Governance and Complexity—Emerging Issues for Governance Theory

ANDREAS DUIT* and VICTOR GALAZ*

Unexpected epidemics, abrupt catastrophic shifts in biophysical systems, and economic crises that cascade across national borders and regions are events that challenge the steering capacity of governance at all political levels. This article seeks to extend the applicability of governance theory by developing hypotheses about how different governance types can be expected to handle processes of change characterized by nonlinear dynamics, threshold effects, cascades, and limited predictability. The first part of the article argues the relevance of a complex adaptive system approach and goes on to review how well governance theory acknowledges the intriguing behavior of complex adaptive systems. In the second part, we develop a typology of governance systems based on their adaptive capacities. Finally, we investigate how combinations of governance systems on different levels buffer or weaken the capacity to govern complex adaptive systems.

1. Introduction

Processes such as climate change, technological innovation, the spread of pandemic diseases, and rapid fluctuations in world markets all challenge a linear, scale-free, and static worldview that has guided large parts of the scientific study of society and politics (Hall 2003). Such processes also have an immense impact on present and future levels of human well-being, political stability, and democratic vitality. What is more, the speed of interactions and the multiplication of linkages among elements in biophysical, technical, and human systems at a number of spatial scales seems to be increasing, creating a global "time-space" compression (Held 2000; Young et al. 2006).

While these processes have been portrayed and acknowledged by a number of political science scholars (e.g., Held 2000; Pierre and Peters 2005; Young et al. 2006), we often fail to recognize that these and other cross-level drivers of change do not add up in a linear, predictable manner. On the contrary, insights from the last decades of empirical and theoretical research on complex adaptive systems clearly show that biophysical as well as man-made systems are characterized by both positive

*Stockholm University

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and negative feedback loops operating over a range of spatial and temporal scales. This results in developments over time, characterized by periods of incremental change followed by fast and often irreversible change and "surprises" with immense consequences for economies, vital ecosystems, and human welfare (Moench and Dixit 2004; Peters et al. 2004; Schneider and Root 1995).

The purpose of this article is to elaborate how advances in governance theory can, and should, contribute to our understanding of the possibility of governing the intriguing behavior of complex adaptive biophysical and human systems. Starting out from works on complexity theory in other disciplines, we seek to extend and sharpen the applicability of governance theory by exploring how different governance models handle processes of multilevel, uncertain, and nonlinear change.

2. What Is So Special about Complex Adaptive Systems?

Research on the characteristics and components of complex adaptive systems (CAS) has made substantial progress in the last decades, particularly within the natural sciences. There is no one all-encompassing complexity theory but rather a number of different research traditions (ranging from systems theory to cybernetics) pursuing diverse methodological agendas (Manson 2001) such as computer simulations, multivariate analysis of empirical data, field-based case studies, and combinations (Cederman 1997; Gunderson and Holling 2002; Janssen 2002a). There have also been a number of parallel attempts in the social sciences to analyze the nonlinear nature of social, political, and economic behavior (Arthur 1999; Baumgartner and Jones 2002; Jervis 1997; Levin 1999; Pierson 2003).

Key Features of CAS

Complexity theory starts from the assumption that there are large parts of reality in which changes do not occur in a linear fashion. Small changes do not necessarily produce small effects in other particular aspects of the system nor in the characteristics of the system as a whole. CAS are special cases of complex systems and an extension of traditional systems theory (Hartvigsen, Kinzig, and Peterson 1998). Perhaps the most salient difference lies in that systems theory (within social sciences) assumes that a single-system equilibrium is reached through linear effects and feedback loops between key system variables, whereas CAS contains no a priori assumptions about key variables, emphasizes nonlinear causal effects between and within systems, and views system equilibrium as multiple, temporary, and moving (Dooley 2004, 357). Compared to systems theory, a CAS perspective therefore enhances analytical leverage by acknowledging a much greater variety of system behavior.

There is at present no generally agreed upon definition of what counts as a CAS. However, four traits are commonly found in the literature. First,

CAS consists of *agents* (e.g., cells, species, social actors, firms, and nations) assumed to follow certain behavioral schemata. Second, as no central control directs the behavior of agents, *self-organization* occurs when agents are acting on locally available information about the behavior of other nearby agents. As a result of this, *co-evolutionary processes* driven by agents' attempts to increase individual fit gives rise to temporary and unstable equilibriums, which in turn generate the *shifting system behavior with limited predictability* (often denoted emergent properties) associated with CAS (Anderson 1999; cf. Holland and Miller 1991; Levin 1999). A number of phenomena have been associated with complex systems behavior (e.g., "chaotic change," "emergence," "hysteresis," "strange attractors," "bifurcation," and "self-organized criticality"), but there is no established nomenclature for CAS effects. In order to facilitate the objective of investigating the capacity of governance to handle CAS, we have therefore chosen to focus on three theoretically acknowledged and empirically well-elaborated categories of system effects. As we show in Table 1, these effects are present in many of the systems societies try to govern.

Threshold Effects. CAS does not respond to gradual change in a smooth fashion. The reason is that these systems contain what has been denoted "threshold behavior," "tipping points," or "abrupt change." The main point is that small events might trigger changes that are difficult or even impossible to reverse. In some cases the transition is sharp and dramatic. In others, although the dynamics of the system have shifted from one state to another, the transition itself may be slow but definite. Hence, seemingly stable systems can suddenly undergo comprehensive transformations into something entirely new, with internal controls and characteristics that are profoundly different from those of the original (Gunderson and Holling 2002; Kinzig et al. 2006).

