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Efficiencies and Antitrust Reconsidered: An Evolutionary Perspective

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Abstract

The author reconsiders the issue of efficiencies and antitrust from the perspectives of evolutionary biology and the growing field of evolutionary economics. He begins by discussing how the term efficiency as currently used in antitrust today is more of a term of social science and economic ideology than a meaningful scientific concept. He then moves on to address how the lessons of evolutionary biology and economics, including the need for systemic diversity and unremitting competition at all systemic levels, can be applied to structural antitrust and efficiencies analyses. The author concludes that it is time to bring fresh perspectives to the study of efficiencies and antitrust. He recommends a series of reforms, including increased and more aggressive enforcement against horizontal mergers between competitors; renewed interest in vertical mergers and agreements; and more aggressive guarding of competitive diversity and opportunity against unfair predatory conduct by dominant firms, monopolies, and oligopolies.

Keywords

efficiency and efficiencies, evolutionary economics, antitrust, evolutionary biology

I. Introduction

An abundance of excellent research and scholarship discussing the importance of efficiencies in antitrust analyses is readily available today.[1] A highlight of this diverse and abundant scholarship is that

1. *See, e.g.,* Robert H. Lande, *A Traditional and Textual Analysis of the Goals of Antitrust: Efficiency, Preventing Theft from Consumers, and Consumer Choice*, 81 FORDHAM L. REV. 2349 (2013); Maurice E. Stucke, *Reconsidering Antitrust's Goals*, 53 B.C.L. REV. 551, 563–95 (2012); Jesse W. Markham, Jr., *Lessons for Competition Law from the Economic Crisis: The Prospect for Antitrust Responses to the "Too-Big-to-Fail" Phenomenon*, 16 FORDHAM J. CORP. & FIN. L. 261 (2011); Daniel A. Crane, *Rethinking Merger Efficiencies*, 110 MICH. L. REV. 347 (2011); D. Daniel Sokol & James A. Fishkin, *Antitrust Merger Efficiencies in the Shadow of the Law*, 64 VAND. L. REV. EN BANC 45 (2011); Jamie Henikoff Moffitt,

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economic efficiency is a seemingly simple, yet ultimately complex and elusive concept.[2] As explained by distinguished antitrust professor Eleanor M. Fox, "[E]fficiency and how to reach it are complex concepts. There is no one thing called 'efficiency.'"[3] The elusiveness of meaningful economic definitions has led one risk engineering professor to conclude that "[t]he notion of efficiency [has] become ... quite meaningless on its own."[4]

This article reconsiders the issue of efficiencies and antitrust from the perspectives of evolutionary biology and the growing field of evolutionary economics.[5] Building on this author's earlier work applying evolutionary biology and economics to structural and behavioral antitrust analyses,[6] this article examines efficiencies and antitrust from a dynamic and systemic evolutionary perspective.

Part II of this article first discusses how the term efficiency as currently used in antitrust is more a term of social science and economic ideology than a meaningful scientific concept. Parts III–IV then address how the lessons of evolutionary biology and economics can be applied to structural antitrust and efficiencies analyses.

Part III describes how healthy ecosystems and, by analogy, economic systems thrive on unremitting and intense competition at all systemic levels. This competition is sparked and spurred by a dazzling array of creative diversity, multiplicity, and variation that allows for maximum experimentation and innovation. Based on evolutionary theory—economic diversity, variability, and opportunity are therefore the keys to the overall health and systemic efficiency of our economic system.

Part IV reviews structural and physical issues from an evolutionary point of view. Part A discusses how nature is consistent in building structural and functional redundancies into its complex ecosystems, which enhance the overall system's robustness and sustainability, as exogenous and endogenous

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Merging in the Shadow of the Law: The Case for Consistent Judicial Efficiency Analysis, 63 VAND. L. REV. 1697 (2010); Darren Bush, *Too Big to Bail: The Role of Antitrust in Distressed Industries*, 77 ANTITRUST L.J. 277 (2010); Roger D. Blair, *Merger to Monopsony: An Efficiencies Defense*, 55 ANTITRUST BULL. 689 (2010); John B. Kirkwood & Robert H. Lande, *The Fundamental Goal of Antitrust: Protecting Consumers, Not Increasing Efficiency*, 84 NOTRE DAME L. REV. 192 (2008); Eleanor Fox, *The Efficiency Paradox, in* HOW THE CHICAGO SCHOOL OVERSHOT THE MARK: THE EFFECT OF CONSERVATIVE ECONOMIC ANALYSIS ON U.S. ANTITRUST 77 (R. Pitofsky ed., 2008).

2. In science, as in economics, "[e]fficiency is a concept that is deceptively simple yet can be elusive." Robert E. Blankenship et al., *Comparing Photosynthetic and Photovoltaic Efficiencies and Recognizing the Potential for Improvement*, 332 SCIENCE 805 (May 2011).
3. Fox, *supra* note 1, at 81. Fox adds that "efficiency is a multifaceted concept ... and that enforcers and judges know little about how to 'reach' efficiency." *Id.* at 88. American Antitrust Institute President Albert A. Foer similarly notes that "efficiency itself is far from a simple concept and is susceptible to multiple meanings." Albert A. Foer, *On the Inefficiencies of Efficiency as the Single-Minded Goal of Antitrust* 7 (AAI Working Paper No. 14-02, April 16, 2014). *See also* Stucke, *supra* note 1, at 577 ("The term efficiency is not self-defining, but encompasses different concepts."); Joseph F. Brodley, *The Economic Goals of Antitrust: Efficiency, Consumer Welfare, and Technological Progress*, 62 N.Y.U. L. REV. 1020, 1032 (1987) (arguing that "consumer welfare" and "efficiency" have become "the dominant terms of antitrust discourse without any clear consensus as to what they exactly mean").
4. NASSIM NICHOLAS TALEB, ANTIFRAGILE: THINGS THAT GAIN FROM DISORDER 160 (2012). Evolutionary economist Eric D. Beinhocker concurs. Beinhocker notes that "[e]xamined through the lens of Complexity Economics, ... asking whether markets are efficient makes about as much sense as asking whether the ecosystem of the Amazon rain forest is efficient. Efficient compared to what?" ERIC D. BEINHOCKER, EVOLUTION, COMPLEXITY, AND THE RADICAL REMAKING OF ECONOMICS 399 (2006); *see also* Fox, *supra* note 1, at 77 ("What is efficiency?").
5. *See, e.g.*, BEINHOCKER, *supra* note 4; RICHARD R. NELSON & SIDNEY G. WINTER, AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE (1982); MAYNARD SMITH, EVOLUTION AND GAME THEORY (1982); ROBERT AXELROD, THE EVOLUTION OF COOPERATION (1984). A full discussion of these seminal economic works is beyond the scope of this article.
6. *See, e.g.*, Thomas J. Horton, *The Coming Extinction of Homo Economicus and the Eclipse of the Chicago School of Antitrust: Applying Evolutionary Biology to Structural and Behavioral Antitrust Analyses*, 42 LOY.U. CHI. L.J. 469 (2011); Thomas J. Horton, *Unraveling the Chicago/Harvard Antitrust Double Helix: Applying Evolutionary Theory to Guard Competitors and Revive Antitrust Jury Trials*, 41 U. BALT. L. REV. 615 (2012); Thomas J. Horton, *Fairness and Antitrust Reconsidered: An Evolutionary Perspective*, 44 MCGEORGE L. REV. 823 (2013); Thomas J. Horton, *Confucianism and Antitrust: China's Emerging Evolutionary Approach to Anti-Monopoly Law*, 47 INT'L LAW. 193 (2013).

environmental conditions change (as they inevitably and frequently do). Part B then addresses how large size and dominance are not synonymous with efficiency in nature, since increases in physical size inevitably create new risks, instabilities, and inefficiencies.

Applying the lessons of evolutionary biology and evolutionary economics, the author concludes that it is time to bring fresh perspectives to the study of efficiencies and antitrust. The article recommends: (1) increased and more aggressive enforcement against horizontal mergers between competitors; (2) renewed interest in vertical mergers and agreements; and (3) more aggressive guarding of competitive diversity and opportunity against unfair predatory conduct by dominant firms, monopolies, and oligopolies.

II. Efficiency and Antitrust Economics Today

The search for economic efficiencies permeates antitrust analyses today.[7] As noted by Fox, "[A] chorus of conservative and libertarian policy makers and specialist technicians proclaim the new litany: Antitrust is for efficiency."[8] Distinguished antitrust scholar Herbert Hovenkamp observes that productive and allocative efficiencies are the key criteria for evaluating economic transactions under the antitrust laws.[9] Fox adds: "The contemporary antitrust community posits that antitrust law is for efficiency and that the efficiency goal should drive the outcome of antitrust cases and limit the scope of antitrust."[10] For Chicagoans, "[e]fficiency is the scientific linchpin of economics."[11] "Efficiency is therefore rightly a cornerstone of sound antitrust policy."[12]

Chicago School economists argue that their desire to employ a neoclassical market efficiency model as a primary guide for antitrust policy is nonpolitical[13] and scientifically based.[14] Yet, they

