

THE CLIMATE OF OPINION: LEGAL AND ECONOMIC THEORIES FOR AN UNINHABITABLE EARTH

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In either hand the hastening angel caught
Our lingering parents, and to the eastern gate
Led them direct . . .
[T]hey looking back, all the eastern side beheld
Of Paradise, so late their happy seat
[S]ome natural tears they dropped, but wiped them soon;
The world was all before them, where to choose
Their place of rest, and providence their guide:
They hand in hand with wandering steps and slow,
Through Eden took their solitary way.

--*Paradise Lost*¹

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1. John Milton, *Paradise Lost* XII, 637-49, in *The Oxford Authors: John Milton*, 355, 618, 603-618 (Stephen Orgel & Jonathan Goldberg eds., Oxford Univ. Press 1990) (1674).

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INTRODUCTION

In 1982 Berkeley chemist and carbon-cycle expert Melvin Calvin testified before an oversight subcommittee, chaired by Albert Gore Jr. (D-Tenn.), within the House Committee on Science and Technology. The subject was possible restrictions on the use of fossil fuels, to address the “greenhouse effect” (the increase in atmospheric carbon dioxide). Representative Gore wanted more evidence before acting. Calvin disagreed: “[W]hen the signals are so big that they come out of the noise,” he explained, “[y]ou cannot do a thing about it . . . You have to look for early warning signs.”²

By all accounts Calvin’s own ‘early warning’ went completely unheeded. On the economic front, a wave of governmental deregulation that had begun tentatively in the Carter administration grew into an epic tidal wave with the election of Ronald Reagan in 1980. “The most notable changes have meant a reduction or substantial elimination of regulatory constraints” (many involving fossil fuel industries and the environment) “whose scope is unprecedented in modern American history.”³ In some ways, the ideal of deregulation came to represent antipathy toward organized government in general. “[T]he nine most terrifying words in the English language,” declared President Reagan, “are: ‘I’m from the Government, and I’m here to help.’”⁴ That line, with its ironic, counterintuitive punch, was met with raucous applause wherever Reagan went.

In 1989, at the Noordwijk Ministerial Conference in the Netherlands, delegates who expected to be signing a global climate treaty--with binding commitments to freeze greenhouse-gas emissions--were blindsided by the United States, represented by John Sununu, who was President George H.W. Bush’s chief of staff. That was essentially humanity’s last warning.

By now, “[m]ore carbon has been released into the atmosphere since the final day of the Noordwijk conference, Nov. 7, 1989, than in the entire history of civilization preceding it.”⁵ So much for “early warning signs.” It is as if someone, waiting skeptically for a certain event to happen--or

2. Melvin Calvin, Congressional Testimony, House Committee on Science and Technology, Hearings at 29 (1982). *Federal Energy R & D Priorities: Hearing Before the H. Subcomm. On Energy Dev. & Applications & the Energy Rsch. & Prod. Of the H. Comm on Sci. & Tech.*, 97th Cong. (1982) (statement of Melvin Calvin, Professor of Chemistry, Univ. of Cal.).

3. Sam Peltzman, *The Economic Theory of Regulation after a Decade of Deregulation* 20 (Brookings Papers: Microeconomics (1989)).

4. Ronald Reagan, President, U.S., News Conference, (Gerhard Peters & John T. Woolley, *Ronald Reagan, The President’s News Conference*, THE AM. PRESIDENCY PROJECT, (Aug. 12, 1986), <https://www.presidency.ucsb.edu/documents/the-presidents-news-conference-957> [<https://perma.cc/J7BH-74NG>], archived in THE AM. PRESIDENCY PROJECT, UC SANTA BARBARA.

5. Nathaniel Rich, *Losing Earth: The Decade We Almost Stopped Climate Change*, N.Y. TIMES MAGAZINE 92 (Aug. 15, 2018).

even denying that it could happen--were to find out that it had, in fact, *already* happened.⁶ It is as if one could turn back the clock and think of America, once again, as “a shining city on a hill”--except that the hill would now be surrounded by water six feet deep.⁷

And, as it turns out, even the scientists were insufficiently vigilant...⁸ “This has had severe consequences, diluting what should have been a sense of urgency and vastly understating the looming costs of adaptation and dislocation as the planet continues to warm.”⁹ Thus, when climate diplomats involved in current negotiations “think about this moment,”

[T]hey are confronted by something of a cognitive dissonance . . . The world’s biggest polluters are nowhere near where they should be to draw down their emissions at a time when the human toll of climate change is near impossible to ignore.¹⁰

6. Cf. Erle C. Ellis, *What Kind of Planet Do We Want? Science Alone Won’t Save the Earth. People Have to do That*, N.Y. TIMES (Aug. 12, 2018), at SR12 (“The new normal is not about staying within earth’s natural limits. We passed those long ago.”).

7. See Ronald Reagan, President, U.S., Gerhard Peters & John T. Woolley. See Election Eve Address, “A Vision for America,” (Nov. 3, 1980), *Ronald Reagan, Election Eve Address ‘A Vision for America’*, archived in THE AM. PRESIDENCY PROJECT, (Aug. 11, 1980). UC Santa Barbara.

Amitav Ghosh has drawn attention to the central role of *mainland Asia* as the bearer of bad news, “the simpleton who, in his blundering progress across the stage, unwittingly stumbles upon the secret that is the key to the plot.” Starting with a period of sustained economic expansion in the late 1980s, this region, with its outsized portion of the global population, has provided a kind of “natural experiment” whose striking results can now be conclusively confirmed:

[T]he patterns of life that modernity engenders can only be practiced by a small minority of the world’s population. . . . Every family in the world cannot have two cars, a washing machine, and a refrigerator.

AMITAV GHOSH, *THE GREAT DERANGEMENT: CLIMATE CHANGE AND THE UNTHINKABLE* 92 (2016); cf. *id.* at 111-14 (arguing industrial civilization is subject to limitations of scale and would collapse if adopted by the majority of the earth’s people).

