# Contagion and Chaos

## Disease, Ecology, and National Security in the Era of Globalization

Andrew T. Price-Smith

The MIT Press
Cambridge, Massachusetts
London, England

Set in Sabon by SNP Best-set Typesetter Ltd., Hong Kong. Printed on recycled paper and bound in the United States of America.

Library of Congress Cataloging-in-Publication Data

Price-Smith, Andrew T.
Contagion and chaos: disease, ecology, and national security in the era of globalization / Andrew T. Price-Smith.
p. ; cm.
Sequel to: The health of nations / Andrew T. Price-Smith. c 2002.
Includes bibliographical references and index.
ISBN 978-0-262-16248-7 (hardcover: alk. paper)—ISBN 978-0-262-66203-1 (pbk.: alk. paper)
1. Communicable diseases—History. 2. Communicable diseases—Political aspects. 3. Communicable diseases—Social aspects. 4. National security. 5. Security, International. 6. Diseases and history. I. Price-Smith, Andrew T. Health of nations. II. Title.
[DNLM: 1. Communicable Diseases, Emerging-prevention & control. 2. Disease Outbreaks—history. 3. Environmental Health. 4. Health Policy. 5. Security Measures. WA 100 P946c 2009]
RA643.P73 2009
362.196'9—dc22

2008021363

10 9 8 7 6 5 4 3 2 1

# 1

# Theory and Exegesis: On Health and the Body Politic

Most of the change we think we see in life
Is due to truths being in and out of favor
—Robert Frost, "The Black Cottage"

My analysis does not seek to explain all possible outcomes related to the effects of disease on structures of governance, but rather to generate plausible analytical relationships between variables that will permit further empirical testing and refinement. As the philosopher of science Thomas Kuhn stated, "To be accepted as a paradigm, a theory must seem better than its competitors, but it need not, and in fact never does, explain all the facts with which it can be confronted."[1]

## On *Physis* and Republican Theory

In *The Social Contract*, the Swiss republican political philosopher Jean-Jacques Rousseau explicitly linked population health, economic productivity, and effective governance:

> What is the object of any political association? It is the protection and prosperity of its members. And what is the surest evidence that they are so protected and prosperous? The numbers of their population. Then do not look beyond this much debated evidence. All other things being equal, the government under which, without external aids . . . the citizens increase and multiply most is infallibly the best government. That under which the people diminishes and wastes away is the worst.[2]

Indeed, Rousseau recognized that implementation of the social contract effectively entailed an exchange between the sovereign and the governed wherein the latter pledged their fealty (and taxes) to the former in exchange for the protection of their lives and property: "Their very lives

which they have pledged to the state, are always protected by it. . . ."[3] Such duties of the state were noted by the English republican political theorist Thomas Hobbes, who argued in *Leviathan* that the state possessed a fundamental obligation to protect its people from predation by external agents (i.e., foreign militaries) or by internal agents (criminals).[4] One might certainly extend the argument to posit that the state is also obligated to protect the people from pathogenic forms of predation. States that fail to protect their citizens from predation may be viewed as in violation of the social contract. Such failures erode governmental claims to legitimacy in the eyes of the much diminished and debilitated people. In the domain of the political, both Rousseau and Hobbes are claimed as part of the Realist tradition, yet, as Daniel Deudney and Nicholas Onuf argue, they are in fact best conceived of as belonging to an antecedent and "republican" tradition of political thought. Realpolitik and Liberalism, which originated in the nineteenth century, then are conceptualized as the analytical descendants of this earlier republican school, and facets of both of these successor paradigms may be located in that earlier theoretical progenitor.[5]

To provide conceptual clarity, I adopt Deudney's concise definition of a republic as "a political order marked by political freedom, popular sovereignty, and limited government."[6] The republican tradition, which was certainly dominant in ancient Greek thought (Aristotle, Plato, Thucydides), was based in part on Aristotle's heralded debate between *physis* (nature) and *nomos* (convention) and the mutual influence they exerted upon each other.[7] Ultimately, Aristotle held that *physis* provided the basis for the emergence of *nomos*, and thus the natural world profoundly influences the derivative world of human constructs, such as political entities.[8] Aristotle was therefore the progenitor of structural-materialist thought in political philosophy. Plato concurred, and argued that *physis* constituted a powerful driver of political transformation. Such logic was particularly evident in his chronicling of various natural disasters (earthquakes, floods, fires) that devastated human societies and left the survivors to reconstruct (or re-invent) their modes of social and political association.[9]

The Hellenic republican tradition infused Western political thought and informed Machiavelli, Rousseau, Montesquieu, and Hobbes, who also held that material-contextual variables[10] were of profound significance in determining the trajectory of political affairs, both domestically and internationally.[11]

Such material factors were often cast as forces of "nature" and regarded as representing constraints and/or opportunities for a polity.[12] Montesquieu also noted the pivotal role of *physis* when he proclaimed that "the empire of climate is the first and most powerful of empires."[13] This is certainly logical from an epidemiological perspective, insofar as the disease gradient and the aggregate burden of disease on a society increase dramatically as one moves from temperate climes into the tropics. As Deudney argues, Montesquieu's work is central to understanding the relations between *physis* and *polis*, and Montesquieu stands as a pivotal empiricist in the domain of political thought even though much of modern international relations theory ignores his work. "Montesquieu's materialist arguments," Deudney writes, "are marshaled as part of a general effort to explain the origins and differences in the mores and laws of particular societies."[14]

