

## COMPLEXITY, POLITICS AND PUBLIC POLICY

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### Contents

1. Introduction
  2. New Methods for Looking at Politics
  3. Theories of Decision-Making
  4. Self-Organization and "The Edge of Chaos"
  5. Positive Feedback, Increasing Returns and Path Dependence
  6. Conclusion
- Glossary  
Bibliography  
Biographical Sketch

### Summary

This paper explores the meaning and role of emerging insights from the sciences of complexity in the study of politics and public policy. Considerable attention is devoted to the relevance of Complex Adaptive Systems (CAS) to understanding important phenomena in politics and the realm of public policy. While traditional approaches to the study of these areas are not without merit, an understanding of CAS can yield important methodological and substantive insights. This paper discusses the advantages that simulations utilizing agent-based modeling offer for researchers. Several characteristics of CAS are also explored that can help us gain a better understanding of political and related phenomena. These characteristics include self-organization, positive feedback and path dependence. Examples are used to illustrate the applications of these facets of CAS to politics and policy.

### 1. Introduction

The history of science and scientific advance is, to a fundamental extent, the effort to understand, explain and ultimately predict phenomena that are observed in the natural or social world. Early efforts to understand human physiology, the behavior of planetary bodies or the fate of societies was based on the desire to understand, explain, and ultimately even to predict events. The study of politics also has historically-involved efforts at explanation and even prediction. These efforts range from classic works such as Aristotle's *Politics*, de Tocqueville's *Democracy in America* and much more recent efforts such as William Riker's *Theory of Political Coalitions* or Mancur Olson's *Logic of Collective Action* and Anthony Downs's *An Economic Theory of Democracy*.

The emergence of complexity theory and the related areas of nonlinear dynamics and chaos provide an important new approach to understanding the study of politics, political change, and related areas of study. Although the application of complexity theory and its offshoots is still in its relative infancy, it has the potential for helping us re-evaluate and re-examine many of the pre-existing lines of inquiry among political scientists and students of public policy, and may help us to offer new insights into a wide range of political processes at both the individual and aggregate levels of analysis. Whereas perhaps ten years ago the terms “complexity”, “chaos” and “nonlinear dynamics” or “self-organizing systems” would have drawn puzzled expressions, today they are an increasing part of the vocabulary of the social sciences.

The study of complex adaptive systems (or CAS) has emerged from the efforts by researchers in a range of disciplines to understand phenomena that could not be adequately explained by more traditional theoretical and methodological paradigms. The study of complexity encompasses what has often been referred to as the “science of chaos”. Indeed, although terms such as “chaos” and “complexity” are often treated as substantively and conceptually distinct, systems exhibiting chaotic dynamics can be understood as a subset of a broader class of phenomena we refer to as CAS.

A CAS can be conceptualized as an entity consisting of a number of elements, where a change in the condition of one part affects other elements of the system. Complex systems, or components of such systems, may periodically exhibit unstable, nonlinear kinds of behavior. Unlike linear systems which exhibit high levels of predictability (a unit change in  $x$  produces a unit change in  $y$ ), nonlinear processes reveal disproportionate changes between  $x$  and  $y$ , in a manner that produces unpredictable and even perhaps seemingly random behavior. Furthermore, changes in these relationships are subject to positive feedback in which changes are amplified, breaking up existing structures and behavior, and creating unexpected outcomes in the generation of new structure and behavior. These changes may result in new forms of equilibrium, or novel forms of increasing complexity, or even temporal behavior that appears random and devoid of order. This is the state of “chaos” in which uncertainty dominates and predictability breaks down.

With the focus on nonlinearity, instability and uncertainty, the application of complexity theory to the social sciences, including the study of politics, was perhaps predictable. The political realm is clearly nonlinear, where instability and unpredictability are inherent, and where cause and effect are often a puzzling maze. The obvious fact that political systems are historical and temporal systems also increases the potential value of complexity theory to the social sciences.

The insights provided by complexity and its progeny do not represent an attack on any particular methodological approach that has been adapted by social scientists. Rather, the science of chaos and complexity should suggest that many phenomena that are of interest to us in both the natural and social worlds may exhibit a level of “complexity” that limits our ability to predict their future evolution and which calls for the use of new analytic frameworks and tools that can supplement and enhance existing research approaches.

The charge of this paper is to explore the role that complexity plays in better understanding political and related phenomena. An extensive research agenda is being developed and established that applies the lessons of complexity to a range of issues, and it would be virtually impossible to elaborate on all of the possible ramifications and applications of these new approaches. This paper aims to point out some of the most critical elements or characteristics found in CAS, and suggest ways in which they can contribute, or have already contributed, to research efforts in politics and the policy sciences.

The writer first explores, in “New Methods for Looking at Politics”, important issues relating to new methodologies for understanding CAS. This paper examines three such methodologies: cellular automata, genetic algorithms and neural networks. Also discussed, in the same context, are the uses of agent-based modeling as a powerful new simulation tool. Such modeling holds the potential to uncover what could be otherwise highly opaque dynamics in CAS. An important element of most agent-based modeling is the ability to imbue the “agents” with different qualities or characteristics, such as the way in which agents make decisions. This, along with related concerns, is dealt with in “Theories of Decision-Making.”

The dynamical properties of CAS are characterized by properties of self-organization and path dependence. In “Self-Organization and The Edge of Chaos” this study discusses the fact that over time the individual elements of a system, independent of each other, are capable of evolving complex rules of interaction based on a set of simple rules of behavior governing each element. The significance of this property, in which self-organizing systems are capable of instability and disorder -- “the edge of chaos” -- is also explored.

CAS can also exhibit properties of positive feedback and path dependence. These principles can help us understand why so much of what we observe in politics, and other areas of the social sciences, is disequilibrium or “far from equilibrium” processes. Understanding the concept of positive feedback, increasing returns, and the related concept of path dependence offers new possibilities for better understanding important aspects of the political world. This is dealt with in “Equilibrium, Positive Feedback and Path Dependence.”

The paper concludes with some final observations; it is suggested that while CAS may hold considerable promise for the Social Sciences, a carefully drawn research agenda would help us avoid the pitfalls of excessive claims for this paradigm.

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## Biographical Sketch

**Euel Elliott** is Professor of Government, Politics and Political Economy in the School of Social Sciences at the University of Texas at Dallas. He has wide-ranging research interests, having published in the areas of voting and election behavior, public opinion and the dynamics of public policymaking. For the last several years he has been interested in applying the lessons of complex adaptive systems to political and policy related phenomena. He is the co-editor, with L. Douglas Kiel, of *Chaos Theory in the Social Sciences* (1996) and more recently, *Nonlinear Dynamics, Complexity and Public Policy* (2000). He is currently involved in an ongoing research project using agent-based simulations to explain organizational dynamics.