THE NEW "EMERGENCE ECONOMICS" OF INNOVATION AND GROWTH, AND WHAT IT MEANS FOR COMMUNICATIONS POLICY

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It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.[1]

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1. Although this aphorism summarizes well a strand of evolutionary thinking and frequently is attributed to Charles Darwin, its initial author is unknown. *See, e.g.*, John van Whye, *It Ain't Necessarily So*, GUARDIAN, Feb. 9, 2008 (Features & Extracts), at 10.

INTRODUCTION

As the financial crises of 2008-09 amply illustrate, your typical member of Congress or White House staffer probably knows less about economics than ordinarily is assumed. And what they think they know has been superseded by newer, more robust, and more accurate forms of thought.

The hoary economics presented to us in public policy debates maintains, for example, that the market is linear and always seeks equilibrium, that economic actors are perfectly rational, with perfect knowledge of themselves and the marketplace, that production is generated only by capital markets or government subsidy, that growth is exogenous, and the whole of the economic system is always equal to the sum of its parts. It turns out that every one of these key assumptions is either overstated, or plain wrong. Recently, the U.S. economy has been paying a heavy price for some of these flawed assumptions.

This paper will introduce the rough formula for what we call here "Emergence Economics"—namely, that individual agents, acting through interconnected networks, engage in the evolutionary market processes of differentiating, selecting, and amplifying certain business plans and technologies, which in turn generates a host of emergent economic phenomena. This formula is fueled by the latest findings from physics, biology, psychology, cognitive neuroscience, and plain common sense. The Internet then will be discussed as a notable and perhaps unique product of market and non-market forces, as modular infrastructure, and as a platform for broad-based innovation. Next, the paper will turn to some key emergent phenomena, including ideas, innovation, economic growth, and what we call "Net effects." Finally, we will bring these economic and technological elements to bear in the world of communications policy, where a proposed new framework separates out the virtues of "tinkering" with market gaps and inputs, versus the vices of "tampering" with evolutionary processes and outcomes.

Back to School

Today's discussions about national communications policy often seem to be rooted to the past, in the form of economic and technology assumptions that more or less ended in the 1960s. As it turns out, the rise of new economic thinking, along with new technology platforms culminating in the Internet, directly challenge many of those chief assumptions. Now is the time to articulate the fundamental economic and technology tenets that should inform our nation's communications and information policies, and to begin suggesting some ways those

policies should be recast in their light.

We don't deny that today's economics of academia currently incorporates much of the schools of thought that collectively we refer to here as "Emergence Economics," or that certain strands of this thought have surfaced repeatedly throughout the history of economics. It is certainly not our intention to create, or settle, a dispute over whether and how the various facets of Emergence Economics are being incorporated into presumed policy economics, here called "Old School Economics." Our only point is that the prior version represents the story of economics as told to, and accepted by, most of our nation's policymakers and thus has become a bulwark of official thinking about public policy issues. By contrast, the various schools of Emergence Economics simply are not familiar to most policymakers. It is our hope that, little by little, this reality can begin to change.

A New Economy

Twenty years ago, no one would have anticipated the Internet as we know it today. Consumer-grade computer modems were still in their infancy, and the few dial-up online communities that existed were a far cry from the globally connected "network of networks" that now pervades so much of what we do. In many ways, the Internet was a happy accident. What started out as isolated islands—universities, bulletin board systems, commercial services—linked together and grew as the result of the actions of millions of unaffiliated people. The underlying software protocols opened up the ability to interact and speak freely across thousands of interconnected networks. The growth of the Internet, and the online and offline economy it facilitates, was beyond even the wildest predictions. In many ways, the Internet is what happened while we were busy planning something else.

Even with the benefit of hindsight, we do not fully understand what led to this success. Advances in computer technology, including digitization of information, dramatic increases in computing power, and concomitant declines in the cost of computer storage, were necessary conditions, but they also could have facilitated a variety of other outcomes. To comprehend how the Internet developed into a thriving marketplace of innovation and economic growth, many turn understandably to the field of economics. Unfortunately, Old School Economics has little to say about this leading test case.

A New Framework

Two fundamental observations drawn from Emergence Economics lead us toward a more helpful analytic framework.

First, we live in a *networked* economy, formed bottom-up by interactions between people in a highly connected marketplace. Some basic rules govern these interactions, but for the most part the system emerges freely and unpredictably. Economic actors become nodes, and the structure of the market evolves based on their collective practices. Whereas Old School Economics more often than not attempts to statically engineer these relationships, Emergence Economics recognizes that such an abstraction fails to accurately represent a far messier reality. Instead, the network economy thrives when there is space for experimental evolution, in which new ideas emerge and technology constantly is refined.

Second, we live in a *growth* economy in which the chief currency is ideas, and the mechanism for growth is innovation. While Old School Economics tells us that productivity comes simply from adding more capital, or generating greater efficiency, Emergence Economics emphasizes ways in which technologies, broadly defined, transform the means of production. The advent of new technologies can create better recipes for economic growth. What's more, these technologies do not emerge inexplicably from outside the system, but instead are the product of economic actors working within (indeed, comprising) the system according to diverse motives. In addition, growth is not limited by physical goods, but is enabled by the transmission, reproduction, and improvement of ideas. An economic framework that actually recognizes this dynamic can establish a foundation for even greater growth in the future.

This networked growth economy differs greatly from some traditional economic models that posit static, linear forms of growth. Economists often use the phrase "virtuous circle" to describe systems that contain positive feedback loops in which their outputs cycle back into their inputs. Rather than moving toward equilibrium, these economies are self-reinforcing and have the potential to multiply their effects in unexpected ways—generating both positive and negative feedback. The virtuous circle often appears in the form of technological innovation that facilitates future technological innovation and drives "network effects" where each new user adds benefit to the rest of the system. Emergent economies combine these dynamics, harnessing the discoveries of others in such a way that the system as a whole grows far more effectively than if it were a disconnected set of actors. The interdependent virtuous circles can become part of a complex *virtuous feedback* network.

And so, what of the proper role of the government policymaker—the legislator, the regulator, the reviewing judge—in the face of an innovation-fueled, network-connected, emergent economy? There is little doubt that the policy environment needs to catch up to newer

economic thinking. As we shall see, while the lessons here are many, at bottom they point to caution, and even outright skepticism, about becoming a more active force in the market. Such caution should be tempered by optimism. The tools of government, when employed sparingly, carefully, and in the right context, can improve the environment for new ideas, economic growth, and human freedom. However, this bottom-up regulatory approach requires an appreciation for, and understanding of, esoteric-seeming topics like network-based dynamics, and the conditions that are most likely to foster productive tipping points.

Some Caveats

We have a few important caveats to relay at the outset. First, the literature in this field is broad and deep in some places, scanty and unfinished in others. Nonetheless, as Michael Shermer rightly declares, economics has been undergoing "the most dynamic revolution since Adam Smith," because "rich transdisciplinary hybrids are emerging to breathe new life into an old science . . . ."[2] This paper necessarily presents an overview of what so far is known, or surmised, or even guessed at, but it does not purport to replace the foundational work of many others. Nor do we seek to discredit the world of modern economic thinking; indeed, as previously noted, many of the intellectual trends we discuss here slowly but surely are being incorporated into more mainstream schools. In particular, we look to Joseph Schumpeter and Friedrich Hayek as two towering transitional figures linking together various strands of Old School Economics and Emergence Economics. The chief concern is that, while mainstream economic thinking today appears to be incorporating new intellectual frontiers, many policymakers still cling to the basic assumptions underpinning older forms of economic theory, as if those assumptions remain received wisdom. As a result, our objective here is comparatively humble, yet practical: to condense what currently comprises this sprawling body of advancing work in a way that can aid policymakers and others in analyzing public policy issues, particularly in the communications realm.

In addition, the coming discussion of "markets" and "systems" and "properties" should not cause us to lose sight of the common human element. Whatever happens in any agent-constructed space, such as economics, should be taken to reflect humanity in all its breadth and depth. Words and concepts are not the things they describe; they merely serve as organizing principles to try to make sense of a seemingly disorganized world. Ironically, economics, technology, and law—

2. MICHAEL SHERMER, THE MIND OF THE MARKET xix (2008).

together which form the three-way intersection for this paper—often are perceived as sterile, artificial, and even tedious fields. We would argue instead that they should be seen as the flesh-and-blood instantiation of ordinary humans participating actively in the world.

Moreover, it must be stressed that all economic models inherently are wrong to one degree or another. As mere abstractions of reality, they inevitably miss at least some of the nuance and sinew of the world that each of us inhabits. While the concepts explored here should not be confused with exacting corollaries to the real world, nonetheless, they do provide an important corrective to what has gone before.

Finally, we must point out that neither author of this paper is an economist, at least (yet) by training or trade. Perhaps some will dismiss what follows solely for that reason; after all, the saying goes, "the only thing more dangerous than an economist is an amateur economist."[3] Still, the world of economic theory should not only be available to, and articulated by, a cloistered few.[4] As Old School Economics gradually, and we think inevitably, gives way in the minds of policymakers to new forms of economic thinking, we can only hope that more of us are able to join in the evolving conversations.

I. EMERGENT ECONOMY: OVERTHROWING THE OLD REGIME

A. Introducing Emergence Economics

So what exactly is this supposedly new form of economics? Analyst Eric Beinhocker adopts the term "Complexity Economics" to describe a variety of different analytic and empirical approaches to the economy, with a more exacting faithfulness to the real world. In this paper we combine Beinhocker's impressive synthesis with emerging work in other areas, most notably network science, new growth theory, and behavioral economics. Other useful contributions include the origins of innovation, competition theory, "Net effects" like spillovers and social production, and economic sociology. As a result, we thought it best to avoid confusion by using a broader umbrella phrase, "Emergence Economics," to denote this more wide-ranging set of emerging viewpoints that have found, or are finding, their way into mainstream economics.

In reality, this "new" economics draws from several long existent but submerged themes in neoclassical economics. Phenomena once thought

3. Economist Jokes, http://netec.mcc.ac.uk/JokEc.html.

4. We also take heart from Hayek's statement that "an economist who is nothing but an economist cannot be a good economist." F.A. HAYEK, THE FORTUNES OF LIBERALISM 196 (Peter G. Klein, ed., 1992).

to be minimally important, peripherally relevant, or outside the scope of proper economic thinking altogether are being brought to the forefront. In the case of communications-based technology sectors, for example, economist Hal Varian has noted that:

> [T]here are some forces that are particularly important in high-tech . . . [T]hese forces are not "new"; indeed, the forces at work in network industries in the 1990s are very similar to those that confronted the telephone and wireless industries in the 1890s.[5]

Varian undoubtedly is correct—many of the various elements at play in today's economy have been there for many decades. Perhaps the best way to understand Emergence Economics is to compare it to the earlier, more traditional form of economics, which was handed down to us by the neoclassical theorists, synthesized by post-war economists, and still remains the intellectual grounding for many of today's political theories. Below, we will look briefly at four aspects of what we call Old School Economics—markets, competition, people, and analysis—and contrast them with the different perspectives brought by Emergence Economics.

One gating question first must be addressed, however: if Emergence Economics actually presents a more truthful version of the economic landscape, and has been or is being incorporated into more mainstream economic theory, why have these ideas taken so long to be absorbed into the social and political mainstream? Economist Paul Ormerod cites as likely reasons sheer intellectual inertia and, until recently, a lack of sophisticated analytic tools.[6] Unfortunately, as we shall see, public policy in the United States still tends to hew closely to the dictates of Old School Economics. In a small way, this paper seeks to offer a much-needed corrective to that situation.

1. The Nature of Markets: Complex Cascades

Neoclassical theory states that the economy is a static equilibrium system, existing at rest, and moving from one equilibrium point to another as it seeks balance. Under this view, the economy literally is a

5. H. VARIAN, ET AL., THE ECONOMICS OF INFORMATION TECHNOLOGY 3 (2004).

6. PAUL ORMEROD, WHY MOST THINGS FAIL ix (2005). One author goes so far as to claim that traditional economist theories employ an explicitly religious defense of the marketplace. *See* ROBERT NELSON, ECONOMICS AS RELIGION (2001). Another author notes that some supporters of traditional economics want so badly to believe in their models that, "paradoxically, these economic formulas and models were symptoms of the very desires and emotions they were designed to eliminate." MARK TAYLOR, CONFIDENCE GAMES 276 (2004).

closed equilibrium system.[7] Neoclassical theory also sees an "invisible hand" at work in competitive markets. In a free market economy, the thinking goes, a natural resting point is reached, where supply equals demand, resources are put to their most efficient use, and the welfare of society is optimal. Such a market is deemed optimally efficient. The business cycle is just that: a regular, periodic, and predictable movement between boom and recession. Economic processes are dominated by dampening, negative feedback that keeps things contained. Any indeterminacy typically is assumed away by econometric models.[8] The business cycle is determined exogenously, by occasional shocks originating from outside the system itself.[9]

By contrast, a central tenet of Emergence Economics is that the economy is a "complex adaptive system," which is a subcategory of open systems.[10] In a complex adaptive system, micro-level interactions lead to the emergence of macro-level patterns of behavior. A key aspect of any complex adaptive system is the inherent lack of predictability in its future operations, because they do not add up in a simple, linear way. As one example, financial markets are far more turbulent, deceptive, and risky than previously thought, with prices leaping up and down in a more or less concentrated fashion.[11] Oftentimes, small, innocuous events can set off avalanches of change that are inexplicable in Old School Economics, while large disturbances ultimately may have no lasting impact. The direction of the stock market relies on the actions of millions of individual agents, motivated by innumerable and interrelated concerns. Dips and peaks in the economy refuse to recur in a predictable manner.[12] To quote 2002 Nobel Prize winning economist Vernon Smith, "We do not understand why markets work as they do."[13]

Further, the economy is not an equilibrium system at all, and will never reach a resting place, for such a state would equal death. Ormerod

7. *See* TAYLOR, *supra* note 6, at 239-40.

8. ORMEROD, *supra* note 6, at 79-80.

9. *Id.* at 191. Léon Walras, champion of economic equilibrium theory, famously noted, "For, just as a lake is, at times, stirred to its very depths by a storm, so also the market is sometimes thrown into violent confusion by crises, which are sudden and general disturbances of equilibrium." LEON WALRAS, ELEMENTS OF PURE ECONOMICS 381 (William Jaffe trans., George Allen and Unwin Ltd. 1954) (1874).

10. W. BRIAN ARTHUR, ET AL., THE ECONOMY AS AN EVOLVING COMPLEX SYSTEM II (1997). Or, as Michael Shermer puts it, economies are complex systems "that emerge out of the simple actions of people just trying to make a living and provide for their children." SHERMER, *supra* note 2, at 5.

11. BENOIT MANDELBROIT, THE (MIS)BEHAVIOR OF MARKETS 225-52 (2004).

12. PHILIP BALL, CRITICAL MASS 189 (2004).

13. Vernon Smith, Nobel Prize Lecture at the Interdisciplinary Center for Economic Science at George Mason University: Constructivist and Ecological Rationality in Economics, (Dec. 8, 2002), at 506 n.14, *transcript available at* http://nobelprize.org/nobel_prizes/economics/laureates/2002/smith-lecture.pdf).

points out that there are numerous empirical and theoretical bases to criticize the concept of general equilibrium.[14] The real world also exhibits positive feedback, or increasing returns; there are always new sources of positive feedback, so there is no "long run" in the real world. Time is an important element of economic phenomena, one missing in general equilibrium theory.

The idea that the market is optimally efficient also runs headlong into reality. Lawrence Summers has noted that careful analysis "call[s] into question the theoretical as well as empirical underpinnings of the Efficient Market Hypothesis,"[15] while Yale's Robert Shiller claims that the "efficient market hypothesis is the most remarkable error in the history of economic theory."[16] Mark Taylor, a noted expert on complexity theory, agrees that the efficient market hypothesis and related theories "were wrong on virtually every count," so that "the more carefully one ponders the markets, the more suspect the whole notion of efficiency becomes."[17]

Old School Economics is riddled with these basic flaws for a good reason. It is widely understood that neoclassical economic theory has viewed the economy through the prism of the physical sciences of the late 19th Century, particularly atomistic statistical mechanics.[18] The metaphor appropriated from the Industrial Revolution is the economy as a human-made machine (like a steam engine), whose behavior is fixed, stable, predictable, and controllable.[19] This perspective emphasizes static rules executed by top-down hierarchies of relatively expert and impartial officials who prize efficiency and consistency.[20] By contrast, Emergence Economics views the economy through the prism of modern day physics and biology, with metaphors better suited to the Information Revolution. Under that perspective, human society, of which the economy is a subset, is more like a living organism—a complex system characterized by constant change, evolution, and disequilibrium that percolate from the bottom up.[21]

14. ORMEROD, *supra* note 6, at 50-51.

15. Lawrence H. Summers, *Does the Stock Market Rationally Reflect Fundamental Values?*, 41 J. OF FIN. 591, 592 (1986).

16. KEVIN PHILLIPS, BAD MONEY-RECKLESS FINANCE, FAILED POLITICS, AND THE GLOBAL CRISIS OF AMERICAN CAPITALISM 78 (2008). As Warren Buffet put it, "I'd be a bum on the street with a tin cup if markets were always efficient." *Id.*

17. TAYLOR, *supra* note 6, at 269, 273.

18. *See* BALL, *supra* note 12, at 204-06; TAYLOR, *supra* note 6, at 273; ORMEROD, *supra* note 6, at 17-35.

19. *See generally* ROBERT AXELROD & MICHAEL D. COHEN, HARNESSING COMPLEXITY 28-31 (1999); PAUL ORMEROD, BUTTERFLY ECONOMICS (2000).

20. AXELROD & COHEN, *supra* note 19, at 28-31.

21. *See* ORMEROD, *supra* note 19. Crucially, the neoclassical economists failed to include in their thinking the Second Law of Thermodynamics, which describes entropy and the notion of an open system.

One illustrative example of the different approaches is the prices for goods and services. Traditionally one of the central tensions in economics is between producers (supply) and consumers (demand). Supply and demand supposedly balance out precisely; there is no waste, and goods are distributed in a "Pareto optimum" way. Further, to maximize a firm's profits, the price should always be set equal to marginal cost (or where additional revenues will exceed additional costs).[22] Relatedly, stock prices accurately reflect all available information at all times, and so should follow a "random walk," with no patterns or clues for future prices.[23]

Emergence Economics challenges each of these assumptions.[24] Supply rarely equals demand. Empirically, we often see a wide divergence in the prices of individual goods and services. Demand and cost curves are extremely difficult to know with any clarity.[25] Uncertainty and lack of information shroud the future in doubt, which makes setting prices that much more difficult.

2. The Nature of Competition: Imperfect Incentives

The traditional view of economic competition is that "perfect competition" compels free markets to allocate scarce resources in a manner so efficient that all our conflicting wants and needs are resolved in the most satisfactory manner possible.[26] The watch phrase is "consumer sovereignty."[27] Free markets are presumed to be both efficient and fair. The efficiency principle says that under perfect competition, and with no market failures, free markets will squeeze as many useful goods and services as possible out of the available resources (maximal output at minimal prices), and that anything that interferes with the price system's ability to do so is a detriment to social well-being.[28] The concept that the supply of every traded good or service is precisely equal to the demand for it at prevailing prices led to the related concept that the economy rests in perfect equilibrium.[29]

Now, however, the study of competition slowly is turning from a

22. ERIC D. BEINHOCKER, THE ORIGIN OF WEALTH, 60-62 (2006).

23. TAYLOR, *supra* note 6, at 244-46.

24. Robert Nelson calls these theories "an economic tautology." NELSON, *supra* note 6, at 58-69.

25. ORMEROD, *supra* note 6, at 23-35; BALL, *supra* note 12, at 254-55.

26. Ormerod observes that the phrase "perfect competition" is "yet another example of the terrifying ability of economists to brand their central concepts so effectively." ORMEROD, *supra* note 6, at 83-84.

27. This concept was first formulated by Ludwig van Mises. *See* G. Stolyarov II, *The Concept of Consumer Sovereignty in Economic Theory*, HELIUM, http://www.helium.com/items/112764-the-concept-of-consumer-sovereignty-in-economic-theory.

28. JAMES CASE, COMPETITION 160-63 (2007).

29. *Id.* at 183-84; BALL, *supra* note 12, at 191.

theoretical to an experimental science. And the "free market rarely, if ever, operates under conditions of perfect competition . . . ."[30] Further, careful analysis shows that most firms are not pure maximizers of profit or utility, but also seek to attain other primary objectives such as attracting and retaining productive workers.[31] Common diversions to raising prices include predatory pricing, discriminatory pricing, price-fixing, attempts to monopolize, and unfair and deceptive advertising claims. In addition, the demonstrated phenomenon of "sticky prices" leads to higher than necessary prices that refuse to descend to their theoretically sanctioned levels.[32]

Old School Economics also has failed to convey the reality of modern-day competition in another fundamental way. The classical world view is founded on scarce material objects and their efficient allocation—or as Paul Romer puts it, "a finite quantity of things with which we can work—basically, the matter in the earth's crust."[33] Value comes from rearranging that matter into a more valuable form. The physical world is characterized by diminishing returns, and increasing cost per additional unit produced. Firms compete via prices in existing goods, and laws were built around establishing property rights and ensuring no monopoly control. In the Information Age, however, we rely increasingly on ideas as "the recipes we use to rearrange [matter] to create more value and wealth."[34] Because ideas are not scarce, the process of discovering them does not suffer from diminishing returns. Indeed, increasing returns come from both the "shoulders-of-giants" process (new ideas build on existing ideas, and then beget more new ideas), and falling costs per unit (such as producing a software CD). Competition is facilitated not by firms trying to drive prices, but by firms seeking to capture market share through new products.

Joseph Schumpeter was an original prophet in this area. He saw claims about "perfect competition" as relatively unimportant; instead, what counts is "competition from the new commodity, the new technology, the new source of supply, the new type of organization. . . competition which. . . strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives."[35] Schumpeter also argued that some degree of monopoly is preferable to perfect competition, because supernormal profits are the

30. BALL, *supra* note 12, at 255.

31. *Id.* at 268-69.

32. CASE, *supra* note 28, at 196.

33. Joel Kurtzman, *An Interview with Paul Romer*, STRATEGY+BUSINESS, First Quarter 1997, http://www.strategy-business.com/press/16635507/9472.

34. *Id.*

35. JOSEPH SCHUMPETER, CAPITALISM, SOCIALISM, & DEMOCRACY 84 (Harper Perennial 1976) (1942).

temporary fruits of innovation. Persistent competition from innovations creates a threat that "disciplines before it attacks," so that as soon as innovators cease to innovate, pricing power will desert them.[36]

3. The Nature of People: Behavioral Beings

Under Old School Economics, the pursuit of self-interest is a rational activity of individuals, based on utility (a measure of pleasure and pain). Paul Samuelson, a towering figure in 20th Century economics, assumed that people are "representative agents," both logical and consistent in their behaviors, and have perfect knowledge of all probabilities. Old School Economics also includes assumptions about *homo economicus* possessing "rational and errorless choice, presupposing perfect foresight," and "foreknowledge free from uncertainty."[37]

Unlike the academic equations and assumptions that undergird Old School Economics, behavioral economics is based on the actual discernible rules by which humans make everyday decisions.[38] In the real world, barriers to decision making almost always exist. Information is costly, incomplete, and rapidly changing. At best, we employ "bounded rationality," by making decisions in the face of obvious external and internal constraints.[39] Ormerod observes that every individual decision involves massive complexity and defies the orderly application of the rational calculations of economic theory. Indeed, "in the new economics, we not only address a specific problem, we try to start from the outset with rules of behaviour which have empirical support rather than with rules which we believe *a priori* a rational agent ought to follow."[40] We will discuss this critical point in further detail in Part II.

Further, there is no such thing as self-interested individuals acting in isolation. Hayek showed us that desirable outcomes are the joint product of both individual actions and the institutional framework in which individuals operate.[41] Social change is both volatile and often inexplicable, as agents engage in "clustering" and "herding" behavior. Ample evidence demonstrates that, in Beinhocker's words, "the

36. *Id.* at 85. Some modern-day students of "imperfect competition" do not necessarily agree with this point, as some oligopolies may cling to pricing power indefinitely. One salient example mentioned in the literature is Microsoft, which could have sold its Windows operating system for $49, but instead chose a profit-maximizing price of $89. *See* CASE, *supra* note 28, at 206. Indeed, these same economists observe that free markets long have tolerated all manner of supernormal profits, and such markets tend to evolve into tight oligopolies over time. *Id.*

37. CASE, *supra* note 28, at 199; BALL, *supra* note 12, at 209-11.

38. BALL, *supra* note 12, at 213-14.

39. *Id.* at 211-12.

40. ORMEROD, *supra* note 6, at 125.

41. *Id.* at 224.

interactions of millions of people, making decisions, engaging in strong reciprocal behavior, acting out their cultural norms, cooperating, competing, and going about their daily lives, creates an emergent phenomenon that we call society—a phenomenon as real as the emergent pattern of a whirlpool."[42]

4. The Nature of Analysis: Mismatched Models

Traditional economic theory has proven inadequate in terms of the two standard criteria for a scientific theory: prediction and explanation. Models in Old School Economics often use simplifying and highly restrictive assumptions. Famously, Milton Friedman insisted that unrealistic assumptions in economic theory do not matter so long as the theories make correct predictions.[43] Such optimism would seem misplaced. Indeed, all mathematical statements are conditional in nature. Assumptions must be appropriate for the purpose of the model, and must not affect the answers the model provides for that purpose.[44] In econometrics, statistical correlations do not provide a causal explanation of the phenomena, and data often is not readily available or is problematic. Paul Ormerod believes that, "to be of any value, theories must be confronted with reality."[45] Philip Ball explains further that:

> Economic models have been augmented, refined, garlanded, and decorated with baroque accoutrements. Some of these models now rival those constructed by physicists in their mathematical sophistication. Yet they still lack their "Newtonian" first principles: basic laws on which everyone agrees.[46]

There also is an uncomfortable feeling that economic models oftentimes lose the human element in their too-neat equations. We want to believe that economic theory does not regard us as "automata" and

42. BEINHOCKER, *supra* note 22 at 450.

43. *See, e.g.*, Milton Friedman, *The Methodology of Positive Economics, in* ESSAYS IN POSITIVE ECONOMICS 3, 30-31 (1953) ("Perennial criticism of 'orthodox' economic theory as 'unrealistic' . . . because it assumes man to be selfish and money-grubbing . . . ready to change prices and/or pricing rules whenever their sensitive intuitions . . . detect a change in demand and supply conditions" and "assumes markets to be perfect, competition to be pure, and commodities, labor, and capital to be homogeneous . . . is largely beside the point unless supplemented by evidence that a hypothesis differing in one or another of these respects from the theory being criticized yields better predictions for as wide a range of phenomena.").

44. Robert Atkinson notes, for example, that "innovation changes the quality of capital. If all you can measure is quantity, you're going to miss the real story . . . . In short, we need to look at the real economy as it plays itself out over time in the millions of workplaces in the nation." ROBERT D. ATKINSON, THE PAST AND FUTURE OF AMERICA'S ECONOMY 147 (2004).

45. ORMEROD, *supra* note 6, at xiii.

46. BALL, *supra* note 12, at 181.

"preprogrammed, omniscient computers" to make their mathematical models work, but instead takes seriously "the thousand and one parts of our daily lives that cannot be reduced to numbers but that make our lives worth living."[47]

B. Presenting a Rough Formula For Emergence

Economic activity fundamentally is about order creation. We organize our world by transforming energy, matter, and information into the goods and services we want. By cooperating, specializing, and trading, we can create even more order than otherwise we could on our own.[48]

The complex interactions that make up our networked innovation economy are not simple to model, and in turn do not lend themselves to simplistic policymaking. This kind of market operates as an open, dynamic, and nonlinear system. Emergence Economics is our suggested umbrella phrase for a rapidly developing field that incorporates a broad set of tools to understand this type of activity. Eric Beinhocker outlines some of the principles of this approach in his recent book, *The Origin of Wealth*.[49] We have assembled these and other elements into a rough formula that captures the essence of the economic activity:

Agents + Networks + Evolution = Emergence

Agents in this case consist of the full spectrum of economic actors—large and small businesses, noncommercial organizations, ordinary consumers, individuals with varying motivations, universities that generate foundational research, government officials, and others. These agents form ad hoc relationships that change over time and interconnect into larger social *networks*. Through this process, individual agents build on others' innovations, and the system overall *evolves* toward greater productivity. When these dynamics arise, the system develops an *emergent* structure, generating spontaneous and nonlinear growth (or in some cases, decay). Emergence, then, is what results from a complex interplay of agents, networks, and evolutionary forces.[50]

This is not meant to suggest a straightforward linear equation. Each element is its own complex adaptive system, which greatly expands the

47. *Id.* at 208.

