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Linking "Micro" to "Macro" Models of State Breakdown to Improve Methods for Political Forecasting

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Abstract

Three predictive problems bedevil our ability to foresee political crises and state breakdown: (1) how to tell when a previously stable state falls into a situation of hidden but dangerous instability; (2) how to tell, once a certain level of instability has appeared in the form of protests, riots, or regional rebellions, whether chaos will grow and accelerate into revolution or civil war, or if the protests are likely to be contained and dampen out; and (3) how to tell which individuals and groups are likely to be the main source of mobilization for radical movements, and whether opposition networks will link up, grow and spread, or be isolated and contained. Prior work has focused on each of these problems separately. However, all three issues are crucial to understanding and foreseeing conflict dynamics. These issues operate on different time-scales and require separate models. In this article we discuss how better models of each process could be developed and, crucially, integrated with data for a more effective prediction system. A major theoretical challenge for us is to link these different approaches in order to increase their predictive power. A major empirical challenge is to identify data (direct or proxy) that can be used to parameterize, validate, and test our models.

Introduction

Recent years have seen major political crises throughout the world, including the popular insurrections of the Arab Spring, revolutions in countries as different as Burkina Faso and Ukraine, civil wars in Africa (Nigeria, South Sudan, Mali, the Central African Republic), the collapse of democracy in Thailand and Turkey, and

ongoing conflicts in eastern Ukraine, Afghanistan, Libya, Syria, and Yemen. Foreign policy analysts nearly universally expect to see rising tensions both within and between countries in the next five to twenty years (NIC 2017). Being able to predict future crises in the world and to assess the resilience of different countries to various shocks (geopolitical, geo-economic, and environmental) is of foremost importance in averting the potentially huge human costs of state collapse and civil war.

However, the existing methods for forecasting are not ideal and a significant number of political crises in the world have come as a total surprise to policy makers. It is conceivable that outbreaks of political violence are in principle impossible to predict (Cederman and Weidmann 2017). On the other hand, it is equally possible that predictive models of revolution can be improved. We will not know until we try it.

We propose that better models of societal resilience can be developed by integrating structural theories of revolution with recent advances in cultural evolution and behavioral economics. In this "white paper" we outline the steps that could yield new and improved modeling tools enabling analysts to assess risks for political stability posed by intra-elite divisions, various extremist groups, and external shocks in different regions, greatly increasing the explanatory and predictive power of current models. We illustrate these ideas with several empirical case-studies. Our ultimate goal is to develop a prototype model for exploring possible future trajectories in fragile states. This agent-based model will require inputs from experts on the particular society to be modeled, including structural variables (such as trends in the quality of life for the general population, proxies for intra-elite competition and conflict, and state strength) and "environmental" variables (e.g., data on rival power networks, proxies for the strength or breakdown of social norms restraining political violence).

Theoretical Framework

State-Centered Theories of Rebellion and Revolution

The first states appeared around 5,000 years ago in Egypt, Mesopotamia, and (somewhat later) North China. The cultural innovation that distinguished these new social formations from other centralized, hierarchical societies (e.g., simple and complex chiefdoms) was the rise of a class of professional, full-time government specialists—the bureaucrats. Whereas a parsimonious model of a chiefdom would need to distinguish between the elites (e.g., paramount and subordinate chiefs and their retinues) and the commoners (the rest of the population), a model of state-level societies needs to have at least three compartments—commoners, the elites, and "the state" (administrative

apparatus). In other words, our theories need to treat the state as an agent, or "actor" (Skocpol 1979; Goldstone 1991). An approach that focuses on the state as an actor is particularly important in the development of sociological theories attempting to explain state collapse or breakdown (otherwise, it is not clear what it is that collapses, or breaks down).

The relationship between the state apparatus and the elites (here defined as a small proportion of the population who concentrate in their hands the coercive, economic, administrative, and ideological forms of power) can be complex. According to Marx and Engels' classic formulation in *The Communist Manifesto*, "The executive of the modern state is but a committee for managing the common affairs of the whole bourgeoisie." One interpretation of this view is that the state is not an autonomous agent, separate from the elites. An alternative interpretation is made in the "dialectic-structural" model of Calavita (1984: 6). Calavita emphasizes the role of the state in managing the *common affairs* of the *whole* class of power-holders. She argues that to manage the collective interests of the elites, the state must enjoy a relative degree of autonomy. "This autonomy is 'relative' in that it is relatively free from manipulation by individual capitalists but not at all autonomous from the requirements of the political economy as a whole" (Calavita 1984: 8). The state's goal is the stability and perpetuation of the whole system, which may require the sacrifice of the private interests of some segments of the elites. If the selfish (partisan) interests of the ruling class overwhelm the need for cooperation, the whole system is in danger of being replaced, either as a result of internal revolution, or of external conquest.

The important point here is that the degree of state autonomy can vary greatly. At one extreme is the case when the state is captured by an elite faction and becomes a vehicle for pursuing their interests. More typically, the state is a coordination device for managing collective interests of all elites. Finally, the state can also serve the collective interests of both elites and commoners, as we see under the "Nordic Model" (Brandal et al. 2013).

