The Telecommunications Economy and Regulation as Coevolving Complex Adaptive Systems: Implications for Federalism

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I. INTRODUCTION

In numerous articles and papers, I have stressed in varying ways that *sustainable* regulatory telecommunications policies require simultaneous satisfaction of economic viability and political feasibility constraints, and that satisfaction of these constraints is becoming more challenging for regulatory regimes based on competition rather than monopoly. Some articles have examined the sustainability of specific regulatory policies, such as universal service,[1] rate rebalancing,[2] and the effects of detariffing on liability rules.[3] Others have broadened the scope of inquiry, looking at sustainability problems arising from fundamental attributes of the U.S. governance structure,[4] including efforts to retrench from public utility regulation[5] and to resist extension of common carriage obligations to broadband access services.[6] Throughout this research, I have sought to

1. Barbara A. Cherry & Steven S. Wildman, *Unilateral and Bilateral Rules: A Framework for Increasing Competition While Meeting Universal Service Goals in Telecommunications*, *in* MAKING UNIVERSAL SERVICE POLICY: ENHANCING THE PROCESS THROUGH MULTIDISCIPLINARY EVALUATION 39 (Barbara A. Cherry et al. eds., 1999).

2. *See generally* Barbara A. Cherry, *The Irony of Telecommunications Deregulation: Assessing the Role Reversal in U.S. and EU Policy*, *in* THE INTERNET UPHEAVAL: RAISING QUESTIONS, SEEKING ANSWERS IN COMMUNICATIONS POLICY 355 (Ingo Vogelsang & Benjamin M. Compaine eds., 2000) [hereinafter *Deregulation Role Reversal*]; Barbara A. Cherry & Johannes M. Bauer, *Institutional Arrangements and Price Rebalancing: Empirical Evidence from the United States and Europe*, 14 INFO. ECON & POL'Y 495 (2002).

3. *See generally* Barbara A. Cherry, *Improving Network Reliability—Liability Rules Must Recognize Investor Risk/Reward Strategies*, *in* RETHINKING RIGHTS AND REGULATIONS: INSTITUTIONAL RESPONSES TO NEW COMMUNICATION TECHNOLOGIES 309 (Lorrie Faith Cranor & Steven S. Wildman eds., 2003).

4. *See generally* Barbara A. Cherry & Steven S. Wildman, *Preventing Flawed Communication Policies by Addressing Constitutional Principles*, 2000 MICH. ST. L. REV. 55 (2000) [hereinafter *Preventing Flawed Communications Policies*].

5. *See generally* Barbara A. Cherry, *The Political Realities of Telecommunications Policies in the U.S.: How the Legacy of Public Utility Regulation Constrains Adoption of New Regulatory Models*, 2003 MICH. ST. L. REV. 757 (2003) [hereinafter *Political Realities*].

6. *See generally* Barbara A. Cherry, *Utilizing "Essentiality of Access" Analyses to Mitigate Risky, Costly, and Untimely Government Interventions in Converging Telecommunications Technologies and Markets*, 11 COMMLAW CONSPECTUS 251 (2003)

provide the foundation for a more general analytical framework for designing sustainable telecommunications policies based primarily on legal and economic analyses and incorporation of models and insights from the political science literature.

Most recently, I have sought to further enhance this framework by incorporating insights from complexity theory. Within the general academic community, there is a growing recognition that complexity theory, originally developed in the physical sciences, may also be applicable to the social sciences. Complexity theory is based on the distinctive properties of complex systems and provides a different paradigm for understanding and interacting with complex systems. Complexity theory is already influencing research concerning sustainable environmental policies,[7] and recent research is examining its potential application to communications policies.[8]

In research foundational to this Article, Bauer and I assert that complexity theory should be used to improve our understanding of the requirements for sustainable telecommunications policies.[9] More specifically, Bauer and I assert that if the telecommunications sector and the legal/policymaking institutions are viewed as coevolving and complex adaptive systems, then there are important implications for regulatory policy. One implication is that law and regulation will have a diminishing capacity to achieve specifically desired outcomes but will retain influence

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[hereinafter *Essentiality of Access*]; Barbara A. Cherry, *Misusing Network Neutrality to Eliminate Common Carriage Threatens Free Speech and the Postal System,* 33 N. KY. L. REV. 483 (2006).

7. *See*, *e.g.*, M. Beth L. Dempster, A Self-Organizing Systems Perspective on Planning for Sustainability (1998) (unpublished M.A. thesis, University of Waterloo) (on file with author); Robert J. Lempert, *A New Decision Sciences for Complex Systems*, 99(3) PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 7309 (2002), *available at* http://www.pnas.org/cgi/reprint/99/suppl_3/7309.pdf; J.B. Ruhl, *Complexity Theory as a Paradigm for the Dynamical Law-and-Society System: A Wake-Up Call for Legal Reductionism and the Modern Administrative State*, 45 DUKE L.J. 849, 855 (1996) [hereinafter *Complexity Theory Paradigm*]; J.B. Ruhl & Harold J. Ruhl, Jr., *The Arrow of the Law in Modern Administrative States: Using Complexity Theory to Reveal the Diminishing Returns and Increasing Risks the Burgeoning of Law Poses to Society*, 30 U.C. DAVIS L. REV. 405 (1997).

8. *See*, *e.g.*, P. H. Longstaff, *The Puzzle of Competition in the Communications Sector: Can Complex Systems be Regulated or Managed?* (Harvard Univ. Program on Info. Res. Policy, Working Paper, 2003), *available at* http://www.pirp.harvard.edu/pubs_pdf/longsta/longsta-p03-1.pdf; Barbara A. Cherry & Johannes M. Bauer, *Adaptive Regulation: Contours of a Policy Model for the Internet Economy* 26 (presented at the ITS 15th Biennial Conference on Sept. 6, 2004), *available at* http://userpage.fu-berlin.de/~jmueller/its/conf/berlin04/Papers/Cherry_paper.pdf [hereinafter *Adaptive Regulation*]; Johannes M. Bauer & Barbara A. Cherry, *Transatlantic Conundrums: Lessons for Europe?*, *in* ENCIP *i*2010: COMMENTS AND CONTRIBUTIONS, EUROCPR 2006: SELECTED PAPERS (Verhoest ed. 2006), *available at* http://www.encip.org/document/eurocpr_2006_publication.pdf.

9. *Adaptive Regulation*, *supra* note 8, at 31.

over possible, usually unpredictable, trajectories of sector performance. Instead, greater focus must be placed on how to design policies and policymaking processes that are more suitable for interacting with, interpreting, and responding to the telecommunications sector over time. In other words, greater attention must be paid to the adaptability of policies and the policymaking processes themselves as they evolve with the telecommunications sector.

This Article reviews the analysis in my previous work with Bauer[10] and then examines its implications for federalism, a distinctive characteristic of policymaking processes, in the U.S. More specifically, this Article shows that, from the perspective of complexity theory, federalism is a patching algorithm that confers system advantages for adaptability through diversity and coupling of policymaking jurisdictions. Such diversity and coupling is important for adaptability of the policymaking process itself by providing mechanisms for both experimentation and stability that are essential for development of sustainable policies. In addition, as a coevolving complex adaptive system, a federalism regime needs to evolve over time. For telecommunications regulation in the U.S., other scholars have already noted a shift from dual federalism towards cooperative federalism. This Article asserts that, as for sustainable environmental policies, further evolution in the federalism regime is required to improve the adaptive properties of the U.S. policymaking processes to provide sustainable telecommunications policies. Such evolution will require greater flexibility in the sharing of jurisdictional powers as well as the utilization of new tools to enhance development of robust and adaptive policies. An important implication of the complexity theory perspective is that policies of complete federal preemption, and particularly full deregulation, must be approached with great caution. This is because such policies eliminate the adaptive properties of a more highly patched and coupled policymaking system.

This Article is organized as follows. The next Part briefly discusses the shortcomings of the traditional paradigm implicit in most policy research for developing sustainable telecommunications policies in the present environment. Part III provides an overview of the analysis in *Adaptive Regulation: Contours of a Policy Model for the Internet Economy*[11] for creating a new paradigm based on insights from complexity theory, upon which the present Article relies and expands to examine the implications for federalism.[12] Parts IV and V describe the origins of

10. *Id.*

11. *See id.*

12. *Id*. at 22–31. In order to retain a primary focus on the implications for federalism, it is necessary to provide a condensed overview of the analysis in *Adaptive Regulation*. This

federalism and its historical evolution in the U.S. Part VI describes recent pressures for further evolution of federalism in the U.S. Part VII then examines federalism from the perspective of complexity theory. It shows that federalism is a patching algorithm that provides mechanisms of both innovation and stability that can improve the ability of the policymaking system to develop sustainable policy. This Part also reviews research analyzing cooperative federalism and adaptive decision-making tools in the context of environmental policy, with particular emphasis on the implications for policies of federal preemption and deregulation. The Article concludes with Part VIII, which discusses preliminary conclusions for revising federalism in the pursuit of sustainable telecommunications policy.

II. LIMITS OF THE PRESENT POLICY PARADIGM FOR SUSTAINABLE POLICIES

For over a century, nations' telecommunications networks—whether privately or publicly owned—were established and maintained under monopoly regulatory regimes. Notwithstanding losses in some forms of economic efficiency, monopoly telecommunication regimes have been sustainable and relatively stable over long periods of time. Given the then prevailing technological characteristics of supply, the economic conditions created by legal barriers to entry also permitted the pursuit of numerous social goals, such as universal service. Furthermore, once established, the institutions that developed to oversee and enforce the regime—which, in the U.S. consisted of federal and state regulatory administrative agencies—have persisted with only modest modifications.

