

## **Governance:**

### **Prospects of Complexity Theory in Revisiting System Theory<sup>1</sup>**

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*Abstract:* The broadest meaning of governance is the regulation of social activities utilizing a variety of modes and mechanism of societal regulation. These range from collectively binding decisions to uncoordinated individual action guided by social norms and rationality principles. In the political science literature of the 1950s and 1960s this theoretical problem was treated in terms of "control" and "regulation" by variants of system theory. However, during the 1980s this systematic perspective was crowded out by individualist approaches – above all rational choice – and a macro perspective of societal regulation was lost. Although governance theory tries to speak to these questions, its foundation in general social theories is rather weak. This paper argues that various streams of complexity theory offer a broader and deeper theoretical foundation for theories of governance and regulation than other existing approaches.

Complexity theory was initially developed in the physical and biological sciences. However, social scientists rapidly recognized its potential in formulating dynamic theories of the evolution of social systems. Whereas the various approaches differ in detail, they share common elements. These include the explicit modeling of multiple positive and negative feedbacks among the agents in a system, the introduction of learning and adaptation at the level of purposive agents, and the recognition of the multi-layer nature of social systems, in which phenomena at higher levels emerge from (but are not necessarily fully determined by) interactions at lower levels.

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## 1 Introduction

Within the last two decades, governance has arisen as a core concept in the social sciences. Emerging from organizational sociology and management science during the late 1960s and 1970s, within the 1980s and 1990s it diffused into almost all branches of the

social sciences. It became a conceptual bridge between an increasing number of disciplines and also has influenced political practice at the national and international level (2004).

Its major advantage is that it provides a rather abstract frame in order to cover a broad array of institutional arrangements and mechanisms by which the coordination, regulation and control of social systems and subsystems can be conceptualized. However, during the last decade, the concept became overextended. Many scholars use it as a “conceptual pass partout” with inflationary meanings, similar to the term “system” and “structure” in den 1970s. On the other hand, it might be exactly this conceptual vagueness and polyvalence that make it compatible with a wide range of social theories.

The main argument in this article is that the notion of governance has great potential as long as it is not conceptualized as a holistic macro structure referring to the functional “logic” of whole countries or even regions in the world. The analysis of governance structures or “modes of governance” has to link macro and micro levels, and to specify concrete “mechanisms” and their combinations through which societal self-steering actually works. Thus it can be conceived as a modernized systems theory. Recent developments in complexity theory can enrich this approach. In this way it can provide for a realist ontology of how modern societies have evolved, maintain order and stability, and adapt to new situations and challenges.

This article does not seek to give an encompassing overview of the blooming branch of governance literature, but it will focus on its core problems and a re-conceptualization from a complexity perspective. The paper begins with a short sketch of the "old systems theory", how it addressed the question of societal control and self-regulation, and which questions have been left unanswered. The second part of the paper outlines a perspective on social order and control through the lens of governance theory. An outline and comparative

analysis of three alternative formulations of complex systems theory in the social sciences is presented in part three. The final part discusses the implications of the complexity approach for governance theory.

## **2 From Traditional Systems Theory to Governance Theory**

Our main argument in this section is that governance theory is a modern variant of system theory - a structural and institutional approach on the various forms of social coordination and their combination. In such a perspective, societies generate social and political order not only through central decision-making and top-down control but also by local interaction and horizontal coordination. To arrive at such findings, social and political theory had to go a long way.

As Tainter (1988: 33-34) convincingly claims, there are – despite the undisputed variety of theories in social sciences – basically two main schools of thought which may be labeled as “conflict” and “integration” theories. The major classical contributions to the conflict school have been made by English and Scottish enlightenment philosophy, Marxism as well as American pluralism (Bentley and Truman). Main contributions to the integrationist view were made by Hegel, Spencer, Durkheim, and Parsons. Whereas conflict theory emphasizes that societies are held together *despite* diverging social interests, integrationist theorists stress cohesion and downplay conflict. Integration theory emphasizes (1) shared, rather than divided social interests; (2) mutual advantages instead of dominance and exploitation; (3) consensus, not coercion; and (4) societies as integrated systems rather than an arena of power struggles.

Both schools may be subdivided into macro or micro perspectives according to their dominant level of explanation (Bunge 1998, 2000). From a macro conflict perspective, order and stability either emerge out of the interests and actions of large collective actors or of “action aggregates” (e.g. classes, political elites) to maintain their privileged position and to use various institutions (e.g. government or ideology) as stability maintaining mechanisms. In contrast, the integration perspective at the macro level views these institutional arrangements not just working as in the interest of specific societal actors, but as specialized subsystems contributing to the stability of society as a whole.

## **2.1 Societies as arena of power struggle**

In a macro version of conflict theory the organic or machine-like view of society may be dissolved into a multiplicity of conflicting groups or individuals. Societies and governments are seen as stages of power struggles with politics a peaceful way of negotiating these conflicts. While this “arena perspective” may be found in many approaches, its clearest expression is provided by pluralist theory. Pluralism attained scientific prominence especially in the United States with the best known names doubtlessly being Bentley (1967) and Truman (1971). In their view politics is an endless struggle between social groups. Government actually is decomposed in a multitude of competing and cooperating groups, if it is not regarded as a group in its own right or as a neutral arbiter, who solely registers the group pressure and adjusts its decisions like a referee according to the shifting balance of group forces. In the most extreme version, institutional arrangements do not have any proper weight themselves and are mere reflections of contending socio-political forces.