In a seminal contribution, which is celebrated in this special issue of *Cliodynamics*, Jack Goldstone (1991) developed a "demographic-structural" model of state breakdown, which traces the manifold effects of population growth that undermine social stability and eventually cause state breakdown. These developments negatively affect all three compartments (population-elites-the state), leading to popular immiseration, intra-elite overproduction and conflict, and the state's fiscal insolvency. Goldstone applied his theory to rebellions and revolutions in the early-modern world: the English Civil War, the French Revolution, and the wave of state breakdowns that affected nearly all significant empires in Eurasia in the seventeenth century. Subsequent work by other researchers extended Goldstone's insights to pre-modern state-level societies

(Nefedov 2003; Turchin 2003; Korotayev et al. 2011). These historical analyses indicate that all state-level societies are susceptible to periodic waves of social and political instability (rebellions, revolutions, civil wars, and state collapses). More recently, studies of Turchin (2016) on the modern United States and Korotayev et al. (this issue) on the United Kingdom indicate that even contemporary economically developed and democratically governed nation-states are not immune to this general macrohistorical pattern.

Because state breakdown (here defined as the loss of control by the state apparatus over the population and the elites) usually leads to an outbreak of political violence that may take away millions, and more, of lives, cause huge economic losses, and generally depress human wellbeing, it becomes imperative for us to understand its causes. Such an understanding is a necessary (although not sufficient) requirement for designing effective collective action aiming to avoid a crisis brought by state collapse, or working through it with minimal losses of human life and wellbeing. The problem is that structural theories of political violence and state breakdown operate at "macro" scales. The theoretical focus is on whole societies and the typical time intervals over which dynamics unfold is decades. In order to make structural theories useful to managing state-breakdown crises, we need to connect structural models to "micro" models that delve into the causes of violence perpetrated by individuals and groups, and whose dynamics occur on a faster time scale (weeks, days, and sometimes hours).

Structural-Demographic Models of State Breakdown

Structural-demographic theory was developed as a tool for understanding long-term social pressures that lead to rebellions and revolutions, civil wars, and other major outbreaks of socio-political instability. The theory represents complex human societies as systems with three main compartments (the general population, the elites, and the state) interacting with each other and with their environment to create socio-political stability or instability via a web of nonlinear feedbacks (Turchin 2016). Each of these four structural components has a number of attributes that change dynamically in response to changes in other structural-demographic variables. For example, the "elite compartment" has the following characteristics: overall elite numbers, composition, incomes and wealth, adherence to norms of social cooperation, and the intensity of intraelite competition and conflict (Turchin 2013: Figure 1). Depending on the questions that we wish to explore, a specific model would focus on some of these features, but not others (because otherwise the model would become too complex for analysis).

The Selfish Elite Model of Turchin (2003: A.3) illustrates this approach to modeling structural-demographic dynamics by focusing on the "sizes" of compartments:

$$\frac{dC}{dt} = \frac{\beta_c \rho (1-gC)C}{1+aE} - \delta_c C$$

$$\frac{dE}{dt} = \frac{\beta_e \rho aE(1-gC)+C}{1+aE} - \frac{\delta_e E}{1+cS} \tag{1}$$

$$\frac{dS}{dt} = \gamma \frac{dE}{dt} - \alpha E$$

Here C stands for the population numbers of commoners, E is the numbers of elites, and S is the state's power, proxied by accumulated state wealth. The commoners (C) are the productive class who generate the wealth needed to support themselves, the elites, and the state. The production rate per commoner is equal to $\rho(1 - gC)$, where ρ is the maximum rate and g scales how production per commoner declines with increasing commoner population. Parameters β_c and β_e are birth rates for commoners and elites, respectively; and δ_c and δ_e are death rates.

In the absence of elites ($E = 0$) the population of commoners grows logistically. When elites are present, however, they tax away a portion of resources, which reduces the share of the production remaining with the commoners to $1/(1 + aE)$ (parameter a scales how increasing elite numbers translate into increased tax rate).

The dynamics of elite numbers are governed by two processes. The first term on the right-hand side of the elite equation specifies how the amount of resources extracted from commoners is translated into elites. The second term is the elite disappearance rate, which includes death and downward social mobility. Parameter δ_e is interpreted as the maximum rate of elite disappearance that obtains in the absence of the state ($S = 0$). As the state becomes stronger, it imposes internal order and suppresses violence and crime. As a result, elite survival rate increases due to lower probability of being killed or dispossessed of their property.

Finally, the state's strength, proxied by the accumulated resources that it has at its disposal, increases due to a portion of taxes, collected by the elites, being transmitted to state coffers (parameter γ determines the proportion of taxes that goes to the state). State resources are spent on employing elites as bureaucrats and officers. Historical states also spent a large proportion of their revenues on wars, with army sizes tending to increase as populations grew. As a result, as

populations grew and the number of elites increased, so did state expenditures. This model, however, only focuses on one aspect of this dynamic, with parameter α translating elite numbers into state expenditures.

The Selfish Elites Model has three equations and ten parameters. It is a model of medium complexity, and its dynamics can be explored numerically (Turchin 2003). But, as the description of the model shows, our ability to understand the dynamics predicted by the model comes at the expense of making many simplifying assumptions. In particular, political violence enters the model implicitly, via the second term on the right-hand side of the elite equation. When the state collapses (S = 0), the elite disappearance rate, due to violence and property dispossession, is maximized. In many ways this is not a satisfactory way to model political violence, which is a dynamical process in its own right.