8. See SPECIAL REPORT ON GLOBAL WARMING OF 1.5 °C, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE SPECIAL REPORT: GLOBAL WARMING OF 1.5°C, IPCC (Oct. 8, 2018) <https://www.ipcc.ch/sr15/> [<https://perma.cc/FNR9-3FHN>]; See also William J. Ripple *et al.*, *World Scientists’ Warning of Climate Emergency 2021*, 71 BIOSCIENCE 894, (2021) <https://doi.org/10.1093/biosci/biz088> [<https://perma.cc/4455-52W4>], (11,258 scientist signatories from 153 countries, advance publication Nov. 5, 2019):

The climate crisis has arrived and is accelerating faster than most scientists expected (IPCC 2018). It is more severe than anticipated, threatening natural ecosystems and the fate of humanity (IPCC 2019). Especially worrisome are potential irreversible climate tipping points and nature’s reinforcing feedbacks (atmospheric, marine, and terrestrial) that could lead to a catastrophic “hothouse Earth,” well beyond the control of humans (Steffen *et al.* 2018). These climate chain reactions could cause significant disruptions to ecosystems, society, and economies, potentially making large areas of Earth uninhabitable.

9. Eugene Linden, Opinion, *How Scientists Got Climate Change So Wrong*, N.Y. TIMES, (Nov. 8, 2019) <https://www.nytimes.com/2019/11/08/opinion/sunday/science-climate-change.html> [<https://perma.cc/K3MW-WFQE>].

10. Somini Sengupta, *World Powers Vowed to Cut Greenhouse Gases. They’re Still Rising Perilously ‘Bleak’ U.N. Report on a Planet in Peril Looms Over New Climate Talks*, N.Y. TIMES, (Nov. 26, 2019) (online ed.) (original version <https://www.nytimes.com/2019/11/26/climate/greenhouse-gas-emissions-carbon.html> [<https://perma.cc/923S-PRBV>]); see generally LEON FESTINGER, *A THEORY OF COGNITIVE*

Many studies on this subject discern and follow a standard pattern, well documented by Nathaniel Rich: “What started as a scientific story was turning into a political story.”¹¹ In this article we focus neither on the scientific story nor on the political story, but on something in between: *the economic story*, as represented by the models and assumptions of economic theory. (A story about *political will* in tackling climate change would be very short indeed--with few characters and little meaningful dialogue.)¹² The problems of global warming and climate change pose intractable challenges for a liberal, capitalist democracy like the United States. Those challenges have deep social, intellectual, and psychological origins, which prevailing economic theories merely reflect and model. In the real world, these economic theories inform the actual economic practices--of individuals, collectives, institutions, industries, and whole nations--that have led us to the precipice of an uninhabitable earth.

Three core assumptions of capitalist economic theory and practice may be singled out for special scrutiny: (1) an abiding faith in the “efficiency” (in some sense yet to be defined) of free markets; (2) a corresponding belief in the inefficiency (and general undesirability) of regulated markets; and (3) an assumption--implicit or explicit--that the distant future should be heavily discounted in relation to the closely held present.¹³ That last assumption owes much to the inherently “conservative” nature of human information processing.¹⁴

Faith, belief, and conservatism are woefully unequal to the environmental plight at hand, whose scope in many respects truly “surpasseth all human understanding.”¹⁵ “[T]he earth of the Anthropocene is precisely a world of insistent, inescapable continuities, animated by forces that are nothing if not inconceivably vast.”¹⁶ In these distinctly unpromising circumstances we follow an approach pioneered by Justice Oliver Wendell Holmes, Jr., who wrote in a 1919 opinion that

[T]he ultimate good desired is better reached by free trade in ideas--
 . . . the best test of truth is the power of the thought to get itself

DISSONANCE (1957); LEON FESTINGER, CONFLICT, DECISION, AND DISSONANCE (1964).

11. Rich, *supra* note 5, at 42.

12. See, e.g., SAMUEL BECKETT, *WAITING FOR GODOT: A TRAGICOMEDY IN TWO ACTS* (Grove Press 1954).

13. Daniel S. Hamermesh & Neal M. Soss, *An Economic Theory of Suicide*, 84 J. POL. ECON. 83, 83-98 (1974) (“... A man--or a society--commits suicide “when the total discounted lifetime utility remaining to him reaches zero.”)

14. Ward Edwards, *Conservatism in Human Information Processing*, in *FORMAL REPRESENTATION OF HUMAN JUDGMENT* 17-52 (Benjamin Kleinmuntz ed., 1968).

15. See generally DAVID WALLACE-WELLS, *THE UNINHABITABLE EARTH: LIFE AFTER WARMING* (2019).

16. GHOSH, *supra* note 7, at 62.

accepted in the competition of the market....¹⁷

Our thesis: None of the above assumptions informing economic theory and practice meets the appropriate tests of its “environmentally relevant” marketplace of ideas.

In what follows, the first four parts reconstruct, and deconstruct, the economic theories that have brought us to the brink of an uninhabitable earth: Adam Smith’s vision of a mercantile economy--sustained by unlimited natural resources--in which individual market participants contribute (unknowingly and unintentionally) to a “virtuous circle” of socially beneficent exchanges (*i*); the centuries-long veneration of and reliance on free, unsupervised, and unregulated markets (epitomized by Hayek’s work) for the optimal allocation of resources (*ii*); the related notion of deferring to “efficient markets” as the ultimate arbiter of economic value, given the well known difficulties of outperforming market returns (*iii*); and the economic theory of regulation, which sees regulators as effectively “captured” by regulated industries--and the political process as incapable of rationalizing any better regime (*iv*). A fifth and final part surveys the landscape of possible “solutions” to the problems of climate change (*v*). To the extent that economic analysis might mitigate some of the damage it itself has wrought, prudential considerations counsel recourse to the “second-best” approaches of behavioral economics and social psychology. In an age when rational *arguments* carry little weight, recourse to various forms of essentially non-rational *influence* may be the only alternative.