In recent years, many nations have been transitioning from monopoly to competitive regimes and their telecommunications sectors are experiencing rapid rates of technological change. The attempts to transition to competitive regimes in an environment of dynamic technological change have unleashed tremendous forces for change not only on the providers of telecommunications services but on the governmental, legal, and policymaking institutions. These changing circumstances are challenging nations' abilities to design and implement *sustainable* telecommunications policies.[13] This is evident in the recent policy experience in the United

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overview attempts to be sufficiently detailed so as to familiarize the reader with key terms, concepts, and the underlying logic of the analytical framework for purposes of the present Article.

13. In the U.S., FCC Commissioners—whether Democrat or Republican—have emphasized both the need for and the challenge of developing sustainable policies in a competitive environment. *See*, *e.g.*, 2002 Biennial Regulatory Review, *Report and Order and Notice of Proposed Rulemaking*, 18 F.C.C.R. 13620, 13955–57 (2003) (Copps, Comm'r, dissenting); Review of the Section 251 Unbundling Obligations of Incumbent

States, for example, where important policies such as interconnection or universal service are undergoing continuous challenges and modification.

Bauer and I argue that these challenges are not just aberrations but reflect a fundamental shift in the governability of the increasingly complex system of communications technologies and services.[14] This reality undermines the efficacy and appropriateness of the traditional policy analysis paradigm. Under the traditional paradigm, policy recommendations are developed based on optimization of some measure of societal preferences reflected in an objective function, often a form of efficiency, using models that are essentially mechanic and deterministic.[15] Bauer and I assert that a new paradigm of policy analysis is needed that explicitly recognizes the evolutionary dynamic inherent in policymaking systems and the systems they endeavor to influence. Complexity theory provides critical insights for such a new paradigm.

III. TOWARD A NEW PARADIGM FOR SUSTAINABLE POLICIES

Bauer and I assert that constructive evaluation of a new paradigm for policy analysis should start with a clear articulation of the meaning of *sustainable policy*.[16] Although often referenced, debates concerning sustainable policies usually leave the term "sustainable" undefined. In prior research, I have examined various dimensions of policy sustainability (and unsustainability). Therefore, Bauer and I define the term *sustainable policy* to reflect the insights and conclusions of this research. "More specifically, *sustainable policies are defined as rules that are politically adoptable and for which the desired policy goals are reasonably likely to be achievable.*"[17]

An important contribution of this definition to policy research is not only its consistency with others' general discussions of policy effectiveness,[18] but also its explicit reference to the conditions of

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Local Exchange Carriers, *Report and Order on Remand and Further Notice of Proposed Rulemaking*, 18 F.C.C.R. 16978, 17505–06 (2003) (Powell, Comm'r, approving in part and dissenting in part).

14. *Adaptive Regulation*, *supra* note 8, at 5.

15. *See generally* G. MORÇÖL, A NEW MIND FOR POLICY ANALYSIS: TOWARD A POST-NEWTONIAN AND POSTPOSITIVIST EPISTEMOLOGY AND METHODOLOGY (2002).

16. *Adaptive Regulation*, *supra* note 8, at 5.

17. *Id.*

18. *See*, *e.g.*, Johannes M. Bauer, *Harnessing the Swarm, Communications Policy in an Era of Ubiquitous Networks and Disruptive Technologies*, 54 COMM. & STRATEGIES 19, 21 (2004) ("A policy instrument is effective if it is necessary and sufficient to cause a desired or prevent an undesired outcome."); J.B. Ruhl, *The Fitness of Law: Using Complexity Theory to Describe the Evolution of Law and Society and its Practical Meaning for Democracy*, 49 VAND. L. REV. 1407, 1451 (1996) ("A law is fit if it achieves its policy.") [hereinafter *Fitness of Law*].

"adoptability" and "achievability." As discussed more fully in *Adaptive Regulation*, "there are numerous constraints on adoptability and achievability—some foreseeable ex ante and others understandable perhaps only ex post—which this definition is intended to convey."[19] Of particular relevance are economic, political, and legal constraints that relate to political feasibility and economic viability of policy options. In addition, these constraints must be addressed on a dynamic basis and inherently give rise to various forms of inefficiencies. Part III.A of this Article summarizes the types of constraints affecting adoptability and achievability, their dynamic properties, and effects on efficiency.[20]

Bauer and I assert that the next step in evaluating a new paradigm is to recognize that, as outputs of policymaking systems and inputs to systems they intend to (or do) affect, "*policies are outputs of and inputs to coevolving complex adaptive systems*."[21] This is because the distinctive properties of complex systems have unique effects on adoptability and achievability, which, in essence, limit human ability to predict—much less control or manage—system behavior. Part III.B reviews key attributes of complex adaptive systems and their applicability to the economic sectors and policymaking systems.[22]

Finally, Bauer and I assert that the heightened difficulties of meeting the conditions of adoptability and achievability on a dynamic basis in complex systems have profound implications for developing sustainable policies.[23] Most fundamentally, this requires a shift from the traditional paradigm that emphasizes static optimization of parameters to an evolutionary paradigm that emphasizes adaptability. As discussed in Part III.C of this Article, we must modify our expectations of what policy goals and instruments can realistically accomplish, and policymakers need to be willing to use and develop new research tools to enhance development of more robust policy options.[24] Furthermore, and most relevant to the present Article, the policymaking system itself must be evaluated to determine whether it provides an appropriate balance of global structure and local randomness to enable innovation and order. From a complex system perspective, this means evaluating the patchiness and coupling of the system and its resultant adaptive capabilities. The remaining Parts of this Article analyze the implications of examining federalism from a complex system perspective.

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19. *Adaptive Regulation*, *supra* note 8, at 6.
20. *Id.*
21. *Id.* at 13.
22. *Id.* at 7–8.
23. *Id.* at 26.
24. *Id.* at 9–10.

A. General Constraints and Properties of Sustainable Policies

The design of sustainable policy starts with *goal-rule compatibility* between an underlying policy goal and the means selected for its accomplishment, so that an entity's fulfillment of the governmental requirement will likely lead to achievement of the goal for which the requirement was implemented.[25] Such compatibility requires not only a rational relationship between a goal and rule, but an empirically justifiable one as well. For the coexistence of multiple goals and rules, sustainability also requires *combinatorial rule compatibility*; that is, compatibility among any relevant combination of goals and their associated rules. This requires the requisite "cause and effect" relationship among goals and rules so that a combination of goals and rules do not work at cross-purposes, rendering certain goals necessarily unfulfillable.

Some policies do not satisfy goal-rule or combinatorial rule compatibilities—either initially or over time as circumstances change—because they violate conditions for economic viability of the relevant activity, firm, or industry. Wildman and I identify three general contexts in which economic constraints may limit design of sustainable policies.[26] First, an economy requires a legal system that generally supports private investment to ensure viability of the market itself. This requires legally enforceable rules that support economic transactions, such as a private property rights system and contract principles to facilitate exchange.[27] It also requires limitations on government behavior to protect private parties from arbitrary administrative action and expropriation of investment.[28]

The other two contexts arise when government attempts direct interventions to affect specific activities, firms, or industries in a system of exchange. One is that change in policies must satisfy *transitional sustainability*. This means that the effects of policy change on preexisting investment, contracts, or conduct of private parties must not render the

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25. Barbara A. Cherry, *Designing Regulation to Achieve Universal Service Goals: Unilateral or Bilateral Rules*, *in* TELECOMMUNICATIONS TRANSFORMATION: TECHNOLOGY, STRATEGY AND POLICY 343, 346–47 (E. Bohlin & S. L. Levin eds., 1998).

26. *See Preventing Flawed Communications Policies*, *supra* note 4, at 60, 97.

27. This is consistent with a growing literature that emphasizes the legal preconditions for competitive markets, an exemplary discussion of which is found in Kovacic. *See*, *e.g.*, William E. Kovacic, *Institutional Foundations for Economic Legal Reform in Transition Economies: The Case of Competition Policy and Antitrust Enforcement*, 77 CHI.-KENT L. REV. 265 (2001).

28. *See generally* Brian Levy & Pablo T. Spiller, *A Framework for Resolving the Regulatory Problem*, *in* REGULATIONS, INSTITUTIONS, AND COMMITMENT: COMPARATIVE STUDIES OF TELECOMMUNICATIONS 1 (Brian Levy & Pablo T. Spiller eds., 1996). The framework developed by Levy and Spiller is based on foundational research by Douglass C. North for which he was awarded the Nobel Prize in economics. DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE, AND ECONOMIC PERFORMANCE (1990).

desired commercial activity impossible or the firm or industry financially unviable. The other is that policies must satisfy *prospective sustainability*. This requires the coexistence of goal-rule and combinatorial rule compatibilities for the affected commercial activity, firm, or industry on a prospective basis throughout the time period relevant to achievement of the underlying goals. Prospective sustainability problems may arise in the absence of transitional sustainability problems, such as the imposition of coexisting, conflicting rules.

Sustainable policies must also satisfy the conditions of political feasibility for policy adoption and policy maintenance throughout the time period relevant to achievement of the underlying goals. "[P]olicy choices face political feasibility constraints in three different, albeit interrelated, contexts . . . ."[29] First, political feasibility requires that a government's intervention be constrained by those limitations on government action that generally support the legitimacy of government itself. This means that any government policy must consist of rules consistent with the "social contract" reflected in its governance structure.[30] Second, a specific policy option must be *initially adoptable*; that is a policy must consist of rules that are adoptable under the circumstances prevailing at the time of adoption.[31] Third, a policy must have *post-adoption stability*. This means that a policy must consist of rules that are able to remain in effect throughout the time period relevant to achievement of the underlying goals. In this regard, a policy must survive subsequent efforts of policy retrenchment.[32]

The mere multiplicity of the economic, legal, and political constraints on policy sustainability poses difficulties for simultaneously satisfying

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29. *Political Realities*, *supra* note 5, at 772. *See also* Barbara A. Cherry, *Regulatory and Political Influences on Media Management and Economics*, *in* HANDBOOK OF MEDIA MANAGEMENT AND ECONOMICS 91, 95 (Alan B. Albarran et al., eds., 2006) [hereinafter *Media Management & Economics*].