It is possible to add a separate equation for political violence (Turchin and Korotayev 2006). However, adding more realism to the model makes it increasingly more complex. Experience shows that once we get beyond four or five equations and 15–20 parameters, models become so complex that it is very difficult to truly understand their behavior. Experienced modelers follow Einstein's dictum that models should be "as simple as possible, but no simpler than that."

What is to be done, then? How do we reconcile the need for realism with the limitations imposed by our ability to understand complex models? One approach that has shown great utility is the separation of time scales. In our case, structural-demographic variables evolve on long time scales—years and decades. Political violence, on the other hand, can flare up in a matter of days or weeks, and in some cases on even shorter time scales (for example, urban riots often build up in a matter of hours). Structural-demographic factors, which operate on a long time scale, set the environmental conditions that are either conducive to violence outbreaks, or, on the contrary, tend to suppress them. However, negative structural-demographic trends, which promote political instability, do not immediately lead to state breakdown; rather they set up a "revolutionary situation" that is conducive to the growth of revolutionary movements and extremist groups and to a general climate of violence. While states are particularly vulnerable to outbreaks of political violence during such periods, what is needed to translate a revolutionary situation into an actual revolution is a trigger, or a set of triggers (Goldstone 1991, 2014; Turchin 2013). In the next section we discuss structural-demographic trends that promote political violence in somewhat greater detail, and in the section after that we return to the question of how actual political violence is triggered.

Structural Pressures for Instability

The Selfish Elite Model is dynamically complete because it can be iterated without bound. It models both how societies enter structural-demographic crises, and how they exit from them—both state breakdown and state reconstitution. As was explained in the previous section, dynamical completeness comes at the expense of many simplifying assumptions. In particular, this approach ignores (or, rather, "averages over") the dynamics of individuals and groups of individuals (organizations, movements, ethnic groups) whose actions result in a crisis. These contentious dynamics (Tilly 1993) play out in a landscape set by slowly changing structural factors, and the landscape, in turns, determines the options and pay-offs available for contending agents. In this section we limit our focus to only a part of the structural-demographic cycle: quantifying structural-demographic pressures for instability during the pre-crisis period with the Political Stress Indicator (PSI; Ψ) (Goldstone 1991, modified by Turchin 2016).

The Political Stress Indicator reflects the tri-partite representation of social systems (population–elites–the state) by integrating the sources of pressure toward instability arising from each part: Mass Mobilization Potential (MMP), Elite Mobilization Potential (EMP), and State Fiscal Distress (SFD). These three components are combined in the index multiplicatively:

$$\Psi = \text{MMP} \times \text{EMP} \times \text{SFD} \qquad (2)$$

Social pressures arising from popular distress are indexed with Mass Mobilization Potential (MMP), which has three subcomponents (relative wages, the urbanization rate, and the effect of age structure):

$$MMP = w^{-1} \frac{N_{urb}}{N} A_{20-29} \qquad (3)$$

where w^{-1} is the inverse relative wage (related to the "misery index," see Turchin and Nefedov 2009). *Relative wage* is the wage scaled by GDP per capita. The urbanization index N_{urb}/N is the proportion of total population (N) within the cities (N_{urb}). The last term, A_{20-29}, is the proportion of the cohort aged between 20 and 29 years in the total population. This quantity reflects the role of "youth bulges" in the genesis of instability waves.

The second component of Ψ, which deals with elite overproduction and intraelite competition utilizes a similar approach:

$$\text{EMP} = \varepsilon^{-1} \frac{E}{sN} \qquad (4)$$

EMP omits the effect of youth cohorts, because it is undesirable to include this quantity twice in Ψ (it is already incorporated into MMP). The first term on the right hand side, ε^{-1}, is the inverse relative elite income (average elite income scaled by GDP per capita), which is analogous to w^{-1} of the working population. The second term measures the effect of intraelite competition for government offices. It assumes that the number of positions will grow in proportion to the total population (N). The proportionality parameter s is the number of government employees per total population (which is allowed to change dynamically). Thus, EMP combines two potential sources of intraelite competition: economic and political. If s is a constant, then the formula for the Elite Mobilization Potential simplifies to EMP = $\varepsilon^{-1} e$, where relative elite numbers $e = E/N$ (and the proportionality constant is dropped, because we are only interested in relative changes of PSI components with time, rather than the absolute level around which they fluctuate).

The third component of Ψ, State Fiscal Distress, has two parts. One is a measure of national debt scaled in relation to the GDP. The second part measures the degree of trust (or, rather, distrust) that the population and elites have in the state institutions (a proxy for the state legitimacy). The formula for SFD is thus:

$$\text{SFD} = \frac{Y}{G} D \qquad (5)$$

where Y is the total state debt, G is the GDP, and D is a measure of public distrust in the state.

The various building blocks of Ψ usually do not develop independently of each other. In particular, structural-demographic variables reflecting attributes of general well-being and elite dynamics are interconnected by a series of feedback loops. See Turchin (2013, 2016) for a mathematical model that captures these feedback loops and the resulting dynamics.

Models of Meso- and Micro-Dynamics

As we described in the previous section, societal resilience to internal conflict declines as (i) popular immiseration drives higher mass-mobilization potential, (ii) intra-elite competition causes increasingly conflictual politics and erosion of social norms restraining political violence, and (iii) the state fiscal crisis reduces state control over the coercive apparatus (e.g. police and army). In addition to these internal factors, the probability of an outbreak of political violence can also be affected by external geopolitical and geo-economic factors (Goldstone 2014), such as foreign support for the opposition or the withdrawal of support for the

ruler, shifting prices of international commodities, and a successful revolution in a culturally similar country.