Threshold effects have attracted wide interest and empirical validation for a number of real-world systems, such as within physics (Goldenfeld and Kadanoff 1999) and ecological theory (e.g., Folke et al. 2004; Scheffer and Carpenter 2003). Granovetter's (1978, 1983) classic article of threshold effects in collective action as well as Pierson's (2003) elaboration of how abrupt social change can be triggered by minor disturbances in political systems are two parallel explorations in the same tradition. Krasner's notion of a punctuated equilibrium is another example (Krasner 1984).

Surprises. Another property of CAS is their interconnectedness (Gibson, Ostrom, and Ahn 2000; Gunderson and Holling 2002). The point is that interconnected systems contain poorly understood interactions driven by both positive and negative feedback and processes operating over a range of spatial and temporal scales. These interactions often result in "surprises," in which system behavior differs qualitatively from a priori expectations (Gunderson 2003). Although surprises seem to have attracted most interest by ecologists and the global change community (Janssen

TABLE 1
Nonlinear Behavior in Human, Technical, and Biophysical Systems

System	Example	Nonlinear Behavior Type	Description	Reference
Social-ecological	Freshwater	Surprise	Climate warming combined with agricultural runoff in the Great Lakes and Upper Mississippi basins leads to spread of subtropical cyanogmailbacterium, making loss of water supplies permanent rather than sporadic.	(Chorus et al. 2000; St. Amand 2002)
	Soil degradation	Threshold	Soil degradation can reach a threshold that leads to economically irreversible shifts in productivity.	(Antle, Stoorvodel, and Valdivia 2006)
	Extreme weather events	Cascade	Floods and droughts in Asia tend to have both short- and long-term livelihood health impacts (spread to social and economic systems).	(Moench and Dixit 2004)
Social-technical	Infrastructure	Surprise, cascade	World Trade Center infrastructural collapse cascaded across infrastructure systems and magnified damages in New York City (e.g., water infrastructure, transportation, electric power systems, phone lines, and information technology systems).	(Zimmerman 2001, 100f)
	Urban railway systems	Surprise, cascade	Hong Kong's Mass Transit Railway experienced a spontaneous and unpredictable crisis situation in 1996. A smaller incident was magnified through positive feedback, which resulted in a complete system breakdown.	(Ellis 1998)
Social-health	Epidemic	Surprise	Pathogenic H5N1 avian influenza found in domestic birds in northern Nigeria and spread quickly within the country in February 2006.	(Enserink 2006)
	Epidemic threshold	Threshold	The existence of epidemic thresholds in certain types of social networks has been identified using both computer modeling and empirical data. The threshold consists of a critical value that defines whether a disturbance will propagate and infect the whole network.	(Eguíluz and Klemm 2002)
	Cholera outbreaks	Surprise, cascade	Serious cholera outbreaks in Latin America and Southern Asia are triggered by temporal variability related to El Niño–Southern Oscillation, with serious health and livelihood implications.	(Pascual et al. 2000; Patz 2002)
Socio-economical	Poverty traps	Threshold	Chronic or persistent poverty can be understood as "poverty traps" into which people may fall and have difficulty escaping. These traps depend on the existence of multiple self-reinforcing dynamic equilibria.	(Barrett and Swallow 2006)
Political-economical	Financial crash	Surprise, cascade	Financial crash in Argentina 2001–2002 with endogenous political-economical origin triggered by exogenous shocks. Crises cascaded to the social and economical systems, i.e., increased mistrust of government institutions, and resulted in an explosion of poverty.	(Perry and Servén 2005; Sornette 2002, 2526–2528)
	Institutions	Threshold	Existence of "deep equilibria" in institutional development, which imply that once arrangements settle on that point, they are highly likely to endure for an extended period of time, for example proportional representation party systems.	(Pierson 2003, 157f)
	Social capital	Threshold	Societies can end up in "social traps," which are difficult to escape as it would require actors to abandon deep mutual mistrust developed over a long time.	(Rothstein 2005)

2002b), the phenomena have also been analyzed in detail for such diverse systems as urban transport, financial markets, and epidemics.

Cascading Effects. Both thresholds and surprises have the potential to produce immense consequences for human welfare if they cascade across scale (e.g., from local-regional-global), time (e.g., delayed impacts), and/or systems (e.g., from the technical to the economical or political system). For example, extreme weather events in South Asia such as flash floods or droughts tend to spread across interconnected systems, that is, from the biophysical to the social and economical system. As case studies in Gujarat (India) demonstrate, while no families in the studied communities were below the poverty line in a normal year, drought periods pushed almost 69% of the households below this line. This increase in poverty had a major impact on vulnerable populations, particularly on the health of women and children (Moench and Dixit 2004, 90–98). The likelihood of cascades is related to the degree of coupling between systems. The argument is that loosely coupled systems have more time to recover from failure and are therefore better able to buffer potential cascades, while tightly coupled systems do not allow time for delays and thereby increases the risk that disturbances become amplified (cf. Perrow 1984, 89–96). Similar notions can be found in Pierson's account of "causal chains" (Pierson 2004) and Mahoney's notion of "reactive sequences" (Mahoney 2000).

Finally, it should be noted that these features obviously are much more dynamic and strongly interconnected with each other in field settings—surprises can trigger threshold behavior that in turn cascades across systems and spatial scales.

How Common Are CAS?

In Table 1, we present a number of empirical examples of systems that seem to imbed the features of CAS, that is, thresholds, surprises, and cascading effects. The real-world features of CAS presented above have mostly been elaborated systematically by transdisciplinary scholars (e.g., Berkes, Colding, and Folke 2003; Gunderson and Holling 2002). Although fully aware that the theoretical and empirical applicability of complexity theory is likely to be a highly controversial topic in the social sciences (Byrne 1998), we nevertheless argue that there is enough evidence to justify the need for political scientists to consider the implications of CAS.

