Why Are Contemporary Political Revolutions Leaderless? An Agent-Based Explanation

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Abstract. Modern revolutions, like the recent uprisings in the so-called Arab Spring, seem to be organized by social network technologies and characterized by a lack of a strong political leadership. This feature is in sharp contrast with the previous historical revolutions, often shaped by charismatic figures. The present paper provides an explanation for this radical change into an agent-based framework: simulations show that, without the use of social media, influential leaders are necessary to obtain a huge mass mobilization whereas, in the presence of a social network, it is possible to accomplish this result without the need of a strong political leadership.

Keywords: Political revolutions · Arab Spring · Political leadership · Social network technology · Agent-based modeling

1 Introduction

One of the main aspects of the recent wave of revolutions in the so-called Arab Spring is the absence of a strong political leadership, substituted by an intensive use of social network technologies as a mean to obtain mass mobilization, as noted by Hussain and Howard (2013). This evidence is in sharp contrast with the previous historical experience: in fact, charismatic figures, like Robespierre, Lenin, Mao and Khomeini, have shaped the major revolutions in History.[1] The present paper tries to provide an explanation for this radical change into an agent-based framework.

In particular, this paper presents a model in which a subjugated population of agents decides to rebel or not against a central authority. This decision is made under two different settings: in the absence of a social network, with and without charismatic leaders, in one case; and in the presence of a social network, in the other case. The simulations of the model show that, without the use of social media, influential leaders are necessary to obtain a huge mass mobilization

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[1] Goldstone (2001, pp. 156-158) reviews the main theories about the role of political leadership in different revolutions.

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while, in the presence of a social network, it is possible to observe such a result without the need of a strong political leadership.

The rest of the paper is organized as follows: next section presents a brief survey of the main sociological and economic theories about revolutions as well as the agent-based models that are more related to the present paper; Section 3 describes the details of the model; Section 4 presents the main results emerging from the simulations of the model; finally, Section 5 concludes.

2 Literature Review

For decades the most popular sociological theories of revolution were the Marxian theory (Skocpol, 1979) and the relative deprivation theory (Davies, 1962): the former emphasizes the role of changes in production methods in generating discontent and rebellion while the latter focuses on the gap between expectations and realized economic performances to explain the sense of frustration and, consequently, the riot participation. Both of them establish an automatic link between the structural conditions that generate grievance in the society and the likelihood of revolutions. Moreover, in both theories the participation in revolutionary episodes is motivated by a collective good argument, such as the desire to change the oppressive social order.

By contrast, Tullock (1971) develops an economic approach to explain the participation in revolutions: since the benefit of an extra unit of public good is small relative to the cost of obtaining it through the participation in a rebellion, individuals decide to participate or not according to their private gains or losses. Silver (1974) provides a classification of revolutions based on Tullock's theory. Moreover, Kuran (1989) criticizes the idea of an automatic relationship between social grievance and revolution, arguing that most historical revolutions were unanticipated. He provides an explanation based on the observation that people who dislike their government tend to conceal their political preferences as long as the opposition seems weak. For this reason, regimes that appear absolutely stable might see their support vanish immediately after a slight surge in the opposition's size, even if caused by nearly insignificant events. Furthermore, in line with Kuran's theory, Rubin (2014) argues that cascades of preference revelation are more likely to happen after a big shock in highly centralized regimes because in these political systems citizens have higher incentives to falsify their true political opinions in order to avoid economic or legal sanctions imposed by the central authority.

There are also some game theoretic papers that analyze the economic causes of political change: for instance, following Acemoglu and Robinson's (2001) model of the economic origins of democracy, Ellis and Fender (2011) derive conditions under which democracy arises peacefully, when it occurs after a revolution and when oligarchic governments persist.

Finally, this paper is also greatly influenced by Granovetter's (1978) theory about threshold models of collective behaviors and by Epstein's (2002) agent-based model of civil violence. According to Granovetter, individuals face many situations with multiple alternatives and the costs and benefits associated to the different alternatives depend on how many other individuals have chosen which alternative. For this reason, each individual has a personal threshold and decides to join a collective action, like a riot or a strike, if the number of people who already participate exceeds this threshold. Following this idea, Epstein develops an agent-based model of civil violence in which agents decide to rebel against the government if their level of grievance corrected by the risk of being arrested is higher than their personal threshold. Moreover, Makowsky and Rubin (2013) develop an agent-based model to study how social network technology fosters preference revelation in centralized societies: they show that the presence of a social network makes more likely the destabilization of an autocratic regime and this is the reason why centralized governments attempt to restrict information flows via the media.