In the post–Cold War era, the rise of environmental politics, and the environment-and-security debate in particular, sought to resurrect the decisive role of *physis* with some partial success,[15] although political science in the early twenty-first century maintains its profoundly ideational bias. In his exemplary discussion of the role of *physis* in republican discourse, Deudney argues that "the physical world is not completely or primarily subject to effective human control and . . . natural material-contextual realities impede or enable vital and recurring human goals. Such arguments attempt to link specific physical constraints and opportunities given by nature to alterations in the performance of very basic functional tasks universal to human groups."[16] Leo Strauss echoed this axiom of the fundamental role of *physis*, and the Aristotelian search for "first causes," when he argued that "the discovery of nature is the work of philosophy."[17]

Thus, Realist theory is heir to the materialist tradition of republican theory, particularly in its application of technological change to questions of security (e.g., the development of nuclear weapons).[18] Realists seek to explain politics as it is, and not as it ought to be, suggesting that there are fixed and empirically based laws that govern the political sphere. Conversely, the poverty of much "critical" or post-modern political theory emanates from its blatant omission of material-contextual factors, including demography, geography, energy, advances in technology, and the subject of this discourse, population health.[19] Largely as a consequence of Weberian thought, political discourse in the late twentieth century exhibited the increasing dominance of the ideational over the

material, impoverishing current debates. The extreme marginalization of material variables within the predominant political discourse is problematic, as it leads to the inaccurate assumption that human societies are no longer subject to the laws of nature (and thus completely divorced from *physis*). Conversely, an extension of Aristotelian logic would hold that material-contextual factors are primal and intrinsically important, and that they form the empirical basis for ideational variables such as culture, identity, and political constructs. Of course, this relationship between physis and nomos exhibits evidence of reciprocal causation, as human society (largely through technological ingenuity) has over the centuries increasingly altered nature through its actions.

Such material-contextual factors continue to operate at both the domestic (or unit) level and the international (or system) level, freeing us of the dichotomization of modern political analysis into the domestic and system levels of analysis. While such divisions may suit intellectuals who seek parsimony, they are profoundly incapable of dealing with the many trans-boundary issues that now vex human societies. For example, emergent and re-emergent pathogens (e.g., SARS and HIV) originate within states, often function as global collective action problems, and ignore the porous political boundaries of sovereign states. In the same vein, environmental collective action problems (e.g., protection of the atmospheric and oceanic commons) routinely cross the unit/system level boundary. Onuf argues that this division itself is a legacy of Weberian thought, notably its second modern phase: ". . . social thought and practice before modernity's second phase . . . made no clear distinction between social relations within and among states."[20]

In this analytical domain, republican theory diverges from its theoretical successors, as both Realist and Liberal theories presuppose a sharp delineation between international and domestic politics, the latter having little if any influence on conduct between polities in the former. However, the empirical reality is that many problems arising within the territory of a sovereign state may defy containment within that polity, and function as externalities that destabilize not only contiguous countries but also (in some cases) distant polities and/or the entire international system. For example, an infectious disease arising in China (e.g., SARS) may not remain contained within that polity but may proliferate throughout East Asia and North America, and may destabilize global economic relations. In similar fashion, failed states generate externalities that often affect the entire system, as did the rise of Al-Qaeda under the

Taliban in the failed state of Afghanistan. The political scientist James Rosenau echoes this skepticism toward the unit/system level dichotomization, holding that "in a rapidly changing, interdependent world the separation of national and international affairs is problematic."[21] Rosenau argues that this porous and nebulous domain of interaction between the domestic and international levels is best conceptualized as "the Frontier."

Another area of divergence between republican theory and orthodox late-twentieth-century Realism lies in the latter's almost exclusive focus on relations between the great powers, and the general neglect of middle powers and smaller states as "inconsequential" to the operations and mechanics of the global system. In the realm of infectious disease, however, global pathogenic threats may emanate from failed states or quasi-states, or from those polities that exhibit low endogenous capacity, with poor public health infrastructure, entrenched poverty and structural inequities, high population density, and ecological degradation.[22] Thus, owing to dynamics of global interdependence, processes at work within the weakest countries on the planet may generate negative externalities that ultimately compromise the material interests, and perhaps even the national security, of the great powers. This emphasis on complex interdependence between sovereign countries, particularly in the realm of trans-national issues, is the domain of republican theory's other successor, Liberalism. Yet the notion that disease could be transferred from one society to another is ancient, finding its first manifestations in Thucydides' account of the Plague of Athens, which suggests that the plague was imported via trade from Africa.[23]

As Rousseau noted, the health and size of a given population would certainly have been regarded as indispensable to the vitality of that body politic, and to the puissance of that nation. The manifestation of pathogenic infectious disease represented (and represents) a direct threat to the population base, erodes economic productivity, often weakens the institutions of the state and its ability to provide public goods, compromises governmental legitimacy, and often led to intra-class and/or intra-ethnic conflict within the state. Thus, an exogenous agent could act to fundamentally threaten the material interests and the stability of the affected polity in question. Furthermore, republican theory is concerned with placing constraints on the development of hierarchy within the state, recognizing the potential for despotic government and violence, directed by the state against its own people. Such concerns become

readily apparent in the chapters that follow as the disruptions induced by plague, cholera, HIV, and pandemic influenza often resulted in draconian violence by the state against the people in order to quell the disruption engendered by the pathogen in question.