7. *See, e.g.*, Chesapeake & Ohio Ry. Co. v. United States, 704 F.2d 373, 376 (7th Cir. 1983) (Posner, J.) ("The allocative-efficiency or consumer-welfare concept of competition dominates current thinking, judicial and academic, in the antitrust field"); RICHARD A. POSNER, ANTITRUST LAW ix (2d. ed. 2001). Indeed, the Federal agencies have credited proffered potential efficiencies with playing key roles in several controversial decisions to close merger investigations. *See, e.g.*, Press Release, U.S. Department of Justice (DOJ), Statement of the DOJ's Antitrust Division on Its Decision to Close Its Investigation of XM Satellite Radio Holdings Inc.'s Merger with Sirius Satellite Radio Inc. (Mar. 24, 2008); Press Release, DOJ, Statement on Its Decision to Close Its Investigation of the Joint Venture Between SABMiller PLC and Molson Coors Brewing Co. (June 5, 2008) (citing "substantial and credible savings that will significantly reduce the companies' cost of producing and distributing beer") (By way of disclosure, the author served as the lead trial attorney for the United States in the investigation). Despite such pressures, numerous critics have questioned whether efficiency should be the sole or even primary goal in antitrust analysis. *See, e.g.*, Kirkwood & Lande, *supra* note 1; Stucke, *supra* note 1; Daniel L. Rubinfeld, *On the Foundations of Antitrust Law and Economics,* in HOW THE CHICAGO SCHOOL OVERSHOT THE MARK, *supra* note 1, at 56; Eleanor M. Fox, *The Modernization of Antitrust: A New Equilibrium*, 66 CORNELL L. REV. 1140, 1182 (1981) (discussing antitrust's major historic goals).
8. Fox, *supra* note 1, at 77. *See also* Bush, *supra* note 1, at 279 (describing efficiency as the "king" of antitrust); Robert H. Lande, *supra* note 1, at 2351–53 (2013) (describing some of the effects of an efficiency-only policy); and Robert H. Bork, *Legislative Intent and the Policy of the Sherman Act*, 9 J.L. & ECON. 7, 26 (1966) (concluding that the legislative history of the Sherman Act showed that Congress was primarily concerned with enhancing economic efficiency).
9. *See* Herbert Hovenkamp, *Antitrust Policy After Chicago*, 84 MICH. L. REV. 213, 226–29 (1985).
10. Fox, *supra* note 1, at 88.
11. Kenneth G. Elzinga, *The Goals of Antitrust: Other Than Competition and Efficiency, What Else Counts?* 125 U. PA. L. REV. 1191, 1212 (1977).
12. Kenneth A. Heyer, statement on behalf of the U.S. DOJ, Antitrust Modernization Commission Hearings on the Treatment of Efficiencies in Merger Enforcement (Nov. 17, 2005), at 1.
13. Hovenkamp, *supra* note 9, at 229. *See also* Bush, *supra* note 1, at 295.
14. Elzinga, *supra* note 11, at 1212. Judge Richard Posner has long argued that the promotion of economic efficiency is "positive, not normative; scientific, not ideological." RUDOLPH J.R. PERITZ, COMPETITION POLICY IN AMERICA: HISTORY, RHETORIC, LAW 228 (1996), discussing RICHARD POSNER, ECONOMIC ANALYSIS OF LAW (1973); RICHARD POSNER, ANTITRUST LAW: AN ECONOMIC PERSPECTIVE (1976); *see also* ROBERT H. BORK, THE ANTITRUST PARADOX: A POLICY AT WAR WITH ITSELF 8 (1978) ("Basic microeconomic theory is of course a science.").

necessarily concede that measuring economic efficiency is difficult or impossible,[15] and that "[e]conomic efficiency does not always square with the term as used in engineering."[16] Indeed, "[p]ractical difficulties of courtroom proof severely limit implementation of efficiency goals, however important."[17]

Given the uncertainty and confusion surrounding the economic definitions and quantification of productive,[18] allocative,[19] and dynamic efficiencies,[20] one is tempted to ask whether in practice these concepts provide meaningful scientific support for the philosophies that bigger is better, and markets operate best when free from antitrust intervention.[21] Despite Chicago School claims to the contrary,[22] economics today "is a social science, not a natural science and not a subdiscipline of mathematics."[23] "Even as a technological concept, efficiency carries social and political implications."[24] More and more, scholars are coming to recognize the importance of looking to the biological and social sciences for interdisciplinary guidance.[25]

15. *See* WALTER ADAMS & JAMES W. BROCK, THE BIGNESS COMPLEX: INDUSTRY, LABOR AND GOVERNMENT IN THE AMERICAN ECONOMY 302 (2004) ("Although economic Darwinism makes superior economic performance the centerpiece of its policy position, its advocates concede that measuring such performance is inordinately difficult, if not downright impossible"); BORK, *supra* note 14, at 124 (1978) (conceding that "[t]he real objection to performance tests and efficiency defenses in antitrust law is that they are spurious. They cannot measure the factors relevant to consumer welfare, so that after the economic extravaganza was completed we should know no more than before it began."); ALFRED E. KAHN, STANDARDS FOR ANTITRUST POLICY, IN MONOPOLY POWER AND ECONOMIC PERFORMANCE: THE PROBLEM OF INDUSTRIAL CONCENTRATION 160 (Edwin Mansfield, ed. 1968) (arguing that "economics offers no objective measure of the vitality of competition in all its aspects.").
16. Elzinga, *supra* note 11, at 1192, n. 4. Indeed, Chicago School scholar Judge Frank Easterbrook urges us to avoid econometric answers because they are both expensive and indeterminate. ADAMS & BROCK, *supra* note 15, at 302, citing Frank H. Easterbrook, *On Identifying Exclusionary Conduct*, 61 NOTRE DAME L. REV. 972, 979 (1986). Peritz argues that the engineering concept of productive efficiencies and the Chicago Schoolers' notions of allocative efficiencies are "distinctly different concepts" that "have no necessary logical relationship." PERITZ, *supra* note 14, at 239. Peritz adds that "[Judge] Posner's shifting between productive and allocative efficiencies creates both analytical and normative ambiguity in his work." *Id.*
17. Joseph F. Brodley, *The Economic Goals of Antitrust: Efficiency, Consumer Welfare, and Technological Progress*, 62 N.Y.U. L. REV. 1020, 1028 (1987). *See also* Stucke, *supra* note 1, at 578–84 (discussing the "difficulties in measuring efficiency").
18. *See, e.g.*, Stucke, *supra* note 1, at 581 (discussing the "difficulties in measuring productive efficiencies").
19. *See, e.g., id.* at 578–81 (discussing the "difficulties in measuring allocative efficiencies" and the "different meanings" of the term "allocative efficiency").
20. *See, e.g., id.* at 582–84 (discussing the "difficulties in measuring dynamic efficiencies," and arguing that "despite the importance of dynamic efficiency, antitrust policy still lacks adequate tools to measure it or assess the long-term effects of restraints on dynamic efficiencies"); *see also* PERITZ, *supra* note 14, at 238 (arguing that Judge Posner's "claims about the scientific character of [h]is efficiency hypothesis were ill founded"); Mario Rizzo, *The Mirage of Efficiency*, 8 HOFSTRA L. REV. 641 (1980).
21. For an excellent discussion of the history of such a laissez-faire policy outlook, *see* PERITZ, *supra* note 14, at 28 (discussing the "growing admiration for the genius of large-scale enterprise, apprehension about the power of majoritarian government, and commitment to a federalist vision of free markets."); David Nasaw, ANDREW CARNEGIE 706–07 (2006) (discussing Andrew Carnegie's philosophy that small manufacturers and businesses were relics of the past because of great economics of scale).
22. *See, e.g.,* Richard Posner, *Some Uses and Abuses of Economics in Law*, 46 U. CHI. L. REV. 281, 295 (1979) (likening economic efficiency to scientific theories such as physics); PERITZ, *supra* note 14, at 241 (discussing Judge Posner's attempts to "portray microeconomics ... as a scientific endeavor devoid of politics"); BORK, *supra* note 14, at 8.
23. Foer, *supra* note 3, at 22–23. Foer adds that "the line between what is political/social and what is economic is not always clear." *Id.* at 23.
24. Jennifer K. Alexander, *The Concept of Efficiency: An Historical Analysis*, in PHILOSOPHY OF TECHNOLOGY AND ENGINEERING SCIENCES, vol. 9, 1007, 1008 (Anthonie Meijers ed., 2009).
25. *See, e.g.*, Amanda P. Reeves & Maurice E. Stucke, *Behavioral Antitrust*, 86 IND. L.J. 1527, 1528 (2011) (discussing how economics' "rationality assumption is under attack from several interdisciplinary fields, most notably behavioral economics"); BEINHOCKER, *supra* note 4; Horton, *Coming Extinction*, *supra* note 6.

Looking back at the historical origins of the concept of economic efficiency, one finds that "[c]onsistent throughout efficiency's history has been its equation with direct and effective action, from the Aristotelian system of causes through medieval conceptions of the nature of the Christian God."[26] The philosophical and theological underpinnings of the concept of efficiency have helped it to develop a "moral and value-laden character."[27] Indeed, "[p]re-modern conceptions of goodness, power, and simplicity informed the developing idea of efficiency through doctrines of divine economy."[28] God was seen as the "Supreme Economist" who created an efficient and grand organization of life on earth.[29]

The modern neoclassical economic theories of efficiency carry forward the "moral character" of an ideal society based on "positive social and economic good."[30] In the words of Jennifer K. Alexander, "[t]he modern concept of efficiency resulted from the intersection of output/input measures with theories of divine simplicity, economy, and power, and with a theory of immediate causal agency."[31] Consequently, we should not defer to Chicago School efficiency concepts as technical scientific or engineering principles.[32] We should instead recognize and treat them as political and social philosophies of economic management.

Neoclassical Chicago School notions of economic efficiency are direct descendants of Frederick Taylor's 1911 treatise *The Principles of Scientific Management,*[33] which was designed ostensibly to "bring about a restructuring not only of industry but of society, creating a utopia of perfect efficiency."[34] It is important to note, however, that many engineers "did not consider his management work to be engineering and the [American Society of Mechanical Engineers] refused to publish his

26. Alexander, *supra* note 24, at 1011. Alexander adds that scholars have traced the concept of efficiency to "a tradition growing out of philosophy and theology associating efficiency with action and with the power and goodness of God." *Id.* at 1012.
27. *Id.* at 1013.
28. *Id.*
29. *Id.*
30. *Id.* at 1014.
31. *Id.* at 1014. Alexander adds: "Efficiency was a central concern in the reform efforts that characterized American and European history from the turn of the twentieth century until the Great Depression, reforms spurred by worries over the effects of industrialization and urbanization in a changing international order, and expressed in efficiency movements tied to national health, governmental reform, military prowess, and protection of empire, nation, or race. Efficiency became ubiquitous in the United States during the progressive era, a time of intellectual, social, and political turbulence. Efficiency described not only technical matters, like the thermal economy of an engine, but personal ones as well: careful spending habits, fastidious bodily hygiene, and good childhood education. Technical features like quantification and calculation jumbled together with social, governmental, and personal concerns to produce a word resonating of technical expertise, personal integrity, and good government. Efficiency expressed both sober qualities of hard and patient work, and enormous hopes for remaking society and the world. Frederick Winslow Taylor's system of scientific management is the most recognizable American efficiency maker of this era." *Id.* at 1017.
32. *See, e.g.*, Jennifer Alexander, *Efficiencies of Balance: Technical Efficiency, Popular Efficiency, and Arbitrary Standards in the Late Progressive Era USA*, in 38 Soc. Studies of Sci. 323 (2008). ("Arbitrary measures of efficiency unsettle the dichotomy between engineering efficiency and efficiency in more popular forms: this dichotomy runs through the literature on the progressive era U.S.A."); *id.* at 327 (discussing "the two traditions of efficiency, one technical, allied with the science of energy and machine design and testing practices, the other general, associated with economy and prudent management").
33. Frederick Winslow Taylor, The Principles of Scientific Management (1911).
34. Nicholas Carr, The Shallows: What the Internet Is Doing to Our Brains 150 (2011). Taylor urged that "In the past the man has been first ... in the future the system must be the first." Taylor, *supra* note 33, at 7. Taylor's goal was "the gradual substitution of science for rule of thumb throughout the mechanic arts." *Id.* at 25. Like his later Chicago School economic disciples, Taylor believed that "the affairs of citizens are best guided and conducted by experts." Neil Postman, Technology: The Surrender of Culture to Technology 51 (1993). *See also* Horton, *Antitrust Double Helix*, *supra* note 6, at 647–48 (discussing the drive to eliminate juries as antitrust decision makers).