48. BEINHOCKER, *supra* note 22, at 5-20.

49. *Id.*

50. It must be noted here that the rough formula for emergence is a generic calculation that can work equally well for humans acting in other complex adaptive systems, such as political or social roles. For a far more in-depth treatment of the mathematical equations of evolutionary dynamics, see MARTIN NOWAK, EVOLUTIONARY DYNAMICS (2006).

scale and scope of the resulting emergent behavior. Instead of straightforward emergence (if there is such a thing), we have emergence layered on top of emergence, many times over. The "rough formula," thus, is an over-simplified approximation intended to illuminate these properties and should not be misconstrued as a faithful representation of reality. By isolating, we both illustrate and distort.

Importantly, what we exchange in this system are not just finished goods and services—per traditional economic theory—but raw ideas, applied technologies, and new means of productivity. Communications networks—increasingly converging to the Internet—constitute a core physical infrastructure that supports such growth across many sectors of our economy. Innovation and technology are key elements, because they propagate through the network as components of new recipes for economic growth. We will explore more fully in later sections the role of the Internet, and the emergence of ideas and innovation, economic growth, and "Net effects." We will also show how policymakers generally should not attempt to engineer or intrude into these market-based relationships, but still can help keep the system open to productive dynamism. For now, though, we will sketch out the four interrelated components of a "rough formula for emergence."

1. Agents

Any theory of economics must begin with a sound theory of human nature. After all, "[e]conomies are ultimately made up of people."[51] With that overarching premise in mind, we will briefly examine how Old School Economics is built on the flimsy and ultimately unsupportable premise that human beings are perfect economic agents.

In this paper, we will use the word "agent" generically to describe humans acting in their environment. To be an agent is to have several different meanings and connotations: as a self-possessed entity, as acting on behalf of others, and in the chemical sense, providing catalytic change. The term is preferred to either consumer or user, both of which tend to reduce humans to a one-way relationship of purchasing access to goods, services, or other resources.

Agents are economic actors, and individual nodes in a network. Whether acting as consumers or investors, CEOs or government officials, all of us play this interactive role in the economy. The central insight of economics is that agents respond to incentives.[52] Beyond that observation, traditional economic theory assumes that agents have

51. BEINHOCKER, *supra* note 22, at 115; *see also* SHERMER, *supra* note 2, at 190 ("Any theory of economics must begin with a sound theory of human nature.").

52. WILLIAM EASTERLY, THE ELUSIVE QUEST FOR GROWTH 143 (2001); ORMEROD, *supra* note 6, at 63.

definite characteristics. These assumptions include: agents are modeled collectively, use complex deductive calculations to make decisions, have complete information available for free to gather and process, account for all relevant factors, face no transaction costs, have perfect freedom to act, make no errors and have no biases and—being perfect—have no need for learning or adaptation.[53] Under the standard model of human behavior, each of us displays perfect rationality, by pursuing our economic self-interest in carefully calculated ways.[54] Economic actors only interact through market prices. As Leijonhufvud has put it, the usual economic model of human behavior posits incredibly smart people in unbelievably simple worlds.[55]

Each of these assumptions is misplaced. Much well-grounded thinking about agents and what they do comes from the latest teachings of evolutionary psychology, neuroscience, and game theory. In fact, a new form of economics has emerged—behavioral economics—with the actual human being at its core. Behavioral economics seeks to right some of the false assumptions that lie at the heart of Old School Economics. For example, agents do not possess perfect rationality; instead, at best they live with bounded rationality.[56] Imperfect and asymmetric information is the rule, rather than the exception, in most high-stakes competition.[57] Nor are we "homogeneous billiard balls or gas molecules" but creatures with different interests, intentions, and biases, all of which inevitably color whether and how we make economic decisions.[58] These aspects of our behavior stem from the fact that our senses, thoughts, and memory are attuned to the embodied, evolved environment of early *homo sapiens*. Survival and procreation, not "truth," are the governing realities that have shaped us.[59] In summary, then, recent research in the area yields several observations:

- we prefer stories to statistics (relying on anecdotal evidence);

53. BALL, *supra* note 12, at 204-25; BEINHOCKER, *supra* note 22, at 97, 115-39.

54. BEINHOCKER, *supra* note 22, at 51; ORMEROD, *supra* note 6, at 64.

55. Axel Leijonhufvud, *Towards a Not-Too-Rational Macroeconomics*, *in* BEYOND MICROFOUNDATIONS 39, 39-55 (David Colander ed. 1996).

56. Herbert Simon first introduced this concept in the 1950s, but only recently has it begun to influence everyday economic thought. BALL, *supra* note 12, at 211-12; ARIEL RUBINSTEIN, MODELING BOUNDED RATIONALITY 3 (1998). Joseph Stiglitz and George Akerlof, 2001 Nobel Prize winners, have helped further the concept of bounded rationality in economics. As Daniel Kahnmen puts it, "The failure of the rational model is not in its logic but in the human brain it requires." PETER L. BERNSTEIN, AGAINST THE GODS 284 (1996).

57. CASE, *supra* note 28, at 49.

58. TAYLOR, *supra* note 6, at 273.

59. To put it more colloquially, one can apply neuroscience metaphorically to the motion picture A FEW GOOD MEN (Castle Rock Entertainment 1992), where Tom Cruise (as The Brain) asserts "I want the truth," and Jack Nicholson (as The World) responds, "You can't handle the truth."

- we seek to confirm (remembering the hits and forgetting the misses);
- we crave causality (underestimating the role of chance and coincidence in life);
- we misperceive aspects of our world (senses can be deceived);
- we oversimplify (avoiding analysis paralysis);
- we have faulty memories (memory is constructive);
- we hold beliefs based on many external influences (parental, sibling, peer, educational, social, and cultural);
- we have framing biases;
- we rely only on available evidence;
- we utilize linear processing;
- we have difficulty accurately calculating risk and probabilities;
- we can be confused and even paralyzed by having too many options;
- we compartmentalize our economic behavior; and
- we have individually varying skills, perspectives, and intuitions.[60]

In particular, Stanovich notes that while our problem-solving strategies lead us to select regular, deterministic, indication-dependent, functional, and linear processes, the world itself exhibits irregular, indeterminate, and independent processes.[61] We fall for the "decision illusions" our minds show us, because "we are limited to the tools nature has given us, and the natural way in which we make decisions is limited by the quality and accuracy of these tools."[62]

These varying aspects of our behavior obviously directly affect

60. The literature literally teems with excellent treatments of all these well-grounded scientific findings. *See, e.g.*, DAN ARIELY, PREDICTABLY IRRATIONAL (2008); PAUL BLOOM, DESCARTES' BABY (2005); MARK S. BLUMBERG, BASIC INSTINCT (2006); GILLES FAUCONNIER & MARK TURNER, THE WAY WE THINK (2003); CORDELIA FINE, A MIND OF ITS OWN (2006); ROBERT FOGELIN, WALKING THE TIGHTROPE OF REASON (2005); CHRIS FRITH, MAKING UP THE MIND (2007); MARC D. HAUSER, MORAL MINDS (2006); THOMAS KIDA, DON'T BELIEVE EVERYTHING YOU THINK (2006); MELVIN KONNOR, THE TANGLED WING (2003); GEORGE LAKOFF & MARK JOHNSON, PHILOSOPHY IN THE FLESH (1999); DAVID J. LINDEN, THE ACCIDENTAL MIND (2007); HUMBERTO R. MATURANA & FRANCISCO J. VARELA, THE TREE OF KNOWLEDGE (1992); READ MONTAGUE, YOUR BRAIN IS (ALMOST) PERFECT (2007); ANDREW B. NEWBERG & MARK ROBERT WALDMAN, WHY WE BELIEVE WHAT WE BELIEVE (2006); TOR NORRETRANDERS, THE USER ILLUSION (1998); DANIEL L. SCHACTER, THE SEVEN SINS OF MEMORY (2002); BARRY SCHWARTZ, THE PARADOX OF CHOICE (2005); KEITH E. STANOVICH, THE ROBOT'S REBELLION (2005); NASSIM NICHOLAS TALEB, FOOLED BY RANDOMNESS (2005); RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE (2008); TIMOTHY D. WILSON, STRANGERS TO OURSELVES (2004).

61. STANOVICH, *supra* note 60, at 63-69.

62. ARIELY, *supra* note 60, at 243.

whether, why, and how we make decisions in the marketplace.[63] As just one example, profit-seeking entities can actively prey on those constraints as part of the process of selling goods and services, which only exacerbates the shaky foundations for an agent's market decisions. A broker in a particular transaction might obscure relevant information in the interest of gaining higher commissions, or the exclusive provider of services might package them in such a way that consumers do not realize that they could get a better deal with alternative combinations. Others have pointed out the political implications for democratic societies as well.[64]

Of course, firms are just collectives of individuals, and often act as if possessed of a single mind. Firms share similar individual characteristics of agents, in particular routinely lacking relevant information and possessing inherent uncertainty.[65] Ormerod states that agents of all types, including firms and governments, "have very limited capacities to acquire knowledge about the true impact either of their strategies on others or of others on them."[66] Agents face massive inherent uncertainty about the effects of their actions.

Some see the constraints inherent in our human information processing systems as signs of significant and inherent weakness—the proverbial glass half empty. However, other research points in the opposite direction: human beings are more capable, multi-faceted, and flexible than heretofore has been recognized. Again, these fundamental characteristics are not reflected in Old School Economics. Among the key findings:

- we have a variety of motivations, including non-economic ones;
- we utilize not just reason but imagination, intuition, and insight as the foundations for creative thinking;
- we often know more than the official producers;
- we can understand and even transcend our constraints;
- we are wired to engage in market-exchange calculations;
- we are altruistic, cooperative, and sharing creatures;

63. *See, e.g.,* PAUL W. GLIMCHER, DECISIONS, UNCERTAINTY, AND THE BRIAN (2003); RICHARD RESTAK, THE NAKED BRAIN (2006); TALEB, *supra* note 60 (humans tend to overestimate causality and underestimate luck). Recent books have also begun to apply lessons from biology and complexity science to the management of large organizations. *See, e.g.*, THE BIOLOGY OF BUSINESS (John Henry Clippinger III, ed., 1999) (collection of essays explaining "the Complex Adaptive System of management"); AXELROD & COHEN, *supra* note 19.

64. BRYAN CAPLAN, THE MYTH OF THE RATIONAL VOTER (2007); DREW WESTEN, THE POLITICAL BRAIN (2007).

65. ORMEROD, *supra* note 6, at 21-35.

66. *Id.* at 221.

- we can use intelligent action to "tip" the world in certain directions;
- we use induction (pattern recognition), as well as deduction (the scientific method); and
- we possess important traits as autonomous entities interacting to carry out particular tasks.[67]

Most importantly, human beings have an inherent ability to learn, to adapt, to change, and to grow. We "evolved the adaptation of adaptability."[68] Our brains have been created with built-in plasticity, so that they are malleable and open to conscious change from new experiences and new learning.[69] We are adaptive agents (or more precisely, agents capable of adaptation) in an ever-evolving landscape. Nor are we the selfish automatons that Old School Economics presupposes.[70] Stanovich further insists that we can use our rational self-determination to gain control over our mismatched genetic and cultural programming,[71] while Donald surmises that we can take advantage of our hybrid brain/cultural mind to break free from our evolutionary heritage.[72] As populations of agents, we can learn from each other, share new ideas and innovations, and serve as a fertile environment for growth.[73] We also have recourse to a vast array of culturally and socially embedded "idea-spaces" that populate our extended minds.[74]

Another point is worth stressing here: the traditional focus on the single individual, standing alone in her perfect wisdom and forethought, ignores growing evidence that large groups of people often can be better at solving problems, reaching decisions, predicting the future, and

67. *See, e.g.*, HOWARD GARDNER, CHANGING MINDS (2006); MALCOLM GLADWELL, THE TIPPING POINT 259 (2002); RICHARD OGLE, SMART WORLD (2007); SHERMER, *supra* note 2; NASSIM NICHOLAS TALEB, THE BLACK SWAN (2007); ERIC VON HIPPEL, DEMOCRATIZING INNOVATION (2005); James Odell, *Agents and Complex Systems*, vol. 1, no. 2 J. OF OBJECT TECH. 35 (2002), *available at* http://www.jot.fm/issues/issue_2002_07/column3. In Benkler's memorable words, "it turns out that we are not intellectual lemmings." YOCHAI BENKLER, THE WEALTH OF NETWORKS 466 (2007).

68. SHERMER, *supra* note 2, at 190 (emphasis in original removed).

69. JEFFREY M. SCHWARTZ & SHARON BEGLEY, THE MIND AND THE BRAIN (2002).

70. In an often-overlooked work, Adam Smith declares: "How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortunes of others, and render their happiness necessary to him, though he derives nothing from it, except the pleasure of seeing it." ADAM SMITH, THE THEORY OF MORAL SENTIMENTS 1 (J.J. TOURNEISEN 1793) (1759).

71. STANOVICH, *supra* note 60, at 95-171.

72. MERLIN DONALD, A MIND SO RARE (2001).

73. AXELROD & COHEN, *supra* note 19, at 5.

74. OGLE, *supra* note 67, at 13-17 (2007).

fostering innovation.[75] Philip Ball puts it well:

> One of the features of collective behavior arising from local interactions is that it becomes impossible to deduce the global state of a system purely by inspecting the characteristics of its individual components. This is physical science's most important message to social science: do not be tempted too readily into extrapolating from the psychology of the individual to the behavior of the group.[76]

While we will return to this concept at a later point, for now the crucial takeaway is that Old School Economics has little to say about collective intelligence operating in the marketplace.

In short, evolutionary psychology, neuroscience, and game theory studies together show that humans are both more limited, and more limitless, than Old School Economics has assumed. We are eminently fallible, yet highly adaptable, agents. Any well-grounded economic theory must take nuanced account of both the half-empty and half-full views of economic agents. Neoclassical economic theories fail this fundamental test.

2. Networks

Of course, constrained yet adaptable agents (normal human beings) do not exist in a vacuum. The full productive potential of agents comes from their interactions with each other, which facilitate sharing of information and effort. Any particular agent may have a link to several other agents, which in turn link to others through lines of communication, common tasks, market agreements, or any number of other relationships.

In Old School Economics, agents only interact indirectly, through static and closed market mechanisms.[77] As a result, many of the connections within the economy are downplayed, or even ignored.[78] Reality is a bit more complex than that. In a dynamic system, relationships are bound to change over time. The true value of an agent is affected, and often greatly enhanced, by links to other agents. It is the structure of the connections between the component parts that gives systems of people their distinctive and characteristic features.[79] When viewed as a whole, human systems show themselves to be complex sets of

75. HOWARD RHEINGOLD, SMART MOBS: THE NEXT SOCIAL REVOLUTION (2003); CLAY SHIRKY, HERE COMES EVERYONE (2008); JAMES SUROWIECKI, THE WISDOM OF CROWDS (2004).

76. BALL, *supra* note 12, at 297-98.

77. BEINHOCKER, *supra* note 22 , at 97, 141-59.

78. ORMEROD, *supra* note 6, at 146.

79. *Id.* at 173.

relationships that can be fully understood neither from the perspective of the individual agents, nor the system as a whole.

The economy is best conceptualized and analyzed as a connected system, a network of individual agents. In the language of network science, the agents are "nodes" and the links are "edges." Thus, networks are interactions of nodes and groups of edges between and among nodes. In particular, the interactions of agents (whether individuals, firms, or governments) include inherent elements of unpredictability and help create complexity in the overall system. Networks both define, and are defined by, these interactions.[80]

The characteristics of networks sometimes can be counterintuitive, but once understood, can be extremely powerful. The field of network science explores how networks form and attempts to explain why certain dynamics arise in networks that do not appear in more static, linear systems.[81] In fact, there is a growing consensus that "common structures, growth patterns, and collective behaviors will arise in networks composed of very different kinds of elements and linkages."[82]

As mentioned previously, physicists and biologists for decades have been studying complex adaptive systems, which are open systems of interacting agents that adapt to each other and the environment. Examples of complex adaptive systems include neurons in the brain, immune systems, biological ecosystems, and the Internet. Economies too are a type of complex adaptive system. Such complex systems may be understood as energy flow structures organized by thermodynamic principles.[83] Economic and social systems are essentially dynamic, and not static.[84] Some have termed it the "econosphere"—the economy as a dynamic, evolving system.[85]

In many systems, individual actors end up having indirect positive effect on others. Economists call these effects "positive externalities", and often discuss the benefits that accrue to others as "spillovers."[86] For

80. "The network is the dominant pattern of the new digital economy." W. Brian Arthur, Myths and Realities of the High-Tech Economy 1 (2000), http://www.santafe.edu/~wbarthur/Papers/Pdf_files/Credit_Suisse_Web.pdf.

81. ALBERT-LASZLO BARABASI, LINKED (2003); STEVEN JOHNSON, EMERGENCE (2002); DUNCAN J. WATTS, SIX DEGREES (2003).

82. Katherine J. Strandburg et al., *Law and the Science of Networks: An Overview and an Application to the "Patent Explosion"*, 21 BERKELEY TECH.L.J. 1293, 1301 (2006).

83. ERIC D. SCHNEIDER & DORION SAGAN, INTO THE COOL 293 (2005).

84. Ormerod, supra note 6, at 18-21, 50-51.

85. Science writer Philip Ball criticizes the practice of using the term "complexity science" to explain aspects of human behavior. He relies instead on the concept of a science of "collective behavior," and sees the market laws emerging from the ordinary (but still unpredictable) push and pull of trade. BALL, *supra* note 12, at 5-6, 179-80.

86. Some prefer to call these externalities "demand side economies of scale." *See* MARK COOPER, FROM WIFI TO WIKIS AND OPEN SOURCE 133 (2006), *available at* http://cyberlaw.stanford.edu/node/5522.

example, I may invent a new method for scanning bar codes that yields me great profit, but you might adopt or adapt this technology to your own benefit (provided that the law allows). Furthermore, to the extent that different agents share this standard—say, a manufacturer using bar codes for inventory management and a retailer using the same codes to automate checkout—the system benefits exceed the sum of the parts. In complex networks, these benefits flow more freely than in disconnected islands. The type of externalities referred to as "network effects" arise only in networks. In this case, each new node added to the network creates added value for the existing nodes. One classic case is the telephone network, in which a globally interconnected system is substantially more valuable to all than a regional or locally delimited system.

A more recent example is the digital network Ethernet standard. The more individuals that owned Ethernet equipment, the more useful the network that connects them together—which eventually helped catalyze the explosion of consumer Internet use. The presence of externalities means that a great deal of what happens in a network, and the value that is created, comes from and flows to other nodes. It also means that the total value created is greater than what each node can create or capture in isolation. In other words, a network becomes more valuable to its users as it grows.[87] We use the term "Net effects" later in this paper to refer to a diversity of presumed externalities that in fact arise internally from the complex network itself.

Network formation theory looks at networks as endogenous constructs that both produce and are produced by a collection of interactions.[88] There are two broad classes of how networks form: random formation, from graph theory (as formulated by Spulber and Yoo),[89] and strategic formation of individual, self-interested agents, from game theory (as formulated by Werbach).[90]

To begin with, networks have a tendency to expand slowly and then exhibit explosive growth as individual networks interconnect. Positive externalities accelerate this activity, because these highly interconnected networks represent considerably more value, and the effects of each new

87. Here is another instance where a basic tenet of Old School Economics—most markets are characterized by declining and eventually negative returns to scale—does not necessarily comport with reality.

88. Kevin Werbach, *The Centripetal Network: How the Internet Holds Itself Together, and the Forces Tearing it Apart*, 42 U.C. DAVIS L. REV. 343, 386 (2008).

89. Daniel F. Spulber & Christopher S. Yoo, *Network Regulation: The Many Faces of Access* 6-7 (Vanderbilt Pub. Law Research Paper No. 05-19; Vanderbilt Law & Econ. Research Paper No. 05-15; Northwestern Law & Econ. Research Paper No. 05-16, 2005), *available at* http://ssrn.com/abstract=740297.

90. Werbach, *supra* note 88, at 21-24.

node feeds back into the system. However, these types of "phase transitions"—abrupt jumps from one state of connectedness to another—can also work in the reverse direction. If those who control particularly central nodes, edges, or clusters see benefit in restricting use of those assets, they can exponentially dampen the growth of the network as a whole.[91]

Another feature of networks is that they can help reduce "transaction costs" of finding and negotiating interactions with partners. This is true both of literal networks, like the Internet, and figurative networks, like social or market relationships. An isolated node would have to generate its own value or negotiate with others to obtain what it needed. Traditionally, the presence of these transaction costs has been used to explain why "firms" are created.[92] By bringing many entities together under a single umbrella, an organization can limit the transaction costs required. In complex networks, these units need not be limited to literal "firms," and the multitude of links can reduce transaction costs in more dynamic fashion.

Complex real world networks exhibit three other kinds of behavior worth noting here. *Small world behavior* states that the diameter of a network (the average number of links between any two nodes) tends to grow much more slowly than the number of nodes.[93] This means that a relatively small number of "hops" is necessary to connect any two nodes in the network. In other words, a small worlds network is relatively tightly connected.[94] *Scale-free dynamics* states that some nodes are vastly more connected than others, so that additional links are more likely to connect to nodes that are already well connected. This behavior explains the so-called "rich get richer effect," where preferential attachment by new users is a real element of networks.[95] Finally, *self-organized criticality* and *critical points* refer to a network's state of precarious stability, where one of several paths is imminently possible.[96] Taken together, these three characteristics provide important insights on how and why complex networks like economies behave the way they do.

91. *Id.* at 28. While such restrictions can appear to make rational sense from the perspective of one agent, another agent with better understanding of the greater dynamics at work likely will find a way to avoid such counter-productive behavior, while also capturing more value than an isolationist approach would yield.

92. R. H. Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937).

93. *See, e.g.*, MARK BUCHANAN, NEXUS (2002); DUNCAN J. WATTS, SMALL WORLDS (1999).

94. Strandburg et al., *supra* note 82, at 1305.

95. *Id.* at 1308-09.

96. BALL, *supra* note 12, at 227-41.

3. Evolution

Old School Economics has no explicit mechanisms for explaining endogenous novelty (within the system), agents who learn and adapt, or sudden growth in complexity.[97] By contrast, Emergence Economics uses the universal algorithm of evolution as the basis for much of its analysis.

"Ultimately, economics is a biological science. It is the study of how humans choose. That choice is inescapably a biological process."[98] Ilya Prigogine explains that "[w]e live in an evolutionary universe . . . [where] the laws of nature . . . no longer deal with certitudes but possibilities . . . [and] irregular, chaotic motions . . . constitute[] the very foundation of macroscopic systems."[99] The economy is one such macroscopic system, and, as we have seen, specifically a complex adaptive system. As such, evolution becomes the ideal algorithm for creating value within that system, an iterative process of experimentation by agents that includes first differentiation, then selection, and finally amplification of things that work. To Schumpeter, "[t]he essential point to grasp is that in dealing with capitalism we are dealing with an evolutionary process."[100] Hayek, another transitional figure in 20th Century economics, also gained the insight that markets involve "the evolutionary formation of such highly complex self-maintaining orders."[101]

a. The Three Stage Process

Evolution is the universal algorithm for change in biological systems, and now has been identified as operating within economic systems as well.[102] Natural selection is simply a description of certain evolutionary processes initiated by agents.[103] In economic systems, one can usefully think of the process of "natural" selection as comprised of three interrelated stages: differentiation, selection, and amplification. The first step of evolution is *differentiation*, in which intelligent agents identify and propose various possible approaches. Next, through observation and action, these agents sort through the variation to find

97. BEINHOCKER, *supra* note 22, at 97, 187-217.

98. Glimcher, *supra* note 63, at 336.

99. ILYA PRIGOGINE, THE END OF CERTAINTY 155 (1997).

100. SCHUMPETER, *supra* note 35, at 82-83.

101. F. A. HAYEK, THE FATAL CONCEIT: THE ERRORS OF SOCIALISM 9 (1988).

102. GEERAT VERMEIJ, NATURE: AN ECONOMIC HISTORY, at 43-58.

103. SHERMER, *supra* note 2, at 41. Corning clarifies that "natural selection does not in fact *do* anything"—it is not a mechanism or causal agency. In reality, "the differential 'selection' of a trait, or an adaptation, is a consequence of the functional effects it produces in relation to the survival and reproductive success of an organism in a given environment. It is these functional effects that are ultimately responsible for the trans-generational continuities and changes in nature." Peter A. Corning, *The Re-Emergence Of "Emergence": A Venerable Concept In Search Of A Theory,* COMPLEXITY, July/Aug. 2002, at 18, 27.

what works and what does not, and *select* the most fit solutions. Finally, the agents share and iterate on the most successful approaches, throwing out the others and *amplifying* the effects.[104] In other words, natural selection both "weeds out" what fails to work and "weeds in" what does.[105]

So adaptation is the formation and continual testing of hypotheses about the environment.[106] This same evolutionary formula lies at the heart of the market process. Agents, acting as "selectors," pick and choose which products, services, and other transactions they want to engage in, and other agents respond accordingly. The different routines that each firm develops are analogous to the genes, or "genotypes," of biological organisms; in turn, these routines influence the specific characteristics of the output (the "phenotypes," or physical organisms themselves) produced by the different firms. These firms then use the infrastructure of the network as the environment to evolve both their practices and the structure of the network itself. Out of this astonishingly complex series of moves, an ordered market system evolves.[107]

Evolution allows for experimentation with a variety of solutions to problems, means of innovation, and shared experience. Many problems we encounter are complex and lack clear ideal paths to a solution. Scientific discovery has long exhibited this hit-or-miss characteristic,[108] and technological breakthroughs similarly can come from unexpected directions. As Daniel Dennett puts it, "evolution is a search algorithm that 'finds needles of good design in haystacks of possibility.'"[109] Evolution discovers design, through trial and error, acting as "The Great Tinkerer." Chance and accident also play a significant role in

104. For a more complete overview of the basics of evolution in a networked economy, see BEINHOCKER, *supra* note 22 , at 213-16.

105. TALEB, *supra* note 67, at 17. Other analysts employ a somewhat different schema for the evolutionary process. For example, authors Axelrod and Cohen divide up the evolutionary algorithm into Variation (the raw material of adaptation), Interaction (between agents and populations of agents) and Selection (to promote adaptation). AXELROD & COHEN, *supra* note 19, at 32-151. They explain that "harnessing complexity" refers to changing the structure of a complex system to increase some measure of performance. *Id.* William Wallace talks about technology creating disruptions to the economy that trigger the "FROCA" process (Frontier, Release, Overexploited, Crash, Adaptation). WILLIAM WALLACE, TECHNO-CULTURAL EVOLUTION 7 (2006). By an interesting reverse analysis, Geerat Vermeij shows how processes common to all economic systems—competition, cooperation, adaptation, and feedback—in turn also govern evolution. VERMEIJ, *supra* note 102.

106. VERMEIJ, *supra* note 102, at 55.

107. *See, e.g.*, RICHARD NELSON & SIDNEY WINTER, AN EVOLUTIONARY THEORY OF ECONOMIC CHANGE (1982).

108. *E.g.* THOMAS S. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (1970); KARL POPPER, CONJECTURES AND REFUTATIONS (1963).