## **2.2 Integration by social systems**

The other camp in this theory development consists of integration theories which operate at the macro level and explain societal order and reproduction by functionally specialized societal subsystems such as government, culture, and the economy. Governmental action is no longer motivated by subjective or instrumental motives, rather by objective requirements and systemic effects. Such views were prominent in various “systemic approaches” of neo-marxism, and, more importantly, sociological structural-functionalism. Both perspectives can be considered to be a reaction to the shortcomings of conflict theoretical approaches, but also to the legalist theories of state and society.

In political science the most prominent authors of this systems theoretical perspective were Parsons (Parsons 1951, 1964), Easton (1967) and Almond and Powell (1966) who aimed to identify the various functions and subsystems by which societies maintain their order and stability, but also adapt to new circumstances. A major integration force in Parsons’ and Almonds’ perspective was culture, an assumption which motivated large research programs on political culture in the late 1960s and early 1970s.

A special variant of system theory was developed in Germany through major contributions by Luhmann (1995) and Willke (1987) which also emphasized functional differentiation and “objective” functions of the political and other subsystem of modern societies. However, a novelty in Luhmann’s perspective was a re-conceptualization of social systems as mere modes of specialized communications, representing a variety of functional subsystems in the production of social order.

A common core of these approaches was to pinpoint objective forces working beneath the surface of formal political structures. Political action was seen less motivated by

concrete motives or interests of societal actors, but rather by objective problem pressures and structural necessities. As Mayntz (1982) rightly criticized, public policy was reduced to “problem solving processes”. Its outputs were explained (1) with the existence of systemic needs and (2) by the assumption that the political system is a “social self-regulation machine” supposed to solve problems that arise.

This functionalist mode of explanation has been strongly criticized in the profession. In particular, philosophers of science stressed the tautological and teleological content of this explanatory logic (Hempel 1965), and the failure to revealing the specific mechanisms or social forces through which functions and effects come about (Bunge 1996, Elster 1989). During the 1980s and 1990s, system theory as a general social theory became increasingly marginalized in political science. When the concept of system was used, it did no longer refer to encompassing regulatory and governing mechanisms, but was rather reduced to the notion of relational structure in the sense of some interrelatedness. For example, in Hughes’ concept of Large Technical System, the notion of system did not mean much more than a web of technical interdependencies and their economic and political implications (Hughes 1987).

### **2.3 Actors and rule systems**

In the 1980s a number of approaches responded to this criticism of system theory with the identification of components and operations through which integration is achieved. One of these variants is the structural approach, which should be distinguished from structural-functionalism, because it emphasizes structurizing effects of social relations, without simultaneously referring to functional imperatives. Structure refers on the one hand to the

empowerment of certain capacities or developments, on the other hand also to limits and restrictions that are implied in structural relationships. From this vantage point, a political system appears both as a structured arena as well as a structured actor to the extent that the actions of this unit are considered to be shaped by the various arrangements by which the action units are constituted and in which they are embedded. Institutional versions of this approach equated structures largely with rule systems. Whereas in conventional institutionalism such systems have been reduced for the most part to constitutional provisions and legal norms, new variants of the institutional approach also explored informal rules and historical traditions in the generation of social and political order.

In the 1980s new approaches have been developed in response to the criticism of determinism, but also to the juxtaposition of micro and macro-analysis. Rational and public choice theories combining elements of pluralism and institutionalism certainly fit into this theoretical movement. Even more relevant for our perspective are approaches combining systems and action theory, or structuralism and individualism. Examples are Boudon's (1978) and Coleman's (1990) "individualist structuralism", but also Mayntz' and Scharpf's "actor-centered institutionalism" (Mayntz & Scharpf 1995, Scharpf 1997), Ostrom's governance by rule regimes (Ostrom 1990, Ostrom 2000), Bunge's "systemism" (Bunge 2000), and even variants of historical institutionalism in which actors are partially autonomous, but at the same time institutionally "embedded" (Thelen 1999).

Most of these approaches employ a multi-level perspective of social analysis in stressing that not only individuals, but in particular, large organizations, and even meta-organizations (organizations of organizations) are playing an increasingly important role in political life (Coleman 1974). On the most general level, some of these approaches could be seen as combinations of pluralism and structuralism, or, more general, of conflict and inte-

gration theory. With their focus on actors as (largely) autonomous agents, and emergent effects in systems of action, however, they add an important analytical dimension.

Figure 1: Pathways to Governance Theory

	<b>Conflict</b>	<b>Integration</b>
<b>Macro analysis</b>	<b>Pluralism Theory (1950-60s)</b>	<b>System Theory (1960-70s)</b>
<b>Micro analysis</b>	<b>Rational action theory (1980s)</b>	<b>Governance Theory (1990ff)</b>

Within the two-dimensional space outlined above, theory development can be traced as a crisscross walk through the theoretical landscape between conflict and integration on the one hand and holistic vs. particularistic perspectives on the other hand (see figure 1). We thus conceive theory development neither as a simple cumulative process towards an increasing number of corroborated theories, nor as a sequence of shifts between incommensurable paradigms, but as process in which changing perspectives advance and extend the analytical toolbox, facilitating an increasingly fine-grained analysis of social and political mechanisms.