seminal management papers."[35] More ominously, widespread enthusiasm for efficiency in the 1930s in Italy and Germany was part of a societal "rationalization," which "sought in efficiency a solution to problems of economic scarcity and social turbulence."[36]

Similar ideals of economic rationalization have driven the Chicago School push for making their conception of efficiency the core concern of antitrust. Their drive for economic efficiency and order ironically grew out of the theme of progressive reform through technocratic management and efficiency.[37] For Robert Bork, following in the footsteps of Andrew Carnegie, "emerging efficiencies or economics of scale ... make larger size more efficient."[38] The "increased efficiency" from larger sized businesses "is valuable to society at large."[39] Quite simply, the economic assumption and presumption is that "bigness is the guarantor of efficiency and progressivity."[40]

An inevitable conclusion of the philosophy that bigger size is efficient is that "mergers and acquisitions increase national wealth,"[41] and are "healthy indicators of a fluid and dynamic economy."[42] Consequently, horizontal mergers should only be stopped if the government can prove that the anticompetitive effects clearly outweigh any cognizable efficiencies.[43] In such a system, "an industry trend toward concentration is not a factor that will be considered in merger policy enforcement."[44]

Much of the current dialogue about efficiencies and antitrust misses the irony that the Chicago School's lionization of efficiency is inconsistent and at war with the economic liberalism of such "founding fathers" as Milton Friedman.[45] Friedman counseled "that the great threat to freedom is the concentration of power."[46] As a result, a key function of government, said Friedman, is to "foster competitive markets."[47] Such markets are critical to "a social climate permitting variety and diversity."[48] Such variety and diversity, Friedman added, is "essential for that experimentation which can

35. Alexander, *supra* note 24, at 1017, n. 5, citing R. KANIGEL, THE ONE BEST WAY: FREDERICK WINSLOW TAYLOR AND THE ENIGMA OF EFFICIENCY (1997).
36. Alexander, *supra* note 24, at 1017, citing M. NOLAN, VISIONS OF MODERNITY: AMERICAN BUSINESS AND THE MODERNIZATION OF GERMANY (1994); and S.F. WEISS, RACE HYGIENE AND NATIONAL EFFICIENCY: THE EUGENICS OF WILHELM STALLMAYER (1987).
37. *See, e.g.*, ERIC FONER, THE STORY OF AMERICAN FREEDOM 155 (1998) (discussing "a 'democracy' run by impartial experts and in many ways unaccountable to the citizenry. This technocratic impulse toward order, efficiency, and centralized management—all, ostensibly in the service of social justice—was an important theme of Progressive reform.").
38. BORK, *supra* note 14, at 205–06.
39. *Id.*
40. ADAMS & BROCK, *supra* note 15, at 132. *See also id.* at 64 (arguing that Chicago School economists contend that bigness "is best able to perform society's resource-planning function and, therefore, is best qualified to promote social efficiency"). For a recent defense of monopoly, *see* ADI AYAL, FAIRNESS IN ANTITRUST: PROTECTING THE STRONG FROM THE WEAK (2014); *but see* Thomas J. Horton, *Seeking Fairness in Antitrust: A Review of Ayal's Fairness in Antitrust: Protecting the Strong From the Weak*, 35 EUR. COMPETITION L. REV. 569 (Nov. 2014).
41. Economic Report of the President (Washington, D.C. 1985), at 196.
42. Robert Pitofsky, Chair, Federal Trade Commission, An Antitrust Report for the FTC, remarks before the Antitrust 1996 Conference, Business Development Assocs., Inc. (Washington, D.C., March 4, 1996).
43. *See, e.g.*, Charles F. (Rick) Rule, Statement for the Hearing of the Antitrust Modernization Commission: Treatment of Efficiencies in Merger Enforcement (Nov. 17, 2005) (arguing that "Judge Bork was right .... The enforcement agencies should be required to identify, in light of all the relevant circumstances, a clear and logical causal connection between the merger and the likelihood of significantly high prices and lower output before these agencies block a merger."); Lande, *supra* note 1, at 2388 (discussing cases that "explicitly place the burden of proving allocative inefficiency harms of market power on plaintiffs"); and Rebel Oil Co. v. Atlantic Richfield Co., 51 F.3d 1421, 1433 (9th Cir. 1995) (holding that an act is anticompetitive only when it harms allocative efficiency and raises prices).
44. William F. Baxter, *Responding to the Reaction: The Draftsman's View*, 71 CAL. L. REV. 630 (1983).
45. *But see* Fox, *supra* note 1.
46. MILTON FRIEDMAN, CAPITALISM AND FREEDOM 2 (40th Anniv. Ed., 2002). Friedman added that the nineteenth-century liberal was "fearful of centralized power, whether in governmental or private hands." *Id.* at 6.
47. *Id.*
48. *Id.* at 4.

bring tomorrow's laggards above today's means."[49] On the other hand, Friedman saw the number of businesses or enterprises where it would be more "technically efficient to have a single producer or enterprise ... [as] more limited than is supposed."[50]

In lauding the economic variety and diversity fostered by competitive markets, and their impact on producing experimentation and innovation, Friedman was on to something profound. Friedman implicitly recognized the importance to a healthy economy of dynamic, innovative, and adaptive efficiencies.[51] Unfortunately, his insight has been lost in the canonization of allocative efficiency (however defined), as critical to the heart and soul of antitrust. It is time to bring fresh perspectives to the study of efficiencies and antitrust. The remainder of this article discusses how the lessons of evolutionary biology and evolutionary economics can shed new light upon the ongoing debates.

III. Diversity and Systemic Efficiency

To meaningfully assess efficiencies in any complex competitive system, we need to start from a systemic and dynamic perspective, rather than focusing on the alleged microefficiencies of individual parts.[52] Such an integrative ecologistic approach emphasizes the interdependence among different species and their habitats (or in economic terms, the competitive and synergistic interactions among the players in a market.)[53] It is crucial to recognize that we are dealing with complex nonlinear systems involving numerous interacting variables.[54]

Eastern philosophies long have understood this.[55] Interestingly, economist Joseph Schumpeter did as well. In describing the economic process of "creative destruction," Schumpeter noted: "[W]e are dealing with an organic process, analysis of what happens in any particular part of it—say, in an individual concern or industry—may indeed clarify details of mechanism but is inconclusive beyond that."[56]

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49. *Id.*
50. *Id.* at 28.
51. *See, e.g.*, Oliver Budzinski & Isabel Ruhmer, *Merger Simulation in Competition Policy: A Survey*, 6 J. COMPETITION L. & ECON. 277, 307 (2009) (arguing that innovative and adaptive efficiencies help drive allocative efficiencies).
52. *See, e.g.*, Daniel M. Hausman, *Health, Naturalism, and Functional Efficiency*, 79 PHIL. OF SCIENCE 519, 522 (2012) ("This is a crucial point: how well a part or process in some system is functioning depends on the goals of the system, and if, as is often the case, the part or process belongs to more than one system, then its functioning must be relativized to a system."); Robert E. Blankenship et al., *Comparing Photosynthetic and Photovoltaic Efficiencies and Recognizing the Potential for Improvement*, 332 SCIENCE 805 (2011) ("Ultimately, a comparison of solar energy options must come from the perspective of a complete life-cycle assessment in order to evaluate the full suite of energy inputs, infrastructure, and renewal requirements, and environmental factors, including greenhouse gas balance."); ROBERT A. WILSON, GENES AND THE AGENTS OF LIFE: THE INDIVIDUAL IN THE FRAGILE SCIENCES 218–19 (2005) ("[V]arious levels of selection are often entwined or fused, not just in the sense that they co-occur, or operate in the same direction, but in that they are reliably coinstantiated and do not make isolatable, distinct contributions to the ultimate evolutionary currency, fitness.").
53. *See, e.g.*, STEPHEN R. KELLERT, THE VALUE OF LIFE: BIOLOGICAL DIVERSITY AND HUMAN SOCIETY 13 (1996) ("The ecologistic view is a more integrative approach to the natural world emphasizing interdependence among species and natural habitats.").
54. ZIAUDDIN SARDAR & IWONA ABRAMS, INTRODUCING CHAOS 82 (1999) ("The nonlinear dynamic systems studied by chaos theory are complex systems in the sense that a great many independent variables are interacting with each other in a great many ways."); *see also* SUSAN M. SCHNEIDER, THE SCIENCE OF CONSEQUENCES: HOW THEY AFFECT GENES, CHANGE THE BRAIN, AND IMPACT OUR WORLD 255 (2012) ("[W]e are dealing with 'complex, multivariable, non-linear, cross-scale, and changing systems."), quoting E. Ostrom, *A Diagnostic Approach for Going Beyond Panaceas*, 104 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 15181–87 (2007).
55. *See, e.g.*, SARDAR & ABRAMS, *supra* note 54, at 167 (arguing that Eastern philosophy has "never seen the world as anything else but a complex system").
56. Joseph A. Schumpeter, *Capitalism and the Process of Creative Destruction*, reprinted in MONOPOLY POWER AND ECONOMIC PERFORMANCE: THE PROBLEM OF INDUSTRIAL CONCENTRATION 19, 28 (Edwin Mansfield ed., rev. ed. 1968); *see also* FRIEDRICH HAYEK, INDIVIDUALISM AND ECONOMIC ORDER (1948).