3 The Model

The population of agents interacts in a bidimensional torus space and the results of this interaction are followed over time.

Each agent i is endowed with two time-invariant characteristics: a value for the grievance g_i, drawn from a uniform distribution on the $[0, 1]$ interval, and a value for the ability to persuade other agents to rebel, which measures the influential power of the agent, denoted by p_i and drawn again from a uniform distribution on the $[0, 1]$ interval.

Following Granovetter (1978) and Epstein (2002), at each time agents decide to be quiet or active, i.e., to rebel or not against the central authority, according to a threshold-based rule. In the present model, the activation rule involves: i) the level of grievance g_i; ii) the average persuasion agent i is exposed to, indicated with $\bar{p}_{it}$, which depends on the persuasion abilities of the other rebellious agents in the neighborhood, but also on the presence of charismatic revolutionary leaders or on the availability of a social network technology; iii) finally, a deterrence term represented by the probability of being arrested P_{t-1}, which is determined by the aggregate behavior of agents in the previous period.

Combining these quantities, the decision rule can be defined: agent i becomes active if and only if inequality

$$g_i + \beta\bar{p}_{it} - \gamma P_{t-1} > \tau \quad (1)$$

holds, where β, γ and τ are positive parameters. This formula simply states that the likelihood that a player joins the rebellion is positively influenced by the level of personal grievance and by the average intensity of pro-revolutionary propaganda this player is subject to, whereas it is negatively associated to the repression faced by agents in the previous period.

The average persuasion each agent can be exposed to is the result of three potential sources. The first of them is the presence of already active agents in the neighborhood. The neighborhood includes the lattice positions within the vision radius of agents, whose length is parametrized by υ: assuming a radius vision equal to one, each agent has four neighbors, in the north, east, south and west position, respectively. The second source is represented by the presence of revolutionary leaders in the neighborhood: this second type of players is characterized by an extraordinary high persuasion ability, indicated by p^l, taking a much higher value compared to the average persuasion of the population of agents. Moreover, leaders are always active, except when they are in jail, as it will be explained below. Finally, the third source of propaganda is the social media technology: in some model simulations, it is assumed that a fraction of agents is connected to a social network and, consequently, it is subject to the persuasion of the other connected rebellious agents, no matter their geographical location. Consequently, the general expression for the average pro-revolutionary persuasion is:

$$\bar{p}_{it} = \frac{\sum_{j \in (N_{it} \cup \bar{N}) \cap A_t} p_j + n_{N_{it} \cap L_t} p^l}{n_{(N_{it} \cup \bar{N}) \cap A_t} + n_{N_{it} \cap L_t}} \tag{2}$$

in which N_{it} is the set of players that are neighbors of agent i at time t, $\bar{N}$ is the set of agents connected to the social medium, A_t is the set of active agents, L_t is the set of active revolutionary leaders, $n_{(N_{it} \cup \bar{N}) \cap A_t}$ is the number of active agents that are neighbors of agent i or they are active agents connected to the social network, and, finally, $n_{N_{it} \cap L_t}$ is the number of active leaders that are neighbors of agent i. The set of neighbors N_{it} is time-varying because agents and leaders can move to an empty random position within their vision radius in each period. On the other hand, the set of connected agents $\bar{N}$ is assumed to be fixed over time: in fact, at the beginning of each simulation, agents are assigned to the social network with a probability equal to c. Therefore, this last parameter measures the degree of connectivity of the society. The two sets of active players, A_t and L_t, are time-varying because active agents and active leaders can be arrested and because agents can turn from quiet to active and vice versa.

In any period t the probability of arrest for a single active player is a decreasing function of the fraction of rebel forces to the overall population:

$$P_t = \frac{exp\left[-\phi(\frac{n_{A_t}+n_{L_t}}{n_a+n_l})\right]}{1 + exp\left[-\phi(\frac{n_{A_t}+n_{L_t}}{n_a+n_l})\right]} \tag{3}$$

where n_{A_t} is the number of active agents in the population at time t, $n_{L_t}$is the number of active leaders, n_a and n_l are the numbers of agents and leaders, respectively, in the population, and ϕ is a positive constant; the logistic transformation ensures that the probability lies inside the $(0, 1)$ interval: more precisely, it starts with a value equal to 0.5, when there are no active players, and it decreases up to a value close to zero when a huge rebellion takes place. This expression captures the fact that the arrest probability of a single revolutionary is higher when there are few active players and it declines when more agents decide to join the rebellion, as in Epstein (2002): in fact, if the repression capacities of a state, like the number of cops, are fixed, it is more difficult to arrest a single active agent in a crowd of rebels than when this specific agent protests in isolation. If an agent or a leader is arrested, he turns from active to quiet and the number of periods in jail is drawn from a uniform distribution on the $[0, j_{max}]$ interval, like in Epstein (2002).