Internal and external pressures for instability do not necessarily or immediately lead to state collapse; rather they set up a "revolutionary situation" that is conducive to the growth of revolutionary movements and extremist groups and to a general climate of violence. While states are particularly vulnerable to outbreaks of political violence during such periods, what is needed to translate a revolutionary situation into an actual revolution is a trigger, or a set of triggers (Goldstone 2014). For example, an assassination of one of the leaders may serve as such a trigger.

We need theory that will explore how slowly changing structural variables affect the fast dynamics of violence outbreaks. For example, violence dynamics can be described with game-theoretic models capturing material costs and benefits considerations, social norms, and particular social institutions. We expect that as structural trends become increasingly more negative, our models will predict that triggers, such as symbolically significant deaths, will lead to a violence cascade with greater probability. Vice versa, as structural conditions improve, most triggers will be dampened out and thus fail to lead to a spiral of violence and counter-violence. Our models should allow us to determine whether worsening structural trends have a nonlinear, threshold effect on the probability of conflagration following a triggering event.

In contrast to structural causes that act over long periods of time, transient causes are sudden events that change humans' attitudes and behaviors and have the potential to push societies out of equilibrium. Human behavior is influenced by many interacting factors including material cost-benefit considerations, genetically informed social instincts, personality, and culturally transmitted norms, values, and institutions (Wrong 1961; Granovetter 1978; Richerson and Boyd 2005; Weber et al. 2005; Simpson et al. 2012). The causes of sudden changes in human attitudes and actions leading to revolutions have been the subject of extensive empirical and theoretical work. A common observation is that mass support for a regime plunges in a cascading fashion. There are several possible reasons for such cascade dynamics including the "bandwagon effects" due to self-reinforcing changes in the perception of costs and benefits of actions (Granovetter 1978; Macy 1991; Heckathorn 1993; Marwell and Oliver 1993; Oliver 1993; Centola 2013), weakening of preference falsification (Kuran 1989, 1995; Yin 1998), information cascades (Lohmann 1994), and the effects of dispiriting emotions (e.g., fear, sadness, and shame) and emboldening emotions (Pearlman 2013). A trigger of a cascade, or a "single spark [starting] a prairie fire" (Mao 1930), can be a spike in inflation (e.g., growing food prices), defeat in war, a successful revolution in a nearby country, broad and inconsistent repression, or a

symbolic act—like the self-immolation of Mohamed Bouazizi that surprisingly started the Arab Spring.

Such specific triggers are very hard to predict. On the other hand, both the structural pressures that build up slowly and predictably as well as the prevailing conditions that may or may not facilitate the spread of upheaval are amenable to analysis and forecasting. Critically, although the triggering events are impossible to predict accurately, their effects depend entirely on the underlying structural factors and facilitating circumstances. Self-immolation in Tunisia in 2010 set off a series of open revolts and violent conflicts across North Africa and the Middle East: pressures had been building for decades and easy communication via social media fanned the flames of revolt. Alternatively, self-immolation by several Vietnam War protesters in the US in 1965, although signaling an increase in unrest and some limited acts of violence in the preceding decade, failed to lead to such a prolonged violent revolt as the Arab Spring has seen.

Structural factors and transitory forces affecting humans' attitudes and behaviors operate on different time scales. Demographic changes occur on the slowest time scales. The growth in political and economic inequality among the elites and the general population takes place on intermediate time scales. The psychological perception of the ongoing political and/or economic situation and the strength of political support for government and opposition can change very rapidly. Correspondingly, different modeling approaches need to be used for each of these time scales.

As a first step to connecting macro-dynamics to micro-processes we need to recognize that the structural-demographic compartments (such as "population", "elites", etc.) are internally heterogeneous. For example, instead of modeling the elite population as an undifferentiated mass, we can subdivide it into three "sub-compartments": established elites (E), elite aspirants (A), and counter-elites (C). In modern bureaucratic states the model focuses on political or administrative elites, and therefore E stands for the combined number of elected officials and unelected, appointed bureaucrats (however, we can also track the numbers of military, economic, and ideological elites separately, or by how the governing elites are recruited in a given society). The numbers of elite aspirants, A, grows both as a result of children of the established elites entering their ranks and upward social mobility creating new claimants for elite positions (for example, a certain proportion of the economically active commoners). Some aspirants move into power positions (freed by established elites who retire, or new positions created by the state). The rest either experience downward mobility into the ranks of commoners, or become counter-elites (C). C is increased by the inflow of frustrated aspirants and decreased by state repression (counter-elites are killed, imprisoned, or driven into exile). The strength of state repression depends on

state power which is determined by inflows (tax revenues) and outflows (expenditures on the state apparatus).

The next step is to recognize that various categories of the population (such as counter-elites and established elites) can form rival power networks, or factions. Thus, on intermediate time-scales, the major dynamic variables are the actions, resources, and power of different factions comprising the subpopulations. These dynamics are controlled by the parameters set by structural-demographic forces, such as numbers of elite aspirants in relation to power positions, and state fiscal strength that enables it to repress radical organizations.