Schumpeter further understood that the strength of any economic system directly related to its adaptability in an ever changing environment.[57]

Like biological ecosystems, economies are dynamic, and not static, complex systems.[58] They function within complex environments that are ever changing and evolving,[59] and often unpredictable beyond the short term.[60] What ensures the long-term adaptability and health of an ecosystem or economic system? Quite simply, it is competitive variety, multiplicity, and diversity at every level of the system.[61] A healthy and robust complex system is dependent upon ongoing adaptation, innovation, and evolution at every level.[62]

University of Michigan economics and complex systems professor Scott E. Page observes that "diversity drives innovation and productivity."[63] Page adds: "Whether one looks at ecosystems, empires, or cities, greater diversity for the most part correlates with greater productivity."[64]

57. *See, e.g.*, Schumpeter, *supra* note 56, at 27 ("Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary .... The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates."); and Spencer Weber Waller & Matthew Sag, *Promoting Innovation*, Iowa L. J. (forthcoming 2015); available at http://ssrn.com/abstract=2479569, at p. 3 ("Schumpeter saw that creative destruction was essential to capitalism itself and a far more significant source of economic growth than the incremental improvements to resource allocation under the more familiar notion of pure competition within markets.").
58. *See, e.g.*, Adrian Bejan & J. Peder Zane, Design in Nature: How the Constructal Law Governs Evolution in Biology, Physics, Technology, and Social Organization 151 (2012) ("[C]onstructal theory sees social structures (economics, governments, educational institutions, etc.) as flow systems that are dynamic, not static ... the living structure is always in flux, ever evolving to provide better and better flow access.").
59. *Id.* ("The evolution of flow structures reflects the interaction between time and the environment. The environment is important because it also evolves, altering the parameters within which flow occurs."); *see also* Schumpeter, *supra* note 56, at 28 (describing how within a capitalist economic system the process of "industrial mutation ... incessantly revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one.") (emphasis in original); and Peter R. Grant & B. Rosemary Grant, How and Why Species Multiply: The Radiation of Darwin's Finches 11 (2008) ("An important conclusion will be that environmental change is an observable major driving force in the origin of new species.").
60. *See, e.g.*, Scott E. Page, Diversity and Complexity 7 (2011) ("[M]ost complex systems are not predictable. Owing to the interdependence of actions, complex systems can be predicted only in the very short run.").
61. *See, e.g.*, Christina Bohannan & Herbert Hovenkamp, Creation Without Restraint: Promoting Liberty and Rivalry in Innovation xi–xii (2012) (arguing that "the amount of economic competition in a society strongly relates to the amount of innovation it produces").
62. *See, e.g., id.* at 1 ("The health and growth of our economy is most heavily affected by two things: competitiveness and innovation. Economists speak of competitiveness as a 'static', or short-run concern, and of innovation as a 'dynamic' concern with growth over longer periods of time."); *see also* Bert Holldabler & Edward O. Wilson, The Ants 395 (1990) (observing that intense head-to-head competition in natural ecosystems results in the "diversification of species occupying the same locality"); and Geerat J. Vermeij, Nature: An Economic History 170 (2009) (discussing the importance in complex ecological and economic systems of "competition and the responses of living things to it").
63. Page, *supra* note 60, at 9.
64. *Id.* at 9. *See also Bill Moyers Interview of E.O. Wilson, in* Bill Moyers Journal: The Conversation Continues 274, 277 (2011) ("We now know from experiments and theory that the more species you take out of an ecosystem—like a pond, patch of forest, marine shallow environments—the more you take out, the less stable it becomes .... It becomes less stable with fewer species, and we also know it becomes less productive.").

Consequently, in complex biological and economic systems, long-term health, stability, and productivity are increased by variation,[65] which is the essence of diversity.[66]

Competitive variation is critical for ongoing natural selection and evolution, as selective pressures act upon "what's already available."[67] "[N]atural selection without heritable variation does not produce an evolutionary change."[68] As a result, variation within biological species and populations is both common and adaptive.[69] Indeed, living ecosystems "are organized for functions that at least maintain diversity and productivity."[70] Diversity and variety at each competitive level allows for the continual rigorous testing of competing adaptations, innovations, and strategies.[71]

Competitive diversity within complex ecological systems is viewed as a "yardstick of biological success."[72] A key reason for this is that evolution "is in love with stressors, randomness, uncertainty and disorder."[73] New innovations and adaptations arise as much by chance and repeated "failures," as they do from "efficient" top down management and planning.[74] As explained by Nassim Nicholas Taleb: "Evolution proceeds by undirected, convex bricolage or tinkering, inherently robust, *i.e.* with the achievement of potential stochastic gains thanks to continuous, repetitive, small, localized mistakes."[75]

In both biological ecosystems and economic systems, many new innovations and adaptations "evolved originally for purposes unrelated to their current function ('exaptations')."[76] For example,

65. *See, e.g.*, James E. Lovelock, *The Earth as a Living Organism*, *in* BIODIVERSITY 486, 488 (Edward O. Wilson ed., 1988) ("[N]ew ecological models demonstrate that as diversity increases so does stability and resilience."); GRANT & GRANT, *supra* note 59, at 47 ("continued adaptive evolution requires a continued supply of genetic variation."); and J.B.S. HALDANE, THE CAUSES OF EVOLUTION 31–32 (1990) ("New genes arise from time to time by a process of mutation. The fundamental importance of mutation for any account of evolution is clear.").
66. *See, e.g.*, DANIEL W. MCSHEA & ROBERT N. BRANDON, BIOLOGY'S FIRST LAW: THE TENDENCY FOR DIVERSITY AND COMPLEXITY TO INCREASE IN EVOLUTIONARY SYSTEMS 26 (2010) (arguing that "the essence of diversity is variation, discrete or not").
67. SCHNEIDER, *supra* note 54, at 40; *see also* Egbert Giles Leigh, Jr., *Adaptation, Adaptationism and Optimality*, in ADAPTATIONISM AND OPTIMALITY 358, 362 (Stephen Hecht Orzak & Elliot Sober eds., 2001) ("[N]atural selection requires variation in order to effect change."); MARTIN A. NOWAK, EVOLUTIONARY DYNAMICS: EXPLORING THE EQUATIONS OF LIFE 24 (2006) ("[V]ariability [is] needed for natural selection. If variability disappears, then natural selection has nothing upon which to act.").
68. GRANT & GRANT, *supra* note 59, at 54; *see also id.* at 58 (arguing that "a key factor" in the adaptability of Darwin's finches "is the large amount of heritable variation they possess"); BRIAN COX, WONDERS OF LIFE: EXPLORING THE MOST EXTRAORDINARY PHENOMENON IN THE UNIVERSE 258 (2013) (describing genetic mutations as "the wellspring from which diversity flows").
69. *See, e.g.*, Kenneth J. Halama & David N. Reznick, *Adaptation, Optimality, and the Meaning of Phenotypic Variation in Natural Populations*, in ADAPTATIONISM AND OPTIMALITY, *supra* note 67, at 242, 242–43, 263–64; KELLERT, *supra* note 53, at 22 ("[T]he more we probe the mysteries of any one species or the structure of any particular ecosystem, the more we are astonished by the seemingly endless variety and complexity.").
70. Leigh, *supra* note 67, at 363.
71. *See, e.g.*, ALEX PENTLAND, SOCIAL PHYSICS: HOW GOOD IDEAS SPREAD—THE LESSONS FROM A NEW SCIENCE 211 (2014).
72. MICHAEL RUSE, DARWINISM AND ITS DISCONTENTS 199 (2006) (quoting KARL J. NIKLAS, THE EVOLUTIONARY BIOLOGY OF PLANTS 204–05 (1997)).
73. TALEB, *supra* note 4, at 67.
74. *See, e.g.*, GRANT & GRANT, *supra* note 59, at 86 (discussing the "significant role" of chance in the divergence of songs in Darwin's finches); MALCOLM GLADWELL, OUTLIERS: THE STORY OF SUCCESS 32–33 (2008); ROBERT H. FRANK, THE DARWIN ECONOMY: LIBERTY, COMPETITION AND THE COMMON GOOD 143 (2011) ("[A]s economists have become increasingly aware, success depends far more on the vagaries of chance than most people once imagined. And so does economic failure."); and COX, *supra* note 68, at 271 ("Species are not the direct product of natural selection, they are accidents—a by-product of the myriad genetic changes that have accumulated through natural selection and random genetic effect.").
75. TALEB, *supra* note 4, at 348. *See also* SEAN DENNIS CASHMAN, AMERICA IN THE GILDED AGE: FROM THE DEATH OF LINCOLN TO THE RISE OF THEODORE ROOSEVELT 13 (3d ed. 1993) (describing how Thomas Edison's and Alexander Graham Bell's inventions were the result of "back-breaking trial and error in painstaking experiments carried out night after night for months—and sometimes years.").
76. SCHNEIDER, *supra* note 54, at 40.

bird feathers have multiple functions, and "most bird feathers have nothing to do with flight."[77] Thus, "[s]ystems possessing diverse, connected, interacting agents often prove capable of producing *emergent phenomena as well as complexity.*"[78] In the production and creation of such emergent innovations and adaptations, variety and diversity serve as crucial reinforcers and enablers.[79]

Competitive diversity, variety and multiplicity in complex systems enhance their robustness and long-term adaptability, productivity, and survivability.[80] For example, biological and ecological studies of prairie ecosystems have shown "a strong correlation between diversity and robustness."[81] Similarly, at the species level, healthy species consist "not of solely the fittest genome but instead of a distribution of genomes in a mutation-selection balance.[82] Thus, diversity and variability are critical to long-term survivability and adaptability.[83] They help build and sustain complex systems "that can withstand mighty blows."[84]

On the other hand, "[s]ystems that lack diversity can lose functionality."[85] "Field studies show that as biodiversity is reduced, so is the quality of the services provided by the ecosystems."[86] "Recent experimental studies on whole ecosystems support what ecologists have long suspected: the more species that live in an ecosystem, the higher its productivity and ability to withstand drought and other kinds of environmental stress."[87] By contrast, ecosystems with a "relative lack of diversity" are inherently unstable and fragile.[88]

