan and Roberts (2013).

it is sufficient to raise C to a point at which

$$\theta_H/C < \frac{(1-\pi)(1-z)}{\pi z}$$

to avoid the revolution. Correspondingly, there are values of C that prevent revolution for different levels of information.

6.2 Propaganda

The government could also bias information via propaganda. Propaganda is interesting in that it does not have to convince all of the potential revolutionaries that revolution is a bad idea or that the state is low, but instead it just needs to convince enough of them so that the remaining types know that they will no longer have sufficient numbers to be successful. For instance, if more than $z-q$ of the potential revolutionaries are convinced by the propaganda, then the revolution cannot succeed, regardless of whether the remaining high types are convinced or not.

Thus, propaganda can be disruptive even if it only convinces a small subset of the population that they should not take part in a revolt. This could happen by convincing people that they stand no chance of success, for instance, by inflating the estimates of how many θ_L types there are in the population; or by convincing people that they are better off than they are, or better off than what would happen after a revolultion, etc.

6.3 Redistribution

Finally, the government could also redistribute resources. Again, the government does not have to redistribute resources to all of the potential revolutionaries, they simply need to buy enough of them off to discourage the rest - so they just need to please $z-q$ of the high types. They can produce some very unhappy parts of the population, provided that they make the middle range sufficiently happy that they will no longer revolt.

Specifically, suppose that redistribution by the government is observable and that the government knows the state (so it knows the condition of the whole population). Thus, whenever the government does redistribute income, then the population knows it is the high state. So, it is clear that in that case they must pay at least θ_H to $z-q$ to avoid the revolution. The equilibrium, must be one in mixed strategies. To see this note that if it were a pure strategy equilibrium, then it would be one in which the government only redistributed in the high state. But then when seeing no redistribution, agents would infer it is the low state and not revolt, In that case, the government would not need to redistribute in order to avoid the revolution. Thus, the redistribution must be in mixed strategies. In order for this to make sense with a continuum of agents, we then allow agents to correlate their strategies, so that high types revolt with some probability p when not seeing redistribution. The probability of redistribution is then just enough to make agents indifferent conditional on seeing no redistribution, and the probability of revolt is just enough to keep the government indifferent between being overthrown and paying the redistribution.

7 Concluding remarks

We have provided a model that serves as a basis for the investigation of how information and learning affect the possibility of having successful revolutions. We have shown that there are non-monotonicities so that small amounts of information can actually discourage enough of the population to make success impossible. We have also shown how demonstrations can provide important information, both within and across countries, that can help make revolutions possible, and increase the likelihood of their success.

References

ACEMOGLU, Daron; Tarek A. HASSAN and Ahmed TAHOUN (2014). ”The Power of the Street: Evidence from Egypt's Arab Spring”. Mimeo.

ANGELETOS, George-Marios; Christian HELLWIG and Alessandro PAVAN (2007). ”Dynamic Global Games of Regime Change: Learning, Multiplicity, and the Timing of Attacks”. *Econometrica*, 75(3), 711-756.

BANERJEE, Abhijit V. (1992). ”A Simple Model of Herd Behavior”. *The Quarterly Journal of Economics*, 107(3), 797-817.

BIKHCHANDANI, Sushil; David HIRSHLEIFER and Ivo WELCH (1992). ”A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades”. *The Journal of Political Economy*, 100(5), 992-1026.

BIKHCHANDANI, Sushil; David HIRSHLEIFER and Ivo WELCH (1998). ”Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades”. *The Journal of Economic Perspectives*, 12(3), 151-170.

BREUER, Anita; Todd LANDMAN and Dorothea FARQUHAR (2015). ”Social Media and protest Mobilization: Evidence from the Tunisian Revolution”. *Democratization*, 22(4), 764-792.

BRUMMITT, Charles D.; George BARNETT and Raissa M. D'SOUZA (2015). ”Coupled Catastrophes: Sudden Shifts Cascade and Hop among Interdependent Systems”. *Journal of the Royal Society Interface*, 12(112), 1-12.

BUENO DE MESQUITA, Ethan (2010). ”Regime Change and Revolutionary Entrepreneurs”. *American Political Science Review*, 104(3), 446-466.

CHWE, Michael Suk-Young (2000). "Communication and Coordination in Social Networks". *Review of Economic Studies*, 67, 1-16.