I. THE HISTORY AND TRAGEDY OF THE COMMONS

In a passage about all the labor that goes into making a loaf of bread, John Locke incidentally draws attention to the global reach of the mercantile economy. A complete account, he says, would furnish “a strange ‘catalogue of things,’” ranging from the direct labor of the ploughman, the reaper, the thresher, and the baker, to the labor of those who made all their tools and implements, and even to the labor of those who prepared the raw materials for the tools and implements:

[I]ron, wood, leather, bark, timber, stone, bricks, coals, lime, cloth, dyeing drugs, pitch, tar, masts, ropes, and all the materials made use of in the ship that brought any of the commodities used by any of the workmen.¹⁸

Had there been any economists at the time, they might reasonably have

17. *Abrams v. United States*, 250 U.S. 616, 630 (1919) (Holmes, J., dissenting).

18. JOHN LOCKE, *SECOND TREATISE OF GOVERNMENT* § 43 (Thomas P. Peardon ed., Bobbs-Merrill 1952) (1690).

begun their treatises on the *Political Economy of the Mercantile System* with the stipulation: “Assume that natural resources are unlimited.” And, for their purposes, this would have been close enough to the truth.¹⁹

A. Adam Smith’s World Without End

That was still true a century later, when Adam Smith was writing.²⁰ On the American frontier, it was true even into the nineteenth century, when “a plainsman could kill an American bison, cut out only the tongue for his dinner, and discard the rest of the animal. He was not in any important sense being wasteful.”²¹ Likewise with pollution, writes Garrett Hardin:

It did not much matter how a lonely American frontiersman disposed of his waste. “Flowing water purifies itself every 10 miles,” my grandfather used to say, and the myth was near enough to the truth when he was a boy, for there were not too many people.²²

Those halcyon days are now far behind us--distant and rapidly receding. Now, indeed, there are “too many people,” as an eminently predictable result, “the natural chemical and biological recycling processes [have

19. The New World alone promised such unimaginable natural resources as to fuel a speculative bubble that would essentially bankrupt France, which had the misfortune of tying its currency to the speculative frenzy. See, e.g., Charles W. Collier, *An Inefficient Truth*, 23 :1-2 CRITICAL REV. 29, 61-62 (2011):

“[John] Law’s scheme [for France] was to establish a giant overseas trading company, popularly known as the Mississippi Company. . . . In return for assuming much of the national debt, the Mississippi Company was granted monopoly trading privileges for French Louisiana, a huge territory stretching from the mouth of the Mississippi to what is now Canada. “During its meteoric expansion over the next three years [the Mississippi Company] absorbed in succession the other overseas trading companies of France, the mint, and the General Farms which collected the central government’s taxes.” (Neal 1999, 808-9).

“The price chart of Mississippi Company shares resembles nothing so much as one of those strange rock formations in the American West called a *butte*. It rises abruptly from the desert floor, shooting almost straight up. It then continues sideways for a while, forming a plateau, before plunging just as precipitously down the other side. After languishing far below the nominal issue price of 500 livres per share in 1717-18, share prices reached 10,100 in January 1720, only to fall back to 500 by September 1721. Such was “Europe’s first major stock market boom” (Murphy 2009, 65). The promise of Louisiana still lay far in the future.”

20. ADAM SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS 597-98 (R.H. Campbell, A.S. Skinner & W.B. Todd eds., Clarendon Press, Oxford 1976) (1776) (“. . . England, it must be observed, was a great trading country, her mercantile capital was very great and likely to become still greater and greater every day [A]nd though [there] were very thriving colonies, yet there was not, perhaps, at that time either in Europe or America a single person who foresaw or even suspected the rapid progress which they have since made in wealth, population and improvement.”).

21. Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243, 1245 (Dec. 13, 1968).

22. *Id.*

become] overloaded.”²³ The “natural limits” of the earth have been steadily and irrevocably exceeded.²⁴ We now face a problem that has no “technical solution” - i.e. “[O]ne that requires a change only in the techniques of the natural sciences, demanding little or nothing in the way of change in human values or ideas of morality.”²⁵ Economics cannot solve this problem with the technical tools of its trade; but it is still instructive to review its attempts to do so.

Most notably, the metaphor of an “invisible hand” guiding economic progress was introduced by Adam Smith, in the context of foreign and domestic trade. But its premise was laid much earlier--indeed it derives from human nature, specifically “the propensity to truck, barter, and exchange one thing for another.”²⁶ This is a peculiarly human propensity (“Nobody ever saw a dog make a fair and deliberate exchange of one bone for another with another dog”),²⁷ and it reflects man’s unique dependence on his fellow men. Unlike other animals which, as adults, live independent lives, “man has almost constant occasion for the help of his brethren.”²⁸ It is unrealistic to expect that this great need, this great dependence upon our fellow men, can be satisfied by appealing to their benevolence alone, or even primarily. An economic bargain is addressed, therefore, not to our fellow men’s benevolence but to their self-interest:

Give me that which I want, and you shall have this which you want, is the meaning of every such offer It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages.²⁹

Thus, the important appeals to our fellow men need to be formulated in a way that addresses--largely or even primarily--their own interests. We need to conceive and style our own interests in a way that reflects and mirrors the interests of others. Only thus can we expect others to take enough interest - even indirectly - in our interests.

This is what we need to do, and this is in fact what we do, says Smith; but does it work? Can we in fact conceive, pursue, and achieve our own interests in a way that corresponds to - indeed, appeals to - the mutual self-interest of other individuals? That is the more speculative aspect of the metaphor of the “invisible hand;” and here is its boldest articulation:

23. *Id.*

24. *See* Ellis, *supra* note 6.

25. Hardin, *supra* note 21, at 1243.

26. SMITH, *supra* note 20, at 25. [hereinafter *Wealth of Nations*].

27. *Id.* at 926.

28. *Id.*

29. *Id.* at 9-10.