109. BEINHOCKER, *supra* note 22, at 14 (citing DANIEL DENNETT, DARWIN'S DANGEROUS IDEA (1996)).

evolution,[110] as well as simple luck.[111] If we assume a particular design space in which agents experiment, they can adapt successful designs by continuing to iterate on what proves useful, and eventually converge on one or more "fitness functions."[112] The environment is the design space of evolution; the market—the "econosphere" or "marketspace"—is the design space of economics. People use this design space to purchase, sell, and barter the goods and services best suited to meet their unique needs and desires.[113]

Fitness is the measure of the potential for value creation; it is a contingent concept, premised on the challenges and opportunities of a particular environment. By one account, fitness is simply an entity's capacity to satisfy customer concerns.[114] Viewed functionally, "fitness is measured by the capacity to connect and interrelate effectively and creatively."[115] In networked systems, fitness is an emergent property, arising as an interplay of dynamic elements within the system as a whole.[116] Ogle argues that increasing fitness triggers tipping points by balancing an agent's reach and reciprocity (its weak and strong ties to other entities) within a dynamically linked network of idea-spaces.[117] Ormerod explains that if we increase the fitness threshold at which agents become extinct in the design space, we are making it more difficult for them to survive, and if we reduce it, we are making it easier. "We can readily think of this as corresponding to more and less competitive environments, respectively."[118] Because this "solution space" of fitness is complex and often changing, this is not a linear process. Instead, it is continuous innovation that takes place in parallel and works by building shared knowledge that feeds back into the system.

Although the three-stage formulation of the market's evolutionary process sounds simple, there are several challenges to successfully employing it. One problem is the sheer number of possible formulas. To

110. STEPHEN JAY GOULD, WONDERFUL LIFE 285, 288 (1989) ("Our own evolution is a joy and a wonder because such a curious chain of events would probably never happen again, but having occurred, makes eminent sense . . . . The modern order is largely a product of contingency.").

111. "The reason free markets work is because they allow people to be lucky, thanks to aggressive trial and error, not by giving rewards or 'incentives' for skill. The strategy is, then, to tinker as much as possible . . . ." TALEB, *supra* note 67, at xxi.

112. BEINHOCKER, *supra* note 22, at 195-206.

113. SHERMER, *supra* note 2, at 8.

114. OGLE, *supra* note 67, at 104-05.

115. TAYLOR, THE MOMENT OF COMPLEXITY 197 (2001).

116. OGLE, *supra* note 67, at 111.

117. *Id.* at 109.

118. ORMEROD, *supra* note 6, at 230. Others note that strong selection pressure amplifies the success of the "best" agent while diminishing overall variety in the system, while weaker selection pressure provides more variety but sacrifices some agent fitness. AXELROD & COHEN, *supra* note 19, at 129-30.

try each one can prove to be impractically complex, or the partnerships required can introduce insurmountable transaction costs. To complicate further the process, it can be difficult to discern whether an idea will prove fruitful until several iterations are made or until a complementary approach is developed. In this case, it helps to encourage a plethora of experimentation with minimal barriers to cross-pollination. Participants in the fitness environment inevitably are blind at any given moment to the higher level patterns that are emerging.[119] Finally, successful evolution can only take place when experimenters overcome the social tendency of "path dependence," in which agents simply do things "as they have always been done."

Ormerod's "Iron Law of Failure" further explains that it is failure, not success, which is the distinguishing evolutionary feature of corporate life.[120] Most firms fail. On average, more than 10 percent of all economically active firms in the United States become extinct each year, with roughly the same number of new firms added back to the market.[121] As part of this process, weaker firms are replaced by firms with higher levels of fitness to the existing environment.[122] Traditional economic theory simply ignores this widespread existence of corporate failure.[123] As biological evolution relies on accident—mutation—as the basis for potential change, so do entities in the economic environment often prosper, or fail, due to the exigencies of a particular environment—in other words, fickle fortune.[124]

119. OGLE, *supra* note 67, at 112.

120. ORMEROD, *supra* note 6, at 12.

121. *Id.* at 180; *see also* ATKINSON, *supra* note 44, at 115-16 (the underlying churning of business is a central feature of the New Economy).

122. Taleb claims that the concept of evolutionary fitness is overstated, and that evolution ultimately is a series of flukes, some good, some bad. "The fools, the Casanovas, and the blind risk takers are often the ones who win in the short term." TALEB, *supra* note 67, at 116-17. Some companies survive simply because they were "the lucky ones." Taleb insists we should love free markets because "operators in them can be as incompetent as they wish." *Id.* at 181.

123. ORMEROD, *supra* note 6, at 17-35. Ball agrees that many economic theories of the firm fail to acknowledge that "most firms are ephemeral." BALL, *supra* note 12, at 267. The larger lesson is that, for selection to occur, the system needs "superfecundity"—more designs than the environment can support—which thus creates competition. In biology, there are more potential organisms than any ecosystem can support. The same undoubtedly is true for the market, which helps explain Ormerod's "Iron Law of Failure."

124. Again, Taleb finds luck to be the grand equalizer in a free market, because almost everyone can benefit from it, and it is far more egalitarian than even intelligence. "Randomness reshuffles society's cards, sometimes knocking down the big guy." TALEB, *supra* note 67, at 222. Ormerod observes as one example the success of Microsoft's Windows operating system, which "was far more the result of a series of accidents than of a far-sighted, planned strategy." ORMEROD, *supra* note 6, at 122-24.

b. Two Types of Technology

Writ large, technologies can be thought of as "knowledge of everything—products, processes, and forms of organization—that can create economic value."[125] Evolution operates on two broad types of technologies, which Richard Nelson refers to as "Physical Technologies" ("PTs") and "Social Technologies" ("STs").[126] Physical Technologies are means or recipes for producing objects or ideas; they consist of specifications, instructions, shareable practices, and other ways of transforming materials to serve a goal. These technologies have a modular, building-block character of components plus architecture, and instill order in the physical realm. Social Technologies, on the other hand, are methods and designs for organizing people in service of a goal, and instilling order in the social realm. This might consist of a particular team structure or collaborative relationship.[127] The modern day corporation is seen by some as an enabling technology in its own right and crucial to economic development.[128]

In reality, the two types of technologies evolve in relation to each other, [129] and with concrete business designs (referred to in Beinhocker's work as "Business Plans") that incorporate one or both. A software company might find that one specific software development toolkit makes its work easier, and that small working groups of engineers further improves productivity. Physical Technologies can enable Social Technologies and vice-versa. Each type of technology constitutes an evolution of modular ideas that has the potential to be plugged into other scenarios. As with firms, technologies are subject to their own "law of failure" in the market.[130] The long-term power of these successful

125. RICHARD G. LIPSEY ET AL., ECONOMIC TRANSFORMATIONS 10 (2005). While new technologies cause economic growth by increasing the output that can be produced from a given set of resources, they also enable new products, new processes, and new forms of organization. *Id.*

126. Richard Nelson, *Physical and Social Technologies, and Their Evolution* (LEM Working Paper Series 2003). Others perceive the proper unit of selection in the market as occupations, or "making a living," rather than technology. VERMEIJ, *supra* note 102, at 44.

127. BEINHOCKER, *supra* note 22 , at 241-77.

128. JOHN MICKLETHWAIT & ADRIAN WOOLDRIDGE, THE COMPANY xxi (2003). The company has flourished in modern markets because capital can be pooled for investment, investor risk is spread, transaction costs are reduced, and effective management structures are imposed on large organizations. *Id.; see also* BALL, *supra* note 12, at 250-54.

129. Vermeij observes that "in organisms, technology is part of the body; in people, it is an extension—mechanical, intellectual, and cultural—that we design and that, at least figuratively speaking, takes on a life of its own. In both cases, technology evolves; in organisms it does so largely through natural selection, in humans by engineering and market forces." VERMEIJ, *supra* note 102, at 47. Kurzweil has commented that "technology is the continuation of evolution by other means." TAYLOR, *supra* note 115, at 221.

130. As Romer has remarked, "there are many more dead ends out there than there are useful things to discover." Ronald Bailey, *Post-Scarcity Prophet*, REASON, Dec. 2001,

technologies lies in their capacity to be shared and re-used.

As we have seen, biological ecosystems provide a powerful analogy and insight to the functioning of business networks. Under one model, companies work to connect a large and distributed network of companies to their customers, providing "platforms" that other firms can leverage to increase productivity, enhance stability, and spur innovation.[131] The "keystone" is a pattern of behavior that improves the performance of an ecosystem and, in so doing, improves individual performance.[132] Just as "keystone species" in nature play central roles in their ecosystems, companies such as Wal-Mart, Microsoft, and Li & Fung deploy "keystone strategies," using effective collaboration to actively shape and regulate the workings of their business ecosystems.[133]

c. Losing One's Balance

All of this flies in the face of traditional economic notions of linear progression and natural equilibrium. Old School Economists project a single optimal balance for a particular market, and see growth as a smooth trajectory of improved efficiency and increased output. Our more complex view of the process acknowledges that there are several possible "peaks" of high productivity that operate in different ways, and that it is possible to arrive at those peaks via different "fitness functions." Indeed, just when one peak has reached its maximum utility (say, bamboo-based light bulb filament), an entirely different approach might offer a far better fit (such as tungsten-based light bulb filament).

The notion of fitness implies that combined Physical Technologies and Social Technologies are used by agents to navigate a market landscape of possible growth trajectories— like a map of mountains. In these fitness landscapes,[134] agents combine PTs and STs into a Business Plan ("BP"), according to various strategies. As one approach reaches its limit or a peak, one might say that an equilibrium of sorts has been reached—but only until it is upset inevitably by a different approach making use of a different combination. This leads to a "punctuated equilibrium" that is disrupted by "keystone" technologies.

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http://www.reason.com/news/show/28243.html.

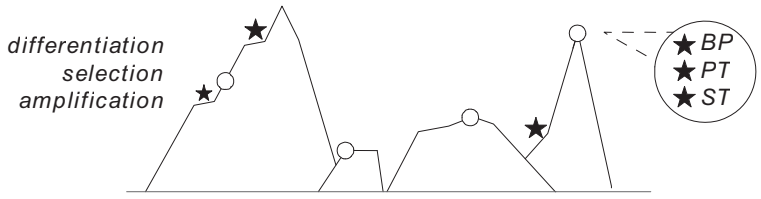
131. *See* MARCO IANSITI & ROY LEVIEN, THE KEYSTONE ADVANTAGE (2004).

132. *Id* at.113-15.

133. *Id.* at 145-67.

134. For further discussion of the creation and development of fitness landscapes in evolutionary biology, see DENNETT, *supra* note 109, at 190-95.

Fig. 1: Fitness Landscapes



Ultimately, no one company can hope to out-innovate the market. An ecosystem tends to beat a product (perhaps even something as innovative as the iPod) because its collective of competitors can explore and innovate and invest in many more ideas than any single company can muster.[135] Beinhocker observes that "in evolutionary systems, *sustainable* competitive advantage does not exist; there is only a never-ending race to create new sources of temporary advantage."[136] The bottom line is, "evolution is cleverer than you are."[137]

4. Emergence of Networks and Growth

Decades of research show that the economic system is a complex adaptive system, where micro interactions of agents lead to macro structures and patterns.[138] In other words, "more is different."[139]

Emergence is not some mystical force that magically comes into being when agents collaborate.[140] Emergent properties are physical aspects of a system not otherwise exhibited by the component parts. They are macro-level features of a system arising from interactions among the system's micro-level components, bringing forth novel

135. *See* John J. Sviokla, *In Praise of Ecosystems*, FASTCOMPANY.COM, Aug. 2005, http://www.fastcompany.com/magazine/97/open_essay.html.

136. BEINHOCKER, *supra* note 22, at 332 (emphasis in original).

137. DENNETT, *supra* note 109, at 74 (citing Francis Crick's version of Orgel's Second Rule).

138. *See, e.g.*, TERRY BOSSOMAIER & DAVID G. GREEN, PATTERNS IN THE SAND (1998); MARK BUCHANAN, UBIQUITY (2001); SCOTT CAMAZINE ET AL., SELF-ORGANIZATION IN BIOLOGICAL SYSTEMS (2001); JOHN HOLLAND, EMERGENCE (1998); JOHN HOLLAND, HIDDEN ORDER (1996); ROGER LEWIN, COMPLEXITY (1992); KLAUS MAINZER, THINKING IN COMPLEXITY (4th ed. 2004).

139. *See, e.g.*, BOSSOMAIER & GREEN, *supra* note 138; BUCHANAN, *supra* note 138; CAMAZINE ET AL., *supra* note 138; HOLLAND, EMERGENCE, *supra* note 138; HOLLAND, HIDDEN ORDER, *supra* note 138; STEVEN JOHNSON, EMERGENCE 78 (2001); LEWIN, *supra* note 138; KLAUS MAINZER, *supra* note 138.

140. JOHNSON, *supra* note 139, at 116.

behavior.[141] The brain is an example: the single neuron has no consciousness, but a network of neurons brings forth, say, the smell of a rose. Similarly, when agents interact through networks, they evolve their ways of doing work and discover new techniques. Out of this combined activity, a spontaneous structure emerges. Without any centralized control, emergent properties take shape based on agent relationships and the conditions in the overall environment. Thus, emergence stems from behavior of agents, system structures, and exogenous inputs.[142]

Emergent systems are often described as being "organism-like" in the sense that they are constantly growing and adapting. Each agent follows localized rules and motivations, but the end result is additive and interdependent. Analogies drawn from biology include the ant colony. Ants follow basic rules for seeking food, emitting pheromones to leave a trail to the food they find, and following other ants' pheromone trails to make their way to food and back to the colony. These characteristics appear in many human systems. James Odell notes that, "[w]ith the stock market, thousands of agents act independently to buy and sell shares of particular stocks and bonds. Yet from this independent behavior, an organism-like product called the stock market emerges."[143] Much of the development of cities similarly derives from the bottom up.[144]

Emergent systems have no single ideal structure. They exist in an ever-changing environment and consist of complex interactions that continuously reshape their internal relationships. Brian Arthur notes that our subjective beliefs constitute the very DNA of the market, and so "co-evolve, arise, decay, change, mutually reinforce, and mutually negate."[145] The market "emerges from subjectivity and falls back into subjectivity."[146] The many independent actions of agents unify, but they do not necessarily work toward one particular structure or equilibrium. For example, emergent systems can be robust to change, and they can be far better at evolving toward efficiency than top-down systems. On the other

141. Tom De Wolf & Tom Holvoet, *Emergence Versus Self-Organisation* 3464 LECTURE NOTES IN COMPUTER SCI. 1 (2005). Characteristics of emergent systems include micro-macro effects, radial novelty, coherence, interacting parts, dynamical, decentralized control, bi-directional links between the macro- and micro-levels, and robustness and flexibility. *Id*. at 3-5.

142. BEINHOCKER, *supra* note 22 , at 185.

143. Odell, *supra* note 67.

144. Citizens solve local problems, combining resources and expertise in the form of new technologies. Steven Johnson describes how early cities evolved around new farming mechanisms, with urban emergence intensifying as fossil fuel technologies were developed. "And with that new flow of energy, new kinds of cities emerged: the factory towns of Manchester and Leeds, and the great metropolitan superorganisms of London, Paris, and New York." JOHNSON, *supra* note 139, at 113.

145. W. BRIAN ARTHUR, THE END OF CERTAINTY IN ECONOMICS (1994), http://www.santafe.edu/~wbarthur/Papers/Pdf_files/End_of_Certainty_Web.pdf.

146. *Id*. at 6.

hand, emergent structures can fall apart when their basic conditions are altered in such a way that they work against the health of the system as a whole. If the ants stop leaving pheromone trails, they can no longer cooperatively feed the colony. If corrupt stockbrokers are allowed to unethically manipulate the system, the complex structure of price signals falls apart. If cities are saddled with stagnant industries, their growth falters, and their economies can crumble. As our current economic woes illustrate, the line between emergence-fostering actions and emergence-stifling actions sometimes can be difficult to discern.

Agents' actions in turn affect the other agents, setting off both positive and negative feedback loops. Beinhocker uses the helpful metaphor of adjusting shower temperatures.[147] The delay between adjusting the knob and the change in temperature means that one is likely to over-shoot, oscillating back and forth until finally settling on the right temperature.[148] But this is a simple case with a single agent. In a recent study, an economist and a physicist sought to understand what happens in youth hostels where many showers share the scarce "market" for hot water.[149] They found that:

> Tuning one's shower in some hotels may turn into a challenging coordination game with imperfect information. The temperature sensitivity increases with the number of agents, making the problem possibly unlearnable. Because there is in practice a finite number of possible tap positions, identical agents are unlikely to reach even approximately their favorite water temperature.[150]

Fortunately we have developed some understanding of what types of conditions lead away from such negative feedback loops, and towards more productive emergence. Generally speaking, a greater ability of agents to connect and explore new modes of production will facilitate the chance connections that a top-down designer might not foresee. Better global information sharing and feedback between agents facilitates better local decisions. The system as a whole can take a leap forward when new innovations come out of this process and are replicated throughout the network. Inductive tinkering by a single agent can lead to breakthroughs with widespread payoff.[151]

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147. *See* BEINHOCKER, *supra* note 22, at 101, 394.

148. *Id.*

149. *See* CHRISTINA MATZKE & DAMIEN CHALLET, TAKING A SHOWER IN YOUTH HOSTELS (2008), http://arxiv.org/pdf/0801.1573v1; *Tweaking Taps for a Constantly Warm Shower*, NEW SCIENTIST, Feb. 16, 2008, at 18.

150. MATZKE & CHALLET, *supra* note 149, at 1.

151. In this important sense, the ant colony analogy falls short. Ants are not known to innovate their basic rules for foraging or their colony structure: they do not build new tools for finding food, nor do they have diverse motivations and modes of compensation for their work.

In place of Old School Economics' conventional wisdom of the market's "invisible hand," Beinhocker emphasizes a notion of "fitness functions."[152] Various emergent structures may be more or less fit for the environment and the task at hand. The best chance of finding good fitness functions lies in leaving the emergent system open to subsequent emergence.

As we shall see, emergence can take several different forms, including ideas, innovation, economic growth, and spillovers. Emergent phenomena include economic patterns such as oscillations, punctuated equilibrium, and power laws. Economic growth comes primarily from new ideas; people, ideas (instructions) and things (materials). An evolutionary approach to economics admits that we do not know now, nor will we ever know for sure in the future, the ideal set of market rules. Instead, we should be content to develop supporting institutions that preserve a bounded space for evolutionary activity, and at most look to shape the inputs to the fitness function of the marketplace.

II. NETWORKED ECONOMY: THE INTERNET AS THE ULTIMATE EMERGENT PLATFORM

'Tis true, there's magic in the web of it.
William Shakespeare[153]

Just as economic theory has been turned upside-down thanks to innovative new analytical and empirical work on many fronts, so have the staid assumptions of telecommunications technology been cast aside by the rise and success of the Internet. In many ways, the Internet is the ultimate emergent phenomenon: a platform for untold forms of economic, social, and personal connectivity and interaction. As we have seen, every network of agents operates under a certain set of rules, developed over the course of time in contingent ways. To understand better how the Internet is a novel creation of history—one which can and should play a significant role in shaping our public policy framework—we need to understand what makes the Internet so unique and successful.

For starters, it is important to understand that the "network of networks" we call the Internet is not some neutral, value-free assemblage of routers and servers and fiber optics. Generally, technology may be viewed from a certain perspective as "neutral," but how we design and use it reflects a distinctive social and psychological bias. As an artifact of human ingenuity, technology expresses deep-seated desires, wants, needs, and fears. While component parts may be used for a variety of

152. *See* BEINHOCKER, *supra* note 22, at 195.
153. WILLIAM SHAKESPEARE, OTHELLO, THE MOOR OF VENICE act 3, sc. 4.

purposes—think for example, of the assemblage of mechanical systems into either exploratory rocket ships or atomic weapons—the design and assembly and uses of those components inevitably reflects very human impulses.

In the case of the present-day Internet, that built-in bias is reflected in the key elements of its architecture and infrastructure. As Lawrence Lessig already has shown us, "Code is Law,"[154] or rather, computing technologies are products of human design that affect our behavior.[155] The structure of the Internet reflects the ethos that produced it.[156] Those who struggled to bring forth the Internet did so in the full knowledge that they were imbuing it with specific characteristics that reflected their personal and professional value systems. Those values include interconnectivity, openness, flexibility, and the lack of a pervasive centralized authority.[157] The Net is also oriented towards user activities at the so-called "edge" of the network, as opposed to network activities at the network's "core." At the same time, the Internet has no fixed, inherent nature, except for what we build into its architecture. The Net is what we make it.[158]

A. *The Net's Origins*

1. Overlooked Components: The Social, Economic, and Legal Backdrop

In describing the essential architectural and modular ingredients that make up the Internet, many tend to neglect some of the most critical elements: namely, the social, economic, and legal environment within which the Internet operates. Some have referred to a technology's "context of use," which describes the society and the web of other artifacts within which technologies are always embedded.[159] A technology is not severable from the culture in which it is embedded. "Material artefacts encode, embody, convey, or transmit whole systems of

154. LAWRENCE LESSIG, CODE VERSION 2.0 5 (2006).

155. *See id.*

156. BALL, *supra* note 12, at 374. *See also* MANUEL CASTELLI, THE INTERNET GALAXY 36 (2001) ("The culture of the producers of the Internet shaped the medium.").

157. *See* JOHN NAUGHTON, A BRIEF HISTORY OF THE FUTURE 275-77 (2000).

158. Depending on your viewpoint, the Internet at any one moment is a technical architecture (physical assets, logical protocols, and software), or a complex of providers (who owns, operates, and manages the technical components), or a complex of users and their applications and content, or a substrate for economic and non-economic activity, or a process of human interactions. No single conceptual metaphor can hope to capture all of these elements at once.

159. Nelly Oudshoorn & Trevor J. Pinch, *Introduction to* HOW USERS MATTER 1-2 (Nelly Oudshoorn & Trevor J. Pinch eds. 2005).

immaterial ideas and behavioural patterns."[160]

Technology evolves with us, our human capacities, our culture, and our environment. Susan Crawford helpfully has called it the "code/law background medium,"[161] but it actually involves a richer and more complex mix of elements. Indeed, one cannot divorce the Net from its social, economic, and legal context. The ecosystem of the Internet is but a part of the larger ecosystem of human life.

Starting at least in the 17th Century, and extending to today, the "constitutive choices" about the modern media—the press, postal and telecommunications networks, cinema, and broadcasting—have taken place in the context of larger political and economic transformations.[162] In particular, U.S. government policymakers undertook supremely political objectives with important economic consequences. In short, politics created our media world, from the emergence of the first newspapers and postal systems to the rise of the mass press, telecommunications, motion pictures, and broadcasting in the 20th Century. Critical choices about freedom of expression, ownership of media, the architecture of networks, secrecy, privacy, and intellectual property have made the modern media as much a political as a technological invention.[163]

The Internet is no different. Now that the post-industrial, information society has come, what kind of society it proves to be ultimately will be a political choice. The Net is subject to the very same social, economic, and political forces that affect any other part of the world, real or virtual. Because of this rich backdrop, government officials and policymakers potentially have an enormous role in shaping the architecture and uses of the Internet. As we shall see, the U.S. Government in particular can, and inevitably will, to some extent "regulate the Internet."

2. An Unlikely Birth

It has become a truism that the commercial Internet, and particularly the World Wide Web, is a phenomenon built largely by end users operating at the periphery of the network. Nonetheless, surprisingly few bother to stop to ponder exactly what that truism may mean, or what specific implications can be drawn for the future.

Certainly the Internet did not start out that way. After all, despite

160. John Ziman, *Evolutionary Models for Technological Change*, *in* TECHNOLOGICAL INNOVATION AS AN EVOLUTIONARY PROCESS 1, 8 (John Ziman ed. 2000).

161. Susan P. Crawford, *The Biology of the Broadcast Flag*, 25 HASTINGS COMM. & ENT. L.J. 603, 606 (2003).

162. *See generally* PAUL STARR, THE CREATION OF THE MEDIA (2004).

163. *Id.* at 1-19, 385-402.

some of the more extreme rants of self-proclaimed "cyberlibertarians," the Internet is a creature spawned not in the rich soil of the valleys around San Jose, but in windowless conference rooms at the Pentagon, with the aid of government-sponsored academia. In particular, government, military, and academia provided the structure and financial support for the nascent network. As a result, "the Internet was born at the unlikely intersection of big science, military research, and libertarian culture."[164]

Indeed, "the real history of the Internet reaches back to that terribly traditional, often-reviled institution of our collective aspirations: government."[165] The "gift culture of the ARPANET"—the secret scientific research project funded by the U.S. military—became a prolific incubator of many innovations.[166] As one noted historian has concluded, "public investment in science and technology—channeled through institutions that continued, however, to be decentralized and competitive—proved instrumental in the emergence of computer sciences, advanced telecommunications, and other developments that led directly to the contemporary phase of the information revolution."[167] Of course, it is highly ironic that centralized decision-making led to a decentralized Internet, that military desire to create a resilient and efficient system led to a highly interconnected, distributed network, and that the top-down mandate to use a particular root protocol allowed the Net to become a platform for bottom-up user choice and freedom.[168]

The Internet required three decades of subsidies to reach commercial market introduction.[169] It has been estimated that the U.S. Government spent some $125 million building the Internet's predecessor networks.[170] Only government, it seems, can afford to be that patient.[171]

Networking pioneer and entrepreneur Charles Ferguson has observed that new technologies like the Internet typically come from neither the venture capital industry nor from the free market.[172] Instead,

164. MANUEL CASTELLS, THE INTERNET GALAXY 17 (2001).

165. DAVID BOLLIER, SILENT THEFT 101 (2003).

166. *Id.* at 103.

167. STARR, *supra* note 162, at 18.

168. BALL, *supra* note 12, at 377-79.

169. For more on this often-misunderstood history, see JANET ABBATE, INVENTING THE INTERNET (1999); KATIE HAFNER & MATTHEW LYON, WHERE WIZARDS STAY UP LATE: THE ORIGINS OF THE INTERNET (2000); NAT'L RESEARCH COUNCIL, THE INTERNET'S COMING OF AGE (2001).

170. Larry Press, *Seeding Networks: The Federal Role*, 39 COMM. OF THE ACM 10, 15 (1996).

171. Lee W. McKnight, *Internet Business Models: Creative Destruction As Usual*, *in* CREATIVE DESTRUCTION 39, 59 (Lee W. McKnight, Paul M. Vaaler, & Raul L. Katz eds. 2002).

172. *See* CHARLES H. FERGUSON, HIGH STAKES, NO PRISONERS: A WINNER'S TALE OF GREED AND GLORY IN THE INTERNET WARS (1999).

he explains that "virtually all the critical technologies in the Internet and Web revolution were developed between 1967 and 1993 by government research agencies and/or in universities."[173] During that same time period, a $10 billion commercial online services industry arose in the free market. "The comparison between the two," he argues,

> is extremely clear and extremely unflattering to private markets. The commercial industry's technology and structure were inferior to that of the nonprofit Internet in every conceivable way, which is the primary reason that they were so rapidly destroyed by the commercial Internet revolution. Internet technology was around and available for more than twenty years, continuously evolving under the noses of companies like AT&T, IBM, CompuServe, AOL, and even Microsoft. But somehow these companies managed not to notice. Neither, by the way, did most VCs.[174]

It certainly is unclear whether the free market alone could or would have created such a thing as the Internet, but the available evidence is not promising. As Ferguson points out, in the 1980s and early 1990s, wholly incompatible, proprietary computer networks arose—bulletin boards, online service providers, private networks, email services. Without the existence of a ready alternative like the Internet, such "closed" networks may well have become the prevailing marketplace norm. Kevin Werbach has noted that "the victory of the interconnected outcomes over the centralized ones was always contingent on historical, regulatory, economic, and cultural factors."[175] The Internet may be viewed as an example of a path-dependent creation, a "telecommunications anomaly,"[176] and even a historic accident.[177] Some may see the Internet as the "Black Swan" of the communications world, a wholly unexpected event that came out of nowhere to bring a profound and widespread impact to the economy.[178]

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173. *Id.* at 13. The emergence of the home computer out of the "Homebrew Computer Club," an eclectic San Francisco-based hobbyist group, rather than IBM, HP, or Xerox, provides an interesting parallel to the Net's rise over proprietary alternatives. As Richard Ogle puts it, "[t]he failure of the mainstream computer industry to anticipate the arrival of the personal computer—an enormous failure of insight and imagination—exemplifies once again the fact that being in thrall to the wrong idea-space can blind you to what seems obvious to others." OGLE, *supra* note 67, at 78.