### **3 Governance as institutional cybernetics**

In order to locate the governance approach in this theoretical landscape, it is useful to take a short look at its etymological roots. “Governance” is derived from the Latin word “gubernare” which means to “steer” for instance a ship. The Latin word is a translation of the Greek words “kybernetes”, which was often used as analogy for "the art of government" similar to the steering of a ship. About 2000 years later this word inspired the science of “cybernetics”, and the notion of governance still indicates this cybernetic background in the analysis of processes of societal control and self-regulation (Schneider & Kenis 1996). However, in contrast to system theory’s use of cybernetic ideas during the 1960s, early governance theory avoided functionalist explanations through emphasis on social and political processes at the micro and meso-level. The aim was to reconstruct in detail how various institutional arrangements and rule systems work in the coordination and control of social actions. Mayntz, for instance, conceives governance as a rule system shaping the actions of social actors (Mayntz 2004), and Benz (2004) views governance as the steering and co-ordination of interdependent actors within complex rule systems (for recent reviews see Kohler-Koch & Rittberger 2006, Treib et al 2007, Van Kersbergen & Van Waarden 2004).

The novelty of governance theory thus is to decompose and deconstruct the institutional fabric and self-organization of modern societies into constellations of actors and rule regimes. In contrast to traditional system theory, it does not take integrative forces for granted, but attempts to specify the various factors and mechanisms that support or endanger social integration.

### **3.1 Modes and mechanism of governance**

From the perspective of cybernetics, a governance mechanism may be defined as a set of institutional components that provide “sensing” and “actuating” devices by which a social system is held within an area of “desired states” and by which undesirable situations are avoided. If a “problem” is defined as the difference between a preferred state and an undesired status quo, the function of governance is “problem-solving” in the sense of moving to desired states. Governance then is a system of rules in action (i.e. applied by social actors) by which desired societal states of affairs are approached (positive control), and undesired states avoided (negative control). In this respect, governance also refers to feedback mechanisms by which the difference between a desired state and the status quo is detected in order to enable a society to keep itself in a viable range. Theories in this tradition try to explain how institutional devices (in terms of rule systems) and control resources enable individual and collective actors to observe and define undesired states while in turn mobilizing, combining and coordinating various resources that are necessary to problem-solving.

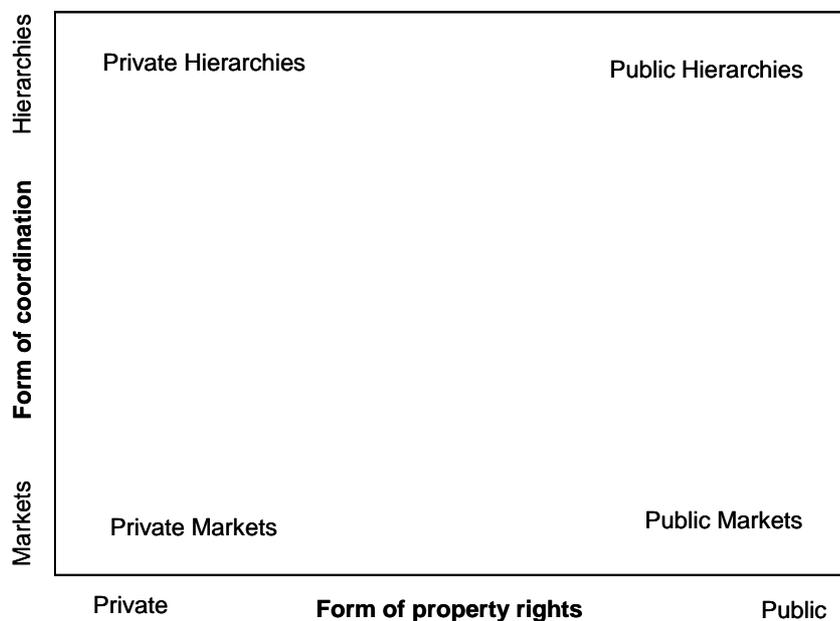
In the neo-institutional literature on governance, two major dimensions are basically distinguished, portraying the extreme poles of a whole spectrum of institutional arrangements in the form of private markets as well as public and private hierarchies, but also institutional combinations and hybrids. The combinatory space of these arrangements is depicted in Figure 2.

(1) Governance by private market: The allocation of resources and determination of social states emerges out of the interactions of many actors with many different interests and preferences and with separable control rights over specific resources. Actors are free to

contract according to their subjective utility functions and their purchasing power. The market-economic determination of a given social state or event then reflects the simultaneous expression of all different preferences by effective demand, and the aggregate offer of resources, to satisfy this demand. The capacity to control a given state of affairs is thus dispersed among a large number of market actors controlling relevant resources.

(2) Governance by public hierarchy: In the hierarchical-political mode of societal control social states or events are determined qua (chains of) authoritative decisions that unilaterally reflect the will of the political sovereign (e.g., the king, the people). The functioning of this form of societal control depends on the capacity of the sovereign to turn its decisions into practice. The capacity to control thus depends on the ability of this power center to exert hierarchical influence over the range of resources that are necessary to achieve a desired state of affairs.

Figure 2: A two-dimensional state space of governance structures



As already stated, the two control mechanisms are the extreme poles in the spectrum of governance mechanisms, and it is possible to conceive these configurations as ideal types on an analytical level. In reality they coexist in combination and are even functionally interdependent. For instance, market governance presupposes a support system provided by public hierarchies guaranteeing property rights and imposing some restrictions on the exclusive private control on resources.

Several situations are identified as warranting public intervention: (1) Some desirable goods and social conditions cannot be provided by market governance alone; (2) some negative effects (externalities) of market governance are socially destructive or at least disliked; and (3) the "rules of the game" in market governance cannot be provided by market governance itself. Such exogenous conditions of market coordination are a major theme in recent economic theories. Many are convinced of the numerous advantages of coordination by the "invisible hand". However, there is considerable disagreement as to which functioning forms of market exchanges emerge spontaneously and the conditions under which market coordination will work efficiently. Some of these approaches stress the fact that pure market coordination is only feasible and efficient when rather simple goods are exchanged (e.g. homogenous and perfectly divisible), whereas the exchange of complex goods will only work if additional institutional constraints prevail.