Every individual is continually exerting himself to find out the most advantageous employment for whatever capital he can command. It is his own advantage, indeed, and not that of the society, which he has in view. But *the study of his own advantage* naturally, or rather necessarily *leads him to prefer that employment which is most advantageous to the society.*³⁰

Smith does not leave his metaphor in purely abstract form; he works it out (or at least illustrates it) empirically. In the context of foreign and domestic trade, the international merchant naturally prefers to keep as much of his capital as possible in his home market (where it is most secure).³¹ This incidentally benefits the home market and supports domestic industry, though that is not the merchant's intention. The way the merchant "naturally inclines" to employ his capital for his own security is at the same time the way "it is likely to afford the greatest support to domestic industry, and to give revenue and employment to the greatest number of people of his own country."³²

In domestic industry, which the merchant is thus naturally inclined to support, the profits to be made are proportional to the industry's "produce" - "what it adds to the subject or materials upon which it is employed."³³ Seeking only to maximize his profits, therefore, the merchant "necessarily endeavours so to direct that industry, that its produce may be of the greatest possible value."³⁴ This has the splendid side effect of tending to maximize the gross national product of the society in question.

He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, *led by an invisible hand* to promote an end which was no part of his intention. . . By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.³⁵

B. An Economic Parable

This happy state of affairs may indeed have prevailed in Smith's pre-

30. *Id.* at 291 (emphasis added).

31. *See id.*

32. *Id.* at 292.

33. *Id.*

34. *Id.* at 293.

35. *Id.* (emphasis added).

industrial eighteenth century, and even into the nineteenth century, when small entrepreneurs and overseas trading companies were busily exploring and exploiting vast new, unpopulated areas of the earth and their seemingly unlimited natural resources.³⁶

Here is a late-eighteenth-century economic parable--based on Adam Smith's premises--involving a whaler (call him Ishmael), an artisan, and a farmer. The whaler sells whale blubber to the artisan, who extracts oil from it. The artisan sells lamp oil to the farmer, who thereby lights up his farmhouse at night and grows potatoes by day, which he sells to the whaler. (See Table 1 *infra*; read clockwise.)

Whaler
Sells Whale Blubber
Buys Potatoes

Farmer
Sells Potatoes
Buys Lamp Oil

Artisan
Sells Lamp Oil
Buys Whale Blubber

All in all, this seems to be a paradigmatic "virtuous circle." Everyone is happier and better-off than ever. Civilization is advanced, too: the farmer can stay up well after sundown reading the latest issue of the *Potato Times*. The whaler has plenty of potatoes to eat, and the artisan makes a good living turning whale blubber into whale oil (the highest quality lamp oil available at the time).³⁷ Multiply this little parable hundreds and thousands of times, and it serves as the economic template for a whole, prosperous society. It is just as Adam Smith said: all pursue only their own self-interest (narrowly conceived), and yet as a result the whole

36. *Id.* at 404-405. "The discovery of America, and that of a passage to the East Indies by the Cape of Good Hope, are the two greatest and most important events recorded in the history of mankind. Their consequences have already been very great: but, in the short period of between two and three centuries which has elapsed since these discoveries were made, it is impossible that the whole extent of their consequences can have been seen. What benefits, or what misfortunes to mankind may hereafter result from those great events no human wisdom can foresee. . ."

"[I]n the mean time one of the principal effects of those discoveries has been to raise the mercantile system to a degree of splendor and glory which it could never otherwise have attained to. . . [I]n consequence of those discoveries, the commercial towns of Europe, instead of being the manufacturers and carriers for but a very small part of the world . . . have now become the manufacturers for the numerous and thriving cultivators of America, and the carriers, and in some respects the manufacturers too, for almost all the different nations of Asia, Africa, and America. Two new worlds have been opened to their industry, each of them much greater and more extensive than the old one, and the market of one of them growing still greater and greater every day." *Id.* at 626-27.

37. See 2 J. Lewkowitsch, 22 *Chemical Technology and Analysis of Oils, Fats, and Waxes* 674-78 (Gerorge H. Warburton ed., 3d ed. 1904).

society is progressively enriched.³⁸ Truly, an “invisible hand” could not have arranged things better.

But, lo, out on the distant horizon dark clouds are forming. Our little parable rests on *two* shaky and untenable premises. The first premise is Adam Smith’s *world without end* - a pre-industrial world of essentially unlimited and inexhaustible natural resources. Instead, as early as the mid-nineteenth century “[w]hales near North America were becoming scarce...”³⁹ In 1853 alone, “8,000 whales were slaughtered for whale oil shipped to light lamps around the world...”⁴⁰ No less an authority than Herman Melville lingered darkly over the fate of “Leviathan”:

Whether owing to the almost omniscient look-outs at the mast-heads of the whale-ships, now penetrating even through Behring’s straits, and into the remotest secret drawers and lockers of the world; and the thousand harpoons and lances darted along all continental coasts; the moot point is, whether Leviathan can long endure so wide a chase, and so remorseless a havoc; whether he must not at last be exterminated from the waters, and the last whale, like the last man, smoke his last pipe, and then himself evaporate in the final puff.⁴¹

A *world without end* is a purely logical construct on a par with the propositional world of Ludwig Wittgenstein, which comprises “the totality of facts.”⁴² (In that world there are no “things” - such as whales - at all.)⁴³ “*The limits of my language,*” says Wittgenstein, “mean the limits of my world.”⁴⁴

Thus, the first shaky and untenable premise of our apparently virtuous economic circle is false: In a world that is limited, there are not enough - not nearly enough - of the “good things” (e.g., whales) needed to sustain even this rudimentary economic system.⁴⁵ “In the 18th and 19th centuries

38 Smith, *supra* note 20.

39 Peter Applebome, *They Used To Say Whale Oil Was Indispensable, Too*, N.Y. Times, (Aug. 3, 2008), <https://www.nytimes.com/2008/08/03/nyregion/03towns.html> [<https://perma.cc/V43H-MNN3>].

40. *Id.*

41. Herman Melville, *Moby-Dick* ch. 105 (Race Point Publ’g) (1851).

42. Ludwig Wittgenstein, *Tractatus Logico-Philosophicus* ¶ 1.1 (D.F. Pears & B.F. McGuinness trans., 1963) (1921); cf. ¶ 1 (“Die Welt ist alles, was der Fall ist.”).

43. *See id.* ¶ 1.1 (“The world is the totality of facts, not of things.”).

44. *Id.* at ¶ 5.6.