174. FERGUSON, *supra* note 172, at 13. Some have noted that the Internet did not so much drive out its competitors as subsume them. *See* Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CAL. L. REV. 479, 552 (1998).

175. Werbach, *supra* note 88 at 18.

176. *See* Paul A. David, *Economic Policy Analysis and the Internet: Coming to Terms with a Telecommunications Anomaly*, *in* OXFORD HANDBOOK ON INFORMATION AND COMMUNICATION TECHNOLOGIES (Robin Mansell et al. eds., 2007).

177. DIANE COYLE, THE SOULFUL SCIENCE 57 (2007).

178. Taleb calls the Net "unplanned, unpredicted, and unappreciated upon its discovery,

The U.S. Government's role certainly was not limited to funding, research, prodding, and eventual privatization. On the regulatory front, policymakers made key decisions that dictated whether and how the Internet would develop into a mass-market phenomenon.[179] Beginning in the late 1960s with the original *Computer Inquiries*, the Federal Communications Commission (FCC) explored ways to protect the nascent online environment from regulation, and give it access to vital communications links. The FCC's *Computer Inquiry* safeguards governed consumer access to last-mile ramps—ordinary phone lines—owned and controlled by the incumbent local exchange carriers (ILECs), and used to access online services. This regulatory framework essentially buttressed the Internet's own open and end-to-end design principles.[180]

The *Computer Inquiry* rules did several important things. First, the world was divided into basic communications services (regulated as common carriage),[181] and enhanced information services (left unregulated). Enhanced services were defined as computer-based software applications and services that utilized the public switched telephone network (PSTN).[182] Second, providers of enhanced services (known as ESPs) gained the right to access basic services, on a nondiscriminatory basis, using the ILECs' commercial rates and terms. This end user right eventually became known as ISP open access. Third, ESPs and others had the concomitant right to attach lawful devices, such as computer modems, to the ILECs' phone networks. The end result was a modular regulatory framework, with targeted common carriage regulation of the lower infrastructure layers of the network, and an "unregulation" regime applicable to the upper applications, devices, and content layers.[183]

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and . . . well after." TALEB, *supra* note 67, at 135. One question is whether this supposed Black Swan event is still endogenous to (arising from within) the market, or whether the U.S. Government's extensive involvement in the Net's birth and success makes it an exogenous happenstance. The answer to that question well could dictate how one approaches the Internet as an economic phenomenon.

179. For a more fulsome discussion of this regulatory history, see Richard S. Whitt, *A Horizontal Leap Forward*, 56 FED. COMM. L.J. 587, 597-600 (2004).

180. *See* Robert Cannon, *The Legacy of the Federal Communications Commission's Computer Inquiries*, 55 FED COMM. L.J. 167, 204-05 (2003).

181. Common carriage conveys a raft of legacy regulations, including market entry and exit requirements, tariffing of service offerings, cost-based pricing, consumer complaint processes, and general oversight by federal and state regulators. *See generally* 47 U.S.C. §§ 201-231 (2000).

182. The FCC's rules define enhanced services as those services "offered over common carrier transmission facilities used in interstate communications, which employ computer processing applications that act on the format, content, protocol or similar aspects of the subscriber's transmitted information; provide the subscriber additional, different, or restructured information; or involve subscriber interaction with stored information." 47 C.F.R. § 64.702(a) (2008).

183. Kevin Werbach observes that the FCC's decision "meant that data services, which

The FCC also took other important steps, such as classifying ESPs as end users, thus protecting them from the excessive per-minute telephony access charges normally applicable to carriers for long-distance telephone traffic that originates and terminates to the ILEC networks.[184] In addition, following the breakup of AT&T in 1984, U.S. District Court Judge Harold Greene presided over a consent decree that barred the Bell Operating Companies from providing interLATA information services until 1991.[185] Finally, in the Telecommunications Act of 1996, Congress retained the FCC's basic/enhanced split in the form of new definitions of "telecommunications services" and "information services,"[186] and added a statutory provision decreeing that the Internet should remain unfettered by regulation.[187] Thus, in the *Computer Inquiry* era spanning roughly from 1980 to 2005, the United States had an open and unregulated communications platform by design (the Internet) that was married by regulation to open end points (the local telephone network).

B. The Net's Architecture

The Internet today is a network of networks, an organic hodgepodge of disparate infrastructure melded together through common software protocols. Understanding the what, where, why, and how of this architecture goes a long ways towards understanding how the Net fits into the rough formula of emergence we discussed above, and in turn the implications for communications policy going forward.

1. The Law of Code: Modularity

The modular nature of the Internet describes the "what," or its overall structural architecture. The use of layering means that functional tasks are divided up and assigned to different software-based protocol layers. For example, the "physical" layers of the network govern how electrical signals are carried over physical wiring; independently, the "transport" layers deal with how data packets are routed to their correct destinations, while the application layers control how those packets are used by an email program, web browser, or other user application or service. This simple and flexible system creates a network of modular

could ride transparently on top of the voice telephone network, were effectively outside of that network's sphere of influence." Kevin Werbach, *Only Connect*, 22 BERKELEY TECH. L.J. 1233, 1259 (2007).

184. *See* 47 C.F.R § 69.01 (2008).

185. United States v. Am. Tel. & Tel. Co. 552 F. Supp. 131, 197 (D.D.C. 1982), *aff'd sub nom.* Maryland v. United States, 460 U.S. 1001 (1983).

186. 47 U.S.C. §§ 153(20), (46) (2000).

187. 47 U.S.C. § 230 (2000).

"building blocks," where applications or protocols at higher layers can be developed or modified with no impact on lower layers, while lower layers can adopt new transmission and switching technologies without requiring changes to upper layers. Reliance on a modular system of layers greatly facilitates the unimpeded delivery of packets from one point to another. [188]

Put simply, the Internet is comprised of Code, stacked in Layers. One can view Code, the software and hardware components of the network, as the bricks and mortar.[189] Writ large, these components constitute "[a] set of procedures, actions, and practices, designed in particular ways to achieve particular ends in particular contexts."[190] By contrast, layers constitute the architectural features of the Internet, in this case its modular structure. The layers are what we build using the raw materials of Code as the building blocks:

> [E]ngineers use multiple protocols that partition a communication problem into disparate sub-problems and organize the software into modules that handle the sub-problems. Functions are allocated to different protocol layers or levels, with standardized interfaces between layers. The flexibility offered through the layering approach allows products and services to evolve by accommodating changes made at the appropriate layer, rather than having to rework the entire set of protocols. In other words, layering allows changes to implementation of one layer without affecting others, as long as the interfaces between the layers remain constant.[191]

Layers create a degree of "modularity," which allows for ease of maintenance within the network. This modularity, or independence, of each layer creates a useful level of abstraction as one moves through the layered stack. In particular, the user's ability to alter functionality at a certain layer without affecting the rest of the network can yield tremendous efficiencies when one seeks to upgrade an existing application (higher layer) that makes extensive use of underlying physical infrastructure (lower layer).[192]

2. Smart Edges: End-to-End

The end-to-end ("e2e") design principle describes the "where," or the place for network functions to reside in the layered protocol stack. The general proposition is that the core of the Internet (the network

188. *See generally* Whitt, *supra* note 179, at 601-09.
189. ALBERT-LÁSZLÓ BARABÁSI, LINKED 174 (2003).
190. ALEXANDER R. GALLOWAY, PROTOCOL xii (2004).
191. Whitt, *supra* note 179, at 602-03.
192. *Id.* at 604.

itself) tends to support the edge of the Internet (the end user applications, content, and other activities).[193] Some have rendered this broadly as dumb networks supporting smart applications.[194] A more precise technical translation is that a class of functions generally can be more completely and correctly implemented by the applications at each end of a network communication.

The e2e principle suggests that "[s]pecific application-level functions usually cannot, and preferably should not, be built into the lower levels of the system—the core of the network." [195] Instead, such functionality ideally operates on the edges, at the level of client applications that individuals set up and manipulate.[196] E2e architecture "[i]s designed to be fairly simple, open and stable at the network level while allowing users the freedom to develop innovative applications to run on top of it."[197] Thus, users remain the driving force in such a system.[198] Rather than relying upon the creativity of a small group of innovators who might work for the companies that control the network, the e2e design enables anyone with a network connection to design and implement a better way to use that network.[199] As Lee McKnight has observed, "most Internet businesses operate on the edge of the Internet, which is where the intelligence and processing power resides by design."[200] The resulting explosion of innovative applications on the Internet likely never would have happened but for the incorporation of the end-to-end design into the network.[201] Thus, innovation and creativity become decentralized. This differs from traditional telephony and cable networks, where control over security, protocols, or permitted applications and content are handled in the core (in headends and central offices), away from the users at the edge. As a result, the power and

193. *Id.* at 604-05.

194. *See* David S. Isenberg, *The Dawn of the Stupid Network,* ACM NETWORKER, Feb.-Mar. 1998, at 24-31, *available at* http://www.isen.com/papers/Dawnstupid.html.

195. David D. Clark & Marjory S. Blumenthal, *Rethinking the Design of the Internet: The End-to-End Arguments vs. the Brave New World*, 1 ACM TRANSACTIONS ON INTERNET TECH. 70, 71 (2001).

196. Susan P. Crawford, *Someone to Watch Over Me: Social Policies for the Internet* 21 (Cardozo Law School Legal Studies Research Paper No. 129, 2006).

197. BOLLIER, *supra* note 165, at 102.

198. *Id.*

199. Ashish Shah, Douglas C. Sicker, & Dale N. Hatfield, Thinking About Openness in the Telecommunications Policy Context 6 (2003), http://web.si.umich.edu/tprc/papers/2003/244/openness2.pdf (paper presented at the Telecommunications Policy Research Conference).

200. McKnight, *supra* note 171, at 47.

201. *See, e.g.*, Mark A. Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era* 14 (Stanford Law School, Working Paper No. 207, 2000) (explaining role of "e2e" design in producing the "extraordinary innovation" of the Internet), *available at* http://cyberlaw.stanford.edu/e2e/papers/Lemley_Lessig_e2epaper.pdf.

functionality of the Internet is left in the hands of the end users.[202]

With regard to the Internet, the end-to-end argument now has been transformed into a broader principle "[t]o make the basic Internet protocols simple, general, and open, leaving the power and functionality in the hands of the application."[203] In the words of one commentator, e2e has become "a policy preference of potentially profound meaning."[204] Of course, the e2e principle can be prone to exaggeration. One cannot have a modern data network without a core, and in particular the transport functionality to connect together the myriad constituents of the edge, as well as the widespread distribution of the applications and content and services provided by the edge. Elements of the core network, while erecting certain barriers (such as firewalls and traffic shaping) that limit pure e2e functionality, may still allow relatively unfettered user-to-user connectivity at the applications and content layers. To have a fully functioning network, the edge and the core need each other. And they need to be connected together.

3. A Network of Networks: Interconnection

Werbach has recently pointed out an often under-appreciated aspect of the Internet's architecture: connectivity.[205] This aspect of the Net goes to its "why," which is the overarching rationale of moving traffic from Point A to Point B. Werbach believes that "the actual development of the Internet focused not on the edges, but on the links."[206] The early Internet was designed with an emphasis on internetworking and interconnectivity, and moving packets of data transparently across a network of networks:

> The defining characteristic of the Internet is not the absence of discrimination, but a relentless commitment to interconnection. . . . The engineers and entrepreneurs who laid the foundations for today's commercial Internet developed a set of technical protocols, business norms, and contractual arrangements to link together diverse

202. By precluding discrimination, e2e also "[s]ets the conditions necessary for a fair fight, so that what survives is truly the fittest and not merely the favored." Tim Wu, *The Broadband Debate, A User's Guide*, 3 J. ON TELECOMM. & HIGH TECH. L., 69, 83 (2004). "E2e can help erase through competition the invariable mistakes that a centralized network planner will make." *Id*. at 83-84.

203. Timothy Wu, *Application-Centered Internet Analysis*, 85 VA. L. REV. 1163, 1164-65 (1999).

204. Jonathan Sallet, *Just How Open Must an Open Network be for an Open Network to be Labeled Open*, 8 FIRST MONDAY 1, 6 (2003), http://www.firstmonday.org/issues/issue8_3/sallet/.

205. *See* Werbach, *supra* note 88, at 3.

206. Werbach, *supra* note 183, at 507.

networks.[207]

Interconnecting then is the baseline goal embedded in the Internet's architecture, creating incentives and opportunities for isolated systems to come together, and for edges to become embedded in tightly interconnected networks.[208] Werbach has shown that interconnectivity creates both decentralizing and centralizing trends in the Internet economy, and both centripetal force (pulling networks and systems into the Internet commons) and centrifugal force (towards the creation of isolated gated communities). He expresses concern that the Net increasingly is being pushed towards disaggregated, proprietary islands of connectivity.[209]

4. Agnostic Protocols: IP

The design of the Internet Protocol ("IP"), or the "how," allows for the separation of the networks from the services that ride on top of them. IP was designed to be an open standard, so that anyone could use it to create new applications and new networks. By nature, IP is completely indifferent to both the underlying physical networks, and to the countless applications and devices using those networks. In particular, IP does not care what underlying transport is used (such as fiber, copper, cable, or radio waves), what application it is carrying (such as browsers, e-mail, Instant Messaging, or MP3 packets), or what content it is carrying (text, speech, music, pictures, or video).[210] Thus, IP enables any and all user applications and content. IP also was designed to follow the e2e principle.[211] Thus, using IP, individuals are free to create new and innovative applications that they know will work on the network in predictable ways.

In 1974, Vint Cerf and Robert Kahn issued their seminal paper on the TCP/IP protocol suite, in which the authors "present a protocol design and philosophy that supports the sharing of resources that exist in different packet switching networks."[212] Based in large part on how Cerf and Kahn designed that protocol suite (plus more than a little help from

207. Werbach, *supra* note 88 at 3. Some of the flavor of this scheme can be found in Postel's Law, named after John Postel: "be conservative in what you do, be liberal in what you accept from others." Werbach, *supra* note 183, at 518.

208. Werbach, *supra* note 183, at 529.

209. Werbach, *supra* note 88, at 8.

210. Whitt, *supra* note 179, at 604-07.

211. Timothy Wu, *Network Neutrality, Broadband Discrimination*, 2 J. ON TELECOMM. & HIGH TECH. L. 141, 146 (2003).

212. Vinton G. Cerf & Robert E. Kahn, *A Protocol for Packet Network Intercommunication*, 22 IEEE TRANSACTIONS. ON COMM. No. 5 637 (1974), *available at* http://cs.mills.edu/180/reading/CK74.pdf.

the U.S. Government to ensure its universal use on the networks), the Internet Protocol has become the ubiquitous "bearer" protocol at the heart of the Internet.[213]

C. The End Result: A "Virtuous Feedback Network"

From these various architectural components of the Internet, the end result is that IP helps fashion a "virtuous hourglass" from disparate activities at the different network layers. In other words, the Net drives convergence at the IP (middle) layer, while at the same time facilitating divergence at the physical networks (lower) and applications/content (upper) layers. The interconnected nature of the network allows innovations to build upon each other in self-feeding loops. This network topology and universal connectivity gives meaning to what some have labeled the Net's three golden rules: nobody owns it, everybody uses it, and anyone can add to it.[214] One might refer to this as a "virtuous feedback network."

From the above discussion of the Internet's different yet related design components, one can see the resulting whole: that, generally speaking, no central gatekeeper exerts unilateral control over activities on the Internet.[215] This governing principle allows for vibrant user activity and creativity to occur at the network edges. Moreover, the values imbued into the Net's architecture were there from the beginning.[216] In such an environment, entrepreneurs need not worry about getting permission for their inventions to reach end users. In essence, the Internet has become a distributed, yet connected, platform for emergence.[217] Indeed, technology platforms such as the Internet are both open (accessible) and communal (adaptable). One could think of it like the electric grid, where the ready availability of an open, standardized, and stable source of electricity allows anyone to build and use myriad of

213. *See* Whitt, *supra* note 179, at 629.

214. DON TAPSCOTT & ANTHONY D. WILLIAMS, WIKINOMICS 273 (2006).

215. Of course, as alluded to earlier, talk about an "edge" versus "core" dichotomy should not obscure the messy reality that the Net includes crucial top-down core elements. ICANN runs the domain name system (DNS) so that there is common addressing scheme for users, while the IETF makes critical engineering and standards decisions that then are implemented throughout the system. One irony is that a certain centrality of common standards and addressing schemes may well be necessary in order for the Net's decentralized nature to fully emerge.

216. NAUGHTON, *supra* note 157, at 268-77.

217. These aspects may help explain why the Internet is different from previous forms of communications and transportation infrastructure. *See, e.g.*, VARIAN, ET AL., *supra* note 5, at 4 (while the Internet represents one instance of "combinatorial innovation," its uniqueness may stem from its foundational software protocols, which are quite different from the physical devices that drove previous technologies).

different electric devices.[218]

The Internet is more than that: it is a complex adaptive system, whose architecture is much richer than the sum of its parts.[219] As such, Net-based human activities produce emergent and self-organizing phenomena. Metaphors seem to fall short when describing the Internet; it is by various accounts an object and a process, a place and an idea.

As the networks and users that comprise it continue to change and evolve, the Net's core principles of modularity, e2e, interconnectivity, and agnosticism are constantly being pushed and prodded by technology, market, and legal developments. That is not to say these developments are inherently unhealthy. Clearly there are salient exceptions to every rule, if not new rules altogether, and the Internet needs to adjust to the realities of security concerns like denial-of-service (DoS) attacks, and the needs of latency-sensitive applications like streaming video. The question is not whether the Net will evolve, but how. Will the inevitable changes come organically, or will they be imposed unilaterally? And by whom?

III. GROWTH ECONOMY: THE EMERGENCE OF IDEAS, INNOVATION, AND "NET EFFECTS"

The emergent phenomena of new ideas and innovation, channeled through generative networks of agents such as the Internet, provide powerful fuel for economic growth and other important effects. Growth long has been a concern for economists as they seek to understand what drives nations to build and maintain wealth. In a highly networked economy, the benefits of innovation in physical and social technologies go beyond traditional economic growth, and generate a diversity of what we call "Net effects."

An initial point is to understand that the Internet as a platform for new ideas and innovations has been slighted in Old School Economics as a mere "exogenous" influence. In fact, general platform technologies like the Internet are endogenous elements, which in turn fuel growth within the system. Beinhocker puts it succinctly:

> [A] change in technology, such as the invention of the Internet, can be seen as an exogenous shock to the economic system . . . . The problem with this approach is that it gives economists an escape hatch and allows them to put the most difficult and often most interesting questions outside the bounds of economics. For example,

218. Richard Lanham finds that the Net reflects "the comedy of the commons," as it is developing into an ever-richer community resource that "combines the power of a free market, where individual gain leads to collective benefit, with the cooperative ownership of the cultural conversation." RICHARD A. LANHAM, THE ECONOMICS OF ATTENTION 13 (2006).

219. BARABÁSI, *supra* note 189, at 174.

> if technological change is treated as a random, outside force (like the weather), then one doesn't need a fundamental theory of the interaction between technological change and changes in the economy.[220]

Yochai Benkler also notes that "our theories of growth and innovation assume that industrial models of innovation are dominant."[221] Economics for too long has focused only on production, labor, and capital as the key elements of the market. To these, Romer, who helped found the New Growth school of economics, now has added knowledge and technology.

The "Net effects" we discuss below are a variety of pecuniary and non-pecuniary benefits that emerge when networked agents interact. Economists often treat these effects as "externalities"—meaning that the forces cannot be accounted for purely in terms of traditional market transactions. This includes "spillovers" (non-affiliated entities benefit from others' innovations), peer-production (networks allow diversely motivated agents to collaborate), and all social, political, and cultural benefits outside the purview of standard market analysis. It is tempting to think of these Net effects as consisting of "primary" benefits (economic growth) versus "secondary" benefits (miscellaneous "economic" and "non-economic" advances). Terms like "spillovers" suggest as much, connoting an unintended minor consequence of a major economic activity. Yet we should be hesitant to impose such a dichotomy on this complex mesh of human activities. Not only do "Net effects" help fuel core growth, they can have profound positive impacts on human life.

Countless things emerge from a networked, layered, end-to-end platform like the Internet. For purposes of this paper, the next two sections will delve into those emergent phenomena that have a direct bearing on the public policy landscape. In brief, ideas and innovation emerge from the Net, which in turn brings economic growth and various "Net effects."

A. *The Nature of Ideas and Innovation*

So where do ideas, and then innovation, come from, and why? Ideas have a diverse and unpredictable variety of sources and uses. As we will see, ideas can be wedded to things, and to other ideas, in ways that drive innovation, and in turn create a host of positive economic and non-economic benefits. As Douglass North puts it, ideas and their creation are "the fundamental driving force of the human condition."[222]

220. BEINHOCKER, *supra* note 22, at 55.
221. BENKLER, *supra* note 67, at 460.
222. DOUGLASS C. NORTH, UNDERSTANDING THE PROCESS OF ECONOMIC

Ideas are the raw material for innovation. Crawford observes that "ideas are not like goods; they are potentially far more valuable."[223] In the ordinary transformational cycle, ideas become concepts, which become inventions, which are utilized for commercial or other purposes. They are the recipes for combining atoms into useful things; while the atoms are limited, the ideas themselves essentially are unlimited. Innovation, by contrast, is the application of ideas—invention plus implementation. Ideas and innovation form an essential feedback cycle, where input becomes output, becomes input again.[224]

Hayek claimed that "there is no simple under-standing of what makes it necessary for people under certain conditions to believe certain things. The evolution of ideas has its own laws and depends very largely on developments that we cannot predict."[225] But we can still try.

1. Ideas

One reason that economic growth defies simple explanation is that ideas beget future ideas, amplifying total output. It is difficult to know at any given time how much a particular idea will produce, as its cascading effects have yet to be realized. Any one innovation is likely to build on another. This "standing on the shoulders of giants" concept is the familiar motivation for much of our intellectual property law, which seeks to balance incentives for one innovator to produce with the benefits to innovators down the road. For years, economists had given short shrift to this reality in their models of economic growth because it was deemed simply too complex. Technological progress, and the ideas that led to it, were considered "exogenous"—outside of the system.

However, Kenneth Arrow noted in 1962 that "[i]nformation is not only the product of inventive activity, it is also an input."[226] This simple observation articulates in the language of economics something that seems almost intuitive today. Still, seeing ideas as inputs is critically important and fundamentally different from the results in simple linear economic models. Arrow described innovation as an inherently uncertain process, and discussed ways in which a society might spur innovation despite this risky environment. He ultimately concluded that there was

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CHANGE 18 (2005).

223. Susan P. Crawford, *The Internet and the Project of Communications Law,* 55 UCLA L. REV. 359, 391 (2007).

224. Others draw lines in the technological change process between invention, innovation, and diffusion. LIPSEY ET AL., *supra* note 125, at 12.

225. Thomas W. Hazlett, *The Road from Serfdom: Forseeing the Fall*, REASON, July 1992, http://www.reason.com/news/show/33304.html.

226. Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention* 13 (Rand Corp. Paper No. P-1856-RC, 1959), *available at* https://www.rand.org/pubs/papers/2006/P1856.pdf.

no clear, single, optimal path, but that the best approach is to foster a diversity of modes of production.[227] In any event, an economy that provides fertile ground for idea creation, reuse, and adaptation tends to spur growth and future innovation more readily than one that does not.

In Beinhocker's telling, ideas that make up Physical Technologies or Social Technologies are particularly valuable in the process of evolution toward more productive systems. Because they feed back into the economy in the form of recipes for production, and because they can be adapted in new and unexpected ways, ideas generate increasing returns. Further, Romer found that knowledge builds on itself, "which means that as we learn more, we get better and better at discovering new things. It also means there's no limit to the amount of things we can discover."[228]

A second overlooked aspect of ideas is that they can be re-used infinitely. In 1990, economist Paul Romer published a landmark paper entitled "Endogenous Technological Change."[229] Building upon Arrow's description of the self-feeding nature of information, Romer further examined the nature of ideas. His key observation was that ideas are non-rival, meaning that any number of persons can simultaneously make use of them.[230] Whereas two people cannot both eat the same apple, for example, ideas can be copied and shared without depriving anyone of their use. However, ideas also are partially excludable, meaning that through law and other constructs we can sometimes prevent this sharing from occurring. Nevertheless, as the cost of transmitting ideas approaches zero, the marginal cost approaches zero as well.[231] From the perspective of social welfare, these ideas would be shared for free. Since information is a non-rival good, it takes only one person to invent an idea, which an entire group then can adapt.[232]

On the Internet, ideas and the resulting innovation could not

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227. *Id.*

228. Kurtzman, *supra* note 33, at 2.

229. *See* Paul M. Romer, *Endogenous Technological Change*, 98 J. OF POL. ECON. S71 (1990).

230. Of course Romer was not the first to have this insight. Thomas Jefferson noted that

> If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of every one, and the receiver cannot dispossess himself of it.

Letter from Thomas Jefferson to Isaac McPherson (Aug. 13, 1813), *in* THE WRITINGS OF THOMAS JEFFERSON 333 (Albert E. Bergh ed. 1905) (1907). Albert Einstein similarly remarked, "[i]f I give you a pfennig [penny], you will be one pfennig richer and I'll be one pfennig poorer. But if I give you an idea, you will have a new idea, but I shall still have it, too." The MacTutor History of Mathematics archive, A meeting with Einstein, Mar. 1996, http://www-groups.dcs.st-and.ac.uk/~history/Extras/Einstein.html.

231. DAVID WARSH, KNOWLEDGE AND THE WEALTH OF NATIONS 366 (2006).

232. ROBERT WRIGHT, NONZERO 48 (2001).

behave less like physical goods. By contrast, something like crops of corn require physical goods to grow (water, fertilizer, soil). Crops also must be grown in a physical place, transported physically for sale, and once purchased cannot be shared without depriving the original owner of the good. Online, ideas exhibit very different characteristics: they are built on top of other ideas, they sometimes exist only ethereally on hard drives, and they are transmitted instantly and cheaply. These intangible ideas increasingly drive the growth of the economy as a whole, and Romer's explanation of this phenomenon (to be explored further shortly) helps explain how some economies are able to grow much more rapidly than their linear counterparts.

A third attribute of ideas is that they are relatively easy and inexpensive to share, at least outside the confines of intellectual property law. Economist Ronald Coase first explained in the late 1930s how modern firms are formed to reduce transaction costs that would otherwise make many types of production prohibitively inefficient.[233] When using traditional price mechanisms, certain costs are introduced in each transaction, such as matching buyer and seller, negotiating the contract, and other overhead related to exchanging the good. Within a firm, these costs can be dramatically reduced or eliminated entirely because activities can be coordinated without negotiating prices, paying sales taxes, or incurring other costs.

In a highly networked environment, sharing certain types of goods becomes much easier and cheaper than ever before. Specifically, nonrival ideas can spread effortlessly to the extent that they are non-excludable. Sharing of innovations has historically involved low transaction costs; with the advent of the Internet, these costs approach zero. Once an idea has been created, eliminating barriers to sharing it can lead to the most efficient use and further innovation. Coase's bright line between individual and firm begins to blur in an innovation economy that takes full advantage of this structure.[234] In some cases, loosely related individuals operating outside of market dynamics develop critical components of the technological infrastructure that multiply production throughout a variety of sectors of the economy.