The emergence of hierarchical integration within and between firms (e.g. specific forms of vertical and horizontal integration), long term contracts, industrial networks, and diverse forms of common and public property as well are seen as institutional substitutes for market coordination, when this form of governance is either completely ineffective or at least inefficient in specific environmental contexts. From a systemic perspective, such non-market-forms can be interpreted as institutional responses to specific risks and frictions

related to certain technical and economic systems. Transaction cost theory, in particular, tries to predict which coordination form – markets or hierarchies, or mixtures - performs better with respect to different criteria. These include resource allocation, innovation and adaptation in a given environmental context in light of varying production and transaction costs (Williamson 1985).

Moreover, a number of authors have conceptualized networks and other social configurations such as clans, as alternative governance mechanisms to markets and hierarchies. If compared to the latter, the flexibility of networks provides a series of adaptive advantages. With respect to market coordination, networks may save transaction costs and provide for less contractual risks (Williamson 1991).

The hierarchy – network – market spectrum may also be applied to the political realm. From this standpoint, markets correspond to pluralistic political fields, whereas a public hierarchy is a configuration, in which policy-making and collective problem-solving would be exclusively limited to the state. Networks, finally, portray a complex division of labor and a decentralized pattern of control resources between public and private organizations. For instance, in a context of increasing functional differentiation and specialization, governments get increasingly dependent on non-state actors. As public policy making thrives on increasingly differentiated information and control resources, governments are less and less able to generate these resources on their own. Because policy resources are often concentrated outside the public realm within powerful private organizations (e.g., firms, associations), governance by governments is unthinkable today without the cooperation and support of non-governmental actors (Kenis & Schneider 1991).

### 3.2 New dangers of holism

Such a view of governance, in which a given situation is always constituted by a plurality of mechanism which interact in the production of social order is very similar to concepts in complexity theory, where order and self-organization can be reconstructed in a bottom-up fashion from locally interacting agents that communicate via networks and coordinate through emergent rule systems. From a complexity perspective, too, it would be naïve or illusionary to assume that whole societies or economic sectors could be governed by one „logic”. For example, a closer look at various forms of law – from customs, common law, statutory law, and regulations to constitutional rule systems – reveals a huge variety of mechanisms. It would be analytically rather counterproductive to subsume all under one single principle.

In many areas of inquiry, where the governance concept is used to analyse the functioning of political systems or the performance of public policies by governmental and non-governmental actors, there is currently this danger of over-simplification. For instance, it is sometimes argued that modern societies are in a transition from hierarchical to network governance. Although there is a grain of truth in this statement, it would not make much sense to assume that societies are only governed by hierarchies, or networks, or markets. Concrete societies are based on combinations of these generic and many other mechanisms, which we perhaps do not fully understand at the moment. If governance theory is used to reintroduce a single all-explaining mechanism, it is being transformed into the same holistic approach that was characteristic for systems theory in the 1960s and early 1970s, At that time Zawodny (1966) remarked: “If you don’t know what you’re talking about, call it „system“; [...] if you don’t know how it works, call it „process”. In order to avoid the danger of

speaking of “governance” if regulatory mechanisms remain obscure, in the next section we present some new approaches, which place a fine-grained analysis of complex interaction processes and rule systems at the core of a new analytical agenda.

#### **4 Variants of Complexity Theory and the Emergence of Social Order**

Theories in political sciences have in general become more actor-centered and conflict-oriented during the last decades – integration aspects move to the background. However, parallel to these theoretical shifts, some new approaches have evolved incorporating basic ideas of systems theory while at the same time relating systemic macro structures to interactions and interdependencies at the micro-level. At least three contemporary approaches may be mentioned in this respect. They are not only limited to political science but can be found in quite different sub-disciplines of the social sciences. These are variants of neo-institutionalism (which we conceive as crypto-systemic), ecological approaches, and complex adaptive systems (based on agent-based modeling).

##### **4.1 Institutional matrixes and rules systems**

Neo-institutional theorizing of the past 20 years can be characterized by the following new facets: (1) a diversified view on the richness of institutional arrangements; (2) an deepening of the concept of institutions to rejuvenate interest in informal arrangements; (3) a micro-analytical and often formal-theoretical foundation of how institutions actually work and impinge on individual action; (4) at least in some approaches the emphasis on the systemic character of institutional arrangements and rule regimes; and (5) more refined models of institutional change and evolution.

A common core of modern institutionalism is that society is no more conceived to be governed by a single integrated “logic” but by heterogeneous and diversified rule systems that are made up by multiple components and various levels. For instance, in such a perspective market arrangements cannot be conceived as a single monolithic institution, but rather as a complex combination of institutional components at various layers or levels. In this respect, for instance, economic institutionalism points to manifold preconditions for the functioning of market exchange which challenge the view that market coordination emerges spontaneously and will work under all conditions. Some of these approaches stress the fact that pure market arrangements are only feasible and efficient when rather simple goods are exchanged (e.g. homogenous and perfectly divisible). In this view, the exchange of more complex goods will only work on the basis of external support systems such as guaranteeing property rights by the state.