The main reason for this is not theoretical but has to do with the behavior and characteristics of the systems that societies try to govern. Threshold behavior and surprises in biophysical or technical systems might seem like marginal issues for governance scholars, yet our assumption is that this sort of nonlinear behavior can spark off political crises that need to be dealt with within existing governance systems. These crises triggers can be present, for example, if the impact of passing critical

biophysical or technical thresholds has large-scale spatial effects; if they are combined with other compounded economic, political, or biophysical perturbations; if they emerge in already vulnerable political systems; or if the impact triggers changes in interconnected social or economical systems. As an example, passing irreversible thresholds in soil degradation might look like a minor political problem, yet if this abrupt irreversible shift is experienced on a large spatial scale affecting the food-producing capacity of a nation or region, governance will have to include strategies for buffering the worst impacts and for ensuring that the impacts do not undermine the social fabric of society. The Argentine financial crash of 2001–2002 is an example of the failure to govern interconnected systems. What started out as an attempt to combat inflation and stimulate growth through fixed exchange rates and fiscal reforms soon escalated into a full-blown economic collapse with wide-ranging social and political consequences. In October 2002, no less than 57% of the population were pushed down below the poverty limit, which in turn lead to the emergence of unofficial currencies, barter clubs, and massive political distrust (Gurgel and Riggirozzi 2007). The triggering factor seems to have been a downturn in the world economy, which was amplified by a weak and noncredible political leadership (Eichengreen 2002; Perry and Servén 2005). Oran Young et al. (2006) provide a number of examples of the societal implications that follow from the "time-space compression" resulting from the increasing speed of interactions and multiplication of the linkages among elements in biophysical and human systems. Crises and risk researchers make a similar point when investigating the anatomy of "modern crises" related to technology, health hazards, or environmental catastrophes. Such crises seldom confine themselves to a particular policy area (say health or energy) but tend to jump from one field to the other, unearthing issues and recombining them into unforeseen "mega-threats" that not only have physical and social implications, but ultimately threaten the legitimacy of the state (from Boin 2004; cf. Pidgeon et al. 2003).

3. Why a CAS Perspective on Governance?

Insights from CAS might seem to provide little added value to existing approaches within social science. For example, Baumgartner and Jones (2002) and Repetto (2006) have studied punctuations and positive and negative feedback imbedded in the policy process. Charles Perrow's (1984) *Normal Accidents* provides a detailed elaboration of the generics of complex technological systems and the type of organizations able to cope with their associated risks. Moreover, governance scholars have recently sought to theorize issues of complexity and governance. In particular, Kooiman (2003) and Pierre and Peters (2005) present interesting insights related to the ability of governance systems to cope with change and uncertainty. Pierre and Peters develop five governance models based on how a governance system induces and responds to information from

society ("feedback") and a system's capacity to respond effectively to this information ("adaptability"). One point is that state-dominated governance models (what they denote the "étatiste model," the "liberal-democratic state," and "state-centric governance") are likely to provide poor or strongly biased feedback, due to distorted information flows from lower to higher levels caused by multiple veto points and strong institutional structures. The adaptability of these systems is also considered low due to information deficiencies and low capacities for reaching consensus with organized societal interests. Governance systems in which the state has a weak role (denoted "Dutch governance" and "Governance without Government") are argued to suffer from information deficiency, but this time due to the lack of incentives to provide information from societal interests. On the other hand, adaptability is assumed to be high as a result of organizational flexibility (Pierre and Peters 2005, 2–48).

Kooiman (2003) also recognizes the highly dynamic and nonlinear nature of governance, society, and governability, and maps out a number of analytical schemes. Governance issues related to societal complexity, diversity, and dynamics are discussed in detail and linked to different governance modes. For example, self-governance and co-governance modes are suggested to perform poorly in dealing with complexity due to their tendency "to ignore the intended and unintended consequences of their behavior for others" (Kooiman 2003, 206). Hierarchical governance, on the other hand, is implicitly suggested to have a higher capacity to deal with complexity as a result of this mode's ability to more effectively monitor and steer unexpected nonlinear developments (Kooiman 2003, 206).

In relation to this literature we believe that there are a number of previously overlooked issues that a CAS perspective highlights. First, it is not only the policy process that alternates between periods of stability and abrupt change (cf. Baumgartner and Jones 2002). Many of the systems we try to govern are themselves displaying one or several CAS-like properties (see Table 1). This alone has important implications for how we should evaluate the effectiveness of different governance forms. Second, the fact that changes in CAS are often the result of interactions among system components across levels makes it necessary to consider cross-scale interaction effects within nested governance systems rather than just within organizations (e.g., Perrow 1984, 9).

The third and most crucial issue emphasized by a CAS perspective is that there is a vast difference in governing complexity and in governing complex *adaptive systems*. While "complexity" defined in a general sense implies change, uncertainty, and limited predictability, complex adaptive *systems* have common features that result from their emergent properties. For example, Perrow's (1984, 330–335, 72–79) elaboration of organizations and their ability to cope with "complexity" builds on defining "complexity" as the possibility of unexpected interactions between components in a technical system. Such definitions, however, disregard potential crises

that cascade not only within but also beyond the technical systems themselves, as well as the crucial role of potentially catastrophic thresholds. The works of Pierre and Peters and Kooiman seem to be based on similar definitions of complexity. The difference between complexity and CAS means that previous hypotheses about the capacity of different modes of governance to handle complexity (Kickert, Klijn, and Koppenjan 1997; Pierre and Peters 2005) are not necessarily applicable for CAS effects, that is, thresholds (as defined in Walker and Meyers 2004), surprises (as defined in Gunderson 2003, 36), and cascading effects (as defined in Kinzig et al. 2006). In sum, this means that we should consider not only how change is played out between governance systems on different scales but also how different governance systems respond to complex adaptive change over time.