In seeking to focus on poorly defined and understood alleged short-term "efficiencies," antitrust regulators and courts are missing the forest for the trees. They also ironically are moving away from

77. *Id.*
78. PAGE, *supra* note 60, at 25 (emphasis in original).
79. *See, e.g.*, SCHNEIDER, *supra* note 54, at 23 ("Variety is usually a reinforcer, as formal research confirms."); and PENTLAND, *supra* note 71, at 87–103 (discussing how "diversity of ideas is a critical variable" in the productivity of groups).
80. *See, e.g.*, PAGE, *supra* note 60, at 8 ("[D]iversity often enhances the robustness of complex systems. By robustness, I mean the ability to maintain functionality rather than analytic stability."), citing *ROBUST DESIGN: A REPORTOIRE OF BIOLOGICAL, ECOLOGICAL, AND ENGINEERING CASE STUDIES* (E. Jen ed., 2005).
81. PAGE, *supra* note 60, at 52.
82. NOWAK, *supra* note 67, at 42.
83. JOAN ROUGHGARDEN, THE GENIAL GENE: DECONSTRUCTING DARWINIAN SELFISHNESS 84 (2009).
84. PAGE, *supra* note 60, at 26.
85. *Id.* at 8. Page adds: "History has many examples of failure through lack of diversity, the potato famine being among the more notable.... [A] lack of genetic variation [in Europe] presented a huge hit target for parasites. When the potato blight hit, it found field upon field of genetically similar potatoes.... [Fortunately,] [d]iversity at the community level—America had a different mix of crops from Ireland—minimized the global impact of the blight." *Id.* at 8–9.
86. EDWARD O. WILSON, THE DIVERSITY OF LIFE 347–48 (1992). Wilson adds that "[r]ecords of stressed ecosystems also demonstrate that the descent can be unpredictably abrupt." *Id.*
87. EDWARD O. WILSON, CONSILIENCE: THE UNITY OF KNOWLEDGE 294 (1998). Wilson further explains: "[T]he more species you take out of an ecosystem ... the less stable it becomes. If you have a tsunami or a severe drought or you have a fire, the less likely the ecosystem, that body of species in that environment, is going to come all the way back. It becomes less stable with fewer species, and we also know it becomes less productive. In other words, it's not able to produce as many kilograms of new matter from photosynthesis and passage through the ecosystem." BILL MOYERS JOURNAL, *supra* note 64, at 277.
88. Peter M. Vitousek, *Diversity and Biological Invasions of Oceanic Islands*, in BIODIVERSITY, *supra* note 65, at 181, 184 (discussing why isolated island species are more susceptible to extinction caused by biological invasions); *see also* Ruth Patrick, *Biodiversity: Why Is It Important? in* BIODIVERSITY II: UNDERSTANDING AND PROTECTING OUR BIOLOGICAL RESOURCES 15, 17 (Marjorie L. Reaka-Kudla et al. eds., 1997) (discussing how both terrestrial and aquatic ecosystems require high levels of species diversity for their long-term health and stability); Horton, *Coming Extinction*, *supra* note 6, at 488 (discussing how diversification "leads to increases in overall diversity, which leads to increased ecosystem and organism adaptability, resilience, and stability").

the competitive visions of economists like Henry Simons,[89] Joseph Schumpeter,[90] and Milton Friedman,[91] who all recognized the importance of dynamic and unremitting competition at all systemic levels. From a big-picture, evolutionary theory perspective, competitive diversity and variability at all systemic levels catalyze and encourage maximum innovation and dynamic systemic efficiency, which leads to a robust and healthy competitive economic system.

Following the teachings of evolutionary theory does not mean that moderate levels of concentration cannot or should not be permitted or tolerated.[92] Evolutionary theory appropriately recognizes that there are limits to competitive diversity in any complex system, and that "too much diversity may well produce either chaos or randomness," or environmental degradation.[93] What it does mean, however, is that "a system is more robust, more efficient, or more innovative if it contains the appropriate amount and kinds of diversity."[94]

It also means that the current tolerance and even encouragement of monopoly and oligopoly[95] in the name of "efficiency" is seriously misguided and dangerous. Following both evolutionary theory and the innovation theories of Christina Bohannan and Herbert Hovenkamp, "carefully designed 'structural' relief [or blocking mergers] in a market with a high degree of concentration need not generally be feared on the grounds that it will undermine innovation."[96] Nor should such relief be feared on the grounds of reducing valuable "efficiencies" that will enhance "consumer welfare."

89. *See, e.g.*, James W. Brock, *Economic Power, Henry Simons, and a Lost Antitrust Vision of Economic Conservatism*, 58 S.D. L. Rev. 443 (2013). Simons, called the "Crown Prince" of the Chicago School of Economics, "rejected concentrations of economic power as being dictated by any efficiencies of large scale organization." *Id.* at 445. He also "considered private economic power to be as great a threat as government power to a free society and a free economy, both in narrow, conventional microeconomic ways, as well as in more fundamental, more far-ranging 'macro' ways." *Id.* at 444.
90. *See, e.g.*, Joseph A. Schumpeter, Capitalism, Socialism and Democracy 83–84 (3d. ed. 1950) ("[I]n capitalist reality as distinguished from its textbook picture, it is not [price competition] which counts but the competition from the new commodity. The new technology, the new source of supply, the new type of organization ... —competition which commands a decisive cost or quality advantages and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.").
91. *See, e.g.*, Friedman, *supra* note 46, at 2 (discussing how "the great threat to freedom is the concentration of power"); *id.* at 4 (discussing the need for a "social climate permitting variety and diversity" and the "variety essential for that experimentation which can bring tomorrow's laggards above today's means.").
92. *See, e.g.*, Bohannon & Hovenkamp, *supra* note 61, at 9–10. As they aptly note: "The two extremes of absolute monopoly and nearly perfect competition both produce the lowest amounts of innovation. Innovation tends to be greatest when the four largest firms account for half or more of a market. In general, the studies support the Arrovian critique of Schumpeter and conclude that pure monopolists lack sufficient incentives to innovate at the optimal level. However, as the number of firms in the market becomes very large, the returns to innovation are dissipated and no firm acting individually has a sufficient incentive to innovate." *Id.*
93. Page, *supra* note 60, at 253. *See also* Andrew Stirling, *On the Economics and Analysis of Diversity* 10 (Sci. & Tech. Policy Research Elec. Working Paper Series, Paper No. 28, 1998) (asserting that "a condition of optimal diversity falls somewhere between two extremes in the degree of connectedness of an economic system: dense homogeneity on the one hand and complete fragmentation on the other").
94. Page, *supra* note 60, at 250. Diversity created through evolutionary competition is radically different from artificial attempts to create diversity without the benefits of selective pressures. Page, *supra* note 60, at 251. This accounts for the man-made ecological catastrophes of introducing invasive species into environments that have not developed appropriate competitive controls and responses. *See, e.g.*, Edward O. Wilson, The Future of Life 44–50 (2002).
95. *See, e.g.*, Verizon Communications, Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 407 (2004) (defending monopoly pricing as "an important element of the free market system"), and Maurice E. Stucke, *Should the Government Prosecute Monopolies?* 2009 U. Ill. L. Rev. 497, 498 (2009) ("The Court's view on monopolies has become forgiving.").
96. Bohannon & Hovenkamp, *supra* note 61, at 11.

IV. Concentration, Size, and Systemic Efficiency

A. The Importance of Plasticity, Adaptability, and Redundancy in Complex Biological and Economic Systems

Lurking behind the current focus on maximizing economic efficiency is the ideal of near perfect control and mastery of our economic systems of production and distribution. As discussed in part II above,[97] this ideal derives in large part from progressive era beliefs in efficiency as a way to control economic and social systems by promoting balance, stability, and regularity.[98] Unfortunately, the implementation of the arbitrary and poorly defined concepts of economic efficiency standards in vogue today has favored economic concentration and consolidation at the expense of ongoing aggressive competition.[99]

Evolutionary biology and economics counsel that healthy complex systems must be adaptable, resilient, and robust. Plasticity and adaptability, which enable competitive entities to explore new functional and behavioral possibilities, are crucial to resilient and robust complex systems.[100] The potential for diverse responses enables them to adapt to continuing exogenous and endogenous stresses, including rare and extreme events.[101]

Naturally, there are costs to maintaining plasticity, variability, and long-term robustness. One cost is that "imperfections" are inevitable and a necessary component of a robust complex system's design.[102] In the words of Adrien Bejan and J. Peder Zane, "nature is filled with accident and variation all the time and everywhere."[103] For example, "rivers meander—they have a snake like pattern whose wavelength is proportional to the width of the channel."[104] Attempts to eliminate imperfections and impose greater efficiency on complex systems ironically can lead to chaos and environmental disasters.[105]

97. *Id.* at 6–8.
98. *See, e.g.*, Alexander, *supra* note 32, at 323 (discussing Progressive Era development of arbitrary efficiency standards as tools to "help guarantee regularity, stability, and reliability" in cases "where ideal or theoretical efficiency could not be calculated.").
99. *See, e.g.*, Brock, *supra* note 89, at 448–61; KENNETH M. DAVIDSON, MEGAMERGERS: CORPORATE AMERICA'S BILLION-DOLLAR TAKEOVERS 120 (2003) (criticizing Chicago School theory that "big business [is] not bad, it [is] the epitome of good. Large corporate size [is] the reward for efficiently satisfying consumer wishes. Continued growth [is] proof of that efficiency.").
100. *See, e.g.*, PAGE, *supra* note 60, at 143–44 (discussing "[t]he ability of entities in the system to explore new functional possibilities, and the rate at which these explorations occur," and observing that "[c]reative systems have amazing plasticity and therefore lots of diversity"); TALEB, *supra* note 4, at 85 ("The more variability you observe in a system, the less Black Swan-prone [fragile] it is.").
101. *See, e.g.*, PENTLAND, *supra* note 71, at 209–10 (discussing resilience and the long-term stability of complex systems); TALEB, *supra* note 4, at 3–5 (describing "anti-fragile" systems as those that not only resist shocks, but improve as a result of them); PAGE, *supra* note 60, at 8 (arguing that "diversity often enhances the robustness of complex systems").
102. *See, e.g.*, BEJAN & ZANE, *supra* note 58, at 65 ("Imperfection is an inevitable phenomenon and a necessary part of design ... good design involves *the nearly uniformed distribution of imperfection* throughout the entire flow system.") (emphasis in original).
103. *Id.* at 73. *See also* Taleb, *supra* note 4, at 4 ("The antifragile loves randomness and uncertainty, which also means—crucially—a love of errors, a certain class of errors.").
104. BEJAN & ZANE, supra note 58, at 72. The authors add that "[i]f nature were a laboratory with a perfectly stable and unchanging environment, then every river basin would be identical." *Id.* at 74. Interestingly, the inanimate systems of river basins and the animate systems of "blood vessels and air passages evolve toward the same design structure." *Id.* Similar phenomena govern the evolution of such complex systems as lightning and city traffic. *Id.*
105. *See, e.g.*, MICHAEL C. BLUM, SACRIFICING THE SALMON: A LEGAL AND POLICY HISTORY OF THE DECLINE OF COLUMBIA BASIN SALMON 129–38 (2002) (discussing how attempts to balance salmon ecology and hydropower in the Columbia Basin have eroded salmon runs to about one-half of what they were thirty years ago, despite cumulative expenditures of nearly $10 billion).