Economic and political systems in this perspective are constituted by a variety of institutions which may be linked and combined in complex ways (Dopfer et al 2004). An instructive example for this combinatory thinking is given by the bundle of rights concept within the property rights approach. Private property is not just conceived as an integrated institutional arrangement, but as a specific combination of various dimensions of rights (e.g. right to use, right to sell, etc.) which may not always coincide. Combinations of rights can be configured into varying property regimes, each creating different incentives and opportunity structures (Schlager & Ostrom 1992). Some forms of property create negative externalities or even perverse unintended effects which again could be averted by a specific division of rights through some form of public regulation. In this respect, macro institutions such as the state and other regulatory arrangements are conceived not only as a more or less

passive support structure in the background, but also as an important designer and shaper of efficient and effective property structures.

Interestingly Elinor Ostrom proposed this multiple rule perspective also for the analysis of policy making systems(Ostrom 1986). A policy process in this view is structured by a series of rules which distribute decision making power and authority among the various politico-institutional positions. Further rules are specifying, how actors get access to positions, which information channels they can use, and how collective decisions get aggregated. Collective action within policy-making systems is therefore governed by self-interested behavior *and* rule-guided interaction, where rules include formal constitutional structures but also informal arrangements.

A rather similar perspective is provided by actor-centered institutionalism (Mayntz & Scharpf 1995, Scharpf 1997) in which interaction between relevant policy actors is largely shaped by institutional arrangements such as politico-administrative hierarchies or actor networks, but important determinants are also specific action orientations. The behavioral model of this approach is not simply based on self-interested rational behavior, but allows a plurality of motives to be taken into account – from extreme forms of rational competition (maximizing differences) to altruism and various forms of self-sacrifice.

This detailed analysis of institutional arrangements and this combinatory perspective also provides for a dynamic and developmental perspective where institutional change and innovation can be conceptualized as a kind of re-combination process, similar to evolutionary variation and selection in the natural environment. This enables at the same time a better understanding of the processes that drive and shape institutional change, but also the factors that account for broad institutional variety and the dynamic spread of institutional forms. For instance, an empirical analysis of the long-term evolution of governance struc-

tures in telecommunications has shown that besides these major institutional models such as private markets or public monopolies, also a series of intermediate combinations have emerged by which individual countries tried to cope with specific challenges and to experiment with various solutions (Schneider 2001). Very often, however, the range of institutional options was limited by prior historical decisions. The selection of a specific institution at a given point in time implies “form constraints” (Gould 1987), for its further development, as it is also conceptualized by the notion of “path dependency” (Liebowitz 1995). Institutional evolution not always leads to more effective and efficient institutional arrangements, but may be locked-in in suboptimal development trajectories.

The use of path dependency modelling in institutional analysis is an example of further advancement in neo-institutional reasoning that was mentioned above. The new approaches avoid holistic explanations and strive for micro foundation and sometimes formalization. The aim is to understand how institutional rules shape individual and collective action in the making of public decisions and policies. Brian Arthur’s model of path dependency, for instance, can show that a small event could create an initial competitive advantage for an inferior institutional arrangement or a second-rate technology, which competitors in subsequent phases cannot make-up, because of positive feedbacks and network effects of the inferior system (Arthur 1989).

A final new facet in some institutional approaches that we will mention here, is the emphasis on the “systemic character” of rule systems. Institutional combinations are not just “ruleworks” (in analogy to the *network*) but rule configurations in a systemic sense implying necessary relations and particular requirements for coherence and complementarity. This aspect, for example, is expressed in the concept of “cross-system complementarity” used in the Varieties of Capitalism debate (Hall & Soskice 2001), which emphasizes

that, for instance, financial systems, corporate governance regimes and systems of industrial relations should support each other or at least be compatible (Jackson & Deeg 2006). Another concept is Douglas North's concept of "institutional matrices" which implies a variety of interconnected rules, in which changes in one rule also affect changes in many others. In complex societies, the various rule systems are combined in an "interdependent web" making institutional change more difficult and contingent of a number of preconditions (North 1991).

## **4.2 Organizational ecosystems**

A second variant of a theory of complex systems are ecological approaches which were mainly developed in the sociology of organizations. However, also in political science some attempts in this direction have been made. These approaches essentially apply the "ecosystem" idea and related key concepts of evolutionary change to social reality. Ecological approaches emphasize (1) the dynamic character of interdependencies and interaction between social actors in analogy to metabolism and food webs in biology; (2) the multiplicity of relations between the components of these systems; and (3) the existence of multiple and relatively autonomous layers and levels in such systems, and emergent relations between these levels.

As mentioned above, the most influential variants of this stream of theorizing are "population ecology" and "ecology of organizations" approaches in organization sciences (Baum 1996, Hannan & Freeman 1977). Both apply biological and evolutionary concepts to organizations, mostly oriented at the natural selection model. A core idea is that organizations are selected by their environments on the basis of their fitness in the context of en-

vironmental restrictions and pressures. Changes in organizational populations thus reflect the interplay of evolutionary mechanisms such as variation, selection and retention. Variation denotes the emergence of new organizational forms (by conscious decisions as well as by blind modification), selection means differential success in survival, and retention point to successful reproduction of a given organizational form.

Besides these dominant sociological perspectives there are also less influential views on community ecologies (Long 1958) which influenced political science and public administration, approaches using the ecological perspective in studies on technology policy (Dutton 1995, Vedel & Dutton 1990), and in the study of interest group systems (Grote & Lang 2003, Grote & Schneider 2005, Ronit & Schneider 1997, Schneider et al 2006). All ecological thinking in social theory were – directly or indirectly - influenced by the Chicago human ecology movement of the early twentieth century which treated human beings no longer as exceptional but rather as one species out of many that interact with each other and their natural environment (Hawley 1950).