45. *See* Eric Jay Dolin, *Leviathan: The History of Whaling in America* 339, 354, 356 (2007):

“[T]he price of whale oils . . . rose dramatically in the 1850s, in part because whalers had to spend more money and time, traveling farther to chase an ever-dwindling number of whales. . . .

“[G]iven. . . how successfully they had been hunted in previous decades, whales were now harder to find, forcing whalers to take longer, more expensive cruises to get a good catch.

. . . [A]dding to baleen’s meteoric rise was the inescapable fact that bowheads, owing to excessive hunting, were on a crash course toward extinction.”

the whaling vessels of a dozen nations sailed all the oceans in pursuit of five species of whales. In that period four of the five were hunted almost to the point of extinction...⁴⁶ This is what happens when the oceans of the world are viewed as a “commons,” open to all, without restriction or regulation. As J.T. Jenkins pleads in his *History of the Whale Fisheries*,

[I]t is imperative that further steps should be taken to *regulate the industry* by international action. Otherwise, a most interesting group of marine animals will be hunted to the verge of extinction, and a great natural asset rendered worthless to enrich a small group of speculators and capitalists.⁴⁷

The second shaky and untenable premise also involves limits: “The earth is unlimited in its ability to absorb the ‘bad things’ our apparently virtuous economic circle produces.”⁴⁸ This too is false.

All plants and animals contain carbon. As a function of their immense size, whales contain exceptionally large amounts of carbon.⁴⁹ In the normal course of events, when a whale dies of natural causes it sinks to the ocean floor. If the water is deep enough at that location, the dead whale might remain undisturbed at the bottom of the ocean indefinitely. Its carbon is “sequestered” there and does not enter the atmosphere.⁵⁰

From an environmental standpoint, the very worst alternative would be to extract oil from a dead whale and burn it (e.g., for lighting), thereby releasing carbon dioxide (CO₂) directly into the atmosphere. Yet, that is precisely what was done.

Whaling was a big business, and whale oil was the best and primary source of lighting until the mid-nineteenth century--after which it was replaced, successively, by lard oil, camphene, kerosene, natural gas, and finally the electric light bulb.⁵¹ But at its height, “whaling . . . was one of the world’s first great multinational businesses, a global enterprise of audacious reach and import. From the 1700s through the mid-1800s, oil extracted from the blubber of whales and boiled in giant pots gave light to America and much of the Western world.”⁵²

It has been estimated that 100 years of using (burning) whale oil for lighting may have released more than 100 million tons of carbon dioxide into the atmosphere.⁵³ This is equivalent to clear-cutting and burning a

46. Scott McVay, *The Last of the Great Whales*, 215 *Sci. Am.* 13, 13 (Aug. 1966).

47. J.T. Jenkins, *A History of the Whale Fisheries* 6 (1921) (emphasis added).

48. *Id.*

49. Victoria Gill, *Whaling ‘Worsens Carbon Release’*, BBC News, (Feb. 2, 2010) <http://news.bbc.co.uk/2/hi/asia-pacific/8538033.stm> [<https://perma.cc/KDK7-3EB9>] (online ed.) (reporting on the American Geophysical Union’s Ocean Sciences conference, and quoting Dr. Andrew Pershing, Univ. of Maine).

50. *Id.*

51. See DOLIN, *supra* note 45, at ch. 18.

52. Applebome, *supra* note 39, at 1.

53. Gill, *supra* note 49.

temperate forest the size of present-day Nicaragua (or driving 128,000 Humvees continuously for 100 years).⁵⁴ In combination with other sources of global warming--starting with industrial-scale burning of coal in the 1850s--the use of whale oil for lighting forms part of a practice now recognized as unsustainable.⁵⁵ Once again, the faulty premises of our little “economic parable” render it untenable.

C. *When Rationality Failed*

A theoretical rebuttal of Adam Smith’s “invisible hand” was not long in coming. It came in the form of William Forster Lloyd’s little-known *Lectures on the Checks to Population* (1833).⁵⁶ The cultural and conceptual frameworks of Smith and Lloyd are in most if not all respects perfectly compatible. Yet even assuming Smith’s rosy, pre-industrial postulate that “what is good for *me* is good for *us*” - that the self-interested entrepreneur is actually (and unknowingly) “advancing the social good” - one might qualify this as: “advancing the social good--a little,” where the additional general benefit is inversely proportional to the size of the social group.

Suppose I own and operate a small farm. If I double my usual workload, I should expect twice my usual income (given a few simplifying assumptions). If I work only half as much, my income should drop proportionately. These consequences, both positive and negative, inform and motivate my actions.

But now suppose you and I own the same farm jointly and agree that the results of our work are to be common property.⁵⁷ Now, if I double my workload, the increased income *to me* is only half of what it was in the previous scenario. But, also with the reduced workload, I now bear only half the loss. “If, therefore, we may estimate the motives for exertion by the magnitude of the personal consequences expected by each individual, these motives would in this case have only half the force, which they would have, were each labouring separately for his own individual benefit.”⁵⁸

With three partners the “motives for exertion” would have only one-third of their original force, and so on. When the group of shared owners is sufficiently large, the motives for individual exertion become imperceptible - effectively nonexistent.

This situation is the root of the problem, says Lloyd; motives for

54. *Id.*

55. *Id.*

56. W.F. LLOYD, TWO LECTURES ON THE CHECKS TO POPULATION (1833).

57. *See id.* at 18.

58. *Id.*

individual effort become increasingly disconnected from the actions of those individuals, who eventually have no motive (neither positive nor negative) for individual effort at all.⁵⁹ It is, in effect, the inverse of an “invisible hand,” i.e., rational individuals have little if any motive for contributing to the “commonwealth,” even though they all share in it. This situation does not change if it is explained to and fully understood by all economic actors involved; it depends on structural features of their social situation, not on their personal dispositions.

Consider a herdsman with ten cows on ten acres. Assume that taking on another animal would result in overgrazing and reduce the herdsman’s income by ten percent. But now suppose there are ten herdsmen, each with ten cows on a 100-acre “commons” (with the same qualitative characteristics as the previous ten acres). If each herdsman adds one more animal to his herd, the total loss to all will be ten percent (just as in the previous scenario). Yet here there is an important difference because only one-tenth of the overall loss is attributable to any one herdsman’s actions.