30. *Political Realities*, *supra* note 5, at 774.

31. Kingdon's model of the policy decision-making process provides a powerful analytical framework for determining the set of politically feasible policy options at a given point in time, as well as for identifying changes in circumstances that may likely enable the adoption of other options. In essence, the Kingdon model describes policy as the outcome of coupling the problem stream (agenda-setting process), the policy stream (development of policy options), and the political stream (consensus among policymakers) during a window of opportunity. *See generally* JOHN W. KINGDON, AGENDAS, ALTERNATIVES, AND PUBLIC POLICIES (HarperCollins College Publishers 2d ed. 1995). I use Kingdon's model to identify the institutional factors contributing to adoption of differing rate rebalancing policies in the U.S. and the European Union under their respective competitive telecommunications regulatory regimes. *Deregulation Role Reversal*, *supra* note 2, at 362.

32. Post-adoption stability poses problems for U.S. deregulatory policies affecting public utilities, particularly telecommunications providers. *Political Realities*, *supra* note 5, at 760. They include the difficulties of retrenching from common law doctrines embedded in common carriage and public utility law as well as the customer benefits of the traditional monopoly regimes that bear welfare state characteristics.

them all. However, the need to satisfy these constraints both initially and over time bears special emphasis, as they give rise to properties characteristic of complex systems. First, adoptability and achievability are dependent on *initial conditions and path dependence*. Adoptability and achievability of a policy (specific pairing of goals and rules) is dependent on the circumstances prevailing at the time of (desired) adoption, including the nation's existing institutional endowment and state of technology. Furthermore, most change in public policy is incremental, requiring the intervention of strong conjunctural forces for major policy change.[33] Second, adoptability and achievability must be *dynamically sustainable*. This is because the ability of a rule to remain in effect over the relevant time period, as well as its effectiveness in addressing the conditions for economic viability, will be affected by changes in the policymaking system and the economy.[34]

The interplay among the numerous economic, legal, and political constraints also has consequences for various dimensions of efficiency. Given the emphasis of the traditional policy paradigm on optimization, particularly of some efficiency measures, the relationship of efficiency to sustainable policy also bears emphasis.

First, as a general matter, limitations on government power are necessary to support both governmental legitimacy and long-term private sector investment.[35] One important source of limitations on government power in democracies is the purposeful imposition of *organizational inefficiencies on policymaking processes*—such as separation of powers and veto mechanisms—in order to check the powers of the majority.[36]

Second, pursuit of a policy in a specific situation may pose *tradeoffs among political feasibility and economic viability constraints*, requiring

33. *Political Realities*, *supra* note 5, at 774 (citation omitted). This article shows how differences in institutional endowments and historical telecommunications policies create differing feasible sets of rate rebalancing policy options between the U.S. and the European Union in the mid-1990s. *See generally Deregulation Role Reversal*, *supra* note 2. This article also shows how the legacy of public utility regulation in the U.S. constrains the feasible set of new regulatory models deemed adoptable in the U.S. *See generally Political Realities*, *supra* note 5.

34. For example, current federal universal service support programs in the U.S. face significant political and economic sustainability problems. *See id.* Furthermore, converging communications technologies and markets and related recent policy changes are rendering unsustainable numerous forms of "essentiality of access" broadband goals. *See Essentiality of Access*, *supra* note 6.

35. Levy & Spiller, *supra* note 28, at 1–2.

36. Barbara A. Cherry & Steve S. Wildman, *Institutional Endowment as Foundation for Regulatory Performance and Regime Transitions: The Role of the US Constitution in Telecommunications Regulation in the United States*, 23 TELECOMM. POL'Y 607, 610–11 (1999) [hereinafter *Institutional Endowment*]; *Preventing Flawed Communications Policies*, *supra* note 4, at 66–67.

adoption of policies that are less economically efficient. For example, universalistic benefits are more politically stable over time than residualistic (e.g., means-tested) benefits, even though the latter are economically less costly to society.[37] In addition, a nation's institutional endowment may require tradeoffs between equity and efficiency. For example, under the U.S. Constitution, protecting certain values (e.g., freedom of speech in the Bill of Rights) is of higher concern than efficiency.[38]

Third, combinatorial rule compatibility often requires tradeoffs *among differing forms of efficiency*, such as between short-term and long-term efficiency. For example, entry barriers (e.g., franchises, patents) may be required to enable development and deployment of new technology or innovation, in exchange for which some period of higher prices by a monopolist must be permitted. Without the opportunity for such profits, the innovation itself would likely not occur. Furthermore, change in policy rules to gain short term efficiency may also need to be sacrificed to provide stability to support investment for long term efficiency.[39]

B. Relations of Telecommunications Policy to Complexity Theory

To assert that telecommunications policies are outputs of and inputs to coevolving complex adaptive systems requires justification for asserting that policymaking systems and the economy are coevolving complex adaptive systems. This Part briefly reviews key concepts of complexity theory and distinctive properties of complex systems. It then reviews their applicability to the economy and policymaking systems.

1. Complexity Theory

Complexity research studies change in nonlinear dynamical systems and the factors leading to their sustainability or demise.[40] In complex systems, order arises spontaneously without any central planner and thus from seemingly random elements. Complex systems also paradoxically generate uncertainty. This dual ability to generate uncertainty and order

37. *Political Realities*, *supra* note 5, at 790.

38. *Institutional Endowment*, *supra* note 36, at 619.

39. *Id.*; *Preventing Flawed Communications Policies*, *supra* note 4, at 68.

40. *See generally* ROBERT AXELROD & MICHAEL D. COHEN, HARNESSING COMPLEXITY: ORGANIZATIONAL IMPLICATIONS OF A SCIENTIFIC FRONTIER (2000) (developing a framework that synthesizes the mechanisms and principles of the complex systems approach); JOHN L. CASTI, COMPLEXIFICATION: EXPLAINING A PARADOXICAL WORLD THROUGH THE SCIENCE OF SURPRISE (1994); STUART A. KAUFFMAN, THE ORIGINS OF ORDER: SELF-ORGANIZATION AND SELECTION IN EVOLUTION (1993); EDGAR E. PETERS, COMPLEXITY, RISK, AND FINANCIAL MARKETS (1999); *Fitness of Law*, *supra* note 18, at 1438.

enables the system to experiment, innovate, and create stability.[41]

Complexity theory is an umbrella term that embraces component areas of study to address distinctive properties of complex systems.[42] These properties include: *catastrophes* resulting from discontinuity in sudden jumps in system behavior; *chaos* resulting from unstable aperiodic behavior and sensitivity to initial conditions; *uncomputability* because system output transcends rules; *irreducibility* because system behavior can not be understood by decomposing the system into parts; and *emergence* of order that spontaneously develops as collective properties from interacting system components. By contrast, simple systems are characterized by predictable behavior, few interactions and feedback/feedforward loops, centralized decision making, and reducibility.[43]

The generators of chaos, emergence, and catastrophe within a complex system could cause the system to spiral out of control. Complexity theory uses the concept of *attractors* to represent the behavioral results that flow from forces of order and disorder that might exist within a system to regulate surprise generators of chaos, emergence, and catastrophe. Fixed attractors are ordered with regard to a fixed point or repetitive cycle lending stability and predictability to the system, but they potentially crumble when faced with external forces of disruption. "These 'strange attractors' lend flexibility and resilience to the system, but they are inherently unpredictable given their susceptibility to surprise behavior"[44] and extreme sensitivity to initial conditions.

When the community of fixed and strange attractors is assembled in the proper balance, the forces of order and disorder are combined to allow the system to adapt so as to remain sustainable. Such systems operate at the *edge of chaos*[45]—as their adaptability prevents degeneration or explosiveness—and are referred to as *complex adaptive systems*.[46] A complex adaptive system may also consist of interrelated subsystems that are also complex adaptive systems. Agent-based modeling, which describes systems in terms of strategies used by agents or populations over time as the agents or populations seek improved performance, is a powerful tool for designing or evaluating complex adaptive systems.[47]

Another powerful concept utilized in the evaluation and design of

41. *See* PETERS, *supra* note 40, at 48.

42. AXELROD & COHEN, *supra* note 40, at 15–20. *See generally* CASTI, *supra* note 40.

43. *See id.*

44. *Fitness of Law*, *supra* note 18, at 1441.

45. KAUFFMAN, *supra* 40, at 29.

46. AXELROD & COHEN, *supra* note 40, at 68–72; JOHN H. HOLLAND, HIDDEN ORDER: HOW ADAPTATION BUILDS COMPLEXITY 4 (1995); *Fitness of Law*, *supra* note 18, at 1442.

47. AXELROD & COHEN, *supra* note 40, at 1–11.

complex adaptive systems is *fitness landscape*. A fitness landscape—a concept developed in evolutionary biology—consists of varying fitness level potentials for an organism in a given environment, with peaks, valleys, and planes of the landscape representing the fitness potential of different combinations of behavioral schemata and organism structures.[48] Complexity theory uses fitness landscape as a metaphor to describe the mechanics of dynamical system evolution and the resulting fitness of system performance (however defined) to its environment.