It is not the purpose of this volume to reconstruct international relations theory. However, I should like to make a few brief observations, and I recommend a republican revision of Realist theory. Such a revision entails maintaining certain postulates of Realism, that the international system is anarchical, that this state of anarchy is primarily competitive, and that sovereign states remain the dominant actors in international politics. Moreover, Realist theory states that states seek to maximize their power in order to attain their primary goal of survival. A republican revision entails considerable modification to Realist orthodoxy. First, echoing the work of the political scientist Robert Jervis, republican Realism abandons assumptions of the Rational Actor Model, holding that foreign policy is often driven by powerful elites and factions within the state, and that these policy makers are subject to cognitive and affective limitations. Thus human nature, human limitations and their effects upon rational decision-making are brought back into Realist theory.[24] Furthermore, republican theory eschews orthodox Realism's fixation upon great power politics as ethnocentric, and holds that interactions between all states (including middle and small powers) are worthy of analysis. Moreover, while states remain the central actors in international politics, republican models accept the rise of non-state actors and other challenges (environmental degradation, disease) as threats to the material interests (and security) of sovereign states. Finally, a republican revision of Realism notes that the harsh dichotomization between the system and domestic levels of analysis is analytically problematic, particularly given that diseases, environmental degradation, or radical networks within a given state may generate externalities that compromise proximate states, and perhaps affect the system in its entirety.

A central claim of the present work is that pathogens can act as stressors on societies, economies, and institutions of governance. The proliferation of infectious disease may thereby compromise state capacity, and may destabilize the institutional architecture of the state. Under certain conditions, infectious disease may therefore represent a direct and/or an indirect threat to the material interests of the state, and therefore to national security. Thus, I pursue a state-centric theory of analysis, but one that acknowledges the complex interaction between state and society

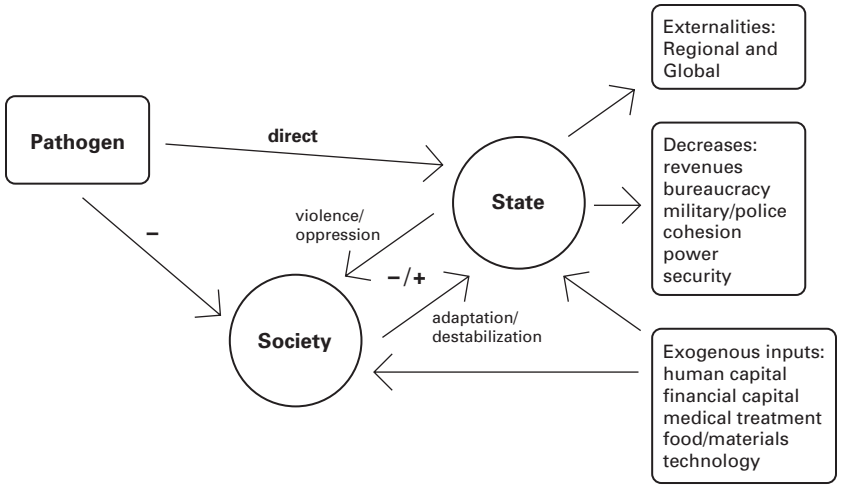


**Figure 1.1**
Theoretical construct of possible relations.

in the context of contagion. (See figure 1.1.) This conceptualization of the relations between variables—an extension of previous work (Price-Smith 2001)—includes significant revisions to the original model: society is included as an intervening variable, and it is specified that effects on the dependent variable (state capacity) can generate radiating externalities that affect entire geographic regions and possibly the global system.

**The Independent Variable: Pathogens**

Emergent or re-emergent pathogens constitute the independent variable. They are, by definition, novel and autonomous empirical agents that have recently become endogenized (or re-endogenized) within the human ecology. The etiology, the lethality, and the vectors of transmission of an emergent pathogen are initially obscure, and therefore the agent may generate enormous uncertainty, anxiety, and fear in affected populations. Re-emerging infections include those pathogens that are becoming re-established in human populations where they had formerly been minimized or eradicated, such that the human population no longer possesses substantial levels of acquired immunity to ward off the contagion. While the historical effects of diverse pathogens are explored in the next chapter, the case studies that follow focus on four emergent pathogens in the

post-1900 era (pandemic influenza, HIV, the SARS coronavirus, and the BSE prion) in order to investigate whether the historical effects of contagion on the state and society (and on their interface) remain potent and malign.

**The Intervening Variable: Society**

Virulent and destructive pathogens may affect the state directly, or their effects on the state may be mediated through the intervening variable of society. The Oxford English Dictionary defines a society as "the aggregate of people living together in a more or less ordered community [and] a particular community of people living in a country or region, and having shared customs, laws, and organizations." Factions or interest groups within society are linked together through social networks, or what the sociologist Robert Putnam has called "social capital."[25] Further, societies exhibit an enormous degree of variation in belief structures, in norms, and particularly in degree of complexity.[26] Society may, therefore, exacerbate the destabilizing effects of the pathogen on the state as it disintegrates into rival factions based on class or ethnicity, or it may generate successful adaptive strategies to ameliorate the effects of contagion.