4. Adaptive Capacity in Multilevel Governance Systems

So how could governance theory approach issues of CAS? As we discuss in the following sections, two ideas are central for this question. The first builds on the observation that different governance systems might coexist and interact over societal levels. Emerging in the early 1990s, the term "multilevel governance" has been applied to a variety of policy areas such as European policymaking (Schout and Jordan 2005; Yee 2004), environmental governance (Jordan and Lenshow 2000), and economic policy (Eising 2004). The rationale for this field is that governance takes place through processes and institutions operating at, and between, varieties of geographical and organizational scales involving a range of actors with different forms of authority (Hooghe and Marks 2003).

In the following sections, we argue that the combination of different governance systems will be decisive for the impact of disturbances and surprises. In order to understand the effects of a disturbance, buffering and amplifying capacities of the entire system must therefore be taken into account. We explore the consequences of this notion by mapping out possible cross-scale interaction effects between different types of governance systems on two levels. Second, the idea of an *adaptive capacity* of governance systems is developed through making a conceptual distinction between "exploitation," that is, the capacity to benefit from existing forms of collective action, and "exploration," that is, the capacity of governance to nurture learning and experimentation (March 1991; March and Olsen 2006).

Adaptive Capacity—Balancing Exploitation and Exploration

Being a relatively new concept within social science (yet often encountered in studies of development policy, natural resource management, and climate change policy), multiple definitions of adaptive capacity are currently in circulation (cf. Brooks 2003). Moreover, concepts with similar

connotations are also frequent in the contemporary scholarly debate about vulnerability (Turner et al. 2003), resilience (Gunderson and Holling 2002), the role of institutional redundancy (Low et al. 2002), and institutional robustness (Anderies, Janssen, and Ostrom 2004). We suggest that adaptive capacity can be seen as a function of two underlying activities: *exploitation* and *exploration.* This distinction is primarily motivated by the fact that in many of its contemporary usages (cf. Smit and Wandel 2006; Turner et al. 2003) the concept of adaptation obscures the conflict between the stability-inducing role of institutions and the capacity to experiment, innovate, and learn from changing circumstances.

In a 1991 article, "Exploration and Exploitation in Organizational Learning," James G. March argues that organizations face a fundamental tension between *exploration* "captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation" and *exploitation*, that is "refinement, choice, production, efficiency, selection, implementation, execution." The tension arises from the fact that "adaptive systems that engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of exploration without gaining many of its benefits," and "conversely, systems that engage in exploitation to the exclusion of exploration are likely to find themselves trapped in suboptimal stable equilibria" (March 1991, 71; cf. March and Olsen 2006, 12f).

March's distinction can be applied to issues regarding the capacity of governance systems in dealing with CAS. More precisely, we argue that the adaptive capacity of a governance system can be understood as a function of the trade-off between exploration and exploitation.

Exploitation. In order for actors within a governance system to be able to engage in the activities associated with exploitation (refinement, choice, production, efficiency, selection, implementation, and execution), problems of collective action must be resolved or at least controlled. The reason for this is that all such activities are either impossible or severely inefficient in a context of high transaction costs (cf. North 1990a). Some authors claim that the problem of collective action is the most fundamental societal problem (Ostrom 1998; Taylor 1996) and that many other forms of social predicaments (e.g., poverty, famine, and environmental degradation) are generated through failures of addressing collective action problems on various levels (North 2005; Ostrom 2005; Rothstein 2005; Sandler 2004).

Force and hierarchy, third-party enforcement (G. Hardin 1968), generalized trust, network structures, (Putnam, Leonardi, and Nanetti 1993), institutional trust (Levi 1997; Rothstein and Stolle 2003), norms of reciprocity (Ostrom and Walker 2003), perceptions, beliefs, taboos (R. Hardin 2002), and the creation of institutional rules (Ostrom 2005) are all examples of mechanisms that can be called upon to ensure cooperation among actors in a governance system, as well as for keeping transaction costs on an acceptable level. Consequently, the strength of these mechanisms also determines the governance system's capacity for exploitation.

Exploration. Unlike exploitation, March's concept of exploration has no obvious counterpart within governance theory, although theories on policy learning (Beland 2006; Busenberg 2000, 2004; Sabatier and Jenkins-Smith 1999) and policy diffusion (DiMaggio and Powell 1991; Meseguer 2005) can be understood as comprised of several components related to learning and experimentation. First, exploration involves the capacity to gather, analyze, and accumulate information about ongoing processes in the community's environment. Learning also implies self-monitoring or the process of extracting and computing information about the state of the community itself (Gunderson and Holling 2002; North 2005). Second, exploitation also involves experimentation, that is, processes of testing, evaluating, refining, and reapplying new forms of governance, institutional configurations, policies, and practices within a given policy area. Such processes of trial-and-error are highly useful for coping with changing circumstances under high uncertainty but are also likely to be costly. In practical settings, the explorative capacity of a given community is reflected in the quality of its educational system and informational infrastructures such as the existence of independent universities, research institutes, and "think tanks," as well as in arenas for public debate and science-policy dialogues and unbiased mass media. Third, exploration also entails having sufficient resources, such as physical, monetary, and human capital. Learning processes, experimentation, and information gathering are often costly, and the capacity for exploration might therefore be limited by insufficient resources.