A system moves around its fitness landscape through various mechanisms.[49] One is the *adaptive walk*, which consists of incremental steps uphill, downhill, or across planes based on assessing the effects on the entire system of movement along the landscape. The adaptive walk is efficient at finding the highest point on the fitness landscape in systems with no interconnections or spillovers between elements; otherwise, it is likely to become trapped at local fitness peaks.[50] Another mechanism is *patching*, which is a variant of the adaptive walk where movements along the fitness landscape are made by assessing the effects on independent patches of system components (i.e., decisions at subsystem levels) of movement along the fitness landscape 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, nonlocal fitness peaks.[51] A third mechanism is *jumps*, which are nonincremental movements across fitness landscapes. In natural systems, jumps may occur through environmental accidents or sexual recombination. In legal systems, jumps can be made deliberately through legal transformation, such as the development of new bodies of law.[52]

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48. STUART KAUFFMAN, AT HOME IN THE UNIVERSE: THE SEARCH FOR LAWS OF SELF-ORGANIZATION AND COMPLEXITY 224 (1995).

49. *See id.*; David G. Post & David R. Johnson, *"Chaos Prevailing on Every Continent": Towards A New Theory of Decentralized Decision-Making in Complex Systems*, 73 CHI.-KENT L. REV. 1055, 1057–58 (1998); *Fitness of Law*, *supra* note 18, at 1416.

50. An example of the adaptive walk is the incremental change that occurs in case law within a common law system. *See Fitness of Law*, *supra* note 18, at 1416.

51. Part VII, *infra*, discusses the adaptive walk and patching algorithms more fully, including the claim that federalism works in the U.S. because it is a patching algorithm to solve public policy problems over a complex social welfare landscape.

52. *Fitness of Law*, *supra* note 18, at 1459–61 (describing the development of environmental law in the 1970s in the U.S. as an example of a deliberate long jump).

The concept of the fitness landscape is also instrumental in understanding the interrelationships among complex systems. Importantly, *coevolving systems* are those that are *coupled*; that is, when movement along one system's fitness landscape alters the fitness landscape of another system.[53] Coevolution may occur either within a complex system comprised of coevolving subsystems or agents or among separate, though coupled, complex systems. An important insight from complexity theory research is that the overall mix of patchiness and coupling of the system components will determine the balance of (1) global structure for providing order, and (2) local randomness for creating innovation and resilience.[54]

2. Economic Sectors and Policymaking Systems as Coevolving Complex Adaptive Systems

Although they did not use the language of complexity theory, economists have long studied the emergence of "system-level properties produced by the structured interaction of simpler components."[55] Starting with the insights of Adam Smith, economists have been interested in how markets spontaneously create order and coordination from individual actions.[56] Recent strands of economic research have been influenced by notions of complexity.[57] This research recognizes that uncertainty is necessary for free markets to exist, as with all systems where a need for change and a need for stability coexist. The primary vehicle for change is competition, and regulation provides a global structure.

Similar themes are addressed by recent neo-institutional and evolutionary economics. One important insight of these bodies of research is that evolutionary processes and processes of self-organization need not lead to efficient outcomes.[58] Evolutionary processes provide mechanisms for selecting a solution, but not necessarily an optimal or efficient one.[59] Moreover, complex systems can have multiple equilibrium states, whose

53. KAUFFMAN, *supra* note 48, at 215–24. As explained in Part VII, *infra*, coupling may also occur among patches within a complex adaptive system. In some cases, as with the policymaking system in the U.S., patches themselves may be complex adaptive systems.

54. PETERS, *supra* note 40, at 6.

55. AXELROD & COHEN, *supra* note 40, at 19.

56. J. Barkley Rosser, Jr., *On the Complexities of Complex Economic Dynamics*, 13(4) J. ECON. PERSP. 169, 169–92 (1999); Warren J. Samuels, *Hayek from the Perspective of an Institutionalist Historian of Economic Thought: An Interpretive Essay*, 9 J. DES ECONOMISTES ET DES ETUDES HUMAINES 279, 279–90 (1999).

57. *See*, *e.g.*, W. BRIAN ARTHUR, INCREASING RETURNS AND PATH DEPENDENCE IN THE ECONOMY (1994); Rosser, *supra* note 56.

58. *See* NORTH, *supra* note 28, at 92–96; RICHARD R. NELSON & SIDNEY G. WINTER, AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE 14–21 (1982).

59. PETERS, *supra* note 40, at 119.

efficiency properties may be difficult to compare.[60]

There is also growing recognition that policymaking systems are complex adaptive systems and that they are involved in a coevolutionary dance with other complex adaptive systems in society, including business and economic systems.[61] Furthermore, the overarching legal system consists of recursive, complex adaptive subsystems that provide patchiness and coupling for its resilience and adaptivity.

For example, Ruhl and Geu assert that the common law is a complex adaptive system.[62] The common law is sensitive to initial conditions, is path dependent, is a self-referential system that replicates itself largely through the process of citation to precedent, and is a provider of sources of novelty that enable change, whether adaptive or maladaptive. Furthermore, Ruhl stresses that the common law is a "system of patched jurisdictions and various loose and strong couplings . . . [that] offers reasonable expectations of evolving towards the region of complexity—to the edge of chaos."[63]

Similarly, Geu asserts that the legislature is a separate and distinct, albeit interrelated, complex adaptive system apart from the judiciary.[64] Furthermore, Geu and Artigiani describe the U.S. Constitution as a complex system within which the complex adaptive systems of the common law and legislatures are nested.[65] Similarly, Ruhl finds that the U.S. Constitution creates a system reflecting patchiness (degree of dispersal of lawmaking power) and coupling (degree of interrelatedness between units into which power is dispersed) that is typical of complex systems.[66]

Ruhl further describes policymaking processes that have evolved within the overall framework of the U.S. Constitution.[67] More specifically,

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60. MASAHIKO AOKI, TOWARD A COMPARATIVE INSTITUTIONAL ANALYSIS 197 (2001); KARL-ERNST SCHENK, ECONOMIC INSTITUTIONS AND COMPLEXITY: STRUCTURES, INTERACTIONS AND EMERGENT PROPERTIES (2003).

61. Thomas Earl Geu, *Chaos, Complexity, and Coevolution: The Web of Law, Management Theory, and Law Related Services at the Millennium*, 65 TENN. L. REV. 925, 926–34 (1998) [hereinafter *The Web of Law*].

62. *Fitness of Law*, *supra* note 18, at 1471; *Complexity Theory Paradigm*, *supra* note 7, at 919; Thomas Earl Geu, *The Tao of Jurisprudence: Chaos, Brain Science, Synchronicity, and the Law*, 61 TENN. L. REV. 933, 941–42 (1994) [hereinafter *Tao of Jurisprudence*].

63. *Fitness of Law*, *supra* note 18, at 1472 (citation omitted).

64. *Tao of Jurisprudence*, *supra* note 62, at 942–46.

65. *See id.* at 988–89; Robert Artigiani, *Chaos and Constitutionalism: Toward a Post-Modern Theory of Social Evolution*, 34 WORLD FUTURES 131 (1992). Consistent with this view of nested complex systems is Reynolds' analysis of the U.S. Supreme Court as a dynamic complex system within the judiciary. *See generally* Glenn Harlan Reynolds, *Chaos and the Court*, 91 COLUM. L. REV. 110 (1991).

66. *See Complexity Theory Paradigm*, *supra* note 7, at 891, 893; *Fitness of Law*, *supra* note 18, at 1471.

67. *See Complexity Theory Paradigm*, *supra* note 7, at 925–26; *Fitness of Law*, *supra* note 18, at 1474.

he describes the development of the modern federal administrative state—which is comprised of congressional delegation of lawmaking authority to nondemocratic agencies whose decisions are insulated through legal doctrines of agency deference by the judiciary—as an adaptation in the lawmaking system's patchiness and coupling. Although the federal administrative state may at one time have been the "*fittest*" system for addressing the sociolegal problems of its day, Ruhl questions whether it remains the "*fittest*" system for the challenges of the future.[68]

C. General Implications for Sustainable Telecommunications Policies from a Complex Systems Perspective

We are now at a juncture where we can review the implications for designing and implementing sustainable telecommunications policies discussed in *Adaptive Regulation*.[69] They can perhaps be best described according to an outline of systemic sources of policy unsustainability and responses required to address such failures. The primary sources of policy unsustainability arise from: (1) initial improper design of the policy; (2) after adoption of even properly designed policy, changes internal or external to the policymaking system; and (3) the failure of the policymaking system to adapt.

To address these sources of unsustainability, we need to modify our expectations of what policies can realistically achieve. A first necessary step is the modification of expectations of policies (i.e., pairings of goals and rules/instruments) by shifting emphasis from static optimization under constraints to adaptability. Policies should not be expected to achieve specific outcomes. Nor should policies be expected to eliminate uncertainty, for—as a complex system—markets have coexisting needs for change and stability.[70] Instead, given the uncertainty and limited predictability of the economy and particularly the telecommunications sector, policymakers need to accept the necessity to experiment and closely monitor the effects of adopted policies. Consequentially, policymakers also need to accept the inevitability of policy failures. As a result, policy goals, as well as the means of achieving them, should be expected to evolve over time.

In addition to changes in expectations, policymakers need to be willing to use and develop new research tools. Such tools include genetic algorithms, exploratory modeling, and simulations to anticipate potential long-term consequences of policy options and their robustness over varying

68. *Id.* at 1483.
69. *Adaptive Regulation*, *supra* note 8, at 22–31.
70. *See* PETERS, *supra* note 40, at 2–3.

scenarios. In this regard, Timothy Muris, former chairman of the U.S. Federal Trade Commission ("FTC"), asserts that government agencies need to improve their institutional foundations for competition policy. This should include investment in competition research and development, for "[i]n a world of greater economic complexity and institutional multiplicity, building intellectual capital is essential to understand new phenomena and to exercise intellectual leadership."[71]

Finally, persuading policymakers to change their expectations of policies and to adopt new research tools is not sufficient. Policymakers must also be willing to evaluate and modify the institutional features of the policymaking system itself. Such an evaluation needs to consider whether the patchiness and coupling of the current system provides an appropriate balance of global structure and local randomness to enable innovation and order. The remaining Parts of this Article examine these implications for federalism from a complex system perspective.