Another set of costs are the so-called inefficiencies of systemic variation and diversity. Charles Darwin noted as early as 1859, that competitively induced diversity enhances overall species and systemic fitness.[106] "[D]iversity, variability, and opportunity are the keys not only to long-term species survival, but to the stability and health of a thriving ecosystem."[107]

An "inescapable benefit" of competitive variation and diversity is that it ensures averaging.[108] Averaging enables diverse systems to become more robust over the long term.[109] This point may seem counterintuitive because a diverse approach may not maximize short-term "efficiency."[110] But as Joseph Schumpeter recognized, long-term innovation, adaptability, and robustness is the real end game.[111] Schumpeter further implicitly recognized[112] that different parts of organisms (or by analogy businesses) carry out their various functions with differing efficiencies,[113] and that there are multiple standards by which such functional efficiencies can be compared.[114] Consequently, obsessively focusing on any one alleged micro-level of efficiency, as opposed to overall systemic diversity, robustness, and competitiveness is little more than a futile academic exercise.

Averaging and blending also helps insure that one part of a system does not grow disproportionately and reach a dominant level that leads to widespread systemic destruction.[115] As described by University of Michigan professor Arlene Saxonhouse: "The parts, each asserting its claims within the whole or each growing disproportionately and gaining dominance with regard to the others, are destructive. Safety for the regime entails the blending of parts and in particular preserving that blending."[116]

A further potential cost of systemic adaptability and robustness is the need for systemic redundancies. As Scott Page notes: "if a system contains redundant parts, then it will be more robust to the failure of one of the parts."[117] Nassim Nicholas Taleb similarly observes that "[l]ayers of redundancy are

106. *See, e.g.*, E.G. Leigh, Jr. et al., *What Do Human Economics, Large Islands and Forest Fragments Reveal About the Factors Limiting Ecosystems Evolution?* 22 J. Evolutionary Biology 1, 6 (2009) (citing Charles Darwin, On the Origin of Species (1859)); and Geerat J. Vermeij, *Comparative Economics: Evolution and the Modern Economy*, 11 J. Bioeconomics 105, 121–22 (2009) ("In short, biological and economic systems have evolved toward an organizational structure that encompasses, tolerates, generates, and accumulates variation ....Not only do systems with such a structure permit innovations to arise and to be incorporated, but they become robust in the face of many internally and externally imposed shocks.").
107. Horton, *Coming Extinction*, *supra* note 6, at 485.
108. *See, e.g.*, Page, *supra* note 60, at 167–82. Page cites the Central Limit Theorem of Mathematics, and observes that "with enough data, the mean of a sample equals the true mean: *Variations cancel*. That cancellation enhances robustness." *Id.* at 169 (emphasis in original).
109. *See id.* at 168–69.
110. *See, e.g., id.* at 181.
111. *See* Schumpeter, *supra* note 56, at 28 ("A system—any system—economic or other—that at *every* given point of time fully utilizes its possibilities to the best advantage may yet in the long run be inferior to a system that does so at *no* given point of time, because the latter's failure to do so many be a condition for the level or speed of long-run performance.") (emphasis in original).
112. *See id.* ("[S]ince we are dealing with an organic process, analysis of what happens in any particular part of it—say, in an individual concern or industry—may indeed clarify details of mechanism but is inconclusive beyond that. Every piece of business strategy acquires its true significance only against the background of that process and within the situation created by it.").
113. *See, e.g.*, Hausman, *supra* note 52, at 522. Hausman notes that such parts or processes "must be relativized to a system." *Id.*
114. *Id.* at 533 ("What constitutes functioning well or badly depends on details of the relevant circumstances in which an organism finds itself ... there are multiple standards by which functional efficiency can be compared and because there are different kinds of malfunctioning.").
115. *See, e.g.*, Edward O. Wilson, *supra* note 94, at 70–75 (describing how the growth of invasive species not "held in check by natural enemies and other population controls" have wreaked environmental havoc and systemic degradation).
116. Arlene W. Saxonhouse, Fear of Diversity: The Birth of Political Science in Ancient Greek Thought 229 (1992).
117. Page, *supra* note 60, at 227.

the central risk management property of natural systems."[118] Such "redundancy is not defensive; it is more like investment than insurance."[119] Geerat Vermeij agrees.[120]

Seemingly "inefficient" and sometimes "expensive" diversity also positively "affects responsiveness, the ability of the system to respond to disturbances."[121] A diversity of possible responses increases the number of exogenous and endogenous disturbances that a system can absorb.[122] For example, humans' adaptive immune systems are biologically "expensive."[123] Yet, "immunity diversity" has played a critical role in humans' evolutionary survival and success.[124]

American Antitrust Institute President Bert Foer aptly observes that "market economies are reluctant to bear the costs of redundancy and stockpiling—the incentive to plan for disaster, it seems, isn't transparent."[125] But is not, Foer asks, the absence of protection against risk a huge systemic inefficiency?[126] Foer is hardly alone in raising such insightful questions.[127] Taleb, for example, counsels economics and business students to tell their professors "that what they call 'inefficient' is often very efficient."[128] Vermeij adds: "[r]edundancy may be at odds with economic efficiency, but in the long run it is better to have a safety net of redundant production than to be efficient and dead."[129]

In seeking to optimize "efficiency" at the expense of free, fair, and robust competition, we have created systemic economic fragility and inefficiency.[130] We have been fragilizing our economy by elevating the pursuit of ill-defined and speculative short-term economic efficiencies above the protection of competitive diversity and systemic robustness.[131] Depriving our economic systems of the stressors

118. TALEB, *supra* note 4, at 44. Taleb adds that nature "is all about redundancy. Nature likes to overinsure itself." *Id.*

119. *Id.* at 45. *See also* PAGE, *supra* note 60, at 83 (describing how genetic redundancy, "multiple encodings of the same phenotypic expression," prevent genetic mutations from running amok).

120. *See, e.g.*, VERMEIJ, *supra* note 62, at 139 (arguing that the power of organization derives in part from "greater redundancy, meaning that the system becomes more forgiving of error and disruption, and that variants arising within the system are not automatically crippling to it"); VERMEIJ, *supra* note 106, at 128 ("Biological systems for billions of years have been characterized by redundancy, which spreads risks and enables systems of loosely linked but still interdependent parts to absorb and recover from shocks."); DANIEL R. BROOKS & DEBORAH A. MCLENNAN, THE NATURE OF DIVERSITY: AN EVOLUTIONARY VOYAGE OF DISCOVERY 463 (2002) (describing how functional redundancies increase stabilizing selection).

121. PAGE, *supra* note 60, at 202.

122. *Id.* at 203–04.

123. *Id.* at 204–05.

124. *Id.* at 206–08. Trees, on the other hand, do not have immune systems, perhaps because they are too costly. As a result, in the United States, chestnut trees, elm trees, and ash trees have been decimated by single attackers as a result of their inability to respond effectively. *Id.* at 205.

125. Foer, *supra* note 3, at 27, note 65.

126. *Id.* at 28.

127. *See, e.g.*, Bush, *supra* note 1, at 279–80 ("[A]ntitrust law has largely ignored the notion that corporate political power may create significant economic effects that may affect the structure and function of the market."); Markham, *supra* note 1, at 262 (describing how "recent changes in the business of global banking and finance beyond the mere size of financial enterprises contributed to a systemic weakness, rather than isolated weakness in one or a few participants"); Fox, *supra* note 1, at 88 ("[I]n the name of efficiency, economically conservative U.S. antitrust law protects inefficient conduct by dominant and leading firms and thus protects inefficiency."); Walter Adams & James W. Brock, *Antitrust, Ideology, and the Arabesques of Economic Theory*, 66 U. COLO. L. REV. 257, 268–69 (1995) (noting the need for government bailouts due to the economic inefficiencies of consolidated economic and political power).

128. TALEB, *supra* note 4, at 45. Taleb adds that "[r]edundancy is ambiguous because it seems like a waste if nothing unusual happens. Except that something unusual happens—usually." *Id.*

129. VERMEIJ, *supra* note 106, at 128.

130. *See, e.g.*, Horton, *Coming Extinction*, *supra* note 6, at 476, n. 28 ("A considerable array of recent literature questions the long-term health and sustainability of our economic system under the Chicagoans' free-market theories in light of the financial collapse of 2008."); JOSEPH E. STIGLITZ, FREEFALL: AMERICA, FREE MARKETS, AND THE SINKING OF THE WORLD ECONOMY (2010).