Contagion may affect society in diverse fashions, as pathogen-induced effects in one domain (e.g., economics) radiate to generate pernicious outcomes in another (e.g., the political). In the domain of demography, pathogens will induce varying degrees of morbidity and mortality of the population, may affect fertility, and may induce emigration from affected regions. In the domain of economics, pathogens will compromise the productivity of workers[27] and may impose a range of direct and indirect costs on firms, families, sectors, and the macro economy. Further, contagion may destabilize markets through supply-and-demand-induced shocks, erode domestic savings, affect patterns of foreign investment into afflicted countries, and inhibit macro-level economic productivity.[28] Disease-induced economic contraction may also result in diminished revenues for the state through taxation, inhibiting its capacity to deliver public services, reducing its legitimacy, and compromising its security relative to foreign rivals. In the domain of psychology, contagion may generate significant negative effects, such as increasing uncertainty, suboptimal risk assessment, misperception, significant levels of affect (emotion), the construction of images of self and other, and the stigmatization of the ill. Pernicious outcomes in these domains may combine

to undermine social networks, compromise societal cohesion, undermine societal resilience, and even generate violence between ethnic groups or between classes. The political scientist Joel Migdal has noted that exogenous shocks (including outbreaks of epidemic disease) can induce significant social destabilization and can affect relations between state and society: "Natural disaster, war, and other extraordinary circumstances can greatly decrease the overall level of social control in societies by taking rewards and sanctions out of the hands of leaders of social organizations or by making the strategies of survival they offer irrelevant to the new exigencies people face."[29]

**The Dependent Variable: The State**

Pathogenic effects on the capacity of the state may be either indirect (mediated by society) or direct, whereupon contagion may result in the debilitation or destruction of the state's human assets (soldiers, police, bureaucrats) and in the weakening of state institutions. The state is defined as "an organization, composed of numerous agencies led and coordinated by the state's leadership (executive authority) that has the ability or authority to make and implement the binding rules for all the people as well as the parameters of rule making for other social organizations in a given territory, using force if necessary to have its way."[30] State capacity, then, refers to the power, capability, and autonomy of the state, and therefore indicates the capability of government.[31] Capacity is composed of various components, including fiscal resources, resilience, legitimacy, reach and responsiveness, coherence, autonomy, human capital, and coercive power (both internal and external). Moreover, capacity determines the state's ability to maximize its prosperity, stability, and projection of power, to exert *de facto* and *de jure* control over its territory, to protect its population from predation, and to adapt to diverse crises. "State capacity," then, refers to the endogenous capability of government, and its level determines the state's ability to satisfy its most important needs: survival, protection of its citizens from physical harm, economic prosperity and stability, effective governance, territorial integrity, power projection, and ideological projection.[32] In the case studies that follow, we will assess the impact of infectious disease (the independent variable) on state capacity in order to determine the possible pathways of associations between variables. This will allow us to construct robust qualitative hypotheses, which may facilitate further quantitative analyses in subsequent investigations.

## Postulates

Previous inquiries suggest that the following postulates regarding the impact of contagion on society, the state, and relations between them may hold at the domestic level. Effects are delineated according to domain of inquiry, and then tested against the historical data and the pathogen-specific cases in the chapters that follow.

### Domestic

**Demographic Impacts** Infectious disease often results in significant negative outcomes for human health, ranging from debilitation to death. Possible outcomes include a sickened population, widespread mortality and contraction of the population, and the contraction of specific age cohorts within a population (as in the case of HIV/AIDS). Epidemics may also generate rapid and significant migration from affected areas as people attempt to flee the source of infection.

**Psychological Impacts** The psychological repercussions of contagion typically include significant levels of emotion (notably fear and anxiety) that typically impede Pareto-optimal rationality in decision making at both the individual and the collective level. Such emotion is primarily a product of uncertainty and of inaccurate estimation of risk. Emotional and perceptual distortions may also generate the construction of images of the "other," resulting in stigmatization, persecution of minorities, and even diffuse inter-ethnic or inter-class violence. High levels of emotion combine with information that conflicts with individual belief structures to generate cognitive dissonance, wherein individuals engage in denial of the discrepant information in order to minimize psychological pain.

**Economic Impacts** Disease-induced destruction/debilitation of the base of human capital erodes the productivity of workers, imposes direct and indirect costs on families, firms, and the state, depletes savings, and compromises a society's ability to generate social and technical ingenuity. At the macro level, disease generates a significant contraction in the production possibilities of a particular economy, perhaps even generating economic dislocation and decline in severe cases. Such contraction imposes constraints on the revenues that the state may extract from the people through taxation, further limiting its capacity. And if instability

is perceived, infectious disease may undermine foreign investment in seriously affected regions.

**Governance** Outbreaks of disease often shift power from the people to the state as the state increasingly imposes draconian controls in an attempt to contain the contagion, and/or to limit the socio-economic disruption associated with the outbreak of disease. Second, disease may generate competition and even conflict between classes or between elites, and may also manifest in the form of inter-ethnic conflict. Third, disease may generate a sclerotic effect on the apparatus of governance, wherein the state's capacity to deliver essential services becomes increasingly curtailed, impairing the government's legitimacy. Governments may become increasingly paralytic[33] as institutions become fragile and ineffective. Fourth, as social relations become increasingly chaotic, and as the state destabilizes, the state may engage in draconian and coercive practices against the population in order to maintain cohesion and order.

**Externalities** Pathogen-induced destabilization at the domestic level may generate negative externalities that affect other states in the international system. Such unpalatable externalities may include economic destabilization, disruption of trade, migratory flows, and even political destabilization. Thus, analytical models must deal with high levels of interactivity and connectivity between agents and outcomes at the domestic and international levels.