IV. FEDERALISM AS AN INNOVATIVE AND DYNAMIC POLICYMAKING SYSTEM

Federalism is a distinctive form of governance structure that was first created in the United States Constitution.[72] "The concept of federalism . . . describes the complex relationship between the states and the federal government . . . ."[73] Due to this complexity, there are many definitions of federalism which vary as to the dimensions of the relationship that are emphasized.[74] However, the concept in common among these definitions is that "[a] federal system of governance arises when a group of equally-sovereign states combine to form a union in which they cede some sovereignty to a central government and retain some sovereignty."[75]

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71. Timothy J. Muris, *How History Can Inform Practice in Modern U.S. Competition Policy* 61 (Geo. Mason Univ. Sch. of Law, Law & Econ. Working Paper Series, Paper No. 04-20, 2004), *available at* http://ssrn.com/abstract_id=545184 (download paper under "SSRN Electronic Research Network" link).

72. FORREST MCDONALD, NOVUS ORDO SECLORUM: THE INTELLECTUAL ORIGINS OF THE CONSTITUTION 262 (1985) [hereinafter NOVUS ORDO SECLORUM].

73. Jonathan R. Macey, *Federal Deference to Local Regulators and the Economic Theory of Regulation: Toward a Public-Choice Explanation of Federalism*, 76 VA. L. REV. 265, 265 (1990).

74. Mark C. Gordon, *Differing Paradigms, Similar Flaws: Constructing a New Approach to Federalism in Congress and the Court*, 14 YALE L. & POL'Y REV. 187, 191 (1996).

75. Thomas S. Ulen, *Economic and Public-Choice Forces in Federalism*, 6 GEO. MASON L. REV. 921, 924–25 (1998) (citation omitted). McDonald claims that a more historically accurate statement is that the federal system in the U.S. was created "as a compact among peoples of different political societies, in their capacities as peoples of the several states." FORREST MCDONALD, STATES' RIGHTS AND THE UNION 9 (2000) [hereinafter STATES' RIGHTS]; NOVUS ORDO SECLORUM, *supra* note 72, at 280.

Although federalism does refer to *some* allocation of sovereign powers among the national government and states, the general concept is not intended to denote a *specific* allocation. Rather, allocation of powers may vary greatly among federal systems, as between the U.S. and the European Union. Furthermore, and more importantly for the analysis here, the allocation of powers within a given federal system may vary over time. That the allocation of powers among the federal and state governments has varied greatly in the U.S. throughout its history is well documented.[76] In fact, the "shifting trends in federalism, between centralization and decentralization, suggest that the Constitution is best understood as a dynamic political instrument."[77]

V. HISTORICAL EVOLUTION OF FEDERALISM IN THE U.S.

The allocation of powers among the federal and state governments specified in the U.S. Constitution at the time of its initial ratification, and as interpreted and enforced throughout the nation's early history, is often referred to as dual federalism. Dual federalism is "[t]he idea that the state and the federal governments operate in distinctly separate spheres."[78] During the nation's first century, federal-state relationships became increasingly turbulent as the nation struggled with the difficulties of keeping federal and state government powers restrained to separate spheres. Escalating tensions among the states' varying economic interests and interpretations of the appropriate scope of federal government power finally reached a breaking point among the states of the North as opposed to the South, culminating in the Civil War.

The defeat of the South that preserved the nation and post-war amendments to the U.S. Constitution were significant events that triggered reallocation of federal and state powers thereafter in the U.S. For example, an unforeseen consequence of the Civil War "was the general public's acceptance . . . of the idea that the [U.S. Supreme] Court was the sole and final arbiter of constitutional controversies."[79] Furthermore, "[f]or the most part, the Court left the states to do their bidding until after the turn of the [twentieth] century," even to the extent of permitting policies of segregation and disenfranchisement of blacks in the South.[80]

Yet, during the late nineteenth century, the Supreme Court embraced

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76. *See generally* STATES' RIGHTS, *supra* note 75.

77. Keith E. Whittington, *Dismantling the Modern State? The Changing Structural Foundations of Federalism*, 25 HASTINGS CONST. L.Q 483, 483–84 (1998).

78. *Id*. at 483, n.1.

79. STATES' RIGHTS, *surpa* note 75, at 224.

80. *Id.*

some acceptance of a federal police power.[81] During this period, Congress enacted its first laws to regulate interstate commerce under the Interstate Commerce Act and the Sherman Act, regulating railroads and creating antitrust law, respectively. During the early twentieth century, the Court also upheld federal laws placing some restrictions on states' regulation of working conditions. The rise of federal government power accelerated, however, after the Great Depression and World War II. Although scholars disagree as to the significance of the New Deal legislation in marking the decline of state powers, they do agree that greater centralization of power in the federal government occurred post-World War II.[82] In this regard, McDonald attributes a significant decline in state powers to key decisions by the Supreme Court.[83] The resulting shift toward increasing federal government power, which became clearer in the post-New Deal period, is often referred to as *cooperative federalism*, which "relies not on a division between, but on a sharing of, federal and state authority."[84]

Cooperative federalism evolved in a distinctive manner for industries —such as telecommunications—regulated by administrative agencies. The legislative delegation of regulatory power over industries to agencies was a legal innovation of the state governments in the nineteenth century. Initially established to regulate the activities of railroads, agencies were later given regulatory powers over other industries such as telegraph, telephone, electricity, and gas. Congress emulated the states by creating the Interstate Commerce Commission in 1887 to regulate railroads, with the Commission's jurisdiction expanded in 1910 to telegraph and telephone companies. In the Communications Act of 1934, Congress created a new agency, the Federal Communications Commission ("FCC"), to regulate telegraphy, telephony, and broadcasting.

The allocation of power among the federal and state agencies under the statutory framework set forth in the Communications Act of 1934, which in relevant respects was virtually identical to the Interstate Commerce Act of 1887, is usually described as a dual federalism model.[85] This is because the jurisdictional authority of the FCC and the state commissions was based on a division between interstate and intrastate communications, respectively. Over time, telecommunications regulation in the U.S. has evolved to a cooperative federalism model, although scholars vary as to when they deemed this transition to have occurred. For example,

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81. *Id.* at 226–28.

82. Whittington, *supra* note 77, at 503. *See also* STATES' RIGHTS, *supra* note 75.

83. *Id.* at 229–33.

84. Philip Weiser, *Cooperative Federalism and its Challenges*, 2003 MICH. ST. L. REV. 727, 728 (2003).

85. *Id.* at 728.

Noam states that:

> During the era following the 1934 Act, public policy-makers were under continuous pressure to reconcile the statutory fiction of separation with the reality of integration. What emerged from these efforts was a system of coregulation, in which both federal and state agencies regulated the same facilities at the same time. . . . The coregulatory regime was essentially cooperative.[86]

Weiser appears to consider the passage of the Telecommunications Act of 1996 to be the defining moment.[87]

VI. PRESSURES FOR A NEW FEDERALISM MODEL IN THE U.S.

"The future of federalism will respond to emerging political forces, such as new political ideologies and economic commitments, that will not replicate old patterns, but will rather react to their own historic logic."[88] In particular, Whittington claims that "[t]hose basic forces that encouraged centralization [by the federal government] through most of the twentieth century have exhausted themselves, and the centralizing bias that was present earlier this century has correspondingly weakened. Moreover, an examination of emerging political currents suggests that the forces of change may instead favor decentralization."[89]

Similar assertions have been made with regard to the administrative state in general, stressing that too much power has become concentrated in the federal government, which hinders adaptability:

> A central lesson of the limitations of New Deal institutions is that effective government services and regulations must be continuously adapted and recombined to respond to diverse and changing local conditions, where local may mean municipal, county, state, or regional as the problem requires. This adaptability is just what the separate, centralized agencies of the New Deal, and the doctrines authorizing delegation of rulemaking power to them, lacked. The constant effort to adjust programs, regulations, and doctrines to changing circumstances has been the agencies' undoing.[90]

With regard to telecommunications regulation, as early as the 1980s, Noam claimed that "[t]he system of coregulation crumbled when the federal level of government, spurred by technological, entrepreneurial, and ideological trends, asserted itself and reshaped the industry structure in which the states

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86. Eli M. Noam, *Federal and State Roles in Telecommunications: The Effects of Deregulation*, 36 VAND. L. REV. 949, 955–56 (1983).

87. *See* Weiser, *supra* note 84, at 728.