Table 1. Values chosen for the fixed parameters of the model

Space Dimensions	n_a	υ	β	γ	τ	ϕ	j_{max}	t_0	θ	σ
21x21	360	1	0.8	0.2	0.85	9	30	100	0.05	0.75

Furthermore, it is assumed that at each time only a fraction θ of agents decides to change its status from quiet to active or vice versa. In order to start the revolution, at time t_0 a shock occurs and, starting from this period, a greater fraction of agents, equals to $\theta + \sigma$, decides to change or not its status. In the case of the Arab Spring, this shock may represent the Mohamed Bouazizi's self-immolation, which gave rise to the revolution in Tunisia.

Table 1 shows the values chosen for the parameters of the model that are fixed in all simulations.[2]

4 Results

This section describes the main results obtained by the simulation of the model. In more detail, eight simulations have been performed: i) in the first one, there are no leaders and there is not a social network technology; ii) in the second scenario, the case of a single leader without an extraordinarily high persuasion ability ($p^l = 0.8$) is considered; iii) in the the third simulation the presence of a charismatic leader is analyzed ($p^l = 1$); iv) the fourth simulation adds one influential leader to the previous scenario; v-viii) finally, the last simulations consider the effect of a social network technology connecting, respectively, the 1%, 5%, 10% and 20% of the agent population, without the presence of political leaders. These eight scenarios are described in Table 2.

For each of these simulations three graphs are reported: the time series of the number of quiet, active and jailed agents. These graphs are shown in Figure 1 for the first four simulations, which are characterized by the absence of a social network technology, and in Figure 2 for the remaining cases, which have in common the presence of social media.

In all simulations, the period before the revolution is characterized by small episodes of rebellion involving very few agents because only a small fraction of the population takes into consideration the possibility of rebelling. These riots are immediately suppressed by the government: in fact the probability of arrest is very high since few agents decide to be active.

[2] The model has been implemented using NetLogo (Wilensky, 1999) while the time series graphs of the next section have been produced using R (R Core Team, 2014).

Table 2. Eight simulations of the model

Simulation	Leaders (n_l)	p^l	% Connected (c)
1	0	.	0
2	1	0.8	0
3	1	1	0
4	2	1	0
5	0	.	1
6	0	.	5
7	0	.	10
8	0	.	20

At time $t_0 = 100$, a shock happens and a considerable number of agents evaluates the decision to rebel or not against the central authority: this gives rise to the revolution. The following situation depends strongly on the presence of influential political leaders and on the availability of a social network.

In the first simulation, the rebel activity increases after the shock but it remains bounded geographically because the transmission mechanism of the rebellion is only local: population members are more likely to be active if they are located in positions surrounded by active and influential agents. This results in a modest turmoil after the start of the revolution, as shown in the first row of Figure 1.

Introducing one revolutionary leader without an extraordinarily high persuasion ability ($p^l = 0.8$) raises considerably the level of protests in the early periods after the shock: in fact, in the second row of Figure 1, a huge pick of activation is clearly visible immediately after t_0. On the other hand, the number of active players declines rapidly over time.

Results change substantially with an influential leader, whose persuasion ability is equal to the double of the average persuasion of agents ($p^l = 1$). In this scenario, the number of active agents increases after the shock and it persistently remains at an high value for a long period of time (second graph in the third row of Figure 1). With two influential leaders this effect is even reinforced: in fact, the number of active players is anchored to a very high value during the entire observed period after the start of the revolution, as can be seen by the graphs in the last row of Figure 1.

Therefore, the model has been calibrated in order to exhibit successful revolutions in the presence of one or two charismatic leaders: in these two cases, the great mass of active agents immediately lowers the probability of arrest after the shock and this leads to a continuously increasing number of active players which rapidly exceeds the number of quiet agents for long periods of time. These types of rebellions can be associated to the major historical revolutions, such as the French (1789), the Russian (1917), the Chinese (1949), and the Iranian Revolution (1979), in which two charismatic revolutionary leaders, like Robespierre and Danton, Lenin and Trotsky, or even one, such as Mao and Khomeini, were influential enough to inspire huge mass mobilizations.