EDMOND, Chris (2013). "Information Manipulation, Coordination, and Regime Change". *Review of Economic Studies*, advanced access.

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), 645-668.

FARRELL, Henry (2012). "The Consequences of the Internet for Politics". *Annual Review of Political Science*, 15, 35-52.

FELDMAN, Mark and Christian GILLES (1985). "An Expository Note on Individual Risk without Aggregate Uncertainty". *Journal of Economic Theory*, 35, 26-32.

GRANOVETTER, Mark (1978). "Threshold Models of Collective Behavior". *The American Journal of Sociology*, 83(6), 1420-1443.

JACKSON, MATTHEW O. Jackson M.O. (2008). *Social and Economic Networks*, Princeton, NJ: Princeton University Press.

JUDD, Kenneth L. (1985). "The Law of Large Numbers with a Continuum of IID Random Variables". *Journal of Economic Theory*, 35, 19-25.

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), 326-343.

KRICHELI, Ruth; Yair LIVNE and Beatriz MAGALONI (2011). "Taking to the Streets. Theory and Evidence on Protests under Authoritarianism". Mimeo, Stanford University.

LITTLE, Andrew T. (2012). "Elections, Fraud, and Election Monitoring in the Shadow of Revolution". *Quarterly Journal of Political Science* 7, 249-283.

LOHMANN, Susanne (1993). "A Signaling Model of Informative and Manipulative Political Action". *The American Political Science Review* 87(2), 319-333.

LOHMANN, Susanne (1994a). "Information Aggregation Through Costly Political Action". *The American Economic Review*, 84(3), 518-530.

LOHMANN, Susanne (1994b). "The Dynamics of Informational Cascades: The Monday Demonstrations in Leipzig, East Germany, 1989-91". *World Politics*, 47(1), 42-101.

LOHMANN, Susanne (2000). "Collective Action Cascades: An Informational Rationale for the Power in Numbers". *Journal of Economic Surveys*, 14(5), 655-684 .

McPHERSON, M. SMITH-LOVIN, L. and J.M. COOK (2001), "Birds of a feather: Homophily in social networks," *Annual Review of Sociology*, 27, 415-444.

MILGROM, Paul (1981). "Good News and Bad News: Representation Theorems and Applications," *Bell Journal of Economics*, 12, 380 - 391.

MANACORDA, Marco and Andrea TESEI (2016). "Liberation Technology: Mobile Phones and Political Mobilization in Africa". Mimeo.

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), 207-224.

SHADMEHR, Mehdi (2015). "Extremism in Revolutionary Movements". *Games and Economic Behavior*, 94, 97-121.

STEINERT-THRELKELD, Zachary C.; Delia MOCANU; Alessandro VESPIGNANI and James FOWLER (2015). "Online Social Networks and Offline Protest". *EPJ Data Science*, 4(1), 1-9.

Appendix

Equilibria for Continuous Distributions Consider a canonical case in which θ_i distributed with mean ω plus some noise ε_i, where ε_i is distributed according to H.[19]

$$\theta_i = \omega + \varepsilon_i.$$

In this case, the probability of success is $1-G(t-H^{-1}(1-q))$. This follows since it must be that the fraction of people with $\omega+\varepsilon_i$ below t less than $1-q$. So, $H(t-\omega)$ must be at most $1-q$, and so ω must at least $t-H^{-1}(1-q)$. The probability of that is $1-G(t-H^{-1}(1-q))$.

Thus, in the case of private values an equilibrium t satisfies (assuming no atoms in the distributions and an interior t):

$$t = \frac{G(t-H^{-1}(1-q)|\theta_i = t)}{1-G(t-H^{-1}(1-q)|\theta_i = t)}.$$

Note that by Bayes' rule, if H and G have densities, h and g, then

$$G(\omega'|\theta) = \frac{\int_{-\infty}^{\omega'} h(\theta-\omega)g(\omega)d\omega}{\int_{-\infty}^{\infty} h(\theta-\omega)g(\omega)d\omega}.$$

Then a common values equilibrium is characterized by

$$\int \omega' dG(\omega'|t) = \frac{G(t-H^{-1}(1-q)|\theta_i = t)}{1-G(t-H^{-1}(1-q)|\theta_i = t)}.$$

[19]So, $F_\omega(\theta) = H(\theta-\omega)$.