88. Whittington, *supra* note 77, at 524.

89. *Id.* at 503. The forces that favor decentralization include erosion of trust in the federal government, revitalization of moral and institutional capacity of state governments, and a new public morality favoring localization of values and acceptance of diversity. *Id.*

90. Michael C. Dorf & Charles F. Sabel, *A Constitution of Democratic Experimentalism*, 98 COLUM. L. REV. 267, 315 (1998) (citation omitted).

operated."[91] Examples of FCC actions include deregulating terminal equipment, opening the long-distance market to new entrants, permitting telephone carriers to provide enhanced and unregulated services, and permitting pay-broadcasting TV. Noam attributes the unsustainability of cooperative federalism for telecommunications regulation to the divergence of goals between the FCC and the state commissions,[92] and that "[t]he primary legal weapon that the federal government has used to achieve its position [of dominance over telecommunications regulation] is the doctrine of federal preemption. . . ."[93]

In addition, Weiser identifies difficulties with cooperative federalism under the Telecommunications Act of 1996. In this regard, Weiser asserts that "[t]o date, the FCC has not conceptualized the Act's cooperative federalism strategy in a clear framework."[94] Even more critical of the judiciary, Weiser states that "the Telecom Act's cooperative federalism strategy, the flexibility and authority that the FCC possesses in making telecommunications policy also inheres in state agencies who act under the oversight of the FCC. To date, however, the federal courts have failed to appreciate this feature of the Act's cooperative federalism design . . . " by declining to give *Chevron* deference to state agency decisions.[95]

Yet, perhaps the most extensive research regarding the pressures for change in the current cooperative federalism model of agency regulation has been in the context of environmental regulation. Furthermore, much of this research has been framed in terms of the need for sustainable policies from the perspective of complexity theory. Given the similarity in approach to the analysis in this Article, reference to the research on environmental policy is incorporated in the following Part that examines federalism as a patching algorithm.

VII. USING COMPLEXITY THEORY FOR EVOLUTION OF A NEW FEDERALISM MODEL

Recalling that policies are outputs of and inputs to coevolving complex adaptive systems, how can sustainable telecommunications policies be created to enable both the policymaking system and the economy to move to higher points on their respective fitness landscapes? More specifically, for purposes of this Article, how should a policymaking

91. Noam, *supra* note 86, at 975.

92. "This divergence of goals occurred when the FCC began to embrace the concepts of efficiency, competition, markets, and entry, while the state commissions continued to emphasize equity and redistribution." *Id.* at 956.

93. *Id.* at 971.

94. Weiser, *supra* note 84, at 730.

95. *Id.* at 731.

system be designed to better enable the production of sustainable telecommunications policies? This Part discusses how complexity theory can be used to answer this question, with primary emphasis on the implications for federalism.

A. Recognizing Federalism as a Patching Algorithm

As with other complex adaptive systems, "problems of this sort are computationally intractable, incapable of true solution by any known methods."[96] Post and Johnson assert that "[l]egal theory would, we believe, be enriched . . . by paying additional attention to the study of various algorithms derived from the study of 'complex adaptive systems' that can successfully operate on problems of this kind."[97]

From the complexity theory perspective, there are several kinds of problem-solving algorithms, two of which are relevant here. One is a simple trial-and-error method known as the *simple adaptive walk.* An adaptive walk procedure is described as follows:

> Aggregate system fitness is calculated for the initial configuration in which the system begins, after which one randomly-selected element is "flipped" [or changed] from state 0 to 1 (or vice versa). Aggregate system fitness is recalculated for this changed configuration, taking into account that the "flip" will affect the fitness contribution of all elements on whom the flipped "spills over," i.e., all elements whose spillover sets include the flipped element. If system fitness post-"flip" is higher than pre-"flip"—i.e., if the new configuration has moved the system *up* the fitness landscape—we change the system configuration to the new configuration with the "flip" in place, and we repeat the process with this new configuration as the initial configuration. If, however, the change causes a decrease in system fitness—if the new configuration has moved the system *down* the fitness landscape—the change is rolled back, returning the flipped element to its starting configuration,[98] and the process is repeated from the original configuration.

The adaptive walk is an effective algorithm for finding the highest point on the fitness landscape for systems with no interconnections or spillovers between elements. "In systems with substantial spillover effects, however, the algorithm performs progressively less and less well. On these more rugged fitness landscapes, the adaptive walk is increasingly likely to become trapped on *local fitness peaks*—places on the fitness landscape from which there are no steps leading upwards at all."[99]

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96. Post & Johnson, *supra* note 49, at 1059 (citation omitted).

97. *Id.*

98. *Id.* at 1075.

99. *Id.* at 1076 (citations omitted). In a system with no spillover effects, each element's fitness contribution is a function only of its own state. *See id.* at 1075.

For systems with substantial spillover effects there is a different algorithm called *patching,* which is a variant of the adaptive walk.[100] The patching algorithm is described in depth by Kauffman, and it was discovered by Kauffman and his colleagues at the Santa Fe Institute.[101] In a patching algorithm, each element in the system is assigned to a single group of elements, or patch. As an element is flipped, the fitness of the patch is recalculated. The individual element is permitted to move from one state to another if, but only if, the effect of the move is positive on the aggregate fitness of the members of its patch. Thus, "[t]he patching algorithm seeks local, within-patch improvements in fitness rather than global improvements. . . . Each patch is allowed to maximize its own fitness, independent of any effects on the fitness of non-members or on the aggregate fitness of the system as a whole."[102] Thus, patching is an adaptive walk over a patched system.

However, an individual element's patch and spillover set may consist of the same elements, have partial overlap, or be disjoint. If an element's spillover set contains an element that is *not* also a member of the patch, then the effect on the nonpatch element will not be incorporated into the assessment of local, within-patch fitness. The measure of overlap between an individual element's patch and spillover set is called its *congruence*.[103] Thus, when an element's patch and spillover set are completely congruent, then the spillover effects are internalized within the patch. But, when an individual element's patch and spillover set are disjoint or partially overlap, the patch and spillover set are coupled, creating spillover effects that are not internalized within the patch.

> Kauffman has shown that this patching algorithm can, in certain circumstances, dramatically increase the efficiency of the search for high aggregate system fitness; an adaptive walk over a patched system finds, in a given number of steps, higher points on the fitness landscape *for the system as a whole* than the same walk over the same system without patching.[104]

It is the *destabilizing effects* of the patching procedure—due to coupling, or lack of complete congruence for all patches—that makes it more effective:

> Patching is effective, it appears, because it reduces the tendency of the adaptive walk to become trapped on suboptimal local fitness peaks . . . By moving to points lower on the fitness landscape, it can reach other, higher configurations that it would otherwise be unable to reach under

100. In a system with spillover effects, "[a]n element's 'spillover set' consists of those elements whose fitness contribution is a function of that element's state . . . ." Post & Johnson, *supra* note 49, at 1078, n.56.

101. KAUFFMAN, *supra* note 48.

102. Post & Johnson, *supra* note 49, at 1078 (citation omitted).

103. *Id.* at 1078, n.56.

104. *Id.* at 1078 (citation omitted).

> the simple adaptive walk. It is, in other words, precisely the systemically *destabilizing* effects of the patching procedure that makes it effective.[105]

Therefore, it is precisely because each patch is permitted to experiment based on assessment of its own patch fitness—notwithstanding the external effects on other patches and the system—that the overall system has the opportunity to move to higher levels of global fitness.

Although predating the development of complexity theory, the courts have similarly referred to the value of state experimentation within the federalism structure of the U.S. Constitution. By far the most widely cited reference is Justice Brandeis of the Supreme Court in his dissenting opinion in *New State Ice Co. v. Liebmann*. Justice Brandeis states:

> There must be power in the states and the nation to remould, through experimentation, our economic practices and institutions to meet changing social and economic needs. . . .
>
> To stay experimentation in things social and economic is a grave responsibility. Denial of the right to experiment may be fraught with serious consequences to the Nation. It is one of the happy incidents of the federal system that a single courageous State may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country. This Court has the power to prevent an experiment. We may strike down the statute which embodies it on the ground that, in our opinion, the measure is arbitrary, capricious or unreasonable. We have power to do this, because the due process clause has been held by the Court applicable to matters of substantive law as well as to matters of procedure. But in the exercise of this high power, we must be ever on our guard, lest we erect our prejudices into legal principles. If we would guide by the light of reason, we must let our minds be bold.[106]

Justice Jackson expressed similar sentiments two decades later in a case before the Supreme Court, with specific reference to the regulation of public utilities by administrative agencies:

> Congress may well have believed that diversity of experimentation in the field of regulation has values which centralization and uniformity destroy. . . . Long before the Federal Government could be stirred to regulate utilities, courageous states took the initiative and almost the whole body of utility practice has resulted from their experiences.
>
> We must not forget that regulatory measures are temporary expedients, not eternal verities—if indeed they are verities at all. . . . It must be remembered that closer than any federal agency to those they regulate and to their customers are the state authorities, whose mechanisms are less cumbersome and whose principles can much more quickly be adjusted to the changing times.

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105. *Id.* at 1079.

106. *New State Ice Co. v. Liebmann,* 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting) (citation omitted).

> We should not utilize the centralizing powers of the federal judiciary to destroy diversities between states which Congress has been scrupulous to protect. If now and then some state does not regulate its utilities according to the federal standard, it may be a small price to pay for preserving the state initiative which gave us utilities regulation far in advance of federal initiative.[107]

Weiser also stresses the value of state experimentation in his critique of cooperative federalism under the Telecommunications Act of 1996. As with Justice Brandeis and Justice Jackson, he does so without reference to—although consistent with—complexity theory:

> A critical advantage of a cooperative federalism approach is that it sets forth a basic federal framework while allowing states to experiment within certain contours. . . . Particularly for situations where there are a number of alternative plausible solutions, relying on state agencies can offer an alternative to the risk of adopting a national approach that steers the wrong course.[108]

Moreover, Weiser asserts that the federal courts should give *Chevron* deference to certain state agency decisions under the Telecommunications Act of 1996 precisely because it would better enable enforcement of state experimentation as Congress (he argues) intended. "By designing a statutory scheme that assigns important interpretive authority to state agencies, Congress recognizes the value of tailoring federal regulation to local conditions as well as the value of experimenting with different approaches."[109]

This similarity in expression of the same phenomenon by complexity theorists and legal theorists has been explicitly recognized, with federalism described as a patching algorithm for solving public policy problems. Post and Johnson provide an exemplary discussion linking the same concept between the disciplines of law and complexity theory:

> Patching may be more than merely a metaphor for decentralized political decision-making structures (though it is that and no less interesting because of it); those structures may, in a sense, be instantiations of the patching algorithm in the political realm. Federalism may "work," in other words, because it *is* a "patching algorithm," a means for solving public policy problems defined over a most complex "social welfare landscape. . . ."
>
> Justice Brandeis memorably praised federalism as a means to allow "a single courageous state [to] serve as a laboratory . . . without risk to the rest of the country"; it may well be, however, that it is of some systemic value that some 'local experiments' *do* pose risks to other

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107. Fed. Power Comm'n v. E. Ohio Gas Co., 338 U.S. 464, 488–89 (1950) (Jackson, J., dissenting).