Besides the basic evolutionary concepts that were outlined above, another key concept for the ecosystem approach is co-evolution. This notion also comes from biology and denotes mutual evolutionary influences between two or more species. Each party is considered to exert selective pressures on the other, thereby affecting each others' survival or selective retention. Co-evolutionary relations may be simple host-parasite links, but also dynamic predator and prey relations which often lead to an “evolutionary arms race”. Such dynamics are sometimes called “Red Queen Effect” (Kauffman 1995), referring to Lewis Carroll's “Through the Looking Glass”, where the Red Queen explains to Alice: "It takes all the running you can do, to keep in the same place."

Co-evolution is a central concept in “organization ecology”, which is a more proactive perspective than the population ecology that organizations (Lewin & Volberda 1999). Organizations change deliberately, observe each other and copy successful evolutionary (specialization) strategies. Organizational populations thus tend to get similar over time. A major selection mechanism is competition. Resource scarcity and competitive pressure force organizations to adapt their organizational structures or be punished with elimination. However, existent structures often cause inertia inhibiting successful adaptation.

Selection pressure in this perspective also is mediated by co-evolutionary interaction structures, which are not just restricted to cooperation and competition, but involve a spectrum of relations (Brittain & Wholey 1988, Lang 2006). Some of these are symmetrical, others are not. For instance full competition is symmetric, because both organizations are in the same niche and extract similar resources. Also mutualism and neutrality are symmetric relations, whereas commensalism, partial competition and “harmful” competition are asymmetric because attitudes or resource flows are not reciprocated. The spectrum of ecological relations is depicted in Table 1.

**Table 1: Ecological relations in structurally integrated networks**

	Organization B		
Organization A	Cooperation	Neutrality	Competition
Cooperation	Mutualism	Commensalism	“Harmful” Competition
Neutrality		Neutrality	Partial Competition
Competition			Full Competition

Source: Brittain/Wholey 1988

An important feature of organization ecology also is the introduction of a multilayered perspective where evolutionary mechanisms are different at the various levels in the overall organizational eco-system, and the interaction of levels produces emergent effects. Local interactions of agents (individuals, organizations) create dynamics at the level of populations or between populations that are not reducible to dynamics at the lower level.

Organizational ecology usually operates at three levels of analysis: Organizations, populations, and communities of organizations. “A set of organizations engaged in similar activities and with similar patterns of resource utilization constitutes a population [...]. Populations themselves develop relationships with other populations engaged in other activities that bind them into organizational communities. Organizational communities are functionally integrated systems of interacting populations” (Baum 1996: 78).

This level differentiation in evolutionary processes also is addressed in the debate on macro evolution (Stanley 1979). This notion emphasizes that each level involves different and specific mechanism – from the highest level, where rare and big events (such as mass extinctions by meteor impact) shape and influence the course of evolution, to the micro level, where natural selection for instance shapes genetic evolution. In the same manner cultural evolution can be conceived as a specific level involving different mechanisms than biological or physico-chemical evolution (Burns & Dietz 1992). A consequence of this multiple causation is that evolutionary processes are largely non-linear, evolution can “jump” and accelerate but also have significant draw-backs. If, for instance, the breakdown of ecosystems leads to the elimination of a large number of species, the clock of evolution will be set back.

Some of these timing and level problems are addressed in the concept of punctuated equilibrium which can be seen as a kind of “revolution theory” for evolutionary processes

(Gersick 1991, Thompson 1983). At a most general level, this perspective applies a Schumpeterian view of innovation and creative destruction to biology. It states that ecological equilibria tend to limit variation (hence innovation), whereas evolutionary breakthroughs and radical innovation mostly happen when equilibria get punctuated by external shocks or endogenous breakdowns. A consequence is a non-linear development process.

During the last ten years there are a few scholars in the political and organization science which applied this concept to organizational adaptation, technological innovation and changes in processes of public policy making (John 2003, True et al 1999).

The ecological perspective has important implications for the study of change and adaptation. If we apply this basic idea to individuals and organizations in the political, economic and social realm of society, governmental bureaucracies, parties, trade associations, firms, and scientific institutions are not just hierarchically integrated wholes whose structures and functions are determined by a macro structures (as it would be in a holistic theory), but relatively independent, loosely coupled subsystems which merely happen to co-evolve and react in a complex way to each other. When these multilayered systems are shaken by environmental upheavals, the relative autonomy of their components and levels implies that adaptation is also multileveled, and not all layers change at the same speed.

### **4.3 Complex adaptive systems and emergence of order from below**

The third variant in theorizing complex systems is complexity theory in the narrow sense as it was developed by Kauffman, Gellman, Holland and others on the one hand (the so-called „complex adaptive systems“-approach, see Holland 2006), and some recent developments in “agent-based modeling” on the other hand . For the latter quite a number of

different labels emerge in the literature: agent-based modelling (Axelrod 1997), multi-agent systems (Berger 2001), agent-based computational economics (Tesfatsion 2003), and artificial societies (Epstein & Axtell 1996).

Compared to versions of complexity theory that were outlined above, a general feature of this family of approaches is that they are all based on bottom-up explanations of social order. The aim is to understand general patterns in the generation processes of order merely by local interaction between heterogeneous agents, creating a growing set of behavioral rules simply by reciprocal observation, communication and bargaining. In such systems order does not come from above, but arises spontaneously. Order emerges without any central planner or top-down programming. This can be interpreted as emergent social complexity to cope with increasingly complex environments.