Finally, on the fastest time-scales the major dynamical variables are the actions of individuals (for example, joining a radical movement or remaining as a supporter of the state) and their underlying preferences and beliefs. The latter change as individuals get previously unavailable information about the regime or the opposition (Lohmann 1994) or certain opinions or actions spread in the population changing the balance of perceived benefits and costs (Granovetter 1978; Macy 1991; Oliver 1993), or reducing the social pressure to comply with individually opposed social norms or policies (Kuran 1995). Under the right conditions, these processes may result in a cascade: once there is a critical mass of contributors to a collective action directed against the regime, everybody else starts contributing as well.

For example, one of the reasons why revolutions often come as a surprise is that "elites typically hide their disloyalty until they see an opportunity to act; and popular groups may seethe with inward anger but give few hints of how far they will go" (Goldstone 2014: 19). In the Kuran (1989) model, each individual has a private, $y \in [0,1]$, and a publicly expressed, $x = 0$ or 1, preference for a certain feature of social order with 0 and 1 being interpreted as the government and the opposition position. This model does not consider material payoffs. Instead, individual utility is written as:

$$u(x|y) = R(q) + M(x, y) \qquad (6)$$

where function R gives the reputational component and function M the moral integrity component. The reputational utility R increases with the proportion $q = q(x)$ of individuals who express the same opinion x. The moral integrity utility M decreases with the difference $|x-y|$ between publicly expressed and private opinions (due to cognitive dissonance). Let $1-q$ and q be the shares of the population publicly supporting the government (i.e., choosing $x = 0$) and the opposition (i.e., choosing $x = 1$). Then the utilities of supporting the government or opposition can be written as:

$$u(0|y) = R(1-q) + M(1-y)$$

$$u(1|y) = R(q) + M(y) \tag{7}$$

Let the "threshold function" $y = Y(q)$ be the solution of equation $u(0|y) = u(1|y)$. [That is, for $y > Y$, utility function u is maximized at $x = 1$, while for $y < Y$, u is maximized at $x = 0$.] Let $g(y)$ be the cumulative distribution function of y in the population. Kuran (1989) shows that if individuals choose their actions x according to myopic optimization protocol, the equilibrium share of opposition q^* satisfies the equation:

$$q = g(Y(q)) \tag{8}$$

In this model, multiple equilibria and sudden transitions between them become possible if $Y(q)$ or $g(y)$ change as a result of changes in private preferences z or reputational utility R (Kuran 1989; Yin 1998).

The dynamics of power and the resources of different factions in the meso-scale models directly affect the exogenous parameters of the micro-scale models, such as expected costs (e.g., the probability of punishment), expected benefits, privately held preferences, and reputational benefits. In a similar way, aggregating individual preferences in the micro-scale models translate into a faction's preference and, ultimately, actions in the meso-scale models. By investigating the meso- and micro-dynamics simultaneously, this approach enables us to significantly increase the power of theoretical predictions. Instead of simply following the slow-moving macro-conditions, by identifying important meso-dynamics (elite polarization) and micro-dynamics (potential trigger events, shifts in perception) one can make stronger predictions on shorter-time scales.

Empirical Examples

We now illustrate the major ideas underlying the theory developed in the previous section with several empirical case-studies.

Weather Underground During the 1970s

We will use the history of Weather Underground, one of the best known and most influential American terrorist groups of the 1970s (Burrough 2015), to illustrate how waves of political violence typically ignite, spread (or not), and then burn out. The period that we cover is roughly a decade from the late 1960s to the late 1970s.

Phase 1. The days of rage. In the early phase, there is little serious violence (the kind that leads to deaths), but this is when verbal violence tends to escalate. Individuals belonging to various groups demonize their enemies and increasingly call for their destruction. This is when the boundaries are drawn and fault lines deepen.

During the 1960s, the main fault-line was between the Radical Left and the Establishment (that is, the governing elites and the state). The issues motivating the radicals were opposition to the Vietnam War, draft resistance, oppression of African-Americans, poverty, and corporate greed. The most important dynamic during this phase was the crystallization and radicalization of the cohesive, "fused" (in the jargon of social psychology (Whitehouse and Lanman 2014)) groups that would later spearhead actual violence. The escalation of verbal violence led to the breakdown of social norms that guard against physical violence. In general, during this phase there is a pronounced positive correlation between the various structural-demographic pressures and the likelihood of violent confrontation. Unless these pressures are released peacefully and the underlying issues properly addressed, this wave tends to lead to an outbreak of violent confrontation. The actual Days of Rage demonstrations took place in October 8–11, 1969, in Chicago. The Weathermen (or "Weatherman" as the organization was initially known) formed during the second half of 1969 as a radical splinter of Students for a Democratic Society, with the goal of overthrowing the U.S. Government.

Phase 2. The triggers. These are specific, highly symbolic events that translate rage into action. The most frequent triggers are "sacrificial victims." This could be a self-sacrifice (such as the self-immolations of Vietnam protestors Alice Herz and Norman Morrison), but more frequently the sacrificial victim is killed almost by accident.

The triggering event that transformed the Weathermen into a terrorist organization was the extrajudicial execution by Chicago police of the charismatic, popular activist and Black Panther leader Fred Hampton in December of 1969. Hampton became a martyr for the anti-racism movement, and his murder led the Weathermen to go underground and launch a bombing campaign.

Phase 3. The spiral of violence. The first victims must be avenged, which creates more martyrs and triggers a chain of revenge and counter-revenge. This dynamic of revenge and counter-revenge is very similar to how tribal warfare in small-scale societies develops. The intensity and duration of this phase depend in great measure on the underlying structural conditions prevailing during Phases 1 and 2.