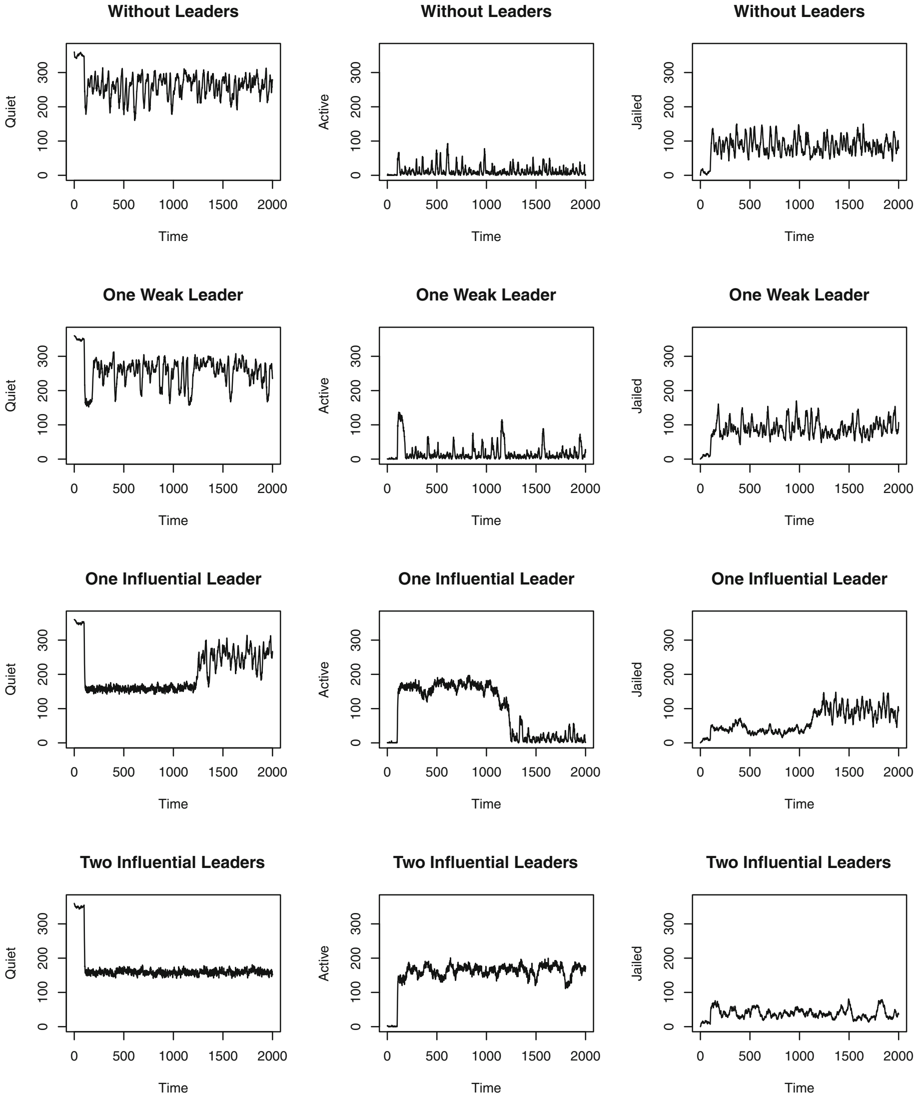

Fig. 1. Time series of the number of quiet, active and jailed agents for different simulations of the model without a social network technology

This last result can be equivalently reached without political leaders, introducing a social network technology connecting a sufficient number of agents. In fact, if the fraction of connected population is very low (1% in the fifth simulation displayed in the first row of Figure 2), the rebel activity is very modest after the shock. On the contrary, if the number of connected agents is slightly higher (5% in the sixth simulation shown in the second row of Figure 2), the