131. *See, e.g.*, TALEB, *supra* note 4, at 5, 23 ("We have been fragilizing the economy, our health, political life, education, almost everything ... by suppressing randomness and volatility."); STIGLITZ, *supra* note 130; Markham, *supra* note 1.

of competitive diversity in the name of efficiency is a long-term losing proposition, and one we need to quickly check.[132]

Attempting to micromanage short-term efficiencies is doomed to long-term failure because economics has never been good at predicting exogenous shocks, "all the unaccountable events of history and environmental change that push the parameter values up and down."[133] "[C]onfounded by the turbulence of the real world,"[134] Chicagoans have sought order and stability through their philosophy of efficiency. Evolutionary theory, however, counsels that the only way to ensure long-term systemic robustness and efficiency is to encourage and protect competitive diversity at all levels. We therefore need to return to an evolutionarily sound antitrust strategy of ensuring that we have an economic system in which competitive diversity and adaptability are protected against the constraints of concentration and predatory conduct.[135]

B. Size and Efficiency in Complex Biological and Economic Systems

Our fascination with size and bigness is entrenched in our human psyches.[136] Our fascination with large size has led us to assume that bigness is better and more efficient in creating allocative efficiencies and consumer welfare.[137] We have come to readily accept that increases in size bring ever increasing economies of scale and efficiencies.[138] But is bigger really better and more efficient?

Nature and evolutionary theory counsel that size is only one of many variables to be considered in assessing relative performance. From an evolutionary perspective, a diverse distribution and array of physical sizes works best in ensuring systemic robustness and health.[139] Consequently, "[i]f one looks at any environment, from fields to forests, from ponds to oceans, there is always an array of organisms

132. *See, e.g.*, TALEB, *supra* note 4, at 38 ("we can now see that depriving systems of stressors, vital stressors, is not necessarily a good thing, and can be downright harmful.").

133. WILSON, *supra* note 87, at 219.

134. *Id.*

135. *See, e.g.*, Vermeij, *supra* note 106, at 128 ("[P]olicies of [economic concentration] are both risky and inconsistent with the economics of nature."); Geerat J. Vermeij, *From Phenomenology to First Principles: Toward a Greater Theory of Diversity*, 56 PROC. CAL. ACAD. SCI. 12, 20 (Supp. I 2005) ("Environments and regions in which competition and adaptation are least constrained produce the species with the highest competitive, defensive, and reproductive performance."); BOHANNAN & HOVENKAMP, *supra* note 61, at 248 ("The History of antitrust is filled with examples of innovation restraints that were motivated by dominant firms' or cartels' search for monopoly profits.").

136. *See* JOHN TYLER BONNER, WHY SIZE MATTERS: FROM BACTERIA TO BLUE WHALES ix (2006) ("Our interest in the size of things is entrenched in the human psyche. It reveals itself in literature from Gulliver's Travels, to the Grimm's Fairy Tales, to Alice in Wonderland .... There is hardly anything we observe in daily life that we, either consciously or unconsciously, do not take measure of its size.").

137. *See, e.g.*, BORK, *supra* note 14, at 178 ("Antitrust should not interfere with any firm size created by internal growth, and this is true whether the result is monopoly or oligopoly.").

138. *See, e.g.*, William E. Kovacic, *The Intellectual DNA of Modern U.S. Competition Law for Dominant Firm Conduct: The Chicago/Harvard Double Helix*, 2007 COLUM. BUS. L. REV. 1, 14–15 (2007); RICHARD A. POSNER, ANTITRUST LAW 28 (2d ed. 2001) (arguing that "whenever monopoly would increase efficiency, it should be tolerated, indeed encouraged"); Herbert Hovenkamp, *Antitrust Policy After Chicago*, 84 MICH. L. REV. 213, 227–28 (1985) (discussing Chicago School tenet that economies of scale are large and prevalent).

139. *See, e.g.*, COX, *supra* note 68, at 118 ("The smallest living thing on Earth is a thousand million times smaller than the largest. The tallest trees reach heights of over 100 m, and weigh more than 1,000 tones. The smallest bacterial cells are less than a millionth of a metre in length, and weigh a million millionths of a gram."). Furthermore, no matter how large a species grows, its members must still face intense intraspecies competition. *See* BONNER, *supra* note 136, at 64 ("The organisms at each size level are competing with one another."); EDWARD O. WILSON, SOCIOBIOLOGY 120 (abridged ed. 1980) (discussing studies showing that competition generally is more intense within species than between species).

of different sizes, from the smallest bacteria to the largest trees or vertebrates and all the middle-sized forms in between."[140]

As discussed above, the current favoring of bigness and its alleged efficiencies actually creates a dominance spiral that threatens systemic diversity and robustness. As the amount of species diversity in a community is reduced, the likelihood of dominant species taking control and further degrading the overall environment increases.[141] This downward spiral ultimately leads to less stability, more fragility, and reduced productivity.[142]

In terms of bigger size being relatively more efficient, nature and evolutionary theory counsel the opposite. First, any increases in size are accompanied by myriad consequences based on the natural laws of physics.[143] As size increases, a host of other constraints impacting shape, speed, locomotion, maneuverability, robustness, longevity and abundance bear down.[144] Quite simply, "no one can escape the universal rules imposed by size."[145] "This is why, despite the efficiency of its method of locomotion, we see no animal bigger than the majestic red kangaroo hopping on the surface of our planet."[146] This also is why Galileo found it impossible to effectively "increase the size of structures to vast dimensions either in art or in nature."[147]

The simplistic assumption that bigger is more efficient further overlooks the law of diminishing returns.[148] "Diminishing returns are a widespread phenomenon in economies and ecosystems."[149] The law of diminishing returns sets upper bounds on the efficiency levels that can be achieved.[150] Furthermore, "[w]hen diminishing returns to type are present, diverse collections do best."[151]

Ironically, from a purely relativistic standpoint, smaller size often is substantially more efficient than bigger size. Small size, for example, is one of the key factors accounting for the "preeminence and hyperdiversity" of insects in nature.[152] This makes sense, as the abundance of organisms varies

140. Bonner, *supra* note 136, at 64.

141. *See, e.g.*, Holldabler & Wilson, *supra* note 62, at 423 (1990) (arguing that "impoverished faunas promote dominant species ... ," and that "the fewer the ant species in a local community, the more likely the community is to be dominated behaviorally by one or a few species with large, aggressive colonies that maintain absolute territories").

142. *See, e.g.*, Bill Moyers Journal, *supra* note 64, at 275.

143. *See, e.g.*, Bonner, *supra* note 136, at 148; Cox, *supra* note 68, at 119 ("The size, structure and form of living things are constrained by the laws of nature, and these are unavoidable.").

144. Bonner, *supra* note 136, at 148–50; *see also* Haim Ofek, Second Nature: Economic Origins of Human Evolution 91 (2001) (discussing how engineers "are faced with a delicate balancing act between economies of scale in surface or diseconomies of scale in weight, or more fundamentally, between an invariable law of solid geometry and the law of gravity").

145. Bonner, *supra* note 136, at x; *see also* J. B. S. Haldane, *On Being the Right Size, in* The Oxford Book of Modern Science Writing 53, 54 (Richard Dawkins ed., 2008).

146. Cox, *supra* note 68, at 139. Cox adds: "The great dinosaurs like diplodocus and argentinosaurus existed on the limit of bone strength, and would have been in extreme peril if they fell over. This would have determined their method of locomotion; tripping would have been avoided at all costs." *Id.* In the end, size "dictates the characteristics of all living forms." Bonner, *supra* note 136, at 3.

147. Bonner, *supra* note 136, at 29, quoting Galilei Galileo, Dialogues Concerning Two New Sciences (1914).

148. *See* Page, *supra* note 60, at 183.

149. *Id.* For example, "[a]dditional workers of the same type contribute diminishing returns to the total product. Economists call this the diminishing marginal product of labor." *Id.* at 183–84.

150. *See, e.g.*, Ofek, *supra* note 144, at 91. Ofek further observes that as organisms get larger and larger, they face a host of natural straitjackets that "impose considerable anatomical and physiological diseconomies of scale on their large-bodied carriers." *Id.* at 92.

151. Page, *supra* note 60, at 183.

152. Wilson, *supra* note 86, at 211. Wilson further observed that in 1992, "about a billion billion insects [were] alive at any given time around the world. At nearest order of magnitude, this amount[ed] to a trillion kilograms of living matter, somewhat more than the weight of humanity." *Id.* at 210. Wilson added: "Insects can thrive without us, but we and most other land organisms would perish without them." *Id.* at 211. Similarly, "the extent of microbial diversity is so

inversely with their size.[153] John Tyler Bonner observes: "It is mostly the big beasts, such as dinosaurs, that die out; the smallest [organisms] started off as a success and have remained so ever since."[154] Robert Wesson adds: "[g]iantism may be adaptive along the way, but it is ultimately unadaptive."[155]

Turning to relative strength, smaller animals have greater relative strengths.[156] Indeed, the consequences of size on organisms' weight-strength ratios are large.[157] For example, comparing the relative performance of an Olympic weight-lifting champion with that of a simple rhinoceros beetle is humbling, as the beetle "can carry loads of over 30 times its own body weight over high speeds and long distance."[158] Of course, in terms of absolute performance, the weight lifter wins, but at a cost of drastically reduced efficiency.[159]

What about energy transfer efficiency? Once again, size and efficiency are inversely related. A major pattern of plant and animal production is that "the efficiency of energy transfer from plants to animals is negatively correlated with the size of dominant primary producers."[160] For example, an elephant is far less efficient in burning energy-providing food than a mouse.[161]

A further complication of increasing size is that "[t]he division of labor (complexity) varies with size."[162] Greater divisions of labor require increased internal networks and interdependencies. But "networks (or economic entities) that are too dense or too extensive can decrease the adaptability and long-term health and stability of an economy or ecosystem."[163]

Over and over, nature limits the number of levels of interdependencies. For example, the number of links in a natural food web is usually five or fewer.[164] Similarly, the average number of tributary streams that feed a larger river channel is approximately four.[165] Furthermore, the inanimate systems of river basins and "the animate systems of blood vessels and air passages evolve toward the same design structure."[166] Compare this elegant natural simplicity to the early development of information systems where the parts of many "were so tightly coupled that it was impossible to evolve."[167]

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great that scientists have difficulty estimating its actual size." Jonathon Shaw, *The Undiscovered Planet: Microbial Science Illuminates a World of Astounding Diversity*, Harv. Mag., Nov.–Dec. 2007, at 44.