A final important aspect of ideas is that they flourish in open systems. Whereas industrial economies based on physical capital require large firms, networked economies thrive when small businesses and entrepreneurs innovate in a maximally open environment. The network ideally should enable access to markets and connect people to ideas, regardless of size. These diversely configured actors then introduce

233. Coase, *supra* note 92, at 395-98.

234. Yochai Benkler, *Coase's Penguin, or, Linux and the Nature of the Firm*, 112 YALE L.J. 369 (2002).

growth-fueling ideas for the next generation of producers. Throughout history, goods have been manufactured primarily for a purpose that was known by the producer. Nevertheless, they have often been modified to the great benefit of the overall market. Ideas are especially flexible in this way, and the platforms we use to generate them are most efficient when they facilitate that flexibility.

2. Innovation

If there is any one business lesson of the last decade that has acquired near-universal empirical support and expert agreement, it is this: innovation is a good thing. The creation of new and different objects, processes, and services are at the heart of any rational conception of economic growth and the fulfillment of human potential. No matter what you call it—creativity, entrepreneurism, novelty, ingenuity—the global economy feeds on the constant infusion of the products of innovation.

The 20th Century will be credited by many as the century of innovation.[235] Indeed, one historian has demonstrated that the "accelerating growth [of useful knowledge] . . . has affected the world more [profoundly] than all other social and political changes taken together."[236] Innovation is a much-admired concept, yet in many ways still rather mysterious and elusive. It has been defined in some quarters as invention plus implementation.[237] Where ideas are the raw makings of a recipe, innovation is the fashioned process or product. More specifically, innovation involves the process of taking a raw idea and developing it into a concept, which "yields some type of invention, and which is finally implemented and commercialized."[238] However one chooses to define it, "[i]nnovation is the source of economic variation,"[239] and "the key factor enabling growth and change in capitalist economies."[240]

Research shows conclusively that innovation tends to flow from the users, not the consumers or providers; from the many, not the few; from the connected, not the isolated; from individuals and small groups, not larger organizations; from the upstarts, not the established; from the decentralized, not the concentrated; from the flat, not the hierarchical; from the autonomous, not the controlled. [241] Innovation is produced from

235. GERARD H. (GUS) GAYNOR, INNOVATION BY DESIGN 1 (2002).
236. JOEL MOKYR, THE GIFTS OF ATHENA 297 (2002).
237. GAYNOR, *supra* note 235, at 3.
238. *Id.* at 3, 7.
239. COYLE, *supra* note 177, at 189.
240. McKnight, *supra* note 171, at 39-41.
241. *See, e.g.*, CARLISS Y. BALDWIN & KIM B. CLARK, DESIGN RULES (1999); JOHN SEELY BROWN & PAUL DUGUID, THE SOCIAL LIFE OF INFORMATION (2000); BHASKAR CHAKRAVORTI, THE SLOW PACE OF FAST CHANGE (2003); CLAYTON M.

those users motivated by many incentives, including profit, pride, and personal fulfillment. The arrival of innovation is not usually predictable or orderly;[242] indeed, "invention often is the mother of the unforeseen."[243] While individual innovations tend to be minor and incremental, collectively they create technical progress. There is also a separate "demand side" perspective to innovation, based on extensive research showing that "venturesome" consumers adopting and using technology are crucial to maintaining economic prosperity.[244]

Clayton Christensen placed the concept of innovation squarely before the general public in his acclaimed trilogy.[245] His writings focus on what he calls sustaining innovations—those allowing firms to provide better and more profitable products to their customers—as opposed to disruptive innovations—those offering initially poorer performance along the dimension that existing customers care about the most. Christensen found that modularity can have a profound impact on industry structure, because it enables independent, nonintegrated organizations to sell, buy, and assemble components and subsystems. "[I]n a modular world, [firms] can prosper by outsourcing, or by supplying just one element."[246] Such firms can become, not just a mere link in a value "chain," but an integral component of a complex and evolving value "net."

CHRISTENSEN, SCOTT D. ANTHONY, & ERIK A. ROTH, SEEING WHAT'S NEXT? USING THE THEORIES OF INNOVATION TO PREDICT INDUSTRY CHANGE (2004); BORU DOUTHWAITE, ENABLING INNOVATION (2002); GAYNOR, *supra* note 235; ANDREW HARGADON, HOW BREAKTHROUGHS HAPPEN (2003); FRANS JOHANNSON, THE MEDICI EFFECT (2004); LARRY LESSIG, THE FUTURE OF IDEAS (2002); CONSTANTINOS MARKIDES & PAUL GEROSKI, FAST SECOND (2004); MCKNIGHT, VAALER & KATZ, EDS., *supra* note 171; JOHN MCMILLAN, REINVENTING THE BAZAAR (2002); MOKYR, *supra* note 236; DAVID NYE, TECHNOLOGY MATTERS (2006); HOWARD RHEINGOLD, SMART MOBS (2002); OGLE, *supra* note 67; NELLY OUDSHOORN & TREVOR PINCH, EDS., HOW USERS MATTER (2003); SCOTT PAGE, THE DIFFERENCE (2007); JOHN THACKARA, IN THE BUBBLE (2005); JAMES M. UTTERBACK, MASTERING THE DYNAMICS OF INNOVATION (1994); VON HIPPEL, *supra* note 67.

242. *See* SCOTT BERKUN, THE MYTHS OF INNOVATION 30 (2007).

243. NYE, *supra* note 241, at 159. Importantly, "since innovation means doing something never done before, there is an element of genuine uncertainty in all innovative activity." LIPSEY ET AL., *supra* note 125, at 30.

244. AMAR BHIDE, THE VENTURESOME ECONOMY (2008). Bhide argues that "the willingness and ability of users to undertake a venturesome part plays a critical role in determining the ultimate value of innovations." *Id.* at 323. He cites a number of supportive elements of the U.S. economic system, including a high level of inclusiveness and participation, a wide variety of organizational forms, venturesome beliefs that embrace new technologies and goods, and a premium on growth. *Id.* at 409.

245. CLAYTON M. CHRISTENSEN, THE INNOVATOR'S DILEMMA: WHEN NEW TECHNOLOGIES CAUSE GREAT FIRMS TO FAIL (1997); CLAYTON M. CHRISTENSEN & MICHAEL E. RAYNOR, THE INNOVATOR'S SOLUTION (2003); CHRISTENSEN, ANTHONY, AND ROTH, *supra* note 241.

246. Clayton M. Christensen & Scott D. Anthony, *Disruption, Disintegration, and the Impact of New Telecommunications Technologies*, *in* THE BROADBAND EXPLOSION 91, 99 (Robert D. Austin & Stephen P. Bradley eds., 2005).

Christensen believes that the Internet's decoupling of services and transport creates innovative new business models across customers and markets. In his words, "IP is the ultimate modular interface."[247] Users operating at the so-called edge of the Internet are responsible for many of the key innovations that we enjoy today. The Internet in itself can be seen as a rare breakthrough innovation.[248] Lee McKnight posits that the Internet facilitates rapid development and diffusion of innovations by network users. IP acts as a "bearer service"—the general purpose platform technology linking technologies, software, services, customers, firms, and markets—so that the Internet becomes "an innovation engine that enables creation of a remarkable range of new products and services."[249] Thus, "the Internet works its magic through rapid development, diffusion, and validation of innovations."[250] Benkler describes how the Internet helps disrupt the traditional producer/consumer model by empowering the rise of end users who can play both roles as part of a continuing conversation and exchange of information. The "Great Shopping Mall" can be transformed into the "Great Agora," featuring "unmediated conversation of the many with the many."[251] "The Internet may be considered a disruptive innovation, but in essence it's a new way of doing business—a new tool to accomplish the same result."[252] As Crawford puts it, the central presumption of Internet innovation is that "everything not prohibited is permitted."[253]

Obviously, these observations amount to a generalization, one not true for all times, places, and people. Certainly, there are innovative large, entrenched organizations—think Apple—and countless uncreative small ones. Nor can a market system survive only with innovation-churning entrepreneurs; after all, "[b]ig firms remain essential to refine and mass-produce the radical innovations that entrepreneurs have a greater propensity to develop or introduce."[254] With regard to the Internet, innovations also are not limited to the content and applications layers, or to consumer-facing retail offerings; they happen deep in the

247. *Id.* at 104.

248. GAYNOR, *supra* note 235, at 34.

249. McKnight, *supra* note 171, at 40 (citation omitted).

250. *Id.* at 41 (citation omitted).

251. Yochai Benkler, *From Consumers to Users: Shifting the Deeper Structures of Regulation Toward Sustainable Commons and User Access*, 52 FED. COMM. L.J. 561, 565 (2000).

252. GAYNOR, *supra* note 235, at 31. "Software platforms have been found to accelerate further the process of creative destruction, mainly because code is digital and malleable," and can be distributed over the Net to potentially billions of computing devices around the world. DAVID S. EVANS ET AL., INVISIBLE ENGINES 338 (2006).

253. Susan P. Crawford, *Shortness of Vision: Regulatory Ambition in the Digital Age,* 74 FORDHAM L. REV. 695, 724 (2005).

254. WILLIAM J. BAUMOL ET AL., GOOD CAPITALISM, BAD CAPITALISM, AND THE ECONOMICS OF GROWTH AND PROSPERITY 92 (2007).

logical and physical infrastructure of the network. Indeed, layering with IP at the center allows for significant network innovation below, as well as above, the IP layer. If nothing else, however, the concept of "innovation from the edge" provides a useful corrective to present-day presumptions about how markets actually work in a capitalist society, and highlights the importance of the edge of the Internet to the rest of us.

B. Economic Growth

So what is growth? To most economists it means a rising standard of living for a country's citizens, measured according to the increase in gross domestic product (GDP) per capita. More generally, growth is measured according to how much value a nation is perceived to produce for each citizen. Growth in economic output per person is "the most important measure and determinant of economic performance . . . ."[255] To Emergence Economics, growth arises from the discovery of new recipes, and the transformation of things from low-value to high-value configurations. In shorthand, it is turning ordinary sand into semiconductors. Romer explains it this way:

> Economic growth occurs whenever people take resources and rearrange them in ways that are more valuable. A useful metaphor for production in an economy comes from the kitchen. To create valuable final products, we mix inexpensive ingredients together according to a recipe. The cooking one can do is limited by the supply of ingredients, and most cooking in the economy produces undesirable side effects. If economic growth could be achieved only by doing more and more of the same kind of cooking, we would eventually run out of raw materials and suffer from unacceptable levels of pollution and nuisance. Human history teaches us, however, that economic growth springs from better recipes, not just from more cooking. New recipes generally produce fewer unpleasant side effects and generate more economic value per unit of raw material.[256]

Some see undesirable effects from growth, like the disruption of traditional culture, congestion, and damage to the environment.[257] While these very real social costs should not be downplayed, "conventional thinking about economic growth fails to reflect the breadth of what growth, or its absence, means for a society."[258] Most think only of a

255. ATKINSON, *supra* note 44, at 141. GDP measures both hours worked and productivity; Atkinson explains that only the latter should be considered relevant for purposes of expanding economic growth. *Id.* at 239-40.

256. Paul Romer, *Economic Growth*, *in* THE CONCISE ENCYCLOPEDIA OF ECONOMICS 128 (2007).

257. For a brief recitation, see VERMEIJ, *supra* note 102, at 295-302.

258. BENJAMIN M. FRIEDMAN, THE MORAL CONSEQUENCES OF ECONOMIC

higher material standard of living,[259] but there are also significant social, political, and moral benefits not priced by the market. Moreover, "changes in per capita GDP radically understate the impact of economic growth on the average person."[260] More often than not, economic growth "fosters greater opportunities, tolerance of diversity, social mobility, commitment to fairness, and dedication to democracy."[261] However, economic progress needs to be broadly based if it is to foster real social and political progress; conversely, stagnation in living standards can lead to rising intolerance and incivility.[262] Growth's byproduct of increased leisure also has had "the most liberating and enriching impact on the citizens of the West."[263] Further, the "enhancement of human freedom is both the main object and the primary means of [economic] development."[264] Romer sums it up that "better growth policy could have implications for the quality of life in all dimensions that are so large that they are hard to comprehend."[265]

So economic growth is a key component to a country's well being. As Romer observes, "[b]y far the most important characteristic of capitalist economies, which distinguishes them from all other previously and currently existing societies, is their slow but steady underlying rate of real economic growth."[266] Still, economists long have sought to understand the mystery of how economic growth happens, and why some nations seem to make sudden jumps whereas others grow slowly.[267] To be sure, the economy is a complex network of interactions; individual agents, acting according to diverse incentives, create growth as an emergent phenomenon.[268] In the late 1980s, however, a new generation

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GROWTH 4 (2005).

259. "It is estimated that the purchasing power of the average American a century ago was one-tenth what it is today." BAUMOL ET AL., *supra* note 254, at 1-2; *see also* LIPSEY ET AL., *supra* note 125, at 5.

260. LIPSEY ET AL., *supra* note 125, at 6.

261. Friedman, *supra* note 258, at 4. Moreover, "[w]hile economic growth makes a society more open, tolerant, and democratic, such societies are in turn better able to encourage enterprise and creativity, and hence to achieve ever greater economic prosperity." *Id*. at 15.

262. *Id.* at 9.

263. PAUL ORMEROD, THE DEATH OF ECONOMICS 23 (1994).

264. AMARTYA SEN, DEVELOPMENT AS FREEDOM 53 (1999). "Individual capabilities crucially depend on, among other things, economic, social, and political arrangements . . . . [H]uman beings are not merely the means of production, but also the end of the exercise." *Id.* at 53, 296.

265. Paul Romer, *Should the Government Subsidize Supply or Demand in the Market For Scientists and Engineers* 47 (Nat'l Bureau of Econ. Research, BER Working Paper No. 7723, 2000).

266. ORMEROD, *supra* note 6, at 48.

267. Atkinson observes, for example, that neoclassical economics does not have the tools or orientation needed to understand why the United States entered a 20 years period of slowing growth beginning in 1973. ATKINSON, *supra* note 44, at 143-47.

268. Lipsey explains that economic growth can be understood in terms of five partially

of economists began to appreciate the concept of growth in the context of technological progress.

New Growth Theory reminds us that growth flows from within the system itself, and is directly and profoundly affected by conscious decisions made by economic actors. As Crawford puts it in the context of networked economies, "[t]he economic growth-based . . . [story] is straightforward: the greatest possible diversity of new ideas that will support our country in the future will come from the online world, because of its special affordances of interactivity, interconnectivity, and unpredictable evolution."[269] If we wish to secure the Internet as an engine for growth going forward, however, we first must understand how to preserve this generative quality in the midst of complex network effects.

1. The Road to Romer

Adam Smith's foundational 1776 work, *The Wealth of Nations*, theorized that as a firm developed specialized roles for workers, their skills would benefit the productivity of the firm and thus the market overall. The cost of goods they produced would be disciplined by the "invisible hand" of competitive pricing, and the market would converge on an optimally efficient equilibrium.[270] In the mid-20th century, Joseph Schumpeter modified this competitive hypothesis, pointing out that firms often form temporary monopolies and subsequently are unseated by other firms in an act he called "creative destruction." The critical advantage of these winning new entrants is their improved technology. Through this process, innovation occurs in a stair-step fashion rather than a continuous line.[271]

Much of economic growth theory has focused on how best to encourage development of these technologies. Nobel Prize winning economist Robert Solow recently observed that Schumpeter:

> worked out his conception of the entrepreneur, the maker of "new combinations," as the driving force and characteristic figure of the

independent, partially interacting subsystems: economic, technological, scientific, political, and cultural. LIPSEY ET AL., *supra* note 125, at 374-77. The coordination of these dynamic evolving systems—semi-autonomous and semi-interdependent—occurs as an emergent property, resulting from the actions of countless individuals and groups. *Id.*

269. Crawford, *supra* note 223, at 6-7.

270. ADAM SMITH, THE WEALTH OF NATIONS 447 (N. Kelly, vol. 1, 1801) (1776), *available at* Google Books. Robert Reich calls Smith's invisible hand "the most famous, or infamous, bodily metaphor in all of social sciences." TAYLOR, *supra* note 6, at 85. Mark Taylor claims that the image originated not with Smith, but John Calvin, who used it to describe God's providence in the world. Smith then appropriated Calvin's doctrine of providence to explain the machinations of the market. *Id.* at 4, 85. Interestingly, the "invisible hand" also can be reinterpreted for modern ears as unguided, emergent behavior of the market system.

271. *See generally* SCHUMPETER, *supra* note 35.

> fits-and-starts evolution of the capitalist economy. He was explicit that, while technological innovation was in the long run the most important function of the entrepreneur, organizational innovation in governance, finance, and management was comparable in significance.. . . I think that this is Schumpeter's main legacy to economics: the role of technological and organizational innovation in driving and shaping the growth trajectory of capitalist economies.[272]

This distinction between technological and organizational innovation is a mirror of the Physical Technologies and Social Technologies that Richard Nelson has identified at the heart of complex economic growth. Even though Solow refers only to the first type of innovation explicitly as a "technology," he is saying the same thing—new ways of working with things and new ways of organizing people are the most important contributions to economic growth.

Solow's own work on growth theory in the 1950's was highly influential, but ultimately failed to fully explain the stair-step pattern of technological progress that Shumpeter described. In Solow's growth model, technology fed into the system at a steady rate. When it came to explaining what generated this innovation, however, the Solow model was at a loss, because it treated this technological advance as something that happened *exogenously,* coming from outside the economy itself. To be sure, technology had assumed a place of importance, but the core question of how to encourage technology and the resulting growth remained unanswered.

2. Enter New Growth Theory

In fact, Schumpeter's core claims about how technological change happens would lay somewhat dormant until the 1980s. By the end of the decade, younger generations of economists were hard at work on the "increasing returns" problem. In short, they asked "why do some economies appear to grow very rapidly, despite the assumption that all the traditional inputs are increasing at a steady rate?"

Exogenous factors are background conditions and givens that lay outside an economic model. In traditional economic theory, the factors of production are land, labor, and capital. Knowledge and human nature were simply "givens," a fixed part of the background.[273] In 1990, then-unheralded economist Paul Romer released a paper where he concluded that the new factors of production should be classified as people, ideas, and things. More importantly, he found that technological change and

272. Robert M. Solow, *Heavy Thinker*, NEW REPUBLIC, May 21, 2007, at 2, 3, *available at* http://www.powells.com/review/2007_07_12.

273. COYLE, *supra* note 177, at 39.

the growth of knowledge should be viewed as endogenous to the system. Romer cited a clear distinction between rival goods (corporeal goods of absolute possession and limited sharing) of objects (atoms), versus nonrival goods (non-corporeal goods that can be copied or shared and used by many people at the same time) of ideas (bits).[274]

So there are objects, and there are ideas. And to Romer, ideas are what truly matter in generating economic growth. He accepted Kenneth Arrow's observation that information (and therefore technological progress) is not only a product of the economy but also an input back into it, creating a positive feedback effect.[275] At the same time, he noted Schumpeter's point that firms can be spurred to innovate to gain or retain their market power.[276] But he also altered these basic ideas in critical ways. Arrow's feedback loop of technological knowledge became not simply learning-by-doing within firms, but rather a global multiplier of productivity when this *non-rival* information resource was shared. Ideas, Romer explained, cannot be over-used. Schumpeter's "creative destruction" could happen, according to Romer, in situations where monopoly was neither complete nor highly difficult to overcome.[277]

A world of objects does not lead to sustained growth, let alone exponential growth. Instead, growth happens when information is fed back into the economy for ongoing re-use, never diminishing the usefulness of the information itself. Mechanisms generating new ideas are as important as access to abundant resources for economic growth.[278] *Optimal* growth happens when the non-rivalry of information is balanced by the appropriate degree and type of excludability, giving innovators incentive to undertake research and development in the first place. In short, "technological change . . . lies at the heart of economic growth."[279]

Romer's work ignited a wave of research on *endogenous* growth—the explanation of how growth is fed by economic factors.[280] It was called "new growth theory" to distinguish it from the "neoclassical" approach derived from Solow. In new growth theory, technological progress became a critical fourth component of economic growth models—both on the input and the output sides of the equation. Professor Charles Jones asserts that Romer's papers "lay out with startling clarity the link

274. Romer, *supra* note 229, at S71-D102.
275. *See id.* at S77-S76.
276. *See id.* at S76-S78.
277. *See id.*
278. VERMEIJ, *supra* note 102, at 310.
279. Romer, *supra* note 229, at S72.
280. *See generally* ELHANAN HELPMAN, THE MYSTERY OF ECONOMIC GROWTH (2004); *see also* Philippe Aghion & Peter Howitt, *Market Structure and the Growth Process*, *in* 1 REV. OF ECON. DYNAMICS 276 (1998).

between economic growth and ideas."[281]

The economics of ideas is different from the economics of objects. For example, because ideas are non-rival, my use of an idea does not inherently reduce the "amount" of the idea available for you to use.[282] There also is an increasing return to ideas, and to ideas and objects together. This notion of the increasing return of ideas is one of the central elements of Romer's theory. Professor Jones points out one ground-breaking consequence: the accumulation of ideas is able to sustain growth in a way that the accumulation of capital cannot.[283] The strongest growth, and the most "virtuous" complex network, feeds ideas back into the system.

The mystery of why some nations grow at faster rates than others can now be explained, at least in part, in terms of how effectively a particular nation's economy optimizes the creation of these new innovative recipes for growth.[284] As Romer says, "it is ideas, not objects, that poor countries lack."[285] Pointing to a different component of the "rough equation" for emergence, Benkler has observed that "what most poor and middle-income countries lack is not human creativity, but access to the basic tools of innovation."[286]

3. Implications For Technological Change

So "long-term growth is driven mainly by technological change," and in turn "new technologies radically alter more or less everything in the socio-economic order."[287] Still, Romer's work, while monumental, leaves important details to be worked out. How does trade between nations affect this dynamic? What is the appropriate balance between the incentives of exclusion and the increasing returns of openness? Are there modes of production in which the innovators share freely from the start? What types of technologies afford the greatest growth potential when they are not restricted by exclusion?

One potential answer to the final question has been articulated in

281. C.I. Jones, *Growth and Ideas*, *in* HANDBOOK OF ECONOMIC GROWTH 1070 (2005). By contrast, as Business Week's chief economist puts it, many economists "grudgingly acknowledge the importance of technological change, but they do not understand it or trust it." MICHAEL MANDEL, RATIONAL EXUBERANCE xii (2004).

282. Jones, *supra* note 281, at 1066.

283. *Id.* at 1075.

284. Economist Douglass North argues convincingly that the development of legal institutions and norms that support market performance also are necessary to undergird a nation's successful economic growth. NORTH, *supra* note 222, at 155-56.

285. Romer, *supra* note 256, at 129.

286. BENKLER, *supra* note 67, at 468. *See also* EASTERLY, *supra* note 52, at 176 ("[D]ifferences in productivity growth explain over 90 percent of the differences across countries in per capita growth between 1960 and 1992.").

287. LIPSEY ET AL., *supra* note 125, at xv.

the ongoing research on "General Purpose Technologies" ("GPTs"). A GPT is a special type of technology that has broad-ranging enabling effects across many sectors of the economy. Some define a GPT as a generic technology that eventually comes to be widely used, to have many uses, and to have many spillover effects.[288] The foundational work on GPTs was first published by Timothy Bresnahan and Manuel Trajtenberg in 1992.[289] They describe how this particular type of technology is most likely to generate increasing returns in line with Arrow and Romer, with growth coming from specific applications that depend on ideas in the "general" layer of technology. Specifically, GPTs play a role of "enabling technologies" by opening up new opportunities rather than offering complete, final solutions.[290] The result is "innovational complementarities," meaning that "the productivity of R&D in a downstream sectors increases as a consequence of innovation in the GPT technology. These complementarities magnify the effects of innovation in the GPT, and help propagate them throughout the economy."[291]

Whereas Romer focused generally on the overall economy, the GPT literature makes clear that some technologies are especially important when it comes to non-rival reuse and follow-on innovation. Over the past decade, economists have expounded upon how electricity, motors, personal computers, and software platforms all exhibit this characteristic.[292] Citing Trajtenberg's work, Joel Mokyr makes a persuasive case that the semiconductor is the greatest "macroinvention" since the emergence of electricity.[293] The Internet in particular is a GPT, with "the potential to contribute disproportionately to economic growth" because it generates value "as inputs into a wide variety of productive activities engaged in by users."[294] One lesson for policymakers is that

288. *Id.* at 98.

289. Timothy Bresnahan & Manuel Trajtenberg, *General Purpose Technologies 'Engines of Growth'?* (1992), *reprinted in* 65 J. OF ECON. 1, 83 (1995).

290. *Id.* at 84.

291. *Id.*

292. *See, e.g.,* EVANS ET AL., *supra* note 252 (software platforms are a type of GPT). Lipsey and his colleagues put GPTs into six major categories: materials technologies (domesticated animals), power (the dynamo), information and communication technologies (the Internet), tools (the wheel), transportation (railway), and organization (the factory system). LIPSEY ET AL., *supra* note 125, at 133.

293. MOKYR, *supra* note 236, at 112 (explaining that the semiconductor's unusual properties as an innovation merit its status as a GPT, including its ability to recombine with other techniques, its complementarities with downstream innovations, and its consequent pervasiveness in many applications).

294. Brett M. Frischmann & Barbara van Schewick, *Network Neutrality and the Economics of an Information Superhighway: A Reply to Professor Yoo*, 47 JURIMETRICS 383, 424 (2007). Lipsey observes that the current ICT revolution is not unique; there have been other GPT-driven "new economies" in the past. Further, while "GPTs have not been common in human

when considering the appropriate balance between various market incentives, one must also consider the extent to which a particular type of technology is a GPT. Looking back at the development of the IT industry more than ten years after his key GPT paper, Bresnahan commented:

> But let us be clear that the lesson here for Schumpeterian Economics is far more general than the narrow and specific point about "open architecture," which seems like a technical concept from computing. Instead, the point is about the role of a permissive, forward-looking system of innovation in which inventions can come from multiple sources. . . . The most economically important use of a general purpose technology need not be determined by the inventors of the GPT, but rather by the inventors of complements, applications.[295]

The additional lesson drawn from Schumpeterian economics is that not all market dynamics are strictly Schumpeterian—at least in the way that term often is employed in contemporary policy rhetoric. To be sure, dynamism, waves of destruction, and temporary incumbency all are part of healthy markets. Nonetheless, the "Schumpeterian" perspective too often becomes twisted into bald assertions that policymakers have no useful role whatsoever because market power inevitably is transitory, and leads invariably to innovation. This is an unhelpful dumbing-down of Schumpeter's insights, one which also overlooks additional significant progress in economic thinking since his time.

Keeping GPTs "general" is not always in the clear interest of a firm that might seek to control them. That firm might envision greater profits or efficiency through making a tremendously useful resource more scarce, by charging much higher than marginal cost, or by customizing solely for a particular application.[296] While these perceptions might be true in the short term, or for that one firm's profits, they can have devastating effects for growth of the economy overall. The more general purpose the technology, the greater are the growth-dampening effects of allowing it to become locked-down in the interest of a particular economic agent.

Relatedly, Jonathan Zittrain of the Oxford Internet Institute has

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experience," the rate of innovation in GPTs has accelerated greatly over the last 10,000 years. LIPSEY ET AL., *supra* note 125, at 131-32.

295. Timothy Bresnahan, *Creative Destruction in the PC Industry*, *in* PERSPECTIVES ON INNOVATION 105, 114, 118 (Franco Malerba & Stefano Brusoni eds., 2007).