In sum, humans erect institutions and establish norms of cooperation and reciprocity in order to achieve predictability, stability, and low costs for social interactions (North 2005). This is in turn essential for engaging in exploitive activities, that is, to raise overall welfare through cooperation and interaction. But with stability comes rigidity. Institutions are path dependent, sticky, and products of circumstances and power struggles present at the time of construction (Mahoney 2000; Pierson 2004; Thelen 1999, 2003). Norms and networks of cooperation are slow changing and have a tendency to grow stronger with increased actor homogeneity ("bonding" vs. "bridging" social capital, see Woolcock and Narayan 2000). In contrast to March's original account of the opposition between exploration and exploitation in organizations—which focused on the seemingly less complicated problem of allocating organizational resources on either exploration or exploitation—the trade-off between exploration and exploitation in governance systems is rooted in a much more fundamental tension between the dual needs for institutional stability and change.

5. Four Governance Types

The balance between exploration and exploitation determines the adaptive capacity of governance systems. The interaction between exploitation and exploration can be further investigated by placing them as orthogonal

dimensions in a conceptual space. First, communities combining high levels of exploitation with low levels of exploration can be viewed as ideally equipped for the task of steady state governance. As long as no surprises (external or internal) occur, or circumstances do not change, this is the most efficient form of governance as it maximizes the capacity for exploitation through a dense set of social mechanisms (e.g., institutions, norms, and hierarchies) that ensure stability and predictability necessary for keeping transaction costs low. This form of governance can thus be characterized a *rigid*, as it maximizes stability while lacking flexibility vis-à-vis changing circumstances. Peters and Pierre argue that these are the characteristics of the state-dominated "étatiste," "liberal-democratic state," and "state-centric governance" models of governance, in which coordination and cooperation are high but responsiveness to external changes is slow and incremental due to either biased or weak feedback. The authors point to countries such as France and Singapore (étatiste) and the Scandinavian countries and Japan (state-centric) for examples of such governance models (Pierre and Peters 2005).

The *robust* governance type combines a high capacity for exploration with an equally high level of capacity for exploitation and is thus well equipped for handling steady state governance, long-term transformation processes, and sudden changes alike. This is of course an ideal state in which the rigidity-inducing effects of institutions are kept from obstructing necessary processes of exploration. It is an empirical matter if this ideal type has any real-world counterparts, but as we will show, the robust governance type is the only governance type that has a sufficiently high level of adaptive capacity to be able to respond to all sorts of complex processes. Real-world approximations of this ideal governance type can be found in the literature on crises management and so-called "high reliability organizations," as well as in studies aiming to identify features of long-lasting and natural resource-dependent communities. These examples are very diverse (ranging from air-traffic control systems, military organizations, and large-scale power systems, to preindustrial English agrarian communities and medieval communities in Japan), but they exhibit some common features which parallel our argument, for example, early detection of change, flexibility in decision making in combination with dense patterns of cooperative action, and the ability to reorganize (King 1995; La Porte 1996).

In contrast, real-world examples of the *fragile* governance type can be found in abundance throughout the world. In this type, weak capacities for exploitation and exploration form a vicious circle where difficulties of accumulating knowledge and capital due to high transaction costs also inhibits the capacity to adapt to new circumstances and to buffer the effects of shocks, which in turn makes it even harder to achieve collective action. Much of the earlier work on development issues has emphasized the role of collective action-related factors such as badly functioning institutions, nonexisting property rights (De Soto 2000), corruption (Rothstein

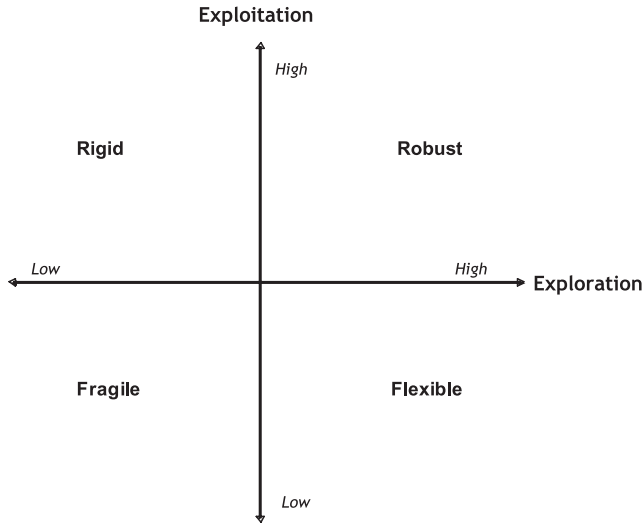
2003; Zak and Knack 2001), or low levels of social capital (Knack and Keefer 1997; Putnam, Leonardi, and Nanetti 1993) for understanding why many countries fail to achieve even moderate levels of economic development and human well-being. Less focus has been put on the role of exploration when explaining why some countries deal more effectively with external changes such as fluctuations in world market prices, natural disasters, and epidemics. The rapid spread of the avian influenza virus in Nigeria 2006 is one example of how a fragile governance system is unable to handle rapid shocks due to the combined lack of institutional structures and adequate knowledge (Enserink 2006).