108. Weiser, *supra* note 84, at 729.

109. Philip J. Weiser, Chevron*, Cooperative Federalism, and Telecommunications Reform*, 52 VAND. L. REV. 1, 36 (1999).

> jurisdictions, causing those jurisdictions to confront (and to solve) new problems that permit new frontiers of the fitness landscape to be explored.[110]

B. Modifying Federalism for Environmental Regulation

Understanding federalism as a patching algorithm has been used in research for purposes of analyzing the cooperative federalism model of agency regulation in the context of environmental regulation. On a system basis, environmental regulation is experiencing problems analogous to those of telecommunications regulation. The most fundamental challenge is the need for policy that enables *sustainable development*:

> The prevailing definition of sustainable development at the international level comes from the 1987 Brundtland Report of the World Commission on Environment and Development: "[A] process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations."[111]

A policy of sustainable development is intendedly intertemporal as it requires meeting "the needs of the present without compromising the ability of future generations to meet their own needs."[112]

With regard to the current model of cooperative federalism, Ruhl claims that the federal administrative state has evolved too far in centralizing power in the federal government so that the level of patchiness and coupling is too low.[113] He asserts that the two most visible mechanisms by which this has occurred are the expansion of the federal power to regulate interstate commerce and the erosion of the nondelegation doctrine. With specific reference to complexity theory concepts, Ruhl states:

> With each further reduction in the number of patches of power, and with each disconnection of couplings between those patches, we draw ourselves further from the edge of chaos and closer to a brittle, nonresilient order. While we may find comfort in the apparent predictability of that state, we will face an increasingly ominous threat of a major catastrophe. . . .

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110. Post & Johnson, *supra* note 49, at 1090–92 (citing *New State Ice Co.*, 285 U.S. at 311 (Brandeis, J., dissenting)).

111. J.B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean Up the Environment by Making a Mess of Environmental Law*, 34 HOUS. L. REV. 933, 993 (1997) (quoting WORLD COMM'N ON ENV'T & DEV., OUR COMMON FUTURE 46 (1987)) [hereinafter *Environmental Law*].

112. J.B. Ruhl, *Sustainable Development: A Five-Dimensional Algorithm for Environmental Law*, 18 STAN. ENVTL. L.J. 31, 38 (1999) (quoting WORLD COMM'N ON ENVT. & DEV., OUR COMMON FUTURE 43 (1987)) [hereinafter *Sustainable Development*].

113. *Fitness of Law*, *supra* note 18, at 1488.

> So, what motivates the intense fear of a patchier, more coupled lawmaking environment . . . is that the states . . . will inherently compete with one another for economic domination, and thus will make poorer choices than will the federal administrative organism on questions of national policy significance. . . .
>
> Even accepting . . . that the administrative state was at one time the 'fittest' system for tackling the sociolegal problems of its day, there is every reason to believe that the premises upon which it was designed are no longer true. Through competition, cooperation, and coevolution, the other species in the sociolegal ecosystem have adapted to the federal administrative state: they have absorbed its policies, dealt with its problems, suffered at its hands, and prospered where opportunities arose. In other words, they have evolved.[114]

Ruhl does offer several recommendations. First, "[a]ll we have learned from Complexity Theory . . . points in the direction of relaxing the grip of federal administrative control of the lawmaking process."[115] Second, "[w]hereas now our options are national versus state politics, greater reliance on interstate compacts and other forms of regional organizations of states will be necessary in order to adjust the levels of patchiness and coupledness that are available for responding to each challenge."[116] Thus, Ruhl recommends a shift in power from the federal government towards state patches, and furthermore, that new patches consisting of groups of state patches should be considered. Such changes would add a new level of patching between the state patches and the federal government as well as more coupling mechanisms.

In addition to altering the patching and coupling of the current form of cooperative federalism, Ruhl advocates an alternative approach to decision making within and among patches known as *adaptive management*.[117] "[T]he command-and-control model carried out through so-called cooperative federalism. . . . has proven to be a tremendously nonadaptive process, as decisions, once made, tend to lock into place. . . . The alternative approach emerging increasingly at many different levels of decision making is known as adaptive management."[118] With adaptive management, the decision-making process is open to continuous change and based on a continuous input of information and analysis.[119] This, in turn, will require the use of tools comprised of *adaptive optimization algorithms*:

> Optimization across a fitness landscape involves using optimizing

114. *Id.* at 1480–83.
115. *Id.* at 1490.
116. *Id.* at 1488 (citation omitted).
117. *Environmental Law*, *supra* note 111, at 996.
118. *Id.* (citation omitted).
119. *Id.* (citation omitted).

> search algorithms not only to control for direction, but also to test the fitness of different system component combinations and adapt to the results continuously. The system's optimization algorithm must be adaptive, moreover, because the systems with which it interacts are evolving in their own searches for the most fit solutions. . . . Complex, adaptive, evolutionary systems incorporate algorithmic decision making tools that allow adaptive long-term fitness optimization through repeated reevaluation of system design.[120]

Such tools will need to be interdisciplinary, require extensive and reliable information, and utilize parameters that are interrelated and coevolve over time. Examples include scenario building, positional analysis to generate sustainability assessment maps, and computer-based modeling techniques.[121]

C. Comparing Models of Policy Reform

Some options under debate for telecommunications policy reform constitute an extreme reconfiguration of federalism-deregulation through federal preemption. Ruhl has also analyzed the appropriateness of deregulation in the context of environmental regulation from a complex system perspective. His analysis provides insights for considering the use of deregulatory policies for telecommunications.

More specifically, Ruhl uses the complexity theory perspective to discuss the shortcomings of two dominant conflicting reform models—incremental change and wholesale deregulation—with regard to the Endangered Species Act ("ESA").[122] The primary shortcoming of the incremental reform model is that it "puts all the emphasis on law in a static state, refusing to experiment not only with law, but also with other social problem-solving systems."[123] The current ESA constrains "the boundaries of the fitness landscape for ecosystem conservation policies and limit[s] us to walking across that boxed-in landscape in search of fitter solutions. . . . Walking the landscape within a tightly defined niche can lead to temporary fixes; real reform requires breaking out of the box."[124]

Ruhl asserts that the shortcoming of deregulatory reform is (perhaps counterintuitively) similar to that of incremental reform. This is because:

> The deregulation model puts all the emphasis on the other social problem-solving systems, using law only as an adjunct for putting them in motion. The problem with the deregulation model, therefore, is

120. *Sustainable Development*, *supra* note 112, at 54–55 (citations omitted).

121. *Id.* at 60–63 (Ruhl develops a five-dimensional algorithm for sustainable development environmental policy, which seeks to optimize the three parameters of environment, economy, and equity over the two dimensions of time and geography).

122. *Environmental Law*, *supra* note 111, at 976.

123. *Id.* at 979 (citation omitted).

124. *Id.* at 978.

> that it prevents us, just as much as does the incrementalist model, from deliberately trying to make long jumps [across the fitness landscape] through focused legal reform. In short, neither of the prevailing reform models permits us to think of environmental law as a complex adaptive system.[125]

Ruhl's reasoning for this assertion is particularly compelling for consideration of deregulatory telecommunications policies as it addresses arguments in favor of deregulation similar to those raised in telecommunications policy debates—not the least of which is the belief that the current federal statutory law is *the* problem:

> The fundamental mistake of the deregulation approach is that it is based on the same linear-causal problem solving approach that has shaped the ESA itself. The premise is that the ESA is not simply part of the problem, but that it *is* the problem. What is abundantly certain, however, is that it is delusional to believe that deregulation will somehow turn back the clock to a time when neither ecosystem degradation pressures nor property rights concerns were acutely in conflict as they are today. The fact that the ESA is not effectively resolving that conflict does not mean that it has caused the conflict or that reeling in the ESA will move us back along the time line over which the conflict has evolved. Indeed, there is nothing we can do to reverse the nonlinear co-evolution of ecosystems, technology, economies, and land use that has led to the ecosystem degradation problem. All we can do is change, and we hope thereby to improve, the direction in which the problem-solving process is headed.[126]

In a similar vein, Greve argues that, as a general matter, a form of federalism that encourages competition among the states for citizens' business is preferable in a world of high citizen mobility and far-reaching technological change.[127] As with Justice Brandeis in *New State Ice Co. v. Liebmann* and Justice Jackson in *Federal Power Commission v. East Ohio Gas Co.,* Greve's reasoning is expressed in terms similar to—although without specific reference to—complexity theory:

> Far from rendering federalism obsolete, enhanced mobility and border-leaping technologies render it *more* appealing. . . . Like the mobility-and-borders argument . . . the complexity-and-interdependence argument cuts not against but for federalism, choice, and competition. . . . If [Congressmen] seem less competent at legislating, that is largely so because the central, collective optimization of social outputs over a vast array of complex, interdependent, uncontrollable activities is impossible. As complexities and interdependencies mount, so do the learning costs and the rigidities attendant to centralized schemes. The law of unintended consequences hits hard.