In the US during the 1960s, there were numerous triggering events and inflammatory rhetoric was escalating, yet the spiral of violence was not as

devastating, widespread, or long-lasting as similar waves in other societies. A detailed study of structural-demographic dynamics in the United States (Turchin 2016) shows that during the 1960s popular wellbeing was quite high and elite overproduction and intraelite competition remained low throughout the period. The underlying structural conditions, in other words, did not favor a large-scale revolt, in part explaining why the violence spike of late 1960s–early 1970s was relatively mild and short lived.

Phase 4. Burn-out. Eventually most people get tired or even sick of incessant and unproductive violence. The most violent individuals are killed off, or imprisoned, or lose support. Having experienced violence at first hand most people are repelled by it; the population becomes "immunized" to the spread of ideologies that glorify violence. Phase 4, thus, is the opposite of Phase 1; it's when the Rage subsides. As the Rage goes away, violence declines, and so does the need to avenge it. But the critical change is in the social mood of the majority of the population, who turn against violence. At the same time even the radicals themselves become tired of it too, or are simply decimated.

By the late 1970s the Weather Underground was partly decimated, but most of its leaders, like Bernardine Dohrn and Bill Ayers, were not killed or imprisoned; they simply gave up after seeing the futility of further violence. Further, the underlying structural conditions were not favorable to the spread and maintenance of this level of violence across the country, leading to dwindling support and eventually the movement completely burned-out. The structural-demographic trends in America of the 1960s and 1970s were much more benign than they are today (Turchin 2016). This is why political violence of the 1970s burnt out quickly without leading to more serious perturbations.

Egypt

The mass demonstrations against the Mubarak regime in 2011 provide another empirical case-study to probe the connection between macro-structural trends and micro-dynamics of political violence. The following narrative relies on (Korotayev et al. 2011).

The 2011 revolution in Egypt was a surprise to most observers and the regime itself. Prior to 2011 Egypt's economy was developing successfully, with relatively high economic growth rates. Poverty and inequality levels were among the lowest in the Third World, and the unemployment rate was less than in many developed countries. The roots of the crisis, in fact, were due to the Mubarak regime's own modernization successes, which led to the sharp decline of crude death rate and, especially, of infant and child mortality in 1975–1990. The result was a very large cohort of children, which after 20 years became a huge youth "bulge."

Although the rate of unemployment in Egypt changed little between 1990 and 2010, in 2010 half of all Egypt's unemployed belonged to the 20–24 age cohort. This group of about one million unemployed youths became the main striking force of the Revolution. Another "success" of Mubarak Egypt was a huge expansion of university education. Between 1995 and 2010 the proportion of Egyptians in their 20s with university degrees quadrupled (from 2.5 to nearly 10 percent). As a result, in 2010 over 40 percent of unemployed Egyptians had university degrees. Thus, the 2011 Egyptian Revolution (and most of the other Arab Spring events) was fueled, in large degree, by an overproduction of educated but unemployed youth, who felt entitled to elite (e.g. state bureaucratic) positions.

Equally important was intra-elite conflict between the "old guard"—the army that governed Egypt since Nasser—and the "new guard", urbanized businessmen led by Gamal Mubarak, the son and heir apparent of Hosni Mubarak. This internal conflict helps to explain otherwise puzzling aspects of the course that the revolution took; for example, why the army failed to act against the Tahrir demonstrators in the winter of 2011, but acted decisively in support of demonstrators against the Morsi government in 2013.

The important point is this: news reports tend to focus on the visible events: the demonstrators from rival movements, their clashing ideologies, and the actual fighting in the streets. Structural-demographic theory adds an important dimension to such surface dynamics by delving into structural factors that determine how strongly the common people are motivated to challenge the regime, and into the maneuvering of various elite factions behind the scenes. We need to develop models that can capture such "invisible" dynamics taking place below the surface, which will give us greater explanatory and predictive power.

Let's now take a brief look at the triggers of the 2011 revolution. Curiously enough, there were about half a dozen self-immolations in Egypt prior to the revolution. However, the effects of these incidents dissipated without triggering a general uprising, unlike in Tunisia. It even prompted a *Time* magazine article by Abigail Hauslohner, "After Tunisia: Why Egypt Isn't Ready to Have Its Own Revolution". This article, published on January 20, 2011, only five days before the Day of Rage that started the revolution, clearly illustrates why it is so difficult to predict what event would trigger an uprising!

The actual triggers were a result of a series of cases of police brutality, of which the best known is that of Khaled Mohamed Saeed who, according to several witnesses, was beaten to death by the Alexandria police on June 6, 2010. The Day of Rage, 25 January 2011, was selected by several opposition groups for protests because it coincided with the National Police Day. The Day of Rage triggered the spiral of violence, in which the police suppressed demonstrations causing

protester deaths, which led to more people joining protests the next day. The scale of protests grew from tens of thousands to millions. Overall, the dynamics of the rebellion, which eventually forced Mubarak to resign on February 11, are in good agreement with the structural-demographic model.