Finally, the *flexible* governance system denotes a condition in which the governance system has well-developed capacities for exploration (e.g., learning processes, feedback loops, monitoring schemes, resources, and capital) but is lacking in the capacity to transform the gains from exploration into objects of exploitation. Adaptation will therefore be incremental, haphazard, and without an institutional foundation but might nevertheless be sufficient for long-term adaptation, albeit at the expense of a lower level of overall well-being. An example of the pros and cons of the flexible governance model can be found in a study of the evolution of "disorganized welfare mixes" in France, Germany, and the United Kingdom. Welfare governance regimes in all three countries have undergone profound changes during the post-war period toward a situation where welfare services are increasingly produced though dense and complex networks of governmental agencies, voluntary organizations, stakeholder organizations, and private enterprises. The end result of this creeping transformation process is the "paradox of the new welfare mixes exhibiting innovative dynamics and systematic organizational failure at the same time, with (more) output heterogeneity as an inevitable consequence" (Bode 2006, 346). The flexible governance system bears some resemblance to the "Dutch governance" and "Governance without Government" models suggested by Pierre and Peters (2005) and can essentially be seen as the governance counterpart to evolutionary or market-based selection processes. Exploration is nondirected, nonhierarchical, and carried out independently by multiple actors trying to maximize individual utility through mutual noncoordinated adjustment and exploration of emerging niches.

The Efficacy of Governance Types—Defining the Mechanisms

An assessment of how different governance models cope with the dynamic behavior of CAS must account for the assumed causal mechanisms that link models with outcomes. As argued above, change takes many forms, but for the purpose of outlining some general hypotheses we intend to rely on two simple distinctions. The first distinction has to do with the rate of change. Here the extreme cases are processes characterized by either states of slow change and continuous events (e.g., demographical change and environmental degradation) or conditions of rapid change and rare events

FIGURE 1
Adaptive Capacity of Four Governance Types



(e.g., extreme weather events, natural disasters, and economic shocks). The former corresponds to steady state conditions and the latter to change processes containing thresholds and cascading effects.

The other dimension is the predictability of the outcome of change, which runs from high (e.g., constitutional reforms in stable democracies) to low (e.g., sociopolitical effects of climate change). In this context, the term predictability includes both predictability of outcomes (effects) of change and occurrence of change (i.e., the probability of a change taking place; cf. Pierson 2003). Figure 1 displays these two dimensions, along with hypothetical plots of the capacity of the four governance types to handle the effects of complex systems (adaptive capacity).

Fragile and Robust Governance Systems

The robust governance type, with its combination of high explorative and exploitive capacity, is assumed to perform equally well regardless of the predictability and rate of change. Slow and predictable change is handled equally well as rapid unpredictable change. Similarly, the fragile governance type performs badly across all forms of change, simply because any form of change is difficult to handle with low capability for exploration in combination with equally low capacity for exploitation.

Network-Based Governance

The strengths and weaknesses of network-based governance (NBG) have been widely debated (Kickert, Klijn, and Koppenjan 1997; Pierre and

Peters 2005). The optimistic view represents NBG as a model that is able to promote a high learning capacity and adaptability in multilevel governance systems due to the flexibility created by informal cooperative arrangements in combination with higher levels of actor diversity and opportunities for repeated interaction (Jones, Hesterly, and Borgatti 1997; Kickert, Klijn, and Koppenjan 1997). The argument is that NBG is able to harness changes in social, political, and ecological contexts by making informal flexible multiactor, multilevel, and multisectoral coordination possible, as well as combining diverse sources of knowledge to cope with uncertainty (Kickert, Klijn, and Koppenjan 1997).

As a consequence of limited capacity for exploitation, the flexible NBG type produces suboptimal levels of overall welfare in times of stability and predictability. The lack of exploitive capacity means that the production of public goods will be difficult, and flexible governance will therefore be less effective in reaping the benefits from a condition of slow and gradual change. However, as change becomes faster and more uncertain, the flexible governance type performs better than the state-dominated alternative. The reason is that actors can adapt to changing circumstances without central coordination drawing on a much richer set of knowledge, institutional diversity, and policy alternatives as compared to state-dominated systems (cf. Folke et al. 2004; Koppenjan and Klijn 2004, 90–99).

Fast, Large-Scale Disturbances in Network Governance. The benevolent capacity of NBG for coping with fast uncertain change will however depend strongly on the spatial impacts of change. The reason for this is that NBG relies heavily on social coordination and control, collective sanctions, and reputations rather than on formal institutional rules and hierarchical authority. This means that NBG is dependent on the possibilities of repeated interactions (such as those provided by geographical proximity), on restricting the number of exchange actors in the network (to reduce coordination costs), and on the possibility of developing shared understandings, routines, and conventions (to be able to cope with change and resolve complex tasks; Jones, Hesterly, and Borgatti 1997; Larson 1992). This, in turn, means that the problem-solving capacity of NBG will be limited in a situation of fast, large-scale change, as these sorts of CAS effects often require quick unilateral response at other spatial scales or in other policy arenas than those targeted by participants in existing social networks. The critical lack of time to form shared understandings between actors and the absence of a "history of play" (Ahn et al. 2001), and hence the limited possibilities of applying collective sanctions are pivotal in this context.

State-Dominated Governance

State-dominated governance is characterized by the heavy involvement and control of state actors in decision making and implementation. The

drawbacks of this model have been widely acknowledged in terms of its limited capacity to deal with information deficits (Ostrom 1999), biased information (Pierre and Peters 2005), or lack of incentives to provide public goods (Ostrom, Wynne, and Schroeder 1993). As an example, Beck, Asenova, and Dickson (2005) conclude that the government's late response to the BSE crisis (i.e., mad cow disease; approximately 1995–2000) in the United Kingdom was caused by close-knit policy networks in which producer interest, experts, and officials were reluctant to disseminate knowledge about the crisis to a wider public. This caused economic losses of around £3.7 billion, public mistrust, and the dissolution of the Ministry of Agriculture. A similar finding is reported in Svensson, Mabuchi, and Kamikawa's (2006) comparative study of the early 1990s banking crises in Sweden and Japan. Although both countries are classified as cases of state-centric governance systems by Pierre and Peters (2005), the close linkages between the private banking sector and the Ministry of Finance in Japan led to a suboptimal handling of the crisis and prolonged negative effects for the economy, whereas Swedish authorities were more independent and therefore able to implement necessary measures. The lesson to be learned from these examples is that although state-dominated governance in Sweden and Japan had contributed to very high levels of economic growth prior to the crises, and the British agricultural industry is highly efficient at most times, the state-dominated governance model is not well equipped to deal with novel and fast changes.