**International**

**Economic Impacts** The emergence, and subsequent proliferation of novel pathogens generates profound morbidity and mortality, uncertainty, and fear. Contagion may destabilize markets, may undercut international trade and commerce, and (if there is a quarantine) may limit the trans-national movement of both trade goods and personnel (i.e., human capital).

**Governance Impacts** Contagion may foster political acrimony, may erode the effective function of international organizations, and may expose persistent problems in cooperation between sovereign states and other agents in the realm of global health governance. Contrary to earlier hypotheses in the health security literature, disease is unlikely to directly

induce armed conflict between sovereign states. However, disease may compromise a state's ability to defend itself and, over a longer term, its ability to project power (martial, fiscal, and ideological).

**Case Studies and Selection**

Previous work in the field of health security has revealed negative empirical linkages between disease and state capacity,[34] and between disease and the incidence of intra-state violence.[35] However, it is prudent to re-examine the dominant hypotheses within the field and reconceptualize the relations among pathogens, society, and the state. Qualitative exploration of the probable relations among variables, through case studies that examine the interactivity of various domains (demographic, economic, social, psychological), may illuminate linkages that heretofore have remained obscure.[36] The case studies presented below analyze the effects of various pathogens on state-society dynamics to reveal historical patterns of behavior and reaction. The postulates developed from the available historical evidence may then be examined in the context of modern manifestations of contagion for the purpose of evaluating to what extent such historical patterns may still apply.

Thomas Kuhn offered a rationale for the case study/synthesis approach: "In the absence of a paradigm or some candidate for paradigm, all of the facts that could possibly pertain to the development of a given science are likely to seem equally relevant. As a result early fact-gathering is a far more nearly random activity than the one that subsequent scientific development makes familiar. . . . Early fact-gathering is usually restricted to the wealth of data that lie ready at hand."[37] Moreover, analyses that focus on a single variable, assuming that others will remain constant, are flawed, as changes in the primary variable may generate significant variance in the others.[38] Thus, even though infectious disease is the independent variable in each of our cases, it is inaccurate to assume that intervening variables (such as societal institutions) remain constant—they do not. The rationale underlying comparisons and case studies (as delineated by pathogen) is by no means novel. Indeed, the medical historian Charles Rosenberg explicitly argued for such a comparative approach based on his conceptualization of "the individuality of disease entities."[39] Pathogens will exhibit differential effects on polities according to lethality, mode of transmission, and psychological effects. Because of such complex systemic interactions, I will employ a series of case

studies, selected according to pathogen, to examine the effects of contagion on state-society dynamics, state capacity, and inter-state relations. Each case study will analyze the impact of a particular pathogen on various domains (e.g., demography, psychology, economics, governance) and will then analyze the interactions among domains. The net result will be the generation of probable associations between variables that will permit refined empirical testing of hypotheses and will reduce the probability of spurious correlations or linkages that have no basis in public health or in medicine.

As criteria for selecting cases, I used the following:

- The case must analyze the effect of one specific pathogen.
- The pathogen must be emergent or re-emergent in that it was a novel agent in the twentieth century or thereafter.
- The pathogen must have generated at least some disruption (economic, social, or political) within the populations of five sovereign states.

The number of case studies (four) is admittedly small, but they are buttressed by a historical comparison of the effects of various pathogens on states and societies across millennia. Despite the small number of studies, the findings should permit preliminary generalizations about the probable relations among variables. The political scientist Steven Walt defends this approach, noting that increasing the number of case studies does not necessarily translate into increased analytical accuracy: "We are often better off with a small number of *valid* observations, as opposed to a large number of observations that do not really tap the concept that we are trying to explore."[40] Furthermore, statistical explorations typically assume linear relations among variables, and cannot easily deal with non-linear systems, feedback loops, thresholds, and multiple chains of causal interactions between variables. As such this analysis is conducted using methods of tracing processes across domains to reveal these complex and interactive relations.[41]

The case-study approach is propitious, as it illustrates the possible pathways of interaction between various agents and nodes within complex bio-political systems. Only through examination of the connectivity between domains (demographic, economic, psychological) at the domestic level can we illuminate pathogen-specific modes of interaction within a polity. Furthermore, the effects of contagion on state and society are often pathogen-specific, with certain agents generating profound negative psychological effects that compound the problems

generated by mortality, morbidity, and economic dislocation. Thus, before we can engage in large-*N*, multi-variate statistical regressions that assume linear functions, we must know what we are looking for. Hence the need for the pathogen-specific case studies that examine the effect of a specific agent on the system.

### Chaos, Non-Linearity, and Emergent Properties

Neither the sun nor death can be looked at with a steady eye.
—La Rochefoucauld

The political scientists Harold and Margaret Sprout, pioneers in the application of ecological principles to the domain of political science, noted that when complex connections exist between elements "any substantial change in one sector of the milieu is nearly certain to produce significant, often unsettling, sometimes utterly disruptive consequences in other sectors."[42] As such, tracing processes though case studies permits a holistic examination of the system wherein "the properties of the whole . . . can only be discovered by studying the whole."[43] The political scientist Robert Jervis concurs, arguing that systems are typically highly complex and contingent.[44] Jervis goes on to define the properties of a system:

> We are dealing with a system when (a) the set of units or elements is interconnected so that changes in some elements or their relations produce changes in other parts of the system, and (b) the entire system exhibits properties and behaviors that are different from those of the parts. . . . The result is that systems often display nonlinear relationships, outcomes cannot be understood by adding together the units of their relations, and many of the results of actions are unintended. Complexities can appear even in what would appear to be simple and deterministic situations.[45]

Thus, natural systems exhibit profound complexity. Small changes that are gradually introduced over time may induce temporally distal nonlinearities, whereupon the system suddenly shifts to a new equilibrium.[46] Thus, human attempts to tame nature typically result in unforeseen negative outcomes. One notable example of such an outcome was the use of DDT to wipe out mosquitoes in order to diminish the transmission of such arthropod-borne diseases (e.g., malaria). Regrettably, the use of DDT resulted in widespread destruction of avian populations and generated evolutionary pressures that eventually created resistant populations of the vector.