Ukraine

This is a difficult case study because the recent history of Ukraine has been the subject of highly ideologized "rival narratives." Unfortunately, reports in Western media often uncritically repeated the "party line" coming from the governments of Turchynov and Poroshenko, which were installed after the overthrow of Yanukovich. The post-revolutionary regime didn't want to acknowledge their part of responsibility for the continuing crisis, and chose to blame it entirely on Russia. Of course, Russia played a key role in the conflict (it is very likely that without the massive flows of war materiel and trained fighters at several critical junctures, the Donbass Rebellion would be bloodily suppressed by Kiev). Yet it would be a serious mistake to take Kiev's view wholesale as it would lead to a complete distortion of the real causes and triggers of the civil war in eastern Ukraine. This section is based on *Frontline Ukraine* by the British historian Richard Sakwa (2015), who charts the middle course between the ideological extreme narratives issuing from Kiev and Moscow.

One of the most fundamental drivers for instability in the structural-demographic theory is the balance between the supply of labor and demand for it (Turchin 2016). Oversupply of labor or, put simply, too many workers looking for too few jobs results in increased unemployment, falling wages, and decreasing wellbeing for the general population. In pre-industrial, agrarian economies the main cause of labor oversupply has been vigorous, sustained population growth that eventually begins to press against the inelastic supply of land. This is the classic Malthusian-Ricardian effect.

In modernizing economies that are about to escape the Malthusian trap, the danger is too rapid population growth that produces a large youth cohort that overwhelms the capacity of the economy to generate enough jobs. Korotayev et al.'s term for this predicament is "the trap at the escape from the Malthusian trap," and the Egyptian Revolution of 2011 provides an illustration of it (see previous section). In post-Soviet Ukraine, the main problem was not population growth—in fact, the population of Ukraine has declined since 1991, and continues to decline. The main problem was the collapse of the Soviet economy and inability of the Ukrainian elites to reform the economy in ways that would generate broadly based growth that would provide employment for the population.

Today, the Gross Domestic Product per capita (GDPpc) of Ukraine is less than it was in the late Soviet period. Ukraine's GDPpc is one third of that of Russia and

less than half of that of Belarus, a country that is much worse endowed with natural resources than Ukraine. Worse, the decline of the mean income per head understates the decrease in economic wellbeing of the majority of Ukrainians because of huge economic inequality. One hundred people control an estimated 80–85 percent of Ukraine's wealth (Sakwa 2015: 61).

As a consequence of high levels of popular immiseration, coupled with divergent views on the country's future between the western and eastern regions, Ukrainian society has repeatedly demonstrated a high capacity for mass mobilization and political protest. The post-Soviet period of Ukrainian history started with the "granite" student strike movement of 1990 that forced Communist leadership to pursue independence. The next spike of political instability was the mass protests against Leonid Kuchma in 2001. This was followed by the occupation of the Maidan in 2004 that forced an unprecedented third round to the presidential elections. Finally, the revolution of 2014 brought down the Yanukovich regime and triggered a bloody civil war in eastern Ukraine (Sakwa 2015: 81).

The dynamics of the ruling elites in Ukraine are another source of continuing political instability. Richard Sakwa (2015: 60) characterizes modern Ukraine as a "bureaucratic-oligarchic plutocracy." The one hundred individuals that own 80–85 percent of Ukraine's wealth are grouped in numerous "families" (such as the Yanukovich "family" before 2014), and those in turn belong to "regional business clans", of which the most influential had been Dnepropetrovsk and Donetsk. In addition to concentrating in their hands the economic power (by owning wealth-producing businesses), the oligarchs also monopolize political power. Billionaires occupy the posts of the president (e.g., Poroshenko), prime ministers (e.g., Timoshenko, although some contend that her private fortune is a bit less than a billion), and governorships of major regions (e.g., Kolomoisky in Dnepropetrovsk). The oligarchs also control the ideological power (all major media are owned by them) and even coercive power. For example, Igor Kolomoisky has sponsored several military units, such as the Dnipro batallion, which has been used in suppressing anti-Maidan manifestations and as shock troops against rival businesses (Sakwa 2015: 128).

Economic and political power has become closely intertwined in post-Soviet Ukraine. In particular, political office is used in a predatory manner, typical of Ukrainian politics (Sakwa 2015: 66) to enrich the incumbent. For example, once Yanukovich was elected as president, the Yanukovich "family" run by his eldest son, Alexander, rapidly became the country's leading clan. After 2014, however, the loss of political power exposed the assets of the Yanukovich family to "raiding" by rival oligarchs (Sakwa 2015: 130). As the size of the overall economy shrank, the competition between oligarchic clans intensified. Intense intra-elite

competition is, thus, the second structural-demographic factor driving political instability in Ukraine, in addition to high mass-mobilization potential.

The third factor is external—the "Great Power" rivalry between the West, led by the United States, and Russia. Although Russia is a much weaker state than the Soviet Union during the peak of the Cold War, it has both the incentive (counteracting the NATO "encroachment") and capability (proximity to the conflict, economic ties, and presence of pro-Russian forces) to be a major factor in Ukrainian politics.

High mass-mobilization potential of the population, intense intra-elite competition, weakness of the state, and powerful external interests have combined to create highly contentious politics in post-Soviet Ukraine. As structural-demographic pressures increased, each successive crisis became more violent, ultimately culminating in the revolution of 2014 and the civil war in the eastern borderlands—the Donbass (comprising Donetsk and Lugansk regions). How did these structural factors affect the dynamics at the micro-level, involving small groups and individuals? Specifically, what are the roots of the Donbass Rebellion?