153. *See, e.g.*, BONNER, *supra* note 136, at 112–13. Bonner adds that "the size-abundance rule holds for a tremendously wide range of organisms." *Id.* at 113.
154. BONNER, *supra* note 136, at 27.
155. ROBERT WESSON, BEYOND NATURAL SELECTION 192 (1991).
156. *See, e.g.*, BONNER, *supra* note 136, at 30–31.
157. *Id.* at 31.
158. COX, *supra* note 68, at 145. Cox adds: "[s]caled up to human size, world record holder Hossein Rezazadeh would have to be able to lift four family cars onto his back and carry them for many kilometers." *Id.*
159. *See also* VERMEIJ, *supra* note 62, at 124. Vermeij adds: "[E]mphasis on efficiency is misplaced. Economic success depends on absolute performance, and very often—in human-economic contexts as well as the evolutionary marketplace—high levels of performance go hand in hand with reduced efficiency." *Id. See also id.* at 125 ("In our technological world, internal combustion plants and atomic power plants give off vast amounts of unused heat, but their power yield is so great and provides such clear economic advantages that their inefficiency is tolerated, much as it is in warm-blooded animals."). A relevant question therefore becomes whether Chicagoans are confusing economic power with efficiency.
160. Douglas S. Glazier, *Global Patterns of Ecological Efficiency at the Biome-Level*, 61 OIKOS 439 (1991). Glazier explains: "this is because much more of the biomass of large terrestrial woody plants is unavailable for animal consumption, compared with that for small herbs and grasses and tiny aquatic photo plankton." *Id.*
161. BONNER, *supra* note 136, at 130.
162. *Id.* at 5.
163. Horton, *Coming Extinction*, *supra* note 6, at 496–97 (and citations therein).
164. *See* WILSON, *supra* note 86, at 180.
165. BEJAN & ZANE, *supra* note 58, at 15.
166. *Id.* at 74–75.
167. Hind Benbya & Bill McKelvey, *Toward a Complexity Theory of Information Systems Development*, 19 INFO. TECH. & PEOPLE 12, 25 (2006). *See also* Horton, *Coming Extinction*, *supra* note 6, at 496–97.

As discussed earlier, the increasing interdependencies and complex interconnections associated with larger size can inhibit adaptability and responsiveness, and lead to greater fragility and volatility. Thus, a collection of small units "is more antifragile than the large—in fact the large is doomed to breaking, a mathematical property ... that, sadly, seems universal as it applies to large corporations, very large mammals, and large administrations."[168] Taleb concludes that "intervening to limit size (of companies, airports, or sources of pollution), concentrations, and speed are beneficial in reducing Black Swan [fragility] risks."[169]

Furthermore, increasing size carries the risk of substantial diseconomies of scale, including "increased communication costs, duplication of effort, inertia, and internal culture clashes."[170] Bert Foer observes that "as firms grow larger and more complex, after some point they may become less efficient and more difficult to manage."[171] Adams and Brock add that "[s]cientific evidence has not been kind to the apostles of bigness and their mythology."[172]

In conclusion, giantism is neither a natural state, nor an efficient result of competitive evolution.[173] Nor in biological ecosystems are large size and dominance synonymous with either efficiency or system robustness and health.[174] Applying evolutionary theory, we should recognize that the only effective way to promote and protect systemic efficiencies is to preserve and protect competitive diversity at all economic levels.

V. Conclusion

Evolutionary biology and evolutionary economics can bring a fresh perspective to the ongoing debate about the importance of efficiencies in antitrust analysis.[175] The term efficiency, as currently used in antitrust, is a values-laden concept that has more to do with social and economic ideology than science or engineering. An evolutionary perspective can help put us back on track.[176]

168. TALEB, *supra* note 4, at 89.
169. *Id.* at 119. Taleb adds that "if something is fragile, its risk of breaking makes anything you do to improve it or make it 'efficient' inconsequential unless you first reduce that risk of breaking." *Id.* at 160.
170. Markham, *supra* note 1, at 315. Markham notes the paradox that "*optimum scale efficiency* is considered measurable and a presentable basis for allowing a merger transactions, but *excessive-scale inefficiency* is not considered a proper basis on its own for disallowing a merger." *Id.* at 314 (emphasis in original); *see also* Harvey Leibenstein, *Allocative Efficiency vs. "X-Efficiency*, 56 AM. ECON. REV. 392 (1966) (describing the concept of "X-inefficiency").
171. Foer, *supra* note 3, at 31. Foer adds that "[t]hemes like communications costs, duplication of effort, management opportunism, principal/agent problems, cannibalism, isolation of decision makers, slow response time, and inertia emerge as counterweights to claimed efficiencies of larger scope or scale." *Id. See also* ADAMS & BROCK, *supra* note 15, at 29–31 (discussing the "core question of whether size inherently promotes economic efficiency in production"); 30–45 (discussing "the relationship between bigness and operating efficiency in American industry").
172. ADAMS & BROCK, *supra* note 15, at 45. They further observe that "[c]ountless studies and analyses, for specific industries as well as for manufacturing and commerce generally, for specialized firms as well as conglomerates, for merged firms and unmerged firms, have found that excessive firm size and high industry concentration are not technologically ordained by any dictates of large-scale operating economies." *Id.* They further urge us to grasp that "excessive corporate size and concentrated power *undermine* efficiency, productivity, and international competitiveness." *Id.* (emphasis in original).
173. *See* Horton, *Antitrust Double Helix*, *supra* note 6, at 637; BONNER, *supra* note 136, at 13–15.
174. *See, e.g.*, Horton, *Coming Extinction*, *supra* note 6, at 495; HOLLDABLER & WILSON, *supra* note 62, at 423.
175. *See, e.g.*, PAGE, *supra* note 60, at 250 (calling for a "cross-fertilization of ideas" across different disciplines); *id.* at 80 ("Of course, to say that an economy resembles an organism or that a legal system works like an immune system does not say that they are identical. It just means that they share enough features that causal relationships we discover in one domain generally hold in another."); PENTLAND, *supra* note 71, at 17 ("The social physics that is emerging brings together branches of economics, sociology, and psychology, along with network, complexity, decision, and ecology sciences and fuses them together using big data.").
176. *See, e.g.*, BEINHOCKER, *supra* note 4, at 187 (2006) ("Businesspeople, journalists, and academics all gravitate naturally to using images of ecosystems and evolution when they talk about the economy. One of the strongest claims of Complexity Economics is that this language is no mere metaphor—organizations, markets, and economies are not just like evolutionary

From an overall systemic perspective, nature creates and sustains efficiencies, robustness, and adaptability through intense and unremitting competition at all interspecies and intraspecies levels. This intense competition is sparked and catalyzed by a dazzling array of creative diversity, multiplicity and variation that allows for maximum experimentation and innovation. Economic diversity, variability, and opportunity, rather than increasing concentration and speculative short-term "efficiencies," are therefore the keys to the overall health, productivity, and robustness of our economic system.

Our current attacks against competitive redundancies and variations are misplaced, since nature is consistent in building structural redundancies and diversity into its complex ecosystems. Such seemingly short-term inefficiencies actually enhance an overall system's robustness and sustainability by allowing it to quickly and effectively respond to ongoing endogenous and exogenous shocks and environmental changes.

Our current tolerance and encouragement of large size, dominance, and concentration also is misguided. Large size and dominance are not synonymous with efficiency in nature, and giantism has never been an effective long-term evolutionary strategy. Indeed, increases in physical size inevitably create new risks, instabilities, and inefficiencies.

To help build and sustain systemic efficiency, productivity, and robustness, we should return to an antitrust philosophy of protecting aggressive competition and guarding competitive opportunities rather than seeking to promote poorly defined, short-term, microeconomic efficiencies.[177] Instead of creating presumptions that mergers and consolidations are efficiency enhancing, we need to return to a fundamental bias in favor of aggressive competition and competitive opportunities at all systemic levels. This means that we should return to a philosophy of forceful and bold enforcement of Section 7 of the Clayton Act.[178]

We also should begin taking a fresh look at vertical mergers and agreements that lead to diminished economic diversity, variation, and competitive opportunity. To do this, we need to approach the alleged efficiencies of vertical acquisitions and agreements with far more skepticism.

Finally, it is time to stop "blaming the victims" and protecting unfair predatory conduct through facile conclusions that dominant firms and monopolies simply are more efficient. We need to start holding such firms accountable for their predatory efforts to destroy competitive diversity and opportunity. As argued previously by this author, we should return monopolization cases to juries, who are far better equipped from an evolutionary standpoint to fairly decide them than "judges straightjacketed by Chicago/Harvard economic theories."[179]

Our attempts to encourage speculative short-term microefficiencies through increasing concentration and size has caused us to lose sight of evolutionary biology's lessons that diversity, variety, and competitive opportunity are the best path to achieving economic efficiencies and systemic robustness. Francis Fukuyama aptly observed that "[b]oth American democracy and American business have been successful because they partook of individualism and community simultaneously."[180] As noted by antitrust professors Harry First and Spencer Weber Waller: "[a]ntitrust has moved too far from democratic institutions and toward technocratic control, in service to a laissez-faire approach to antitrust

systems; they truly, literally are evolutionary systems."); WILSON, *supra* note 87, at 222 (discussing the need to "infuse psychology into economic and other social theory"); Horton, *Coming Extinction*, *supra* note 6, at 469 ("Evolutionary biology has much to teach us about antitrust regulation in our complex, free-market economy.").

177. *See, e.g.*, Horton, *Antitrust Double Helix*, *supra* note 6, at 669 (We should "eschew the normative cliché that the antitrust laws protect competition, not competitors, by reinvigorating and revitalizing the enforcement of our Sherman and Clayton Acts. Guarding competitors against predatory conduct and aggressive mergers will protect the competitive diversity and variety necessary for a stable, thriving, and innovation-oriented economic ecosystem.").

178. 15 U.S.C. §18.

179. *See* Horton, *Antitrust Double Helix*, *supra* note 6, at 669–70.

180. FRANCIS FUKUYAMA, TRUST: THE SOCIAL VIRTUES AND THE CREATION OF PROSPERITY 308 (1995).

enforcement."[181] It is time to reverse our neoclassical approach to economic efficiencies, and follow the lessons of evolutionary biology and evolutionary economics in encouraging and protecting economic diversity and competitive opportunity.[182]

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181. Harry First & Spencer Weber Waller, *Antitrust's Democracy Deficit*, 81 FORDHAM L. REV. 2543, 2574 (2013).
182. *See, e.g.*, PAGE, *supra* note 60, at 254 (arguing that it would be "naïve to take a laissez faire approach to complex systems.").