296. This is not to say that firms cannot create specialized implementations of GPTs. On the contrary, much of the value of GPTs comes from specific instantiations. Nobody would think of toting a desktop computer on a plane in order to work en route, but most laptop computers are not fundamentally different with respect to their general-purpose nature than desktops. If, however, a firm obtained and exercised control over the fundamental PC, operating system, or network platforms, welfare-enhancing specializations would be foreclosed.

discussed how "the generative Internet" has great "capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences."[297] The important feature of generative platforms, such as the Internet, is that users easily can do numerous things with them, many of which may not have been envisioned by the designers. If, for example, the Internet had been built solely as a platform for sending email, and required retooling to do anything else, most applications and business models never would have developed.[298]

Finally, technological change is a historical process in which there is a clear arrow of time. Because "agents' behavior and choice sets are path-dependent, technological change is replete with the possibility of multiple equilibria, lock-ins, and possible 'butterfly effects.'"[299] When it comes to new generative platforms like the Internet, history matters.

C. The External is in: "Net effects"

Of course, the Internet is not just about reducing costs and increasing the supply of goods and services. To many people, the Net is about the less-tangible values. The market is not everything.

Old School Economics defines the "market" in a fairly narrow way, as the result of trading capital and goods and services, and recognizes no values that are not expressed in actual market choice behavior. However, the market can be seen as far more than the sum of economic transactions. Viewed from a broader perspective, the market is more akin to The Great Agora of ancient Greece, the marketplace that held many important human interactions, whether for pecuniary gain or other intrinsic benefits.[300] Under this view, people are more than a bundle of economic wants and needs. Not just consumer or users, we have meaning beyond our economic activity. We value things that we will never purchase.[301] To the extent Old School Economics fails to account for these values and activities, it paints an incomplete picture of human behavior.

The value of new ideas and innovation goes far beyond the sum of explicit capital exchange. As outlined below, new ideas result in innovation spillovers, social production, and even the rise of a new "social layer" of the Net. Benjamin Friedman makes a similar point when he reminds us that economic growth creates a host of social, political, and

297. JONATHAN L. ZITTRAIN, THE FUTURE OF THE INTERNET AND HOW TO STOP IT 70 (2008).
298. *See id.*
299. LIPSEY ET AL., *supra* note 125, at 14.
300. BENKLER, *supra* note 251, at 565.
301. STANOVICH, *supra* note 60, at 261.

political goods that private markets do not trade or price.[302] These additional benefits are not just along for the ride; in addition to being important in their own right, they form a synergistic relationship with economic gain and growth. Recognizing these very real "externalities" goes against the pervasive bias in Old School Economics that only that which can be modeled or quantified as directly benefiting pecuniary interests is meaningful.

1. Innovation Spillovers

When new technologies are developed, they can benefit the private innovator, the public, or both. If the innovator has the ability to exclude others from using the technology, he can charge for its use and thus capture its value. However, it is uncommon for innovations to be completely excludable, and even rarer that the technology controller can find a way to "internalize" all of the value. Invariably, some of the value "spills over." Thus, spillovers are a type of externality from those transactions. The private benefits or costs do not completely capture the social benefits or costs, so one market participant's actions affect others without compensation being paid or received. Pollution is a classic example of a negative externality; scientific research is one form of positive externality.

Professors Frischmann and Lemley, among others, wish to bring back into economic thinking the overall benefits of preserving spillovers, here defined as "uncompensated benefits that one person's activity provides to another."[303] Spillovers generally fall into two categories: unanticipated consumer surplus, and third party benefits.[304] Regardless of the classification scheme employed, it is a simple fact that "no innovator has captured all or even most of the social benefits of his or her invention."[305] Frischmann and Lemley's primary thesis is that the social value of innovations often far exceeds the private value, and these spillovers in turn actually encourage greater innovation.[306]

Economists sometimes try to distinguish between "real" spillovers that truly benefit parties outside the market, and "pecuniary" spillovers that are ultimately resolved and accounted for within a market and between private parties.[307] However, real spillovers often end up feeding

302. Friedman, *supra* note 258, at 400.

303. Brett M. Frischmann & Mark Lemley, *Spillovers*, 100 COLUM. L. REV. 101, 102 (2006).

304. *Id.* at 105. Others have used the language of knowledge "leaks" which create a gap between social returns and individual (or firm) returns. EASTERLY, *supra* note 52, at 152-53.

305. Frischmann & Lemley, *supra* note 303, at 103.

306. Moreover, if all spillovers were completely captured by the original innovator, the economic conditions of everyone else would not improve. In essence, spillovers lift all boats. *Id.*

307. Those spillovers resulting in a wedge between private and social returns—and thus

back into the economy in the form of overall social welfare, while pecuniary spillovers have unforeseen long-term effects through nonrival reuse and follow-on innovation. Economic literature on various types of spillovers reflects this ambiguous nature of externalities versus internalities. For example, some economists speak of "network externalities" while others insist on "network effects."[308] The dynamic and social value of ideas makes them difficult to account for purely in terms of internalized private transactions.

Traditional economic thinking dictates that the economy functions best when firms maximally internalize "real" spillovers, using property rights and price signaling to allocate resources efficiently. The economics of innovation paint a somewhat different picture, particularly when it comes to general purpose technologies. GPTs help "rejuvenate the growth process by creating spillovers that go far beyond the concept of measurable externalities" and far beyond those agents that initiated the change.[309] This has important implications when trying to tally the sum total of beneficial value and activity generated by the Internet.

2. Peer Production

Yochai Benkler's *The Wealth of Networks* lays out the case for social production. The wealth of networks is in their potential for widespread participation in making, sharing, and experiencing information.[310] Benkler discusses the current and potential benefits from social production, the "networked information economy," and the possibility of reversing the control focus of the industrial information economy.[311] He argues that social production serves important values, including autonomy, democratic participation in the political sphere, construction of culture, justice and human development, and community.[312] He also points out that "advanced economies rely on non-market organizations for information production much more than they do in other sectors."[313]

Benkler's major work addresses some nine different "ideal-type

affecting net welfare—are deemed to be "real" or "technological;" examples include the social benefits of education, and the social costs of pollution. Those spillovers involving only a transfer of surplus wealth between producers and consumers are deemed "pecuniary;" the classic example is a consumer purchasing a product for less than he or she was willing to pay. *Id.* at 106-07.

308. *E.g.* Stan Liebowitz & Stephen Margolis, *Network Externalities (Effects)*, *in* THE NEW PALGRAVE'S DICTIONARY OF ECONOMICS AND LAW (1998).

309. LIPSEY ET AL., *supra* note 125, at 98,100.

310. *See also* COOPER, *supra* note 86, at 127 (new forms of collaborative production "bind people together in productive, social, and economic relations to produce and self-supply an increasing array of micro-products to met their needs.").

311. BENKLER, *supra* note 67, at 29-32.

312. *Id.* at chs.5-10.

313. *Id.* at 47.

information production strategies."[314] Here we will only distinguish between two broader modes of human behavior intrinsic to his work. At root, Benkler is interested in *peer production*, a form of activity outside the traditional producer/consumer relationship. Information agents in highly connected networks with low transaction costs find new ways of working together and generating productivity. The Internet, of course, provides plentiful examples of this type of production

In some of these modes of production, traditional economic incentives play a part, and agents seek traditional economic gains.[315] The resulting innovation is important because users get precisely what they want, which in turn increases social welfare.[316] Social welfare is very probably increased by the presence of innovations freely revealed by users.[317] This does not count innovations made available in commerce. "Social welfare is likely to be higher in a world in which both users and manufacturers innovate than in a world in which only manufacturers innovate."[318] Social welfare equals the total income of a society. Similarly, the principles of "Wikinomics" (being open, peering, sharing, and acting globally) lead to what its proponents call mass collaboration. The claim is that, "with peer production we will harness human skill, ingenuity, and intelligence more efficiently and effectively than anything we have witnessed previously."[319] The "Long Tail" of economic abundance (where the mass of niche markets creates a long-tail graphical distribution) helps power this peer production.[320]

Another group of these modes of production constitutes *social production*, in which agents operate under non-traditional incentives. Here, Benkler points out that people produce things for different reasons, including a variety of social-psychological rewards.[321] So incentives clearly matter to people, but not all are purely economic. Philip Weiser estimates that 70 percent of all Web pages "are built by individuals from their desire to share ideas, rather than to make money."[322] Research suggests that computer programmers working for money are likely to be less creative than those programming as a hobby in their own time. There can be an inverse relationship between creativity

314. *Id.* at 43.
315. *Id.* at 462-63.
316. VON HIPPEL, *supra* note 67, at 2-3.
317. *Id.* at 11-12.
318. *Id.* at 107.
319. TAPSCOTT & WILLIAMS, *supra* note 214, at 18.
320. CHRIS ANDERSON, THE LONG TAIL 73, 219 (2006).
321. BENKLER, *supra* note 67, at 96.
322. Philip Weiser, *Law and Information Platforms*, 1 J. ON TELECOMM. & HIGH TECH L. 1, 33 n.147 (2002) (*quoting* Kevin Kelly, *The Web Runs on Love, Not Greed*, WALL ST. J., Jan. 4, 2002, at A8).

and external reward.[323] Volunteer contributors of code to widely used software products are often strongly motivated to innovate by the joy and learning they find in their work.[324]

Benkler argues that "the basic technologies of information processing, storage, and communication have made nonproprietary models more attractive and effective than was ever before possible." Among other things, this allows new "patterns of social reciprocity, redistribution, and sharing . . . ."[325] In a sufficiently open and ubiquitous network, the benefits of the traditional firm can apply to all individuals.

3. The "Social Layer"

Crawford takes perhaps the most expansive view of the non-pecuniary benefits of the Internet as an ideas and innovation platform that enables human interactivity. In "The Project of Communications Law," she claims that a focus only on future applications-layer innovation from the Internet (as promulgated by Web companies), or the Net as a "content-delivery supply chain" (as seen by the broadband companies and the FCC), provides an "impoverished (or at least incomplete) perspective on communications."[326] Interestingly, she includes Yochai Benkler and his social production vision in the "application-layer" centric camp.

Crawford views human online communities as a form of complex adaptive system, which generate not only economic growth, but also new forms of persistent social interaction and dynamic human relationships, which evolve in complex and unpredictable ways. She urges "a changed perspective on the internet that takes as central the evolution of human connections and relationships online."[327] As part of that mission, she touts "cognitive diversity," which ensures that "people with diverse experiences training, perspectives, predictive models, interpretations, and tools are online."[328] She sees the Net as allowing "innovation in social relationships at a system level," which goes beyond seeing the "content" layer of the Internet as the "social layer."[329] The existence of such a social layer promotes diversity, the democratization of information (in creation, distribution, and access), and the decentralization of democracy. Crawford sums it up nicely:

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323. DOUTHWAITE, *supra* note 241, at 125.
324. VON HIPPEL, *supra* note 67, at 8.
325. BENKLER, *supra* note 67, at 462.
326. Crawford, *supra* note 223, at 3.
327. *Id.* at 23.
328. *Id.* at 27, n.109. Scott Page has substantiated a similar point about the benefits of diversity: individuals with vastly different backgrounds and life experiences can yield superior outcomes versus like-minded experts. *See* PAGE, *supra* note 241.
329. Crawford, *supra* note 223, at 388 n.134.

> Treating the internet like just another proprietary, competing network that is no different from the telephone network will cause as-yet-unborn technologies, applications, collaborations, human creativity, devices, growth, economic development, and innumerable other intangible and tangible valuable and interesting things never to come into existence.[330]

D. A new vision of wealth

The American quest to understand prosperity was founded in Adam Smith's discussion of the wealth of nations. In his analysis, wealth comes from specialized production moderated by perfect competition. The "invisible hand" operating in the marketplace generates optimal outcomes.

From the perspective of Emergence Economics, the picture is more complex, but also more true to our contemporary reality. Physical constraints no longer need limit most forms of production, and shareable ideas motivate core growth. These ideas come from an evolutionary process and are fed back into the economic system. "Wealth is knowledge, and its origin is evolution."[331] Prescribing the exact nature of competition takes a back seat to understanding whether competitors are motivated to innovate. The interconnected nature of our real and ethereal networks multiplies the potency of these technologies, and offers new ways to work and cooperate.

The market's successful role in generating wealth does not necessarily imply that this wealth is distributed in an optimally equitable manner. Policymakers certainly can and should address concerns about wealth distribution, but should strive to do so outside the context of the market's evolutionary processes. Any programs ideally would remain consistent with the premises of Emergence Economics by harnessing, rather than impeding, market forces. Further, as we discuss later, the Internet's ability to democratize the "Long Tail" sources and distribution of innovations suggests that widespread access to the Net through more, bigger, and open broadband on-ramps may help alleviate some of these equity concerns.

Promoting wealth involves safeguarding the generative potential of these technologies, whether they are at risk from government hubris, undue market power, or other forces. Along the way, many ideas will fail, but unforeseen breakthroughs will eclipse the losses of these failed experiments. Spillovers are central. Social production is a potent model

330. Crawford, *supra* note 196, at 37; *see also* Susan P. Crawford, *The Ambulance, the Squad Car, and the Internet*, 21 BERKELEY TECH. L.J. 873, 931 (2006).

331. BEINHOCKER, *supra* note 22, at 450.

for innovation. The "social layer" enriches our existence in incalculable ways. Most of all, the Internet experience reminds us that wealth emerges—as if from an "invisible hand"—when diverse agents can connect and evolve.

IV. POLITICAL ECONOMY: EMERGING IMPLICATIONS FOR U.S. COMMUNICATIONS POLICY

Politics is the art of looking for trouble, finding it everywhere, diagnosing it incorrectly, and applying the wrong remedies.
Groucho Marx[332]

So after several dozen pages of intermediate economics and a smattering of Internet history and technology, where are we? Hopefully at this point the patient reader has come to a new appreciation for the complexities of agents and networks evolving together in adaptive markets, the Internet as an optimal platform for massive emergence, and the importance of innovations, economic growth, and other emergent market and non-market phenomena.

This paper will not have accomplished its primary objective, however, with a mere overview of the teachings of what we have come to call here Emergence Economics. We have something more constructive in mind. To repeat what now should be obvious, the marketplace of goods, services, technologies, and ideas does not exist in a pristine state, carved out of equations and metaphors on a university lecture hall blackboard. The market is the living, breathing incarnation of all of us. And a considerable part of that "us" is "The State."

This final section will address briefly how Emergence Economics can help us gain a new outlook on the appropriate roles of government and market in our daily affairs. We will see that these two human constructs are not polar opposites, but rather two distinct and different ways of approaching matters of considerable importance to each of us. Indeed, some argue that public policy is its own complex adaptive system, co-evolving with the economic sector.[333] By enlisting the assistance of our new learning, we will recommend some useful mechanisms for markets and states not just to coexist uneasily, but to reinforce each other's strengths, hopefully in a manner that maximizes tangible and intangible benefits for all concerned. Our aim here is not to

332. AND I QUOTE 265 (Ashton Applewhite et al., eds., rev. ed. 2003).

333. *See* Barbara A. Cherry, *The Telecommunications Economy and Regulation as Coevolving Complex Adaptive Systems: Implications for Federalism*, 59 FED. COMM. L.J. 369 (2007); *see also* Barbara Cherry & Johannes Bauer, *Adaptive Regulation: Contours of a Policy Model for the Internet Economy* (Quello Center for Telecomm. Mgmt. & Law Working Paper, 2004), http://www.quello.msu.edu/images/uploads/wp-04-05.pdf.

argue for one exclusive approach to communications policy, or grapple with specific thorny policy issues, but rather to suggest ways to shift the terms and ground of the debate so that they more faithfully reflect economic realities.[334]

Others have sought to bring to bear on the law the most recent insights of complexity science, network science, and neuroscience.[335] Here we will use the overarching topic of communications law and policy to suggest a course of possible action for lawmakers and regulators to encourage—cautiously and deliberately—the discovery and proliferation of More Better Ideas. We will suggest that this goal can be accomplished largely through market-driven policies that favor more, bigger, and open broadband network facilities leading to a generative Internet platform.

A. The Overall Role of Government

1. The Co-Evolution of Markets and Governments

Some have called economics and politics the 8th and 9th layers of the Internet.[336] While largely accurate, one misleading element of that metaphor is that the two are not separate and distinct spheres of influence. Politics and economics form the background context for each other, and for the Net itself. Each is a particular and extraordinary manifestation of evolutionarily-constrained human intelligence. Like economies, political systems—laws, edicts, regulations, principles, bully pulpits, norms, and the various agents who employ them—are a social construction, a form of human-made culture.[337] "Law itself is a self-organized emergent property of thousands of informal mores and

334. A more comprehensive approach to "adaptive policymaking," including devising a policy design space, will be presented in a forthcoming paper by one of the authors. *See* Richard S. Whitt, *Adaptive Policymaking: Evolving and Applying Emergent Solutions for U.S. Communications Policy,* 61 FED. COMM. L.J. No. 3 (forthcoming 2009). Here we are deliberately confining ourselves to economics—writ large via the newer schools of economic thought—as a foundational basis for public policy. We do not mean to suggest that other, more normative factors should not, and will not, also play a supporting role in the policymaking process.

335. *See, e.g.*, Michael Katz & Howard Shelanski, *Mergers and Innovation*, 74 ANTITRUST L.J. 1 (2006); Lemley & McGowan, *supra* note 174, at 479; Strandburg et al., *supra* note 82, at 1296 (Strandburg urges legal scholars to "jump on the network bandwagon in greater numbers because of the important conceptual advances and analytical tools that network science provides."). Some have even given book-length treatment to the combination of law and science. *See, e.g.*, STEVEN WINTER, A CLEARING IN THE FOREST (2001) (proposing to unite cognitive science and the law).

336. *See* Rohit Khare, *Building the Perfect Beast, Dreams of a Grand Unified Protocol*, 3 IEEE INTERNET COMPUTING 89 (1999), *available at* http://www.ics.uci.edu/~rohit/IEEE-L7-applcore.html.

337. *See* HENRY PLOTKIN, THE IMAGINED WORLD MADE REAL (2003).

restrictions that were codified over time . . . ."[338] To Crawford, "[a]ttention should be paid to the evolutionary ecosystem of the law as the background medium in which innovation occurs, business models evolve, and social factions grow and prosper."[339]

Old School Economics tends to view government as a corrupting exogenous force, an unwelcome outside influence that usually does far more harm than good. Milton Friedman famously remarked that "the government solution to a problem is usually as bad as the problem."[340] Or as Philip Ball puts it, "free-market fundamentalists argue that total noninterventionism is the best way to let the economy reach equilibrium."[341]

Emergence Economics comes at the question from a slightly different direction. Obviously, we now know that the idea of an equilibrium market, one of perfect efficiency and optimal outcomes, lacks serious foundation. More critically, in Ball's words, "it is time to recognize such claims for what they are: expressions of faith, unhindered by facts and based largely on predetermined views about the role of governments, taxation, and legislation."[342] As the history of the Internet amply demonstrates, government can and does play a constant, active, supporting role in the market, shaping the parameters of what companies and individuals can do, even if from the sidelines.[343]

From one perspective, government can be seen as a separate, yet interconnected agent, operating within the market itself. Putting aside the appealing but misguided notion of the pure "free market," the economy simply could not survive without basic laws to prop it up. Statutes and regulations concerning contracts, property, torts, securities, criminal activity, worker and consumer protection, intellectual property—these and more provide the grounding for modern day economic activity. Beinhocker has observed that "the economic evolutionary system is constructed out of a vast array of Social Technologies, many of which rely on government."[344] The state, with its

338. SHERMER, *supra* note 2, at 6.

339. Crawford, *supra* note 161, at 605.

340. MILTON FRIEDMAN, THERE'S NO SUCH THING AS A FREE LUNCH 6 (1975).

341. BALL, *supra* note 12, at 222.

342. *Id.* at 224. Evidence abounds that recent failings by U.S. financial markets stem from poor or non-existent institutions, based in part on market agents relying on half-truths from Old School Economics. *See, e.g.*, CHARLES R. MORRIS, THE TRILLION DOLLAR MELTDOWN 167 (2008) (to a great extent the financial meltdown can be attributed to the U.S. Government coddling the financial industry). One can trace many of these issues as far back as the late 19th Century, when the rise of the stock market helped engender a "speculation-based" economy, with its attendant social benefits and costs. *See* LAWRENCE E. MITCHELL, THE SPECULATION ECONOMY (2007).

343. BEINHOCKER, *supra* note 22, at 172, 472.

344. *Id.* at 425.

uniquely coercive authority, is critically important in setting the rules of the game.[345] Of course, that role has far greater legitimacy in democratic societies. [346]

This legal superstructure also serves the vital purpose of instilling trust and cooperation in strangers, so that they are willing to engage in market transactions. Without such trust, economies cannot hold. In the case of U.S. financial entities in 2008 and 2009, the result has been a frozen credit market, with banks unwilling to lend money. Modern capitalism cannot hope to flourish where legal institutions do not function properly. The law of the jungle decidedly is not the law of the free market.

So the workings of the economy rely on the government. But in turn, economics should inform the law. And of course, the question comes down to how much government is enough. A key distinction between a capitalist and socialist economy is whether the ultimate arbiter of economic fitness is a market or a hierarchy.[347] The easy assumption is that only the state can be a hierarchy, and thus improperly attempt to impose ill-fitting top-down solutions on the market. Beinhocker reminds us, however, that firms too are hierarchies, with similar cognitive constraints that can lead to flawed judgments. Regulation can be public, or private, and the impact on other agents in the market can be much the same: restraints on freedom of choice and action.

Moreover, the economy is a social process, one that does not exist apart from the rest of our lives as social beings. As such, citing behavioral psychology, Beinhocker argues that the true market perspective on human behavior is neither Left (humans are inherently altruistic) nor Right (humans are inherently self-regarding). In truth, we are actually a mix of both, or what behavioral economists call "strong reciprocity."[348] This means we are predisposed to cooperate in social situations, but also to punish group members who behave selfishly.[349] Further, the Right is

345. ORMEROD, *supra* note 19, at 96. No less a conservative authority than Milton Friedman observes, "[t]he existence of a free market does not of course eliminate the need for government. On the contrary, government is essential both as a forum for determining the 'rule of the game' and as an umpire to interpret and enforce the rules decided on." MILTON FREEDMAN, CAPITALISM AND FREEDOM 15 (Chicago University Press 1980) (1960).

346. In addition to serving as "market rule-setter and referee," the state also can provide goods and services that markets otherwise would undersupply." MCMILLAN, *supra* note 241, at 149.

347. BEINHOCKER, *supra* note 22 , at 422.

348. *Id.* at 419.

349. As one set of researchers puts it: "The behavioral sciences have traditionally offered two contrasting explanations of cooperation. One, favored by sociologists and anthropologists, considers the willingness to subordinate self-interest to the needs of the social group to be part of human nature. Another, favored by economists and biologists, treats cooperation as the result of the interaction of selfish agents maximizing their long-term individual material interests . . . . [We show that] a significant fraction of people fit neither of these stereotypes.

correct that the economy is too complex for central planning to work effectively. Hayek in particular pointed out that policymakers have knowledge coordination problems, possess no perfect rationality, and utilize no good market feedback mechanism.[350] On the other hand, the Left also is correct that markets, while useful and necessary, are not optimally efficient. The question is not states versus markets, Beinhocker explains, but "how to combine states *and* markets to create an effective evolutionary system."[351]

Surprisingly (at least to some), Hayek endorses an active role for government—for some purposes:

> It is important not to confuse opposition against . . . [central] planning with a dogmatic laissez faire attitude. The liberal argument is in favor of making the best possible use of the forces of competition as a means of coordinating human efforts, not an argument for leaving things just as they are . . . . To create conditions in which competition will be as effective as possible, to supplement it where it cannot be made effective, to provide the services which, in the words of Adam Smith, "though they may be in the highest degree advantageous to a great society, are, however, of such a nature, that the profit could never repay the expense to any individual or small number of individuals"—these tasks provide, indeed, a wide and unquestioned field for state activity. In no system that could be rationally defended would the state just do nothing.[352]

Put differently, the question is not whether government necessarily is part of the market, but what that role should be. Instead, we should take "a pragmatic approach to the market, against the quasi-religious views that it is always right or fundamentally evil . . . . Markets are not magic, nor are they immoral."[353] If we no longer assume (as Old School Economics does) that markets invariably converge on optimal efficiency, there is reason to believe that government intervention may in some instances be beneficial. Policymakers can have a role in facilitating positive outcomes from this ecosystem, but this role should be carved out carefully, guided in part by the various schools subsumed within Emergence Economics.

Rather, they are conditional cooperators and altruistic punishers . . . which we call strong reciprocators." HERBERT GINTIS ET AL., MORAL SENTIMENTS AND MATERIAL INTERESTS xi (Herbert Gintis et al. eds., 2005). It is thought that gene-culture coevolution resulted in strong reciprocity in human beings. *Id.* at 27-28.

350. *See* HAYEK, *supra* note 101.

351. BEINHOCKER, *supra* note 22, at 427 (emphasis in original).

352. F. A. HAYEK, THE ROAD TO SERFDOM 85, 88 (Bruce J. Caldwell ed., Univ. of Chicago Press 2007) (1944).

353. MCMILLAN, *supra* note 241, at 226.

2. The Policymaker As Adaptive Economic Agent

Easterly correctly observes that "[g]overnment is not a single, all-knowing actor. Government instead is a coalition of politicians representing different factions."[354] The policymaker, whether an individual or an agency, a member of Congress or the Federal Communications Commission (FCC), acts as a representative of government. They are authoritative agents in the economic system, as well as their own complex adaptive systems.[355] As such, the policymaker needs to overcome the typical analytical flaws of economic agents, and try to see the market with fresh eyes.

In fact, as just another agent operating within the economic system, the policymaker possesses all of the cognitive constraints—and adaptive flexibility—of any other agent. True, policymakers in modern democracies are answerable to political hierarchies (if elected, their constituents; if selected, both the elected and their constituents). Further, policymakers have a unique power: the unilateral coercive authority that comes from the state. Whether a policymaker acts or refrains from acting has repercussions in the world. So the policymaker invariably has an impact on the surrounding ecosystem of the market.

The human desire to predict and control runs deep. And planning inherently is a significant and unavoidable part of a policymaker's job. Yet short-term prediction and control of the economy is inherently impossible, due largely to our data gathering and processing shortcomings as agents, and the inherent complexity and unpredictable movements of markets.[356] The pitfalls of central planning of markets are fundamentally problems of information.[357] Much economic policy in the West has been and remains conducted on the basic of short-term forecasts of the economy. "Politicians have sought to change the world. But the point is to interpret it correctly."[358]

The vigor of markets comes from their decentralized nature; they empower people to find creative solutions to problems. Government laws and policies inevitably help shape part of the fitness environment within which companies compete and other agents make their choices.[359] The crucial question, then, is how those government actions affect that fitness

354. EASTERLY, *supra* note 52, at 258.

355. Geoffrey Hodgson has written extensively about the evolution of political institutions as the stuff of social life. *See, e.g.*, GEOFFREY HODGSON, THE EUROPEAN ASS'N FOR EVOLUTIONARY POLITICAL ECON., EVOLUTION OF ECONOMIC INSTITUTIONS (2007).

356. ORMEROD, *supra* note 19, at 75-90; *see also* TALEB, *supra* note 67, at 180 (corporations and governments overestimate their ability to understand the subtle changes that constitute the world).

357. MCMILLAN, *supra* note 241, at 149.

358. ORMEROD, *supra* note 19, at 182.

359. *See* BEINHOCKER, *supra* note 22 , at 425.

environment. Given policymakers' all-too-apparent constraints, the complexity of the market itself, and the effective workings of the market in providing growth and other emergent benefits, considerable caution is warranted.

Ideally, then, U.S. policymakers will not attempt to intervene in the day-to-day processes of the American marketplace. This means, in brief, that government generally should leave to market mechanisms the workings of the evolutionary algorithm: agents differentiating, selecting, and amplifying specific Physical Technologies, Social Technologies, and Business Plans. But this does not mean that policymakers need remain on the sidelines. Where policymakers have identified important public policy goals and objectives, the key is to employ market forces, as much as feasible, to achieve those desired ends. In other words, policymakers should "tinker" with the fitness landscape in ways that can bolster, and not hinder, evolutionary processes. In general, then, government should do less, not more—but less still can become more, if done better.[360]

B. A Communications Policy Approach For Innovation And Growth

Our new economic and technology foundations necessarily implicate significant changes to our public policy thinking. We need a new approach to our nation's communications policy, one rooted in Emergence Economics and its useful lessons.