State-dominated governance hence seems to perform at its best when change is slow and predictability is high. But due to limited capacity for exploration, performance drops rapidly compared to NBG as change becomes more rapid and uncertain. The reason for this is twofold. First, the lower capacity for exploration limits the perceived set of available alternative policies and institutional arrangements. Although the capacity to promote coordination among actors still remains high, central decision makers might lack a full understanding of which actions can and need to be taken. Second, what used to be the rigid governance type's foremost asset—strong and stable institutions and norms—is now turned into a liability. Path dependency and high sunk costs invested in institutional structures obstructs the fast and optimized rearrangement of institutional rules and practices.

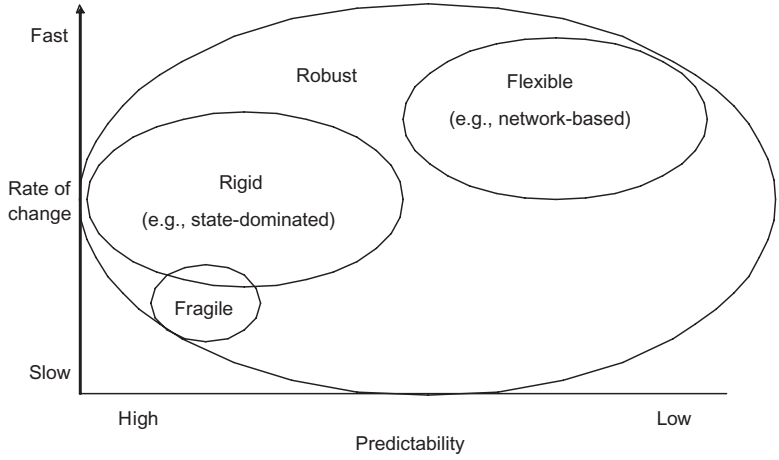
Fast, Large-Scale Disturbances in State-Dominated Governance. However, under conditions of very fast change and high unpredictability (i.e., disasters and crises), state-dominated governance can nevertheless be hypothesized to have an advantage vis-à-vis NBG. As Hirst (2000) has argued, the democratic nation state is still the only actor capable of simultaneously performing three key roles necessary to cope with fast change. First, in its capacity as a source of constitutional ordering, the state is capable of appropriately distributing powers and responsibilities between itself, regional and local governments, and civil society. Second, the democratic

state remains the main institution of democratic legitimacy that most citizens understand and are willing to accept. This is an indispensable asset in times when large-scale and comprehensive collective action is required (cf. Levi 1997). Third, national governments in stable democracies are externally legitimate; their decisions and commitments are taken as reliable by other states and political entities, which provides legitimacy for supranational majorities, quasi-polities, and interstate agreements (from Hirst 2000; see also Lundqvist 2001).

Amplifiers and Buffers—Interaction Effects in Multilevel Governance Systems

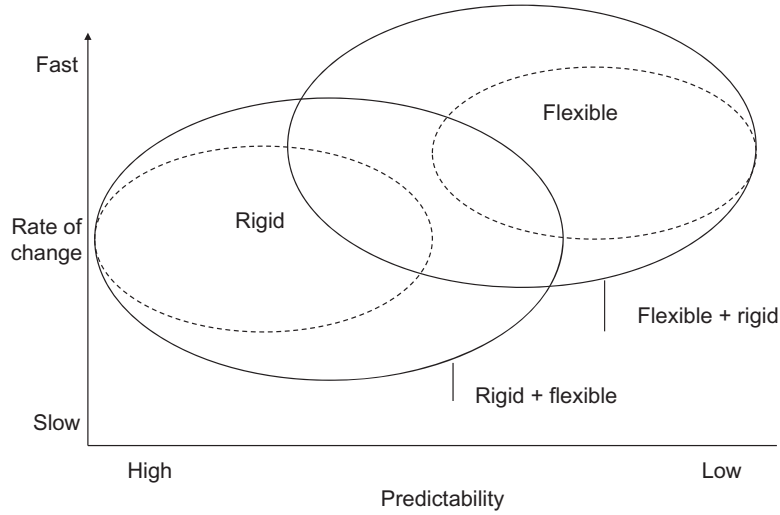
The hypotheses illustrated in Figure 2 presuppose that governance systems are scale free and unitary for a given community. By allowing for interaction effects between different governance systems nested within each other, a somewhat different picture emerges (cf. Cash et al. 2006; Young 2006). Similar notions have been expressed by scholars of natural resource management (Berkes, Colding, and Folke 2003; Ostrom 2005). Concepts such as "institutional redundancy" (Low et al. 2002) and "polycentric institutions" (McGinnis 2000) are based on the recognition of the interplay between institutions on different social levels. India's strategy to cope with climate change provides an example of cross-scale buffering effects:

FIGURE 2
Adaptive Capacity and Different Types of Complex Change



Note: The circles illustrate the adaptability domain of governance types, that is, the area of change in which each governance type is expected to have maximum adaptive capacity. (NB: Large-scale shocks not included).