The micro-dynamics of the Donbass insurrection evolved largely according to the expected pattern. The success of the Maidan uprising in Kiev, which drove Yanukovich from power, triggered an anti-Maidan insurgency in the Russophone regions of Ukraine—from Odessa in the South to Kharkov in the East. The anti-Maidan insurgency adopted the tactics of Maidan, namely the occupation of government buildings. Initially these take-overs were largely non-violent. There was a general reluctance to use deadly force, shared both by the insurgents and the government agents. However, it took only a few weeks for this social norm restraining violence to unravel.

The central government was able to defeat most of the anti-Maidan revolts (with the exception of the Donbass, of which more below). In some regions, such as Dnepropetrovsk, where the oligarch Kolomoisky created a "warlord regime" (Sakwa 2015: 146), the anti-Kiev insurrection never gained ground. In Kharkov some 70 anti-Maidan protesters were arrested, which proved to be enough to pre-empt further action (Sakwa 2015: 150). The Donetsk rebellion, however, turned out to be much more difficult to suppress, and the suppression efforts by the government led to an escalating spiral of violence that eventually resulted in a full-blown civil war.

There were several factors that explain the success of the Donbass rebellion. First, the oligarchs belonging to the Donetsk regional clan, such as Rinat Akhmetov, found themselves on the losing side when Yanukovich, the political leader (or figurehead) of the clan was deposed. Second, pro-Russian sentiment was the strongest in the easternmost two regions comprising the Donbass

(Donetsk and Lugansk). In April 2014, the anti-Maidan activists seized most of the centers of power in Donetsk: the municipal administration building, the police headquarters, and the TV broadcasting center. The oligarch Taruta, who was appointed by Kiev following the overthrow of Yanukovich, was expelled and had to move to Mariupol. Similar take-overs swept across many regional centers in the Donbass like a forest fire. It was clear very soon that defeating this insurgency would require an application of deadly force.

The third factor, and perhaps the most important one to the subsequent course of events, was the appearance of a professionally trained armed force without insignia in Slavyansk, led by a retired FSB colonel Igor Girkin (using the *nom au guerre* of Strelkov), who took over the town's administration and police buildings on April 12. From this nucleus of about two dozen men Strelkov built a highly capable unit of some 2,000 fighters, and eventually became the commander of the Donetsk People's Army.

What this case study illustrates is the autocatalytic nature of violence dynamics at the micro-level. The structural conditions in 2014 were highly conducive to an outbreak of major wave of political violence. Following the state breakdown, which resulted in the ouster of Yanukovich, a large swath of Ukraine, stretching from the Odessa to Kharkov's regions, experienced multiple cases of "spontaneous combustions." In most cases these incipient revolts were quickly suppressed. But in the Donbass a small group of trained and committed fighters was able to grow into a formidable force that eventually fought the Ukrainian army to a stand-still. The external factor has been, without question, very important. Without massive aid by Russia the Donbass Rebellion would probably have been defeated by Kiev before the end of 2014. However, this external factor interacted with equally powerful, and perhaps more important, internal, structural-demographic factors.

Conclusion

Three predictive problems bedevil strategic planning and military response: (1) how to tell when a previously stable state falls into a situation of hidden but dangerous instability (as with the Soviet Union prior to 1989 or the Arab Middle East and North Africa prior to 2011); (2) how to tell, once a certain level of instability has appeared in the form of protests, riots, or regional rebellions, whether chaos will grow and accelerate into revolution or civil war (as in Tunisia and Libya in 2011) or if the protests are likely to be contained and dampen out (as in the Iran "Green Revolution" of 2009 or the Hong Kong Umbrella Movement of 2014); and (3) how to tell which individuals and groups are likely to be the main source of mobilization for opposition movements, and whether opposition networks will link up, grow and spread, or be isolated and contained.

Most prior work has focused on the first problem, trying to model long-term processes that will lead to conflict or instability. However, all three issues are crucial to understanding and foreseeing conflict dynamics. These issues operate on different time-scales and require separate models. What is needed is both to develop better models of each process, and to integrate these models with data for a more effective prediction system. A major theoretical challenge for us is to link these different approaches in order to increase their predictive power. A major empirical challenge is to identify data (direct or proxy) that can be used to parameterize, validate, and test our models.

Here's how we envision such an approach could work. We start by identifying long-term structural factors that undermine socio-political stability and make an outbreak of political violence more probable. The next step is to delve into the particulars of the society, with a focus on power structures. More specifically, how are various kinds of elites recruited? What happens to failed elite aspirants?

At the meso-level we need to map various factions of elites and elite aspirants and measure the degree of polarization in politics and political discourse. More broadly, what kind of social movements can both established elites and counter-elites tap into? At this level it is also important to take into account various external actors, attempting to manipulate the events to their advantage by, perhaps, funding protest movements, or supplying arms and military training to a rebel group.

Finally, at the micro-level we need to identify specific trigger events and investigate whether a combination of such triggers together with the configuration of the power landscape (social movements and rival elite organizations; strength or breakdown of institutions and social norms suppressing violence) and long-term structural vulnerabilities could provide a strong, relatively low-error prediction of where and when instability grows to threaten the entire social system.

Clearly, this is an ambitious research agenda, but the stakes are high. In our opinion, the only way to determine whether prediction and understanding of state breakdown and political violence waves is feasible is to invest in a sustained research program that would combine mathematical models with massive data.

Acknowledgements

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