Each individual herdsman reasons as follows: “Whatever *I* do (for good or bad), the remaining nine-tenths of the overall result--in which I share proportionally--will be unaffected. Personally, I have caused only a one percent loss; the other nine percent is out of my hands.”

Each, therefore, will feel ill effects, corresponding precisely, in character and quantity, with the consequences of his own conduct. Yet they will not be the identical effects flowing from that conduct; but being a portion of the accumulated effects resulting from the whole conduct of the society in general, would . . . still be felt, though the conduct of the individual should be changed. Thus, it is that the universal distress fails to suggest to individuals any motive for moral restraint.

. . . [When] the obligation to prudence [is] *placed upon the society collectively, instead of being distributed to the individual members*, the effect is, that, though the reasoning faculty is in full force, and each man can clearly foresee the consequences of his actions, yet the conduct is the same as if that faculty had no existence.⁶⁰

The invisible hand enters the picture as an expression of (or analogy to) the pursuit and effectuation of intelligible human purposes--normally thought of as a causal process. The idea that the effect (social good) could result without any obvious connection to the cause (individual decision making) would indeed be “a kind of miracle.”⁶¹ As Smith’s friend Adam Ferguson wrote, “every step and every movement of the multitude, even in

59. *Id.*

60. *Id.* at 22 (emphasis added).

61. JESSE NORMAN, ADAM SMITH: FATHER OF ECONOMICS 173 (2018).

what are termed enlightened ages, are made with equal blindness to the future; and nations stumble upon establishments, which are indeed the result of human action, but not the execution of any human design.”⁶²

The invisible hand provides a “mechanism” imaginatively tying individual efforts to the common good; it satisfies the need to make sense of what seemed--in pre-industrial times--to be a wonderfully fruitful and mutually beneficial state of affairs. Surely, that cannot all be coincidental; surely, it has a deeper meaning.

[T]he simple fact that Adam Smith needed an “invisible hand” to guide economic dealings on the exchange market shows plainly that more than sheer economic activity is involved in exchange and that “economic man,” when he makes his appearance on the market, is an acting being and neither exclusively a producer nor a trader and barterer. . . . The invisible actor behind the scenes is an invention arising from a mental perplexity but corresponding to no real experience. Through it, the story resulting from action is misconstrued as a fictional story, where indeed an author pulls the strings and directs the play.⁶³

Adam Smith’s basic assumption that “*decisions reached individually will, in fact, be the best decisions for an entire society*” has indeed the status of a fictional story, a kind of morality play.⁶⁴ Given Lloyd’s simplifying assumptions, instrumental rationality applied at the individual level leads irrevocably to general irrationality at the societal level.⁶⁵ *Gains* that accrue to the individual “maximizer of utilities” are fully realized at the individual level--the only level that microeconomics knows. Any resulting *losses*, however, are shared by all; the individual bears only a small part of any social loss he causes.

Thus, the rational herdsman receives the full benefit of adding one more animal to his herd. Yet, if overgrazing results, he suffers but a small fraction of the harm to the “commons” as a whole. “Therein is the tragedy. Each man is locked into a system that compels him to increase his herd

62. ADAM FERGUSON, AN ESSAY ON THE HISTORY OF CIVIL SOCIETY III, ii (1767); cf. HANNAH ARENDT, THE HUMAN CONDITION 185 (1958):

The perplexity is that in any series of events that together form a story with a unique meaning we can at best isolate the agent who set the whole process into motion; and although this agent frequently remains the subject, the “hero” of the story, we never can point unequivocally to him as the author of its eventual outcome.

63. ARENDT, *supra* note 62, at 185-86.

64. See Hardin, *supra* note 21, at 1244.

65. These results rule out some, but not all, broader social theories. Cf., e.g., Ferdinand Tönnies, *Gemeinschaft und Gesellschaft* (1887); Karl Mannheim, *Ideology and Utopia: An Introduction to the Sociology of Knowledge* ch. 1 (Louis Wirth & Edward Shils trans., 1936); Jürgen Habermas, *Erkenntnis und Interesse I*, ch. 3 (Suhrkamp Taschenbuch Wissenschaft 1973); John G. Benjafield, *Are Economists Rational?*, *Cognition*, 331 (3d ed. 2007).

without limit--in a world that is limited.”

Adding together the component [positive and negative] utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another. . . *But this is the conclusion reached by each and every rational herdsman sharing a commons.* . . . Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons.⁶⁶

A ruinous “race to the bottom” results, with all the stern “solemnity of the remorseless working of things” - Whitehead’s definition of tragedy.⁶⁷ *Homo economicus*, the rational maximizer of individual utilities, does not and cannot represent the broader interests of *homo sapiens*, inheritor of the earth.

II. THE ALLURE OF FREE MARKETS

Virtually all manifestations of global warming and climate change may be traced back, ultimately, to some form of *economic exchange*. (The global markets for fossil fuels would be a direct example. The lightly regulated markets for new automobiles - which pollute the environment when driven--would be an indirect example). Since economic exchange takes place mainly in organized markets, the very nature and roles of those markets could be rate-limiting factors in climate change.

The archetypal free market might be called the “primal scene” of economic exchange.⁶⁸ In a free market, self-interest and competition guide the allocation of capital and other resources to their optimal use in producing goods and services. In more technical terms, “[c]ompetitive markets without externalities populated by well-informed self-regarding rational individuals generate highly productive outcomes because the market has powerful emergent properties that make it an extremely powerful and incentive-compatible societal mechanism for eliciting the revelation, aggregation, and transmission of information about resources, capabilities, needs and desires.”⁶⁹ Part of the enduring allure of free markets may be put in negative form: they are *not* “supervised” (by anyone) - and need not be supervised--in arriving at a finely calibrated allocation of resources. In positive terms: When freed of supervision,

66. Hardin, *supra* note 21, at 1244 (emphasis added).

67. See Alfred North Whitehead, *Science and the Modern World* 12-13 (Cambridge Univ. Press 2011) (1925).

68. See Sigmund Freud & Josef Breuer, *Studies on Hysteria* (1895); Sigmund Freud, *The Interpretation of Dreams* (1900).