We next will sketch out one approach to communications policy that should support greater levels of innovation and growth. This treatment necessarily will be brief at this point, and only provides some suggestions on ways to use Emergence Economics as a guiding instrument. It is our contention that policymakers should have as their ultimate aim to foster an ecosystem in the communications sector that imparts greater economic and non-economic benefits for all agents—producers and consumers, policymakers and citizens. Market forces—defined broadly as the sum total of human productive activities serving a range of pecuniary, social, and personal purposes—remain the most effective mechanism for those benefits to fully emerge.

1. Why Communications Policy?

Why focus on communications policy? Because first and foremost, human communications matter. Our species can only survive and flourish when our power of communication is fostered. Modern technologies have enabled us to build powerful shared platforms where all variants of person-to-person interaction are possible. As Mokyr has demonstrated,

360. ORMEROD, *supra* note 19, at 96, 184.

widespread access to such platforms greatly aids in the dispersion of useful knowledge.[361] Here are several different yet related ways that the concept has been described:

> Information and communications are core elements of autonomy and of public political discourse and decision making. Communication is the basic unit of social existence. Culture and knowledge, broadly conceived, form the basic frame of reference through which we come to understand ourselves and others in the world . . . . The basic components of human development also depend on how we produce information and innovation, and how we disseminate its implementations.[362]

> The complexity of human interactions has been fostered throughout the ages by communications technology, which facilitates the exchange of information on all levels, from individuals to governments. The more information is exchanged, the more feedback processes occur and thus, in general, the more complexity. Computer networks are now transforming the nature and speed of such communication, and the sheer volume of accessible information.[363]

> The parameters of the current Information Age become clear when we understand the information revolution not only as a major sociocultural change but also as something like an orbital movement in which information revolves in such a way that it begins to act on itself. The information revolution occurs when information turns on itself and becomes self-reflexive. This turn has been made possible by new electronic and telematic technologies, through which information acts on information to form feedback loops that generate increasing complexity. This is why the information revolution issues in the moment of complexity.[364]

As we have seen, the Internet so far has been an optimal platform for generating new ideas and innovation, economic growth, and other Net effects. Government policies inevitably affecting the Net specifically, and the communications sector more generally, have a profound impact, for good or ill, on the national economy. In short, communications policy should be seen potentially as a major lever, whether upward or downward, for economic development and growth.

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361. MOKYR, *supra* note 236, at 290-91.

362. BENKLER, *supra* note 67, at 464.

363. PETER COVENEY & ROGER HIGHFIELD, FRONTIERS OF COMPLEXITY 338 (1995).

364. TAYLOR, *supra* note 115, at 106.

a. The Compelling Need To Rethink Our Priorities and Approaches

In conjunction with the critical role of communications in economic and non-economic human endeavors, there is a real need to correct decades of flawed thinking that underpins what passes for communications policy in this country. The forces of Old School Economics have found fertile ground in the communications field.

For the most part, incumbent actors and industries have embraced Old School Economics as a basis to argue for less economic regulation. They claim that the "free market" should have primacy, and "perfect competition" produces the optimal results in the public interest.[365] They also argue that a relatively modest version of the nation's antitrust laws offer the only way to deal with competition/market power concerns.[366] Yet policy opponents of the incumbents tend to argue from the other side of the same coin: that government regulation inevitably is the best response to deal with economic or social concerns. For some of these players, market failure is endemic, and governments are best equipped to rectify the market's many perceived failings.[367] In short, both camps see the market as a coldly efficient machine, one side with approval, the other with approbation. As Julie Nelson puts it, the mechanical metaphor of the market can lead to "naïve and irresponsible neoliberal probusiness policies" versus "naïve and impractical antimarket alternatives."[368] Unfortunately neither those on the self-proclaimed "Right" or "Left" appear to realize that in many cases they are operating

365. For example, the Cato Institute cites its support for traditional America "principles of limited government, free markets, individual liberty, and peace." Cato's Mission, www.cato.org/about.php. As we have seen these concepts are not entirely self-evident, or at least well defined. Of course it is not the ultimate aims, but how they are to be achieved, that deserves the closest scrutiny.

366. As just one example, a recent white paper argues that there are almost no forms of "bundling" and tie-in sales that raise anticompetitive concerns in technology markets, because they invariably create efficiency and do not foreclose competition. Stan Liebowitz & and Stephen Margolis, *Bundles of Joy: The Ubiquity and Efficiency of Bundles in New Technology Markets*, PERSPECTIVES FROM FSF SCHOLARS, Jan. 24, 2008, http://www.freestatefoundation.org/images/Bundles_of_Joy.pdf, at 2. While we acknowledge that bundling often can be pro-consumer and pro-competition, we think it goes too far to claim that to be the case in nearly all instances, or that "a product achieves a degree of market power… wherever an innovation succeeds." *Id.* at 46. As we explain above, successful innovations do tend to create market power, but certainly do not constitute the only source.

367. For example, Free Press states that the "broken" media system "isn't natural," and that media should be compelled to "serve the public interest" by being "vibrant, diverse and independent." Free Press and the Free Press Action Fund, http://www.freepress.net/node/121. Again, whether one agrees or not with those goals, it is not obvious that reliance on regulatory fiat alone is the optimal means for fulfilling them.

368. JULIE A. NELSON, ECONOMICS FOR HUMANS 53, 57 (2006). Nelson suggests as an alternative metaphor the economy as a beating human heart, connoting a living, vital organ. *Id.* at 59.

from false premises. Without a deeper and richer appreciation for economic realities, though, it is impossible to discern whether and how any of these viewpoints should be given credence.

The Federal Communications Commission apparently can do little in this environment but follow the prevailing economic notions. In one order after another, the agency tends to parrot the stated views of the dominant players, on both sides of an issue, and couches its policies in the vernacular of Old School Economics. One recent prominent example is the FCC's 2005 decision deregulating broadband services provided by the incumbent local exchange carriers (ILECs).[369] Here the FCC defined the ILECs' combined Internet access/broadband transmission services as a unitary information service, and thus outside traditional common carriage regulation such as the *Computer Inquiry* nondiscriminatory access safeguards. That *Wireline Broadband Order* exemplifies many of the flaws of relying on traditional economic thinking, at least in this case as articulated by the incumbent LECs and their allies.

The sole question the Commission saw fit to ask and answer in that order is whether the costs of the *Computer Inquiry* regulations outweigh their benefits to the broadband providers. The analysis focuses tightly on a traditional analysis of costs and benefits, and only of the broadband providers themselves—not the Internet, or its users.[370] Tellingly, nowhere in the 86-page order does the Commission discuss broadband as a platform to the Internet, or any potential impact on the generative Internet itself. Indeed, aside from briefly discussing and dismissing concerns raised by independent Internet service providers, the order rarely utilizes the word "Internet."

The FCC also adopts easy assumptions about the state of the broadband market, without recourse to record evidence, save citations to filings by broadband providers themselves.[371] For example, the FCC claims that the then-current broadband market is competitive, and growing far more competitive with expected imminent entry by providers of fixed and mobile wireless services, satellite services, and broadband over powerline (BPL) services.[372] To those who point to persistent market concentration between the cable companies and telephone

369. Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities, *Report & Order & Notice of Proposed Rulemaking*, 20 FCC Rcd. 14,853 (2005) [*hereinafter Wireline Broadband Order*].

370. *Id.* ¶¶ 43, 65-69.

371. Notably the order is littered with phrases including words like "expect" and "anticipate" and "predict." The agency at one point even admits that much of its analysis is based on "what our predictive judgment tells us about how [the broadband] market is likely to develop." *Id.* ¶ 43. Unfortunately, the conclusions are rendered with far more certainty, and finality, than this couched language otherwise would warrant.

372. *Id.* ¶¶ 33, 50.

companies, the FCC claims that such arguments are premised only on "snapshot data" that are "both limited and static," as compared to "larger trends" in "the dynamic nature of the marketplace forces."[373] Of course, while those phrases are couched in the language of Emergence Economics, such duopoly "snapshots" endure to this day.[374]

Amazingly, the FCC casually dismisses one of its more singular achievements of the late 20th Century. "The *Computer Inquiry* rules themselves reflect a fairly static picture of network development, and an assumption that a line could be drawn between the network functions and computer processing without impeding technological innovation."[375] The counter-assertion that such line drawing resulted, not in an arguable reduction of broadband network innovation, but an explosion of online innovation, leading to the Internet itself, seems never to have been seriously contemplated, although it was plainly presented.[376]

The Commission further "expect[s] that facilities-based wireline carriers will have business reasons to continue making broadband Internet access transmission services available to ISPs without regard to the *Computer Inquiry* requirements."[377] The implicit assumption is that the broadband "market" and its incentives system would function properly, allowing for mutually-satisfactory agreements between broadband providers and independent ISPs. This expectation is reached

373. *Id.* ¶ 50.

374. Robert D. Atkinson, *Framing a National Broadband Policy*, 16 COMMLAW CONSPECTUS 145, 175-76 (2007) [*hereinafter* Atkinson, *Framing*]. *See generally* Robert D. Atkinson, *The Role of Competition in a National Broadband Policy*, 7 J. ON TELECOMM. & HIGH TECH. L. 1 (2009) [*hereinafter* Atkinson, *Competition*]. The Commission also cites the incumbent LECs themselves for the self-serving proposition that "the additional costs of an access mandate diminish a carrier's incentive and ability to invest in and deploy broadband infrastructure investment." *Wireline Broadband Order*, *supra* note 369, ¶ 44. Absent the ISP access rules, the FCC posits, broadband providers could "produce new or improved services in response to consumer demand." *Id.* ¶ 71. Even if these arguments have merit—and current evidence is spotty at best—strong counter-claims about stifling independent ISP-based innovations were not afforded similar weight.

375. *Id.* ¶ 70.

376. As one example, the BroadNet Alliance, a coalition of national, regional, and local independent ISPs, submitted pleadings in the FCC's docket explaining how the FCC's ISP-related policies have played a pivotal role in enabling the Internet. Reply Comments of the BroadNet Alliance in Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities, CC Dkt. No. 02-33 (July 1, 2002). In particular, the coalition filed a detailed white paper showing that the *Computer Inquiry* rules "in large part enabled the rise and amazing success of the online world," by creating conditions that allowed consumers to reach the online providers of their choice. *Id.* at 2. As a later ex parte explained, "should this critical access to those facilities no longer be made available to ISPs under the Computer Rules, the only remaining choice for broadband Internet access will be the incumbent's ISP. . . ." Ex Parte Filing of the BroadNet Alliance in Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities, CC Dkt. No. 02-33 (July 24, 2002). That prediction proved prescient.

377. *Wireline Broadband Order supra* note 369, ¶ 64.

despite the fact that "we cannot state unequivocally that incumbent LECs would not otherwise provide wholesale access, absent this compulsion."[378] Nonetheless, despite this lack of confidence, and little record evidence of current or expected market competition to generate the necessary economic incentives, the FCC concludes that "the public interest is best served if we permit competitive marketplace conditions to guide the evolution of broadband Internet access service."[379] The Commissioners felt obliged to add, "this does not mean that we sacrifice competitive ISP choice for greater deployment of broadband facilities."[380] But that is precisely the high-stakes calculus the agency utilized here. The sad reality is that the independent ISP industry all but disappeared in the wake of the FCC's decision, to the point where policymakers and industry players today refer to the integrated broadband/Internet access providers as "ISPs"—effectively acknowledging the reality that there are no others.[381] Causality is always difficult to assign, but the FCC's decision must have played at least some pernicious role.

So the FCC—an independent regulatory body charged with holding industry expertise and operating in the public interest—renders decisions that appear to display little appreciation for the ways that actual markets function, and sometimes fail to function. In the case of the *Wireline Broadband Order*, the agency in particular: (1) relied on arguments and evidence largely from interested party agents; (2) kept a tight focus on the costs and benefits to a single set of agents, the incumbent broadband providers; (3) conversely failed to factor in the potential impact on the Internet as a generative platform; (4) recognized the broadband carriers' supposed market incentives to invest in broadband networks, without appreciating their more obvious incentives not to strike commercially-viable deals with competing ISPs; (5) rejected without a more searching analysis its own *Computer Inquiry* precedent drawing lines between Internet access and broadband networks;[382] (6) acted through revamped statutory definitions, rather than more flexible deregulatory tools such as forbearance;[383] and (7) generally showed a

378. *Id.* ¶ 63.

379. *Id.* ¶ 85.

380. *Id.* ¶ 79.

381. As one commentator sums it, "connectivity has been vertically integrated." MARTIN FRANSMAN, THE NEW ICT ECOSYSTEM 31 (2007).

382. For example, if in fact certain computer processing is so tightly wedded to underlying communications network functionality, as the Commission claims, why would facilities-based Internet access not be defined as a telecommunications service? The agency still could deal separately with the regulatory implications through more tailored statutory tools, such as the forbearance provision of the Communications Act. *See* 47 U.S.C. § 10 (2000).

383. Among other advantages, the forbearance approach would have offered the agency a more empirically-based, provisional, and reversible statutory tool. Instead, one of the many ironies of the FCC's ostensibly deregulatory decision is that, by defining its way out of

decided lack of skepticism about its own predictive judgment. Moreover, the Commission added to its failings by not allowing for any post-decision accountability, which would allow the agency to revisit the decision's factual support after a certain period of time. Such a revisit could include, for example, asking whether broadband deployment and competition were developing as anticipated, and whether independent ISPs were able to strike adequate wholesale deals to provide competing ISP services to consumers.

As we transition from existing communications-related industries to a new world ruled by IP-based networks and applications, we should look towards a different approach. The FCC, for one, needs a framework and some conceptual tools that do a better job of respecting the economic world as actually lived.

b. Caution Ahead

Generally speaking, we have more to lose than to gain from direct government involvement in Internet-based markets, especially if such intervention is based on misunderstanding or even ignorance of market dynamics. As Ormerod observes, imperfect markets plus imperfect regulators equal a strong dose of caution.[384]

In particular, government clearly can impede innovation. Technological creativity has proven to be politically vulnerable; "the history of technological progress is the history of an endangered and much-resisted species."[385] Mokyr finds that in centralized bureaucracies, whether governmental or corporate, "there is a built-in tendency for conservatism" and resisting innovation.[386] But there is more to it than that:

> The political economy of technological change thus predicts that it will be resisted by well-organized lobbies, whereas its defenders will usually be a motley group of consumers and inventors and perhaps a few groups with a direct interest in economic growth. The struggle between the two parties will always take the form of a non-market process, because relying on market forces alone would, by definition, lead to the triumph of the new technology.[387]

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common carriage treatment of broadband networks under Title II, the agency instead has opened wide the door to equally damaging—and far less bounded—regulation of Internet-based services, applications, and content under Title I. This disturbing trend currently is playing itself out in the VoIP arena.

384. ORMEROD, *supra* note 6, at 138-39.

385. MOKYR, *supra* note 236, at 223-34.

386. *Id.* at 238.

387. *Id.* at 253-54.

Putting aside this "purposeful self-interested resistance to new technology,"[388] by the same token we do not intend to imply that the Internet inevitably is the only source of innovation or growth, or that public policy should be skewed relentlessly in that direction. Instead, we are offering a needed corrective to the static thinking of the recent past, largely informed by outdated if not fatally flawed economic theory. Similarly, government policymakers need not approach the Internet as some precious museum piece, which should be forever fixed in the same configuration. The Net in many ways is a living thing, a constantly changing process reflecting countless human choices. It would be as much a mistake for a government official to tamper with the evolutionary algorithm so as to attempt to preserve the Net as it is, as it would have been to prevent its original creation and launch in the name of preserving the original commercial online companies.

At the same time, because the Net has brought such amazing benefits, and promises so much more, there is real value in trying to retain certain core elements against counter forces. Werbach has nicely summed up the challenge: to engage in a balancing act between the centripetal and centrifugal forces that shape the Net. In our view, this balancing act must begin with a presumption (but only that) that interconnected, end-to-end, layered networks like the Internet provide real economic and "spillovers" value. Beyond that, policymakers must be vigilant, open to new ideas, and flexible in devising and implementing policy measures.[389]

An important distinction to keep in mind is the means versus the ends. As we shall see, the ultimate end goal of more good ideas, and the follow-on objectives of many more open and big broadband pipes, may follow reasonably, but the means of achieving those objectives are not so obvious. In particular, the means are influenced by a healthy skepticism that legislators and regulators will get the formula right. That skepticism should be tempered by an understanding of agent limitations—users and firms alike—and an often-opaque marketplace.

2. Defining Our Mission: Goals and Objectives

In sketching out a game plan for revamping U.S. communications policy, first we will need to distinguish between different elements of an

388. *Id.* at 220.

389. The Internet community has developed many successful mechanisms for evolving itself through iterative self-governance. One remarkable example is the Internet Engineering Task Force (IETF), a voluntary group that collaboratively has defined the ever-evolving core protocols for decades. The open, shared standards that come out of this group reflect the diverse constituencies involved, but to date have preserved agents' ability in the network to connect in a transparent fashion.

overarching policy design space. One way to understand this framework is to break it down into its component parts, which include goals, objectives, projects, and tools.[390] The goals are the largest, longest term elements to be accomplished (for example, landing on Mars). The objectives are the intermediate term aims (building and testing a rocket ship to send to Mars). The projects are the specific, short-term aims (devising elements of the engine that will power the rocket), while the tools are the practical mechanisms utilized for achieving all of the above (computer programs that model different components of the rocket ship). The organizational and institutional elements of the design space (the policy players and the policy rules, respectively) are important as well. Consistent with our discussion in previous sections, the chief aim is to be bold about the vision of goals and objectives, while more modest yet flexible about the particular programs and tools used to accomplish them.

a. One Goal: More Good Ideas

At this point, we trust that the turn in the discussion will appear almost self-evident. As we have seen, ideas are the fodder, the raw material, for economic growth and other beneficial Net effects. New technologies—products, processes, and forms of organization—are the most important determinant of long-term economic growth.[391] The free flow of information between and among people can lead directly to a raft of BPs, PTs, and STs competing vigorously and effectively in the marketplace, along with every form of information, entertainment, political discourse, and commercial and non-commercial speech. One overarching goal for policymakers, especially in the communications field, should be to see the market generate a greater number of useful ideas so as to drive the evolutionary process to optimal heights. Romer calls for a "combinatorial explosion" of ideas.[392] By furthering an increased quantity of beneficial new ideas, more potential innovation is enabled.

Crawford for one appears to agree with this goal of More Good Ideas. She recently argued that a key organizing principle for communications law should be to support the emergence of diverse new ideas online.[393] Crawford interprets this as "allowing the end-to-end,

390. In a subsequent paper, one of the authors will further explore and expand upon this "policy design space" framework in the context of federal communications policies. Whitt, *supra* note 334.

391. LIPSEY ET AL., *supra* note 125, at 11.

392. Kevin Kelly, Paul Romer: The Economics of Ideas, http://www.versaggi.net/ecommerce/articles/romer-econideas.htm.

393. Crawford, *supra* note 223, at 35.

content-neutral, layer-independent functions of the internet to flourish and allowing groups and human attention to pick and choose from among the bad ideas presented online, enabling good ideas to persist and replicate."[394]

Of course, what is "good" or "bad" should not be for any to decide unilaterally for anyone else. The market's role, through each and all of us, is to churn through the various options—BPs, PTs, STs, and all other instantiations of useful knowledge—and select what is most fit. The "Long Tail" of the Internet suggests that fitness landscapes can be enabled for a much wider array of options than otherwise has been available previously to market agents. Even a "failed" idea for most agents in the market increasingly can manage to succeed with at least some of us in the deeper niches.

b. One Objective: Harnessing Broadband As An Optimal Internet Platform

With the ultimate end goal in mind—More Good Ideas—we next need a more near-term set of policy objectives that will help us achieve that goal. While obviously there are a number of salient possibilities in the communications sector, we select by way of example the objective of harnessing broadband networks to serve as an optimal platform for the public Internet. Here we will touch on three interrelated components of such a policy objective: Open Platforms, More Platforms, and Bigger Platforms. In each case, the focus is on broadband providing enhanced access to the generative Internet (as opposed to other uses, such as private networks broadcasting proprietary content). Our discussion here necessarily will be brief, and is intended for illustrative purposes.[395]

i. Open Broadband Platforms

First, we should want to promote "open" platforms leading to the Internet, capable of adaptive power by the myriad of end users interacting, innovating, and competing with each other. As we have seen, the Net is not just an e-commerce platform, but also a means of distributing and validating ideas, and other aspects of human communications. The Long Tail, among other things, also helps extend economic growth beyond the "winner take all" mentality, to numerous niches served by smaller players (who also have a chance to become big

394. *Id.* at 35-36.

395. Author Whitt has produced a companion paper that focuses exclusively on U.S. broadband policy; this section necessarily provides only a modified and truncated portion of that work. Richard S. Whitt, *Evolving Broadband Policy: Taking Adaptive Stances to Foster Optimal Internet Platforms*, 17 COMMLAW CONSPECTUS (forthcoming 2009).

players). An enormous gradation of ideas, whether fit to all, or some, or a few, can exist on the Net.

So how do we define openness? There are a variety of ways to analyze the question. As just one example, Jonathan Sallet has written about the various ways of thinking about open networks.[396] He observes that openness can vary based on different perspectives on the network—content and applications accessed by end users, for example, versus the network and ISP connectivity utilized by competing network providers.[397] As Sallet notes, the Bell System traditionally was completely open at the content layers, because any end user could communicate with any other end user, but almost completely closed at the network layers, because there was no right to attach terminal equipment or interconnect competing networks.[398] Kevin Werbach reminds us to think about openness at, and between, the physical interfaces, where the network meets content (such as technical standards for modems), and logical interfaces, where the content moves through the network (such as unique identifiers and routing databases).[399] For now it is useful to note that "openness" can occur at different interfaces within the broadband network, between and among elements of the physical layer, the logical layer, and the applications and content layers.

The Internet itself provides important clues about the degrees of openness for the on-ramps that serve our larger goal of more good ideas.[400] The combination of layering, network connectivity, IP as an agnostic

396. Jonathan Sallet, *supra* note 204, at 3.

397. *Id.* at 6-7.

398. Notably the FCC's "Internet Policy Statement" principles focus only on one end of the broadband connection—the consumer—and all but ignore the other end—the providers of applications, content, and devices. The Statement indicates that "consumers are entitled to access the lawful Internet content of their choice, . . . run applications and use services of their choice, . . . [and] connect their choice of legal devices that do not harm the network . . . ." Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities, *Policy Statement*, 20 FCC Rcd. 14,986 (2005), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-151A1.pdf. This approach overlooks the fact that, if broadband providers take certain actions that end up reducing the supply of such applications and content, the consumer will suffer, even if his or her own "right to access" remains untouched. Given the critical importance of innovation and competition from the edge of the Internet, we should want both ends of the broadband pipe to be open.

399. Kevin Werbach, *Breaking the Ice: Rethinking Telecommunications Law for the Digital Age*, 4 J. ON TELECOMM. & HIGH TECH. L. 59, 80-95 (2005).

400. In a sense, it is true that the Internet today is not an absolutely "neutral" place, in that the various servers, routers, and content delivery networks that comprise it in part can and do distinguish between various forms of traffic. The whole point of the Internet is that it is a robust freewheeling marketplace of ideas and commerce and interaction. We have less concern about the "neutral" state of the Net's architecture than local broadband networks because, among other differences, commercial arrangements between Net players (a) do not otherwise deliberately block or degrade other parties' access to the Net, and (b) are struck today in a comparatively competitive environment, with no single decision-maker able to impose its will on others.

"bearer" protocol, and of course the e2e principle, have allowed end users to utilize the Net as a ubiquitous platform for their activities. The mantra of "innovation without permission" also helps clarify what we mean here. At bottom, we should want users to operate freely, and not be required to secure before-the-fact approval from network operators for their lawful activities. Given the enormous positive values springing from the Internet, then, the government should see as one of its objectives adopting broadband policies that do not interfere with—if not enhance—the salient features of the Net. In particular, agnostic protocols, interconnectivity, and e2e functionality are positive network characteristics that should be preserved and promoted for the Internet's on-ramps.[401]

What we are touting here is an overall environment of openness on broadband platforms, and not necessarily a prescription. How one achieves an open network can be very different from compelling it as a legal or regulatory mandate. A related point comes from the debates over "network neutrality," which inaptly is referred to by too many proponents and opponents alike as a regulation-first approach to preserving openness, rather than (in the authors' view) as the desired outcome.[402] To argue for open platforms to the Net as an objective is not to suggest any particular approach to making it happen. Further, it is not all good out there on the Net. As a faithful reflection of humanity, the Net has its share of unseemly conduct and criminality. To be open to the best does not imply to be open to all.[403] Still, going forward we should remain "open" to other ways of thinking about openness.

ii. More and Bigger Broadband Platforms

Another major national policy objective to support More Good Ideas should be more and bigger broadband networks. The broadband-enabled Internet is rapidly changing the world in countless beneficial

401. Elsewhere author Whitt has discussed optimal Internet access as including the twin "openness" dimensions of sufficient capacity for, and overall integrity of, Internet access on broadband networks. Whitt, *supra* note 395.

402. The current debate over network neutrality is focused only on last-mile broadband connectivity, where the relative lack of competition renders the threat of unilateral gatekeeping more significant and tangible. Thus, it is a misnomer to refer to "net" neutrality, as if the Internet itself is supposed to be completely neutral to all traffic. Of course, it serves the rhetorical objectives of some to criticize various broadband openness proposals as amounting to "regulation of the Internet." We are really talking about the end points serving the consumer, meaning something more like "broadband neutrality" or "broadband openness"—phrases which at this point we doubt will catch on in the current political "marketplace of ideas."

403. Jonathan Zittrain has discussed how open systems like the Internet can be prone to abuse, and argues convincingly for a strategy that "blunts the worst aspects of today's popular generative Internet and PC without killing those platforms' openness to innovation." Zittrain, *supra* note 297, at 150.

ways. From a purely economic perspective, broadband connectivity is becoming a catalyst for innovation, productivity growth, job creation, and global competitiveness. In addition to enabling far richer uses of the Internet, broadband is an innovation platform of its own, and a source of network-based innovations. Broadband also serves as a platform to educational opportunity and civic discourse.

At the same time, there are major challenges both in terms of the reach and the depth of today's broadband offerings. Put simply, we need bigger broadband pipes, and more of them. In the United States, we have relied on a policy that leaves broadband infrastructure largely in the hands of private entities. In conjunction with such private investment, however, many still see a salient role for public policy. Robert Atkinson for one offers an approach to fashioning "a national broadband policy," which he separates into (1) broadband everywhere (providing separate incentives for rural deployment), (2) broadband for everyone (developing digital literacy and broadband applications), (3) greater speeds, and (4) more competition.[404]

Broadband's externalities present a unique challenge to any objective of fostering More and Bigger Platforms. We have every reason to want to give broadband providers the proper economic incentives to further invest in their networks, and to incent new entrants where the economics make sense. By the same token, as we have seen, communications infrastructure typically generates large social benefits not captured by the infrastructure provider. For broadband networks, "because effects" (money made because of something) are greater than "with effects" (money made from selling that something).[405] Atkinson sees four kinds of positive externalities (what we have called innovation spillovers) attributable to broadband networks: (1) network externalities (network effects), both direct and indirect; (2) prosumer investments (consumers become both users and producers); (3) competitiveness externalities (international leadership in technology); and (4) regional externalities (particularly impacts on rural communities).[406] He points out that broadband is unique in that "the social returns of broadband investment exceed the private returns to companies and consumers . . . . [T]here is considerable reason to believe that there are significant externalities from high-speed broadband, and that if left to themselves, market forces alone will lead to less investment in broadband than is societally optimal."[407]

Broadband providers seek to capture (internalize) those externalities by serving as an Internet platform—meaning they want to gain at least

404. Atkinson, *Framing*, *supra* note 374, at 164.
405. Frischmann & Lemley, *supra* note 303, at 102-05.
406. Atkinson, *Framing*, *supra* note 374, at 153-64.
407. *Id.* at 145, 154.

some of the "because effects" revenues and profits. For many this incentives system is the root cause of the "network neutrality" policy debates, which we will not address in any depth here.[408] However, the larger point is that these positive externalities do not appear to register in the incentives structure of the broadband providers. Thus, "[t]he profit/loss statements of individual firms fail to take into account the positive externalities from a widely deployed broadband network, including economic growth, lower-cost health care, and higher quality education."[409] Where these positive externalities exist, so that private investment generates total social value in excess of individual firm value, it may be appropriate for the government to get involved.