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125. *Id.* at 979 (citation omitted).

126. *Id.*

127. Michael S. Greve, *The AEI Federalism Project*, FEDERALIST OUTLOOK NO. 1, June 1, 2000, http://www.aei.org/publications/pubID.11716/pub_detail.asp.

> We do not know what we should do when we do not know what we are doing. Not doing it all at once and in every place seems a good first approximation. National problems do not automatically demand national solutions; instead, they demand a variety of responses that will depend on local tastes, preferences, and circumstances. . . . Even in instances in which a uniform solution seems sensible, it is often best to allow that solution to emerge gradually, under conditions of competition [among the states].[128]

Greve's misgivings of national policy solutions, particularly before an opportunity for competition among the states, should also inform telecommunications policy debates regarding federal preemption.

D. Using Adaptive Decision-Making Tools for Policymaking in General

Utilizing a complex system perspective to develop more effective tools for policy decision making is a growing area of research. Although consideration of specific adaptive decision-making tools for application to telecommunications policymaking is beyond the scope of this Article, merely altering the patching and coupling dimensions of cooperative federalism, as with environmental policymaking, would likely be insufficient to develop sustainable policies. Therefore, a brief discussion of research concerning adaptive decision-making tools is provided here.

Research related to policy decision making emphasizes that the use of classical tools to identify a single best model and a "best" policy are problematic because they may not be *robust* across the range of possible behavior of the complex adaptive systems they represent. In particular:

> Complex systems often are characterized by uncertainty of a type that strains the traditional methods of decision analysis, vital to the systematic examination of policy alternatives.
>
> [W]e often have information about complex systems different from that assumed by traditional decision analysis. For instance, complex systems often display regions of extreme sensitivity to the particular assumptions, while at the same time exhibit important regularities of macroscopic behavior. . . . [T]raditional decision analysis cannot easily address the types of adaptive, evolving strategies that decision-makers often employ when confronted by deep uncertainty.[129]

As a result, new tools are needed to enable the development of more robust policies, where "[t]he goal is to discover a policy recommendation that holds for all plausible models of the problem, or which can be demonstrated to be superior to all other options across this range of

128. *Id.*

129. Lempert, *supra* note 7, at 7309.

plausible models."[130]

To develop robust policies, computerized modeling tools are recommended. Bankes recommends exploratory modeling or exploratory analysis, which uses agent-based models.[131] Agent-based models can be used to recommend single policies or to provide "ensembles of policy options all of which perform satisfactorily."[132] Lempert recommends a form of exploratory modeling, called computer-assisted reasoning ("CAR").[133] CAR uses an ensemble of plausible models when there is deep uncertainty about the future, combining traditional quantitative decision analysis with narrative, scenario-based planning. "CAR combines the human ability to intuit patterns and abstract a big-picture view with the computer's ability to test detailed implications of facts over a huge number of cases. The approach facilitates the assessment of alternative strategies with criteria such as robustness and satisficing rather than optimality."[134]

VIII. TOWARD A REVISION OF FEDERALISM FOR SUSTAINABLE TELECOMMUNICATIONS POLICY

From the discussion in the preceding Parts, it is clear that pursuit of sustainable telecommunications policy requires realistic assessment of the conditions for adoptability and achievability of policies affecting the telecommunications sector. From a complex systems perspective, this requires a paradigm shift in policymaking from the traditional focus on optimization for a specific outcome to an emphasis on adaptability to adjust to ever-changing circumstances. To use a paradigm of adaptability will require policymakers to revise their expectations of what policies can achieve, to be willing to utilize adaptive management techniques, and to even adapt the policymaking system itself.

Embracing a paradigm of adaptability has important implications for how federalism should be viewed for purposes of telecommunications policymaking. Federalism should not be viewed as a structure for policymaking that will generate some static optimal policy solution, but rather as a policymaking structure that can provide adaptability for the development of sustainable policies over time. As a patching algorithm, federalism has the potential to improve initial policy design, to adapt policies in response to changes internal or external to the policymaking

130. Steven C. Bankes, *Tools and Techniques for Developing Policies for Complex and Uncertain Systems*, 99 PROC. NAT'L ACAD. SCI. U.S.A. 7263, 7264 (2002).

131. *See id.* at 7264.

132. *Id.* at 7265. Lempert uses agent-based models of technology diffusion to compare alternative climate change-abatement strategies to address the problem of climate change.

133. Lempert, *supra* note 7, at 7309–13.

134. *Id.* at 7309.

system, and to even evolve its own process over time in order to continue to provide its adaptability function.

As previously discussed, federalism in the U.S. has already evolved from a model of dual federalism to cooperative federalism, with increasing pressures for further evolutionary change towards decentralization from the federal government. This evolutionary trajectory is occurring both for the U.S. policymaking system in general and for its application to administrative agency regimes. As exemplified by research concerning sustainable development policy in environmental regulation, we are now at a unique point in history where further evolution of federalism can arise—at least in part—from conscious choice based on focused analysis. Adaptive decision-making tools developed from complexity theory research can be used to study the effects of alternative policy options, including those that affect the structure of federalism itself.

In this respect, understanding the inherent advantages of federalism as a patching algorithm enables the formulation of several preliminary conclusions regarding pursuit of sustainable telecommunications policy. First, as a general matter, telecommunications policymaking benefits from the inherent advantages of a federalism mechanism as a patching algorithm that provides forces for both policy innovation and stability. Therefore, when considering specific policy options, it may be advantageous to *presume that regulatory power should be shared among the federal and state governments.* Given such a presumption, when considering alternative policy options, those options that effectively reduce or eliminate such shared powers should require greater justification than those options that retain or effectively increase shared powers. Adaptive decision-making tools, such as those discussed in Part VII, should be used to facilitate comparative analyses of specific options.

Second, there are some preliminary conclusions that can be made regarding specific types of policy reform that, by definition, directly affect the federalism mechanism itself. For example, federal preemption affects federalism by constraining or eliminating state government policymaking authority as to the matter under preemption; in other words, preemption constrains or eliminates the experimentation of the state patches. Federal preemption has been defined in various ways depending upon the nature of its design. For purposes of discussion here, the most relevant distinction is between *complete preemption* and *conditional preemption*. Complete preemption totally removes any state policymaking authority over the matter subject to preemption. Conditional preemption:

> provides that, if a state does not regulate according to federal standards, its citizens will be subject to direct federal regulation. . . . Conditional preemption thus forces the states to choose between . . . implementing federal regulation or acquiesc[ing] in the displacement

> of their authority by the federal government.[135]

Thus, the distinction is that complete preemption *eliminates*, whereas conditional preemption only *constrains*, state policymaking authority.

There are several potential negative consequences of federal preemption. There is a loss of innovation and future adaptability from state experimentation. Federal preemption may occur before there has been sufficient experimentation and learning that may indicate a superior policy option. The result may be, as Justice Brandeis identified in *New State Ice Co. v. Liebmann*, greater risk to the nation of an ill-timed national (as opposed to state) experiment. The results of a national policy experiment, if adverse, may also be more difficult to reverse or modify than those of state experimentation.[136] Moreover, from a complexity theory perspective, the potential negative consequences of complete preemption are likely to be greater than for conditional preemption because the former forecloses more state experimentation.

Therefore, not only should there be a presumption that regulatory power be shared among the federal and state governments, but *the federal government should be particularly cautious about implementing policies of complete preemption*. This admonition appears to be particularly appropriate for consideration of telecommunications-related policies given that the network characteristics of telecommunications networks and the rapid rate of technological change will tend to accelerate the speed and scope with which the effects, good or bad, of national experimentation are diffused throughout the nation.

Deregulation is a specific form of federal preemption. As with preemption in general, deregulatory policies vary in the manner to which they constrain or eliminate state policymaking authority. However, unlike some other forms of federal preemption, deregulatory policies may also constrain or eliminate federal policymaking authority. If a deregulatory policy completely eliminates both federal and state policymaking authority, it is often referred to as *full deregulation*. As discussed in Part VII.C, to the extent a deregulatory policy also eliminates federal policymaking authority, deregulation shifts an even greater burden of addressing the ensuing effects to other social problem-solving systems. In this way, the ability of the overall society—of which the policymaking system is a component (or patch)—to adapt has been reduced. Therefore, as with complete

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135. Dorf & Sabel, *supra* note 90, at 425 (citation omitted).

136. A national policy experiment, by definition, has a wider scope of application than a given state experiment. Therefore, it will directly affect a wider scope of activities in the economy. In addition, reversal of a federal policy is usually more difficult than a state policy. This is because state policymaking occurs only within a state patch, albeit with spillover effects for the federal patch and other state patches. On the other hand, federal policymaking occurs in a system of tight coupling with all the state patches.

preemption, *the federal government should be particularly cautious about implementing policies of full deregulation.*[137]

Considering the implications of complexity theory for sustainable telecommunications policy is essential for balanced discussion of policy issues, whether pending or likely to evolve, which propose federal preemption or even full deregulation. The insights from complexity theory admonish us to consider such proposals with caution. We do have the opportunity to use adaptive decision-making tools for a more focused analysis of the likely impacts of such proposals as well as to develop other, perhaps more robust, options. In so doing, we can begin the task of adopting a paradigm of adaptive policymaking for sustainable telecommunications policy.

137. Another reason for caution in implementing policies of full economic deregulation is that such policies are based on the assumption that the legal preconditions for efficiencies of competitive markets have been met. If this assumption is incorrect, deregulation may create tremendous economic and political turmoil, as exemplified by the experience of premature liberalization policies in nations transitioning from central planning economies. *See*, *e.g.*, Kovacic, *supra* note 27, at 288–89.