69. Brad DeLong, *Praise of Friedrich von Hayek* Sub-Blogging, Wash. Ctr. For Equitable Growth (May 9, 2016), <https://equitablegrowth.org/praise-of-friedrich-von-hayek-sub-blogging/> [https://perma.cc/RSN6-CSQG].

markets are highly successful--more so than any individual decision maker or market participant could ever be--in arriving at a finely calibrated allocation of resources; in this sense they are said to be naturally "efficient" (as discussed in Part III, below).

Friedrich Hayek's *The Use of Knowledge in Society* (1945)⁷⁰ provides a classic exposition of free markets in which both their uncanny prescience and their blind spots are on full display.

A. *The Unsupervised Market*

Hayek sets himself the task of conceptualizing a rational economic order. The economic problem of society is "a problem of how to secure the best use of resources known to any of the members of society, for ends whose relative importance only these individuals know."⁷¹ From the very outset, conceptual difficulties arise--difficulties that would never be encountered in the natural sciences.

In those contexts, different researchers might study the same natural phenomenon--a pattern of precipitation, for example. But in dealing with social phenomena, says Hayek, "the 'data' from which the economic calculus starts are never for the whole society 'given'" in the usual sense, or in the way they are "given" to the natural scientist.⁷² The economic problem of society is "a problem of the utilization of knowledge not given to anyone in its totality."⁷³ Instead, this knowledge is "dispersed among many different individuals."⁷⁴

The individuals of whom Hayek speaks are participants in various economic markets. But what kind of "knowledge [would be] initially dispersed among all the people"? What kind of "data" would "never [be] 'given' to a single mind which could work out the implications"?⁷⁵ Hayek says that individual members of society pursue exchanges based on factors "whose relative importance only these individuals know." And this knowledge on which people base their plans is somehow "communicated to them."⁷⁶

Provisionally, one surmises that individual market participants would be in a very good--perhaps the best--position to appreciate the *relative importance* of the resources they exchange. And *prices* are commonly

70. F.A. Hayek, *The Use of Knowledge in Society*, 35 *Am. Econ. Rev.* 519 (1945).

71. *Id.* at 520.

72. *Id.*

73. *Id.*

74. *Id.* at 519-21; cf. *id.* at 519 ("[T]he knowledge of the circumstances of which we must make use never exists in concentrated or integrated form, but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess.").

75. *Id.* at 520, 519 (emphasis added).

76. *Id.* at 520.

thought of as “signaling” important information implicated in exchange.⁷⁷

So we get a picture of many dispersed individuals, busily pursuing various economic exchanges about which they are intimately informed, but which are neither fully appreciated nor understood more generally in the broader global markets--least of all by any “central planner(s).”

One paradigm for this kind of “knowledge” of which Hayek writes might be *local knowledge* (to use Clifford Geertz’s term).⁷⁸ Local knowledge is defined as “a body of very important but unorganized knowledge which cannot possibly be called scientific in the sense of knowledge of general rules: the knowledge of the particular circumstances of time and place.”⁷⁹

An example is booking space on a tramp steamer that you happen to know would otherwise sail half-empty to China. Or, consider the fabled *arbitrageur*, who steps in boldly when the price of gold in a Somali pirate cove falls below its price in London⁸⁰ or when the market price of a closed-end fund falls below the value of its individual holdings (something that should never happen in an “efficient” market).⁸¹ All these people are performing “eminently useful functions based on special knowledge of circumstances of the fleeting moment not known to others.”⁸²

A second paradigm for this type of knowledge might be illustrated by *insider trading*, which was not as stringently prohibited in Hayek’s day. Yet, he seems to anticipate the looming opprobrium:

It is a curious fact that this sort of knowledge should today be generally regarded with a kind of contempt, and that anyone who by such knowledge gains an advantage over somebody better equipped with theoretical or technical knowledge is thought to have acted almost disreputably. To gain an advantage from better knowledge of facilities of communication or transport is sometimes regarded as almost dishonest.⁸³

When my cousin Susy (who happens to be staff secretary to Semiotic Software’s Board of Directors) winks broadly when I ask if I should buy Semiotic stock (she happens to know that Apple is planning a takeover at a 40% premium), I have “some advantage over all others in that [I] possess [] unique information of which beneficial use might be made.” But this use, adds Hayek, “can be made only if the decisions depending on it are

77. *Id.* at 520, 525.

78. *See generally* CLIFFORD GEERTZ, *LOCAL KNOWLEDGE* (Basic Books 1983).

79. Hayek, *supra* note 70, at 521.

80. *See* AMAR BHIDÉ, *A CALL FOR JUDGMENT: SENSIBLE FINANCE FOR A DYNAMIC ECONOMY* 108 (2010).

81. *See, e.g.*, J. Bradford De Long *et al.*, *Noise Trader Risk in Financial Markets*, 98 J. POL. ECON. 703, 728-30 (1990).

82. Hayek, *supra* note 70, at 522.

83. *Id.*

left to [me] or are made with [my] active cooperation.”⁸⁴

As Hayek anticipates, “the common idea now seems to be that all such knowledge should as a matter of course be readily at the command of everybody.”⁸⁵ Or, to put it the other way around: nobody should be able to use “material, non-public” information or knowledge to gain an economic advantage.⁸⁶ The idea is to create an above-board, arm’s-length, “supervised” marketplace in which insiders and outsiders alike may compete on a *fair and equal* basis. But more than a little “efficiency” might thereby be lost.