Such system consists of essentially four components: agents, networks, rules, and environments (Beinhocker 2006, Epstein & Axtell 1996). Agents may represent individuals, organizations and even societies. Networks enable information exchange between agents. Rules can be divided into three groups: (1) rules prescribing interactions between agents and environments; (2) rules that deal with interactions between environments; and (3) rules which regulate the interaction between agents.

The most important condition is that order does not come from above, as for instance Macy and Willer (2002) explain in their study with respect to swarm behaviour of birds. In such a formation there is no top-down control, no programming at macro level. Swarms do not have collective consciousness or group mind. Every single bird adapts its behavior locally to the behavior of its direct neighbours which influence each other. The “program” thus emerges by interaction at the bottom level. Basic assumptions are that agents are autonomous, heterogeneous, interdependent and capable of following simple

rules. This leads to system properties that can be described by: (1) non-linearity (behavior is largely unpredictable and less controllable); (2) emergence, that is, the interaction of local components produces global effects, which are not reducible to the aggregate alone (i.e., the whole is more than the sum of its parts); (3) self-organization, that is, information processing and learning

A key idea is that agents and populations seek improved performance over time (Axelrod & Cohen 2000). They adjust their actions based on experience, trial and error, feedback, imitation and learning. Adaptation works at individual and at population level. In this case we speak of complex adaptive systems (CAS). For John Holland CAS are systems that have a large numbers of components – often called agents – that interact and adapt or learn. „*The actions of the agent in its environment can be assigned a value (performance, utility, payoff, fitness or the like); and the agent behaves so as to increase this value over time*” (Holland & Miller 1991: 265); .

In order to illustrate this complex adaptation process, scientists have used the metaphor of a “fitness landscape” (Kauffman 1993, Ruse 1990) in which adaptation is compared to hill-climbing in a mountainous region. Elevations in the landscape represent better adaptation and increased fitness. A peak in the overall scenery indicates a kind of maximal “fitness”. Multiple peaks would imply that there are several combinations with rather similar degrees of fitness, and a single peak (like the Japanese Fujijama) in an overall landscape indicates that there is only one distinct structural or institutional combination that is best adapted to its environment. The various configurations of an “evolutionary unit” are represented by points in a three-dimensional space. Elevations in the landscape express the vertical dimension in the topography, whereas the two horizontal dimensions are indicating the proximity (similarity) of the various structural combinations to each other. Similar combi-

nations imply adjacent locations in the topography, whereas dissimilar combinations are located more in distance from each other. As Kauffman (Kauffman 1993) convincingly shows, evolutionary adaptation is significantly shaped by the overall topography of the landscape. This may be “smooth” or “rugged”. Variation in a rugged landscape is more risky than in a smooth one, since changes are subjected to stronger forces of selection. In a rugged area, one step in a “wrong direction” can lead to a plunge into a steep gorge. A small variation can drastically reduce the chances of survival. Successful evolution in the sense of a monotonically increasing fitness means a sequence of hill-climbing activities on a mountain range, leading from small hills to ever higher peaks and summits.

The metaphor of fitness landscapes is not just an illustrative analogy, but offers a number of conceptual advantages: It provides not only an easily accessible illustration of the core assumptions of evolution theory, but it also integrates some of the most recent developments in the theory of evolution: (1) “Normal” topographies with multiple peaks imply that there is not only one single successful strategy of adaptation. Often there is a whole series of local optima. (2) Specific topographies may imply a kind of “dead end” in the evolution process. The phenomenon of “path dependency” can imply that a specific sequence of hill-climbing paths leads to a local optimum where further development is “locked-in”. In terms of the fitness landscape, there is no uphill path from a medium peak to an adjacent higher peak. (3) Dependent on the shape of the landscape (rugged vs. smooth), variation also can lead to a stagnating or even declining fitness, as recent advances in the theory of evolution are dealing with this phenomenon in the “punctuated equilibrium” concept.

Complex Adaptive Systems change by various mechanisms (Beinhocker 2006, Kauffman 1993, 1995): (1) An adaptive walk consists of incremental steps uphill, downhill or across planes based on assessing the effects on the entire system of movement along the

landscape. This strategy is efficient at finding the highest point on the fitness landscape, if path dependent restrictions do not trap adaptation in local fitness peaks. (2) Patching is moving along the fitness landscape by assessing the effects on independent patches of system components (i.e. decisions at subsystem levels) in the adaptation of those patches. A patching algorithm improves upon the adaptive walk in more complex systems, because it allows local configurations to change in ways that may be suboptimal in the short term but alters the environment of other local units that ultimately allows the overall system to achieve a better solution over the course of a large number of moves. As a result, the system can potentially move to superior, non-local fitness peaks. (3) Jumps are non-incremental movements between distant sights in the fitness landscape. In natural systems, jumps may occur by mutations, in social and cultural systems through radical innovations or revolutionary changes (Cherry 2004, Cherry & Bauer 2006).

The concept of the fitness landscape also integrates concepts of ecological approaches discussed above. Complex systems are coevolving, when adaptive changes in one system's fitness position alter the fitness of another's in the overall ecology (Kauffman 1995).

During the past 10 years, some organizational scientists have shown that the concept of "fitness landscapes" also may be applied to the evolution of organizational, institutional or cultural structures (McKelvey 1999). Specific institutional arrangements may be conceived as combinations of "institutional genes" or "cultural traits", which are subjected to forces of variation and selection that may be far more complex than the various mechanisms in biological evolution. Applications the political science are still rare (Schneider 2001).