The chains of connections among disparate elements (or variables) within a system may be exceedingly complex, often involving feedback loops and contingencies. The relationship among a pathogen, a vector, and a host is complex, and the debilitation or destruction of the human host will then generate externalities throughout a society that reverberate across various domains (e.g., demographic, psychological, economic, political). Indeed, outcomes in one domain may affect outcomes in other domains, creating feedback loops that perpetuate constant evolution of the system.[47] In addition, many bio-political systems may exhibit lag effects, wherein outcomes are delayed, are indirect, and intensify over the longer term.[48]

Furthermore, when examining the effects of disease on political structures, we may find that iterated indirect effects trump direct effects in their influence on systemic outcomes. Preliminary evidence suggests that the indirect effects of health on state capacity are attenuated and are likely to increase over the longer term.[49]

Aristotle acknowledged principles of non-linearity and randomness when he commented that "things do, in a way, occur by chance."[50] Variables within complex systems often interact to generate outcomes not predicted by linear models. Non-linear functions are often observed in natural systems, the obvious example being booms and subsequent crashes in the population of an animal species. Epidemiological curves also illustrate principles of non-linearity, wherein variables combine to generate exponential growth in the rates of infection, then plateau, and then crash as acquired immunity in the infected host population reaches a self-sustaining critical point.[51]

In his description of the SARS epidemic that struck Toronto in 2003, Justice Archie Campbell, Chief Commissioner of Canada's SARS Commission, described the contagion as a "perfect storm" of diverse factors.[52] This analogy is appropriate: epidemics often exhibit "emergent properties," in that the manifestation of contagion possesses characteristics that are greater and perhaps quite different than its constituent parts and that might be quite unexpected. As the sociologist Emile Durkheim commented, "whenever certain elements combine and thereby produce, by the fact of their new combination, new phenomena, it is plain that these new phenomena reside not in the original elements but in the totality formed by their union [or interaction]."[53] Thus, complex systems may exhibit properties that are attributable not to their discrete components, but rather to the macro-level interaction of those components, and thus

(under conditions of strong emergence) the whole may be both greater than and different from the sum of its parts.[54]

Emerging pathogens, and their manifestations in epidemic or pandemic form, often exhibit "emergent properties" resulting from the interaction of variables in complex and interdependent global systems. The collectivity may not only be a function of the combination of direct effects of the discrete variables within a system; it may also be a function of unanticipated side effects of these variables. For example, population growth and increasing population density generates unanticipated side effects that permit the zoonotic transmission of disease into, and expansion throughout, the human ecology. The exceptionally dense and large aggregate populations of "mega-cities" can act as population pools that support the endogenous (and continuous) transmission of certain pathogens. The classic example of this is measles, which can maintain steady transmission rates only in cities with populations of at least 250,000.[55] Therefore, the rise of huge and concentrated new urban population centers, coupled with environmental degradation and rapid migration, may permit the endogenization of new pathogenic zoonoses (e.g., SARS) within the human ecology.

The concept of chaos is also applicable to evolutionary changes in the genetic structures of pathogenic agents. As the virologist Joshua Lederberg pointed out, the genetic structures of pathogens are highly mutable, and changes in traits of transmissibility and lethality are often governed by chance mutation.[56] The classic example is the influenza virus, whose genetic structure is constantly shifting and changing. The evolutionary trajectory of influenza is decidedly non-linear in nature and, consequently, highly unpredictable. As was demonstrated by the H5N1 variant of the virus, it could rapidly evolve into a lethal pandemic (along the lines of the 1918 "Spanish Flu") or it could simply mutate into a relatively benign and non-pathogenic variant (as happened with Swine Flu in 1976).

## On the Utility of Punctuated-Equilibrium Theory

> Jumps rather than smooth progressions often characterize operations of systems [and] when variables interact in a non-linear manner changes may not be gradual. Instead for a prolonged period there may be no apparent deterioration, followed by a sudden collapse or transformation.
>
> —Robert Jervis[57]

For some time the dominant paradigms within political science have held that human societies (and their institutions of governance) exhibit linear trajectories of progression and/or decline, a process of functional, incremental change, and just "muddling through."[58] However, given that evolutionary change occurs in the natural world according to punctuated, and non-linear models, it seems reasonable to examine the hypothesis that punctuated-equilibrium (PE) models might interact with Schumpeterian theory to explain how non-linear disruptions may foster ingenuity, socio-political adaptation, and rapid institutional change in human societies. Conversely, if disease-induced requirements for ingenuity exceed endogenous adaptive capacity, protracted and widespread institutional breakdown may subsequently occur.[59]