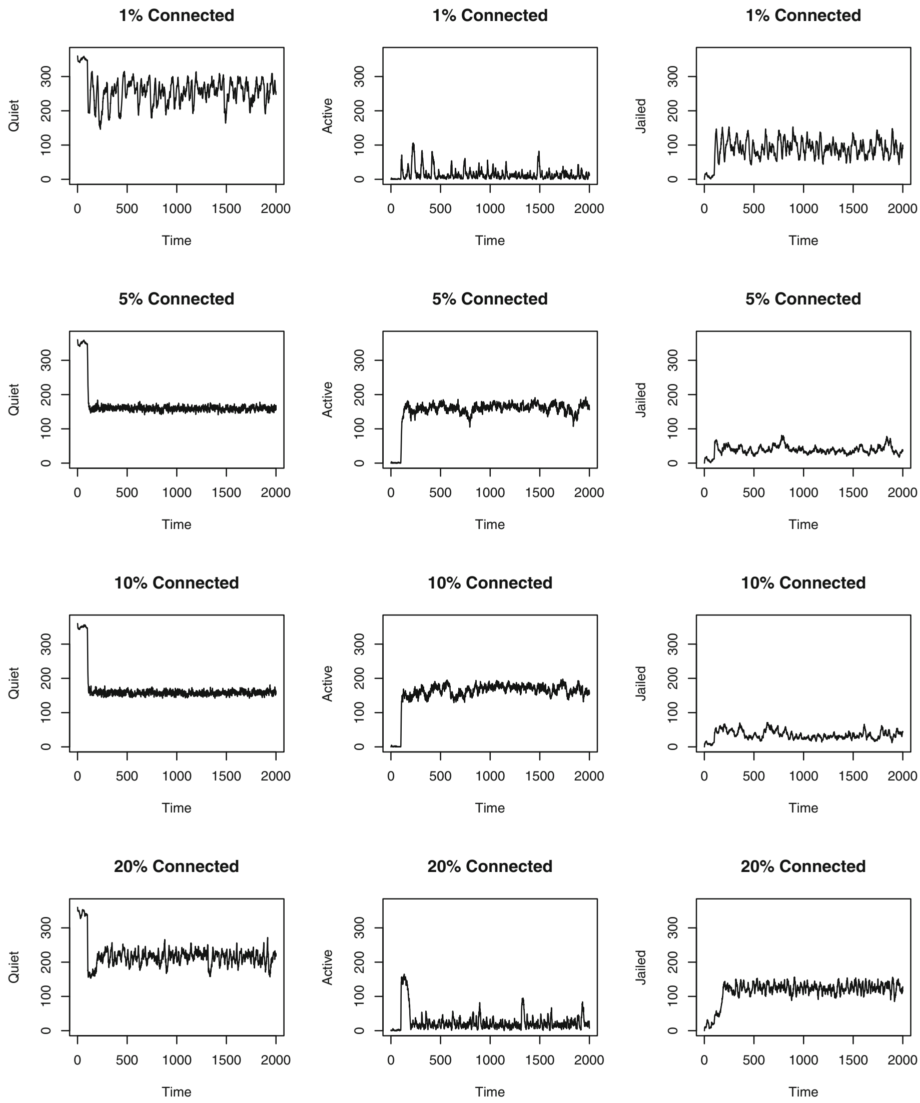

Fig. 2. Time series of the number of quiet, active and jailed agents for different simulations of the model with a social network technology

diffusion mechanism allowed by the social network is able to stimulate massive protests after the shock. The same is true for a percentage of connected agents equal to 10%, as presented in the third row of Figure 2.

However, the effectiveness of the network in stimulating riots is not monotonically increasing in the fraction of connected agents: this result is evident considering the scenario with a 20% connected population (last row in Figure 2).

In this situation, after the initial huge peak, the riot activity immediately drops to a low value. In fact, if the social network is excessively widespread, it also includes agents with a low persuasion ability and this negatively affects the average persuasion of the social medium, undermining the revolutionary potential of the network.

Summarizing the evidence provided by the results in Figure 2, the presence of a social network technology connecting a reasonable number of agents is able to generate massive protest movements by increasing the overall connectivity of the society. This mechanism explains why modern revolutions can be generated by social media without the need of a strong and influential political leadership.

5 Concluding Remarks

The recent uprisings in the Arab World have been characterized by the lack of a strong and universally recognized political leadership and by the intensive use of social network technologies as a mean to obtain consensus and generate massive protests. This represents a sharp discontinuity with the past: the major historical revolutions have been often shaped by charismatic figures with an uncommon influence over the masses of people.

The present paper tries to highlight the mechanisms through which social media can substitute revolutionary leaders in generating mass mobilizations: a widespread network of agents, not endowed with particularly influential capacities, can be as effective as multiple charismatic revolutionary leaders because it allows the geographical diffusion of protests as well as their persistence over time.

The focus is on social network technology rather than standard media, such as television, radio, newspapers, because traditional mass media are often under the strict control of the government in autocratic societies and this explains why they played a little role during the 2011 revolutions in the Arab countries.

The model presented in this paper extends the basic Epstein's (2002) agent-based model of civil violence by incorporating the effects of revolutionary leaders and social media, which are fundamental ingredients in explaining massive protest phenomena. Moreover, it enriches the analysis of Makowsky and Rubin (2013) about the importance of social network technologies in triggering cascades of preference revelation in autocratic societies by explaining the reason why contemporary uprisings are fundamentally different from the historical revolutions, in particular with respect to the mechanisms of mass mobilization.

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