## **5 Towards an Integration of Complexity and Governance Perspectives**

In this section we try to develop an integrative frame of the three versions of complexity thinking as well as a link between complexity and governance theory. As we have shown, a common feature of these approaches is a multilevel and multi-component perspective on society in which social processes are not reducible to few basic principles that shape action and social evolution at the micro and macro level. Rather, a multiplicity of factors and conditions has to be taken into account, if one tries to explain a social phenomenon. Social processes are nested and differentiated, based on multiple mechanisms and a variety of social forces. A major common feature also is that social order is not explained purely by top-down programming but also by self-organized interaction at the bottom level. Systems get adaptive and ordered when individual agents operate independently in response to environments pressures but adjust their behavior in response to the action of others, interlinked by feedback loops.

Beinhocker (2006) recently claimed, mankind would have developed only two mechanisms for facilitating cooperation - hierarchies and markets. Other configurations he generally considers as combinational implementations of these two generic mechanisms. At the same time, however, Beinhocker points to a “vast array of social technologies” on which the economic system would be built on. Many would rely on government since market-based evolution would require mechanisms that balance between cooperation and competition, and he views contract law, consumer protection regulations, worker safety rules, and securities law are seen as social technologies supporting these aims/functions.

However, in our perspective social technologies and governance structures should not be seen as competing rather than as complementary concepts. The category of social

technologies is more general and points to science based applied knowledge on social structures and mechanisms which human society can use intervene into their respective affairs, to solve all sorts of problems and generally improve individual and collective action capacities (see for instance Bunge). Leadership models in management, review processes in academic journal, and new forms of electronic voting problem are all social technologies, but not all are governance structures. The latter term is more specific and should be reserved to a specific class of social technologies enabling and improving the coordination of collective affairs in the sense that they provide providing “sensing” and “actuating” devices by which undesirable social conditions are detected and be transformed to desired states.

In a complex systems perspective the multiple levels and differentiated sections must be integrated into a single picture. In such a view complex governance system are composed by governing agents (organizations or individuals) whose incentives, motives, calculations, etc. at the micro level are an important component in the explanation of steering and regulation processes at the macro level. At the same time, however, these agents are embedded into political, economic and cultural rule systems, which distribute rights, resources and incentives. This structure also may extend to relevant agents in the environment (“exostructure”), whose action may affect their wellbeing and viability, from whom they depend on and which they try to influence (Bunge 1996, 2000). Such governance systems are multilayered. They are nested in national political systems with the specific traditions and institutional entrenchments, which again are components of the global political systems in which nation states compete with various forms of private power.

The analysis of such plural und multilayered order-generating mechanisms must not necessary be formalized and modeled by mathematical equation systems. Explanatory sketches based on arrow diagrams, in which relevant causal flows and relations between

major components, their embeddedness in mechanisms can be depicted, sometimes can contribute more to an explanation than a mathematical model, whose precision is bogus, as some social qualities cannot be measured with the precision required for a substantive model (Bunge 1998).

## **6 Conclusion**

Complexity theory offers a promising approach to deepening and expanding governance theories. During the 1950s and 1960s, variants of systems theory were used to explain how societies control and regulate themselves using mechanisms ranging from collectively binding decisions to uncoordinated voluntary action. Since the 1950s, systems theory has advanced through various twists and turns toward a more fine-grained understanding of social coordination. Whereas this was neither a linear nor a cumulative process the state of knowledge overall has been enhanced, in particular with respect to coordination and adaptation in multi-layer social systems. Governance theory recognizes that societies generate order not only through central decision-making and top-down control but also by local interaction and horizontal coordination. It decomposes and deconstructs the institutional fabric and self-organization of societies into constellations of actors and rules regimes. The mainstream of governance theory has emphasized a few prototypical coordination mechanisms (e.g., markets, networks, hierarchies). Although it has added important insights, the actual mechanisms of governance are much more differentiated.

We discuss three more recent theoretical approaches that promise to go beyond these limitations: neo-institutional, organizational ecosystem, and complex adaptive system ap-

proaches. Because of the way they conceptualize the emergence of social order, these theories can be considered variants of complexity theory. Among other things, these approaches have in common to look at social coordination as a dynamic evolving system of actors, embedded in and shaping a multiplexity of relations as well as in an environment consisting of socially shaped rules and external factors. Social systems are modeled as multi-layer phenomena, in which the interactions among actors in relatively autonomous sub-systems generate emergent phenomena at higher levels. These emergent phenomena cannot be understood by disaggregating the systems into components or representative units. Institutional theory and organizational ecology allow for both bottom-up and top down coordination. Complex adaptive systems approaches and the related class of agent-based models emphasize bottom-up dynamics. As these subsystems and the matrices of rules they build are highly interdependent, institutional change will often be incremental and contingent upon coherent changes in other subsystems, resulting in co-evolutionary developments.

These approaches have several implications for the theory of governance and practical policy. Time, space, the heterogeneity of actors and their cognitive capabilities are important factors that influence the overall dynamics of the system. Unlike in more mechanically oriented theories of government and governance, purposive human agency is embedded in the overall system. Because of the highly interrelated dynamics in social systems, no single actor is typically in a position to control the trajectory of the whole system. At best, the system can be nudged in certain directions. This fluidity of the approach results in a more humble view as to the ability of theory to predict. Theory can understand the process by which adaptive change is generated but it may only be able to provide fairly broad statements about the future state of the system. Likewise, theory may not be able to deter-

mine a “best” course of action but rather facilitate the thinking in scenarios and possible developments. Much work remains to be done in this area before the relative explanatory power of complex adaptive systems theory is fully understood. Detailed case studies are one avenue for future research. The development of practical implications for policy-makers is another area in which fruitful efforts seem feasible.

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