At the domestic (or state) level, preliminary empirical evidence confirms that PE models possess a certain degree of validity. Stephen Krasner, one of the first political scientists to cast doubt on the incrementalist (i.e. functionalist) position, wrote that "studies of political development point to differential rates of change in social and political structures over time."[60] The political economist Douglass North discussed such possibilities of institutional transformation,[61] and the political scientists Frank Baumgartner and Bryan Jones found empirical evidence that PE models explained both the rate and the magnitude of change within US domestic political institutions.[62] In further empirical studies, the political scientists Speth and Repetto, Romanelli and Tushman, and Breunig and Koski all found positive evidence to support the premise of rapid and discontinuous change in institutions of governance.[63] The events of September 11, 2001 provide a powerful example of non-linear change in the US domestic apparatus of governance—change that led to the rapid re-constitution of various and disparate operations into the monolithic Department of Homeland Security. Those events also marked a profound transition in the conceptualization of US national security: non-state actors now were recognized as major threats, and terrorism rose to the top of the security agenda. September 11 also prompted a significant shift in US foreign policy toward pre-emptive war, the neoconservative (ultimately Kantian) promotion of democracy through war, and US intervention in Iraq and Afghanistan. Thus, one exceptional and unanticipated event triggered a flurry of rapid and wide-ranging changes in the United States' structure of governance, and in its patterns of behavior in the international system.

Historically, the study of international relations (a subset of political science) has been marked by the persistence of linear and incremental

orthodoxy, yet challenges to this dogma have arisen in recent years. The political scientist Mark Blyth argues that the emergence of novel ideas propelled rapid and non-linear institutional and economic change in Europe and North America throughout the twentieth century.[64] James Rosenau notes that the "the emergent world is marked by a high degree of disorder and turbulence," and that "the dynamics of turbulence penetrate to the very core of the human experience."[65] Further, Rosenau argues that political analysts have been perennial "prisoners of their theories," and that "the tendency to highlight continuities stems from excessive caution and a lack of clarity as to the nature of anomalies."[66] Additionally, the political scientists Paul Diehl and Gary Goertz explicitly employ PE models to explain the onset and termination of international conflict over the centuries.[67]

The exogenous shock of war can, depending on the adaptive capacity of the polities involved, generate enormous incentives for ingenuity, restructuring, and adaptation. Indeed, the historical record suggests that war often generates profound and rapid transformations both within the affected sovereign states and in international relations. Conversely, if the power of the shock exceeds the adaptive capacity of the affected polity, it will destabilize that system, and in extreme cases it will induce the collapse of that polity. Historical examples of the exogenous shock of war (both inter-state and intra-state) as a driver of state collapse and/or systemic transformation abound. In the twentieth century alone, one need only look at the two world wars to comprehend this notion of punctuated-equilibrium dynamics as the drivers of change at both the domestic and systems levels. World War I is particularly interesting, as it resulted in the political transmogrification of Imperial Germany into a nascent (and brittle) democracy, induced the dissolution of Austria-Hungary and the Ottoman Empire, and laid the foundation for World War II. That war, arguably more destructive than its predecessor, resulted in the division of Germany, the effective end of Britain's and France's imperial ambitions, and the shift of global power away from Europe to Washington and Moscow. World War II also generated social ingenuity: the global economic system was reformed (under the Bretton Woods agreement), and the United Nations was created to preclude such a destructive conflict in the future.

Given that the exogenous shock of war can function to generate either adaptation or destruction at the state and systems levels, it behooves us

to explore the possibility that epidemics of disease may have historically functioned in a similar fashion. The bubonic plague that stalked European populations from 1348 until the mid 1700s, destroying an estimated 25–33 percent of Europe's population, may qualify as a series of exogenous shocks.[68] Pathogenic waves were generated by exogenous agents (bacilli) that traveled via vectors (rats and fleas) into the human ecology, where they generated extreme morbidity and mortality. As I will argue in chapter 2, the pathogenic waves generated by the Black Death generated enormous social, economic, and political instability, led to significant transformations within European polities, and directly contributed to the demise of the feudal system. In the Americas, the catastrophic devastation wrought by smallpox on immunologically naive Amerindian populations overwhelmed the adaptive capacity of the Aztec and Incan empires and directly facilitated their subsequent conquest by European forces.

The utility of the PE model lies in its capacity to explain rapid and non-linear shifts within political systems, be they global (such as the rapid collapse of the bipolar structure of the Cold War era) or domestic systems of governance. Such models account for the rapid destabilization or transformation of states and/or systems, and cast doubt on incrementalist orthodoxy. In the domain of health and governance, PE models suggest that incremental increases in infection rates over time may produce negative and concatenating effects across domains within a system, gradually increasing the stresses on that polity. Eventually incidence or prevalence of a pathogen may cross a threshold, after which rapid and non-linear change is observed in the affected system. If a polity possesses sufficient endogenous adaptive capacity and ingenuity,[69] then successful adaptation will occur, and rapid and positive institutional change is likely. On the other hand, if a polity's resilience and capacity are insufficient, the pathogen may overwhelm existing structures (socioeconomic and political) and precipitate significant instability throughout the system, followed by a new equilibrium that may be very different from the one that preceded it.