As we will argue in the next section, government involvement in contestable markets generally should be limited to a form of "tinkering" with the fitness landscape, through a mix of additional inputs, connectivity, incentives, and feedback. With regard to the need for additional competition in the broadband market, for example, it is not clear that the government has a major prescriptive role, save to remove any regulatory hurdles and get out of the way.[410] While it is one thing to take away impediments that prevent new broadband platforms from emerging in the fitness environment, it is quite another to seek to compel private parties to uptake a specific technology where the economics normally would not support such a result. Atkinson warns that the role of government should not be proactively to compel or subsidize the deployment of additional broadband networks, largely because it is not clear that otherwise it makes sense economically for a "third pipe" competitor to enter the consumer broadband market.[411] Given the complexities and uncertainties of the market, policymakers would be wise to heed that warning.

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408. We will only note that Joseph Farrell and Philip Weiser describe how broadband providers might tend to internalize "complementary" externalities ("ICE"), and argue that such private internalization mitigates competitive and consumer harm. Joseph Farrell & Philip J. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust & Regulation in the Internet Age*, 17 HARVARD J. L. & TECH. 85 (2003). At the same time, they identify a variety of exceptions to this tendency. *Id.* Even where these exceptions do not apply, however, the nature of innovation spillovers would argue that overall social welfare in this domain rarely is served by private firm internalization alone. Frischmann & Lemley, *supra* note 303, at 135-39. Furthermore, as Barbara van Schewick has explained, broadband providers retain certain economic incentives to disadvantage non-affiliated application innovators despite the ICE principles. Barbara van Schewick,. *Towards an Economic Framework for Network Neutrality Regulation*, 5 J. ON TELECOMM. & HIGH TECH. L. 329 (2007).

409. JOHN WINDHAUSEN, A BLUEPRINT FOR BIG BROADBAND 5 (2008), http://net.educause.edu/ir/library/pdf/EPO0801.pdf.

410. Atkinson, *Competition*, *supra* note 374, at 15. In Atkinson's words, "[e]nable, but don't promote." *Id.*

411. *Id.*

C. *Applying the Adaptive Policy Framework: Enabling without dictating*

So what specific lessons can Emergence Economics impart to policymakers, particularly those involved with the information and communications technology sector? One suggestion is to adopt a conceptual framework that separates out those market activities that should not be susceptible to the employment of policy tools, from those that should. We believe in brief that policymakers generally should endeavor—at most—to foster the market's processes, rather than interfere with or even attempt to replace those processes. As we will explain in the sections to follow, this "adaptive policymaking" dichotomy would still allow certain "tinkering" with the fitness environment—providing useful inputs, connectivity, incentives, and feedback. However, the basic workings of the evolutionary algorithm—agents differentiating, selecting, and amplifying various technologies and business plans—should be left to the effectiveness, merits, and complexity of the open market.

Admittedly the line drawing here between harmful dictating and beneficial enabling is not yet a rigorously grounded exercise. But we submit that adopting and utilizing a conceptual framework such as this is preferable to current policy rationalizations based on Old School Economics. We also recognize that this proposed framework remains contingent to circumstances. In an arguably contestable market, where adequate supply and choices for end users allows the evolutionary processes to function, and institutions foster accountability and social trust among market agents, the "tinkering without tampering" formula should prove most effective. Where, however, one market sector may require only minimal tinkering to maximize innovation, economic growth, and emergent public benefits, another sector might benefit from more extensive intervention designed to prop up insufficient market forces, or repair or replace damaged institutions. On balance, we believe that the provisional nature of the enterprise speaks well to our overall emphasis on flexible, tailored, context-specific, and reversible steps by policymakers.

1. Not Dictating the Evolutionary Process

Trusting the evolutionary process of the market amounts to trusting ordinary people to make the right decisions about their lives. Such a stance is democratic with a small "d." Moreover, while the results may not be optimal or efficient for all, the market comes closest to the meritocracy we should want. The self-organizing market process promotes effectiveness over efficiency, and coordinates economic

decisions better than any known options—not optimally, just better.[412] To paraphrase Winston Churchill, "markets are the worst form of economic system—except for all the others."[413]

Effective policymakers need to possess at least two qualities: the ability to make reasonably accurate forecasts, and the ability to understand the effects of changes in policy on the system in question.[414] As we have seen, there are deep underlying reasons for the inability to plan and control outcomes successfully. Ball notes that "[t]here are few easier targets than governmental, regulatory, and planning decisions that have had the opposite of their intended effects. In many such cases these unwanted outcomes can be put down to a failure to appreciate the interconnected and interactive nature of the system concerned."[415] Government officials' predictive ability, and the likelihood of unintended consequences in a CAS like the market, should loom large as potential drawbacks to market interventions.

There will be losers as well as winners from economic growth. The evolutionary process between market players involves weeding out the good from the not-as-good, or preferred over not-as-preferred, or adapted to not-as-adapted. As the path of growth proceeds, old industries die and new ones are created. Agents in the old industries typically will plead for protection against the new technology. The government should resist mightily such entreaties,[416] and refrain from interfering in the weeding-out process by leveling the proverbial playing field to benefit one company, or sector, or industry. Favoring any particular outcome interferes with the effectiveness and meritocratic nature of the contest itself. Under Ormerod's "Iron Law of Failure," evolution necessarily includes extinction. Policymakers should respect that process and not try to disrupt what is beneficial to the system as a whole. Much as forest rangers sometimes allow fires to burn out the ecosystem for its own sake, policymakers should want the fitness threshold—the minimum productivity level necessary for survival—to be sufficiently high for a healthy overall system.[417]

At the same time, this does not suggest that the government must refrain from intervening to ameliorate the *effects* of adaptive change

412. LIPSEY ET AL., *supra* note 125, at 45.

413. In a 1947 speech to the House of Commons, Churchill said that "it has been said that democracy is the worst form of government except all those other forms that have been tried from time to time." RALPH KEYES, THE QUOTE VERIFIER: WHO SAID WHAT, WHERE, AND WHEN 43 (Macmillan 2006).

414. ORMEROD, *supra* note 6, at 55-57.

415. BALL, *supra* note 12, at 454.

416. EASTERLY, *supra* note 52, at 181-82.

417. ORMEROD, *supra* note 6, at 231. As an aside, in the public policy arena often it is those who shout most loudly and vociferously about the disciplinary virtues of the free market, who are in most need of them.

through targeted efforts, such as worker education and retraining programs. However, where markets are functioning adequately to provide agents with sufficient choice and opportunities to act, the forces of change themselves should not be impeded, else innovation and growth are threatened.

a. Don't Differentiate

First, adaptive policymakers should not be in the habit of creating, proposing, or emphasizing particular market alternatives. Businesses, working according to a myriad of strategies, are far better at generating new ideas, and having them tested in the marketplace, than government entities. Beinhocker discusses how the balance between bureaucratic and entrepreneurial tendencies in the market can sustain the evolutionary process of consistent incremental process and occasional big jumps.[418] When the government steps directly into this process, it risks over-emphasizing narrowly-conceived technologies or business plans. For example, the Federal Communications Commission has recognized the innovation-hampering nature of its traditional "command and control" approach to mandating how spectrum licensees use their frequencies.[419]

This is not to say that there should be no governmental role in encouraging the differentiation process. For example, where markets are not functioning properly, it may be helpful to facilitate convening the relevant market actors to fashion cooperative solutions. Whole sectors often face critical dilemmas or limitations, while individual businesses erect intentional or unintentional walls between themselves. If the government can provide a venue for collaborative differentiations, it can productively support the process without controlling it. Similarly, there may be a limited role for the policymaker when businesses rely on scarce government-controlled resources, such as rights-of-way or radio spectrum.

b. Don't Select

Second, the adaptive policymaker should not have any direct role in business plan selection. Market actors must be free to select the Physical

418. BEINHOCKER, *supra* note 22, at 152-56.

419. SPECTRUM POLICY TASK FORCE, FCC, REPORT, ET Dkt. No. 02-135, at 65, 67 n.400 (2002), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-228542A1.pdf. Another example of this dictating approach is the now-defunct U.S. Civil Aeronautics Board (CAB), which prior to the Airline Deregulation Act of 1978 was found to have limited market entry by new carriers, mandated point-to-point routing systems, subsidized various routes, and even set formulas governing ticket prices and profitability. *See* U.S. Centennial of Flight Comm'n, Deregulation and its Consequences, http://www.centennialofflight.gov/essay/Commercial_Aviation/Dereg/Tran8.htm.

and Social Technologies that make up their Business Plans, and to innovate toward what they think will be "most fit" for the economic landscape. Selection is the heart of evolution, and the heart of markets. Here, Beinhocker discusses how the "Big Man" process of selection can slow down or even halt the process of evolution. If a single agent controls the system, often according to self-interest that does not align with overall growth, the process is distorted. He explains that:

> In a big man system, the fitness function maximized is the wealth and power of the Big Man (and his cronies), rather than the overall economic wealth of the society. Thus, the creative, entrepreneurial, and deductive-tinkering energies of the population are directed toward pleasing the Big Man.[420]

Policymakers need to be attuned to Big Man thinking that arises from within government structures, as well as similar thinking that comes from outside. The instinct to pick outcomes can manifest itself in well-intentioned bureaucratic design, or in regulatory capture by market actors. Even tempting calls for solutions in the name of enabling the market—like creating new or stricter property rights, or allocating resources to the highest bidders—can become a form of selection favoring certain preferred agents over others.

c. Don't Amplify

Third, it should not be the adaptive policymaker's role to amplify the "most fit" business plans. New technologies undoubtedly are exciting, but interfering with the evolutionary process at this stage is very risky. Artificially bolstering a successful but nascent approach at the same time threatens to push aside competing innovations, or successful current plans. Amplifying either legacy or new approaches threatens the ability of the market to sort itself out according to the wishes and actions of market players.[421]

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420. BEINHOCKER, *supra* note 22, at 288.

421. Some argue, for example, that the State of California's foray into energy deregulation promoted market conduct that tended to create higher prices, but discouraged other conduct that could have led to price reductions. Darren Bush and & Carrie Mayne, *In (Reluctant) Defense of Enron: Why Bad Regulation is to Blame for California's Power Woes (or Why Antitrust Law Fails to Protect Against Market Power When the Market Rules Encourage its Use)*, 83 OR. L. REV. 207, 211 (2004). The authors there believe that the government's "deregulatory" structure, which among other things relied on non-existent excess capacity to discipline wholesale prices, and consumer price caps to freeze retail prices, actually legitimized anticompetitive conduct by Enron and others, "and made that conduct the norm." *Id.* at 212. Whether one accepts or not this particular interpretation of the complex set of events in California during 2000-2001, it is clear that government actions amplifying specific business plans can lead to negative market outcomes.

Instead, amplification should happen only at the level of individual agents as they navigate the fitness landscape. Business Plans that fail will be de-emphasized; technological combinations that work will be repeated and spread. As this amplification occurs, agents will explore variations on the successful strategy by tweaking it and iterating through the differentiation and selection processes once again.

Amplification of good ideas across multiple agents or sectors happens when agents observe or actively exchange knowledge. This presumes a certain degree of connectivity or cooperation, and here the government may again have a limited and indirect role. When agents close off access to knowledge—through obfuscation, strict propertization, or resistance to shared standards—their actions are counter-productive to the market-wide process of amplification.

2. Enabling the "Econosphere"

A far more appropriate role for government, where important policy goals and objectives are at stake, is to experiment with different changeable elements of the fitness environment within which the evolutionary algorithm operates. As Beinhocker puts it:

> Policies that get the government involved in differentiating, selecting, and amplifying Business Plans would be seen as interfering in economic evolution . . . . In contrast, policies that *shape the fitness environment,* while leaving Business Plan selection and amplification to market mechanisms, are a different matter . . . . As long as markets provide the mechanism for selecting and amplifying Business Plans, then the economic evolutionary process will innovate and adapt in response to those regulations.[422]

One can characterize this role with different metaphors: enabling the "econosphere," filling in market "gaps," tinkering with inputs, or revising rules of the "contest."[423] In one sense, the market constitutes a giant search engine, with economic agents competing algorithmically to determine the optimal results. The fundamental point is to improve the market's ability to formulate and present different options (the quantity function), while leaving the selection processes themselves undisturbed (the quality function). To the extent that growth comes not only from capital markets or government subsidy, but also, if not primarily, from technological progress, the government's role should be to generate conditions in which such growth can occur, without picking or

422. BEINHOCKER, *supra* note 22, at 426.

423. Francois Jacob first popularized the notion that "evolution is a tinkerer." François Jacob, *Evolution and Tinkering*, 196 SCIENCE 1161 (1977).

subsidizing the winners, or hindering the losers.[424]

For purposes of this discussion of communications policy, we believe environmental "tinkering" by adaptive policymakers can be accomplished in at least four different ways: (1) feeding the evolutionary algorithm through diversifying inputs, such as Business Plans and their accompanying Physical Technologies and Social Technologies; (2) fostering connectivity between agents, so that communications links are optimized; (3) shaping the fitness landscape to create economic incentives and increased market trust for certain activities; and (4) enhancing market feedback mechanisms, to facilitate better decisions through generating greater flows of timely and accurate information. Again, to suggest these potential steps of supplying inputs, connectivity, incentives, and feedback is not to endorse their use in any or all situations. Only where an overarching policy decision requires some form of market implementation should one or more of these steps even be considered, and perhaps implemented. But if done correctly, these relatively modest steps can provide major emergent benefits.

The notion of enabling from within the given construct of the market in part has its roots in the insight that some constraints, such as lack of foresight and uncertainty about outcomes, are simply inevitable. Policymakers would be wise to heed this insight, and act within the inherent limitations of human endeavors. In the words of Mark Taylor, a noted complexity theory expert:

> One of the perennial promises of visionaries is that in the future, all things will be possible. Whatever constraints we suffer in this world will disappear and we will be able to enjoy a freedom now barely imaginable. Such promises, however, are always cruel because they cannot be fulfilled. Possibilities are inevitably limited by constraints that can never be overcome. The only viable freedom is not freedom *from* constraints but the freedom to operate effectively *within* them . . . . Constraints provide the parameters within which thinking and acting must occur.[425]

A related issue is that policymakers of all persuasions appear

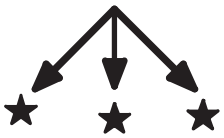
424. A salient example of "tinkering without tampering" outside the ICT space would be various proposals to curb greenhouse gas emissions, including carbon dioxide, by using "carbon offsets." This so-called "cap and trade" system is intended to harness market forces by establishing a total cap on carbon emissions, and then allowing entities to mitigate their own emissions by purchasing "credits" generated from more efficient, alternative fuel sources. While some proposals raise concerns about verification and enforceability—and claims that the government is only licensing pollution—the approach itself is consistent with the notion of productive "tinkering" by tapping into market incentives to achieve larger public policy objectives.

425. TAYLOR, *supra* note 115, at 224.

chronically unable to admit that any single aspect of their policy has failed.[426] They must come to accept the reality that both "market failure" and "policy failure" are inevitable, and learn from the mistakes made, or fitness not achieved. More to the point, failure creates fodder for future growth. "Paradoxically, failure at the detailed, individual level, whether plant or animal, company or government policy, is absolutely necessary for the health and vitality of the system as a whole. We need change and evolution to make progress."[427] Policymakers should prize their own unique position and ability to tinker, and thereby encourage "perpetual novelty, adaptation as a function of entire populations, the role of variety and experimentation, and the potential of decentralized and overlapping authority."[428]

In all respects, then, policy decisions in these contexts should be seen not as enduring mandates, but as a series of experiments that compete to evolve over time. Adaptive strategy suggests that policymakers should levy many small bets, in a trial-and-error (or better, trial-and-success) fashion. One should be willing to execute for today, and adapt for tomorrow.

a. Feed the Algorithm

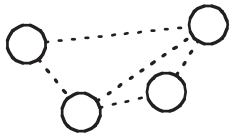


First, the adaptive policymaker can "feed the algorithm" of evolution by adding additional inputs to the process. These inputs include Business Plans, Physical Technologies, and Social Technologies. In some ways, this puts the government in the role of a lab technician, providing different plans and technologies for agents to experiment with in the market through selection.

By allowing, and even nudging, additional inputs to feed the algorithm, optimal amounts of novelty, knowledge, and growth are generated. A diversity of inputs serves as the raw material for differentiation. Ideas are the key input, because they can become innovation (when combined with implementation), physical technologies (when combined with things), and social technologies (when combined with processes). By the same token, supplementing market forces from within via inputs to the emergence algorithm can strengthen the evolutionary process, and yield a richer outcome. The key is to influence the *quantity* of inputs, without disturbing the *quality* of decisions derived ultimately from the algorithm itself. Even light-touch moves can have big downstream effects, both good and bad.

426. ORMEROD, *supra* note 6, at vii.
427. *Id.* at viii.
428. AXELROD & COHEN, *supra* note 19, at 29.

An inescapable conclusion of Romer's work is the need to find ways to increase economic growth. By all accounts, the market by itself is not sufficient to provide every useful input to the rough equation for emergence. One way to feed the evolutionary algorithm is to use the government's spending authority to channel resources.[429] Many experts have discussed the urgent need for technology policy to support research and development.[430] As the Net's own origins plainly show, government-sponsored R&D can help create generative platforms, big and small, for economic growth.



b. Foster Agent Connectivity

The adaptive policymaker also can foster connectivity and networking between various agents in the market. This can be done, for example, by strengthening or adding links (lines of communication) between nodes (agents).

New growth will not happen if the right infrastructure, or institutions—of science and the markets, of conventions and rules—are not in place.[431] What some call the "New Alexandrians," like their ancient counterparts, understand that "creating a shared foundation of knowledge on which large and diverse communities of collaborators can build is a great way to enhance innovation and corporate success."[432] We cannot always rely on competition and short-term self interest alone to promote an optimal infrastructure for ideas. "Vibrant markets rest on robust common foundations: a shared infrastructure of rules, institutions, knowledge, standards, and technologies provided by a mix of public and private sector initiatives."[433] Of course, the Internet is the single best example of such a shared infrastructure, emerging from a mix of first public, and then private actions. So at minimum policymakers should facilitate ways for agents to communicate and interact via the Net.

Joel Mokyr has produced a masterly historical and analytical account of how the costs of accessing useful knowledge (roughly equivalent to our Physical Technologies and Social Technologies) determine how likely it

429. Romer, *supra* note 265.

430. As just one example, the National Academy of Sciences issued a joint paper calling for enhancing "the human, financial, and knowledge capital necessary for US prosperity," in part by increasing federal support for various R&D-related tax credits, and providing additional funding for scholarships and fellowships in science, math, and engineering. National Academy of Sciences, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* 2 (2007), *available at* http://www.hq.nasa.gov/office/oer/nac/documents/Gathering_Storm.pdf.

431. Bailey, *supra* note 130.

432. TAPSCOTT & WILLIAMS, *supra* note 214, at 178.

433. *Id.*

is that such knowledge will expand.[434] He found that the lower the costs of access, and the greater the supply, the more knowledge will be cumulative.[435] "[T]he knowledge revolution in the eighteenth century was not just the emergence of new knowledge; it was also better access to knowledge that made the difference."[436] Policymakers can look to this salient example as a model for fostering greater connectivity between agents in the market.

c. Shape the Landscape

Encouraging greater increases in income over a shorter period of time arguably is the central economic policy task of any nation.[437] And in that quest, incentives for growth obviously matter.[438] With regard to four decades of repeated attempts to turn poverty into prosperity, Easterly concludes, "[n]either aid nor investment nor education nor population control nor adjustment lending nor debt forgiveness proved to be the panacea for growth. [These formulas did not work] . . . because [they ignored] . . . the basic principle of economics: people respond to incentives."[439] Countries where activities that promote growth are rewarded will grow faster than countries where this is not the case.[440] The contribution of the entrepreneur in the growth process is substantial; it has been argued that economies that want to advance faster should embrace a mix of entrepreneurial and big-firm capitalism.[441]

Thus, the policymaker can serve as a "fitness function shaper," which amounts to acting so that "the evolutionary processes of the market can be better shaped to serve society's needs."[442] Because incentives provide useful signals to all agents in the market, the best way to use the fitness landscape to achieve policy objectives is to employ market-based incentives. This can be accomplished by, for example, setting broad policy goals, and then allow agents operating under unfettered economic and non-economic conditions to meet those goals. By shaping the metaphoric fitness landscape within which agents operate—providing incentives to scale particular mountains, or supporting the discovery and sharing of path shortcuts—policymakers encourage policy objectives without interfering with the core activity of

434. *See* MOKYR, *supra* note 236.
435. *Id.* at 8.
436. *Id.* at 74-75.
437. AMARTYA SEN, DEVELOPMENT AS FREEDOM (1999).
438. EASTERLY, *supra* note 52, at 177.
439. *Id.* at 143.
440. BAUMOL ET AL., *supra* note 254, at 13.
441. *Id.*
442. BEINHOCKER, *supra* note 22, at 427.

market evolution.

One of the best examples of a public policy built on a correct understanding of "shaping the landscape" is the FCC's *Computer Inquiry* precedent. As discussed previously, the Commission created its basic/enhanced regulatory dichotomy largely as a way to fence off the online world from unwarranted carrier-style regulation. The FCC's rules established the basis for market forces eventually to evolve new and beneficial Social and Physical Technologies. There would have been no Internet (at least as we now understand it) without that prescient policy decision taken years before the successful rise of commercial online services for consumers.

d. Enhance Feedback Mechanisms

A final form of potentially beneficial tinkering involves creating or enhancing market feedback mechanisms, essentially filling in various information or transparency gaps in the market. This means providing agents with more and better information, and perhaps enhanced decision-making tools as well, so they can make informed decisions. Agents as consumers or users typically lack information, and foresight, and can be easy victims in a marketplace tilted against them. Bounded rationality, asymmetric information flows, cognitive biases, linear thinking—these findings and more suggest that users often stand little chance when negotiating with more powerful agents. The policymaker can help even the odds, at least to some degree. Because consumers and users are adaptable and able to learn and grow, policymakers should give them what they need to take that leap: more information, and a voice.

To be clear, the government should not attempt directly to alter the market outcome. However, policymakers could have a role in maximizing the voices in the marketplace, and trying to ensure they are clearly heard. "As a general rule, democratic interests tend to favor greater transparency, openness, intelligibility, and cheap access to information."[443] One way to do this is to arm the users with tools to better discern for themselves truth from falsehood.

Transparency not only alerts and educates those who make themselves educated agents, consumers, citizens, and producers. It also acts as a form of self-discipline on the affected firms and other entities. Those entities would be less likely to pursue anti-competitive or anti-consumer practices if they must advertise them to the world. Moreover, education can and does go both ways, with students/users imparting

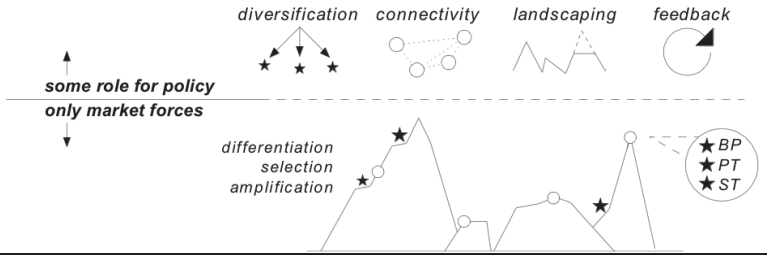
443. STARR, *supra* note 162, at 17.

knowledge by challenging various assumptions, and asking questions not previously considered.[444] By allowing users greater transparency into market processes, and more information about market decision points, governments can initiate a virtuous cycle of interaction between policymaker and citizen. A mutually beneficial "cognitive diversity" can result.[445]

Some lean on user transparency as a key remedy to the network neutrality conundrum. Among other suggestions, Phil Weiser and Rob Atkinson call on the FCC to adopt a "notice and monitoring regime" that would require broadband providers to announce details about their provision of service to consumers, and then adhere to such policies.[446] Atkinson separately has discussed another tool for policymakers, creating user-generated mapping interfaces to track broadband deployment.[447] More information also can help promote self-help; after all, if even a small fraction of end users are more aware of the policies and limitations on service, they can use software or hardware tools to engage in their own efforts to monitor their broadband connections—and, if possible, act accordingly.

Thus, in the context of the fitness landscape metaphor introduced in Section I, this dichotomy between acceptable "tinkering" and unacceptable "tampering" in the workings of the market might be usefully conceptualized as such:

Fig. 2: Tinkering Versus Tampering in a Fitness Landscape



444. JARED M. DIAMOND, COLLAPSE: HOW SOCIETIES CHOOSE TO FAIL OR SUCCEED 419 (2005). Reflecting echoes of behavioral economics, Diamond goes on to dissect various paths to failure by group decision-making, including an inability to anticipate, perceive, attempt to solve, and actually solve major problems. *Id.* at 419-40.

445. PAGE, *supra* note 241. Nonetheless, more information is not always better. Consumer choice can be taken to an extreme; too many options can mean confusion, and even paralysis, while increasing costs unnecessarily to providers. TALEB, *supra* note 67, at 142-45. As with all things, policymakers need to seek an appropriate balance.

446. ROBERT D. ATKINSON & PHILIP J. WEISER, A "THIRD WAY" ON NETWORK NEUTRALITY 14 (2006), http://www.itif.org/files/netneutrality.pdf.

447. Atkinson, *Framing*, *supra* note 374, at 168 n.107.

CONCLUSION

What we have here labeled and critiqued as Old School Economics—that form of economics that has become received wisdom by too many in the U.S. public policy community—still holds many important truths about our human condition. At the same time, some of the key assumptions and verities of that influential form of economic thinking have been proven overstated, or even wrong. The market is a far more rich, dynamic, and complex place than has been assumed. While the larger field of academic economics has been incorporating the newer ways of thinking, for the most part news of these developments has not reached the chambers of the U.S. Congress, or the West Wing of the White House, or the eighth floor of the Federal Communications Commission. For our country's larger economic, social, and political interests to be better served, that situation should change.

What we have distilled and call here Emergence Economics offers us the promise of a new conceptual framework, a way of approaching and understanding the growth-oriented network economy that is being brought about by the Internet. That framework seeks neither to deterministically engineer this dynamic economy, nor to blindly assume that it is evolving toward perfect efficiency. But with new frameworks come new ways of seeing. Romer and others have amply demonstrated that knowledge and technology are not just outputs of the economy, but also essential inputs that drive economic growth and countless other social benefits. Numerous researchers also have shown how game-changing, disruptive innovations tend to emerge from the edges of the Net. These innovations in turn create far-reaching benefits to unaffiliated entities, in the form of innovation "spillovers," and further inputs, throughout the network. This sort of edge-driven, broadly beneficial, mutually reinforcing activity thrives in an environment of open "generativity," where no market player—whether government or firm—unilaterally can pick winners and losers.

The government's unique role in all this, at best, should be to experiment with the optimal background conditions for a dynamic, unpredictable, and evolving environment. In particular, adaptive policymakers should determine whether and how to tinker with the market's inputs, connectivity, incentives, and feedback—and then stand back to let the process itself unfold. With empowered agents working through connected networks via evolutionary processes, we are more likely to unlock the full-blown emergence of new ideas and innovation, of economic growth and other "Net effects." Only when private markets and public policies learn to work constructively with each other, and not in needless conflict, can those emergent benefits be more fully realized in our everyday lives.