FIGURE 3
Two Examples of Buffering Cross-Scale Interaction Effects



While initiatives from the central government to reduce underprivileged communities' vulnerability to the effects of climate change allegedly has been slow and ineffective (Science and Development Network 2005), a number of adaptation and risk-reducing strategies are promoted by a variety of actors (e.g., farmers, NGOs, international aid organizations, and the business community), which are likely to buffer some of the worst social impacts of projected extreme weather events (Mendelsohn and Dinar 1999; Moench and Dixit 2004).

Figure 3 shows how a combination of governance systems on different levels can sometimes produce cross-scale interaction effects. For the sake of simplicity we use the terms national and local to denote two different organizational levels, although much more complex interactions between multiple spatial and temporal scales are likely to be encountered in an empirical setting. The first interaction effect is illustrated by the area labeled "Rigid + flexible" and refers to the combination of local-level flexible governance and national-level rigid governance. An example of a flexible governance system buffering (and even transforming) a higher-level rigid governance system can be found in Tsai's (2006) recent study of how the evolution of "adaptive informal institutions" or coping strategies involving (formally illegal) local-level markets and firms eventually contributed to comprehensive reforms of China's economic policy, ruling party, and state.

In comparison with level-free rigid governance, this combination produces higher adaptive capacity for unexpected shocks without sacrificing performance in situations of slow and local change. The buffering effect resulting from local initiatives following the devastating earthquake in Mexico City is another example (Gavalya 1987).

In a similar fashion, the combination of rigid local-level governance and flexible national-level governance shows overall better adaptive capacity (illustrated in Figure 3 by the area labeled "Flexible + rigid"), as compared to the scale-free performance of flexible governance. Specifically, by virtue of a stronger capacity for collective action, rigid local governance buffers the weak performance of flexible governance in times of slow and gradual change.

On the other hand, if a rigid governance system at the national level is combined with fragile local communities, the drawbacks associated with the first system can be seriously amplified. The reason for this is that shocks and unexpected events that undermine problem-solving capacity at the national level might trigger collapses on the local level (ecological, economic, or social) that risk cascading back to the national level and seriously undermining the legitimacy of the state. Examples of this amplifying mechanism can be found in the literature dealing with the vulnerability of political regimes in the face of external and internal stresses and shocks (Jenkins and Bond 2001; Midgal 1986). Another recent example amplifying effects between different types of governance systems can be found in the case of Hurricane Katrina in New Orleans in 2005. A large part of the storm's devastating impact did not result from a lack of scientific information or failed meteorological predictions (Science 2005) but rather from the combination of a rigid federal emergency management system (Greber 2007; Schneider 2005) and an ill-prepared and disorganized fragile local governance system (Burns and Thomas 2006; Kiefer and Montjoy 2006). The failure of disaster management resulted in massive political distrust and called for political resignations and reorganization of the disaster management apparatus (Waugh 2006).

A similar amplifying effect can be found in the case where the advantages of a flexible governance type at the national level can be undermined by the failure of local communities to cope with crises triggered by unexpected and/or fast change. So although flexibility at the national level might promote learning and uncoordinated adaptation to slow change, the vulnerability of fragile local communities might trigger events such as political crises that bring to light the national system's poor ability to promote collective action.

6. Conclusions: Can CAS Be Governed?

Contrary to what is often assumed by policy scholars and policymakers, large parts of the world are not characterized by linear and predictable social, economical, or ecological processes. Instead, shocks and disturbances are much more common features than previously acknowledged. At the same time, a fundamental shift is on the way in how we govern ourselves. There is a move away from command-and-control management performed by Weberian bureaucrats within centralized national bureaucracies toward a plethora of different schemes of self-government,

public–private partnerships, collaborative efforts, policy entrepreneurs, and participatory initiatives usually gathered under the umbrella term of "governance."

For the Weberian bureaucracy, a high premium was put on the capacity for instigating collective action. Implementing large-scale policies through a centralized and formal administrative apparatus requires the ability to secure large-scale cooperation among citizens (cf. Levi 1997). In addition, the argument advanced by institutional economists such as North (1990b) is also based on the key role played by stability-inducing and transaction cost-lowering institutions for economic development. But the combined processes of the diminishing strength of the nation state and an increasingly complex, interlaced, and rapidly changing world has heightened the need for adaptation and flexibility in order to reduce vulnerability and secure vital resources of communities (Young et al. 2006).

Throughout this article, we have argued that there is a need to shift focus from studying the character of new patterns of governance (e.g., Kooiman 1993; Pierre and Peters 2005) to a research agenda that elaborates the problem-solving capacity of existing multilevel governance systems in the face of change characterized by nonlinear dynamics, threshold effects, and limited predictability.

At the core of such a research agenda is the question of whether it is at all possible to govern the messy and unpredictable nature of CAS. As we have argued, only a governance type that combines high capacities for exploration *and* exploitation—the robust governance type—can be expected to perform well regardless of the certainty and rate of change. However, the robust governance type is dependent upon resolving the fundamental tension between institutional stability and flexibility (Pierson 2004; Thelen 1999, 2003). Designing governance systems that simultaneously produce high levels of collective action and learning often means overriding basic institutional features such as path dependency and stickiness—a feat that is not likely to be accomplished easily and without conflict. This means that we are left with less than optimal governance systems for governing CAS. How to get a better analytical grip on the limits and possibilities of governance in a world where change is nonlinear, uncertain, and imbedded in a diversity of multilevel systems ranging from the natural to the social world remains a matter of great concern for the future of governance theory.

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