### On Cognition, Affect, and Construction

Positivist thought holds that there is an empirical reality to epidemic disease, and that pathogens and disease can be measured, manipulated, and observed. However, it also seems reasonable to argue that human

beings may perceive this "objective" reality in very "subjective" ways, which may vary across individuals and across societies. The medical historian Sheldon Watts concurs, noting that "humans are biological entities (we are an animal type known among ourselves as *Homo sapiens sapiens*), while at the same time we are bearers of culture."[70] There is a common ground between the extremes of constructivism and positivism on this subject, and the starting point is to admit that the overwhelming balance of empirical evidence demonstrates that pathogens exist as distinct and independent organisms that generate destructive effects on their hosts. Pathogens exist as independent (exogenous) empirical entities, and can thrive both within and outside of human societies. And many such agents function as zoonoses which have crossed over into the human ecology from their natural animal reservoirs.

Yet the concepts of disease and "illness" of the host may be interpreted (and indeed fashioned in certain respects) by society. The perception of disease and the processes of cognition will condition a society's response to infectious disease both at the individual level and at the collective level. The social sciences inform the debate by illuminating the causal effects of economic and societal inequities on the pathogen-host relationship, as such inequities (e.g., poverty-induced malnutrition) may in fact weaken the host and make the host more vulnerable to colonization by microbial agents. Thus, epidemics may also be regarded as "constructs" wherein the original damage of the pathogen is exacerbated through human perceptions (and misperceptions), the intrusion of affect (fear in particular), stigmatization of the infected, and overreaction by the state (which has often resulted in draconian measures that have exacerbated or produced societal destabilizations). Watts notes this lingering tension between epistemic communities, and argues that "disease" is a reality (synonymous with disease agent/pathogen) whereas "illness" is—at least in part—a perception. " 'Illness' (as perceived by 'self') can be caused by *individual* misfortune and circumstances."[71] The historian Paul Slack validates this synthesis of views, arguing that "different microorganisms affect their human hosts and human societies in different ways. Yet epidemics are also themselves intellectual 'constructs' which, once formulated, have a history, vitality, and resilience of their own."[72] Thus, acceptance of the empirical basis of epidemics, and of its subsequent interpretation, allows us to bridge the epistemic divide between the social sciences and the natural sciences, and to advance the scholarly debate.

**On Fear as Mechanism**

Disease-induced morbidity and mortality produces quantifiable negative effects on human capital and reduces the productivity of workers, but economic damage and violence between societal factions may also be induced by the visceral fear of contagion. Fear and anxiety generated by infectious disease may generate responses ranging from Pareto-suboptimal decision making to denial to social dissolution to vicious persecution of minorities or of other polities. Destabilization resulting from fear and anxiety may even lead to the oppression of the people by a governmental apparatus of coercion in order to maintain the ideology of order and the "interests" of the state.

Humans, therefore, tend to exhibit bounded rationality, wherein the individual seeks to act rationally under various cognitive and affective constraints. Deudney concurs, noting the profound role of fear as a driver of international politics, particularly in matters of security:

> . . . human rationality is a relatively frail faculty of the human psyche and easily overpowered by the various emotions, most notably fear and anger. Fear is the emotion most intimately linked to security, and how fear is managed—expressed, repressed, directed, or cultivated—is among the most elemental issues of security politics. The dynamics of fear are central to many of the most influential analyses of political security. . . . When human beings are gripped by the emotion of fear their capacity for instrumental rationality is often impaired. As Thucydides so vividly shows, fear can lead individuals and groups to take actions that are panicked and ill-conceived.[73]

The history of contagion suggests that instrumental rationality is often at a premium during episodes of contagion, wherein the visitation of an epidemic generated enormous levels of affect (emotions of fear and anxiety) that heralded social polarization and generated inter-ethnic and inter-class strife. While the bodies of the deceased accumulated, further destabilization arose through misperception and the creation of images[74] of the "ill" and of the carriers of illness (vectors). Such emotional responses require us to re-think previously dominant models of cold cognition, and to postulate that hot-cognitive models (which include the role of affect) are required to explain societal, political, and indeed economic responses to epidemic disease.[75]

Cognitive factors may also inhibit the human capacity to accurately assess risks associated with the emergence of novel pathogens. As the legal scholar Richard Posner notes, individuals tend to overweight risks

associated with phenomena that are considered "dreadful" and "unknown," such as emergent diseases.[76] In addition, Posner argues that humans exhibit "imagination cost," which is a "difficulty in thinking about things that lie outside one's experience."[77] The legal scholar Cass Sunstein argues that the inaccurate assessment of such risk often stems from "probability neglect," which is the persistent inability of most humans to respond in rational fashion to dire risks with very low probabilities.[78] It may be completely rational for human beings to avoid a pathogenic agent that may cause their untimely death or debilitation. Such behavior might be described as prudent risk aversion. The problem lies within the individual's capacity to correctly evaluate a novel pathogen's potential to generate death and debilitation.

The epistemic community of experts on public health is very small. The average citizen has a very limited capacity to make Pareto-optimal rational decisions about risks associated with a pathogen's transmissibility and lethality, or about the availability of prophylactics or countermeasures. In the event of the emergence of novel pathogens, even public health experts will lack such information for a protracted period, and so extreme uncertainty results in profound levels of fear and anxiety, which typically results in significant displays of affect-induced irrational behavior. Fear of contagion can also generate or exacerbate in-group/out-group identity formation, resulting in the scapegoating of "others" and often in the intensification of xenophobia and racism. Thus, fear is notably enhanced by the uncertainty associated with the pathogenic agent in question. The SARS epidemic of 2002–03 was such an epidemic of fear, generated by the great levels of uncertainty about the etiology of the pathogen, its vectors of transmission, its possible communicability and virulence, and the efficacy (or lack thereof) of possible prophylactics and treatments.