Another aspect of the problem of market supervision (or “central planning”) is a chronic underestimation of the significance of *change*. “So long as things continue as before, or at least as they were expected to, there arise no new problems.” But, for example, a “constant struggle” is required to keep production costs from rising. “How easy it is,” remarks Hayek, “for an inefficient manager to dissipate the differentials on which profitability rests.”⁸⁷ Yet these constant, small changes seem to cancel each other out when the economic process is viewed from above (“abstracting from minor differences”) as a statistical aggregate.⁸⁸

Meanwhile, at the local level, febrile change is the only constant. “The continuous flow of goods and services is maintained by constant deliberate adjustments, by new dispositions made every day in the light of circumstances not known the day before.”⁸⁹

Hayek concedes that the individual market participant needs some, more general information “to fit his decisions into the whole pattern of changes of the larger economic system.”⁹⁰ But, “Which of the events which happen beyond the horizon of his immediate knowledge are of relevance to his immediate decision, and how much of them need he know?”⁹¹ As it turns out, Hayek claims, very little in the way of “centralized knowledge” is needed to keep the wheels of commerce and industry turning smoothly. For the individual entrepreneur, “[i]t is always a question of the relative importance of the particular things with which he is concerned, and the causes which alter their relative importance are of no interest to him beyond the effect on those concrete things of his own environment.”⁹²

84. *Id.* at 521-22.

85. *Id.* at 522.

86. *See* Securities Exchange Act of 1934, Pub. L. No. 73-291, 48 Stat. 881; Insider Trading Sanctions Act of 1984, Pub. L. No. 98-376, 98 Stat. 1264; Insider Trading and Securities Fraud Enforcement Act of 1988, Pub. L. No. 100-704, 102 Stat. 4677.

87. Hayek, *supra* note 70, at 523-24.

88. *Id.*

89. *Id.* at 524.

90. *Id.*

91. *Id.* at 525.

92. *Id.*

All the entrepreneur needs to know at the particular moment may be that, say, “more screws of one size than of another are wanted.”⁹³ He need not know why. Almost as if by magic, this type of information is communicated directly to market participants without the intervention, direction, or supervision of anyone in particular. The information is communicated by the *relative scarcity* of the particular screws in question (as reflected in their rising price). No one has to say: “We need more of those screws.” The “man on the spot” has already figured this out.

In a situation of dispersed knowledge, the “economic calculus” each dispersed individual needs to make “can be solved, and in fact is being solved, by the price system.” In the face of change, the individual market participant need not “go explicitly through all the relations between ends and means which might possibly be affected.” The relevant economic calculation can most readily be solved--and in fact can *only* be solved--with constant reference to “rates of equivalence (or ‘values,’ or ‘marginal rates of substitution’).” For each kind of scarce resource there thus emerges “a numerical index which cannot be derived from any property possessed by that particular thing, but which reflects, or in which is condensed, its significance in view of the whole means-end structure.”⁹⁴

Here the strengths and weaknesses (to be discussed later) of the free marketplace are on full display.⁹⁵ Since all such individuals are likewise solving their economic calculations “locally,” there is no need for anyone, anywhere, “to solve the whole puzzle *ab initio*, or . . . to survey it at once in all its ramifications.”⁹⁶

The economy is thus viewed as a sort of ghost ship sailing along without anyone in particular (much less a captain) at the helm.⁹⁷ In the broader economic system, “prices can act to coordinate the separate actions of different people in the same way as subjective values help the individual to coordinate the parts of his plan.”⁹⁸ Thus, the whole system benefits from a highly effective *economy of knowledge*. Hayek gives the example of an unexpected shortage of some basic raw material, say tin. Knowledgeable entrepreneurs will step in to fill the gap without knowing why or where it has arisen. The effects of this change in the balance of supply and demand will reverberate rapidly through:

93. *Id.*

94. *Id.*

95. *Id.*

96. *Id.*

97. *Cf. id.* at 527:

It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of telecommunications which enables individual producers to watch merely the movement of a few pointers, as an engineer might watch the hands of a few dials, in order to adjust their activities to changes of which they may never know more than is reflected in the price movement.

98. *Id.* at 526.

[T]he whole economic system and influence not only all the uses of tin, but also those of its substitutes and the substitutes of these substitutes, the supply of all the things made of tin, and their substitutes, and so on...[W]ithout an order being issued, without more than perhaps a handful of people knowing the cause, tens of thousands of people whose identity could not be ascertained by months of investigation, are made to use the material or its products more sparingly; i.e., they move in the right direction.⁹⁹

The price system “communicates” all the necessary information; local prices are connected in a manner dictated by transportation costs, etc. “The whole acts as one market,” not because any of its members survey the whole field, but because their limited individual fields of vision sufficiently overlap so that through many intermediaries the relevant information is communicated to all.”¹⁰⁰

If the functioning of the price system were the result of deliberate human design, says Hayek, “this mechanism would have been acclaimed as one of the greatest triumphs of the human mind.” But since it is *not* the product of human design, “[t]he problem is precisely . . . how to provide *inducements* which will make the individuals do the desirable things without anyone having to tell them what to do.”¹⁰¹

B. *The View from Above*

The problems of climate change, as we know them, hardly existed in Hayek’s day. But since then, the marvelously functioning markets have conspicuously failed, on their own terms, to provide any meaningful “inducements” for market participants to avoid even the most obvious risks of climate change. Etymologically, *to supervise* means “to view from above.”¹⁰² These unsupervised markets have failed us because we did not comprehend or appreciate their limitations; there was no one to take in the view from above.

“We make constant use of formulas, symbols and rules,” writes Hayek, “*whose meaning we do not understand* and through the use of which we avail ourselves of the assistance of *knowledge which individually we do not possess*.”¹⁰³ Nevertheless, these seemingly opaque formulas, symbols, and rules “have proved successful in their own

99. *Id.* at 526-27.

100. *Id.* at 526 (emphasis added).

101. *Id.* at 527-28 (emphasis added).

102. OXFORD ENGLISH DICTIONARY (3d ed. 2012) (online ed.).

103. Hayek, *supra* note 70, at 528 (emphasis added).

sphere.”¹⁰⁴ As described above, “[t]he price system is just one of those formations which man has learned to use . . . after he had stumbled upon it without understanding it.”¹⁰⁵

The price system functions in the manner of a judgmental *heuristic* or “rule of thumb.”¹⁰⁶ These are time- and labor-saving devices that usually, though not always, help avoid serious error. In any event, they spare individuals the trouble of reexamining every new situation afresh on its merits (“without having to solve the whole puzzle *ab initio*,” as Hayek puts it).¹⁰⁷ “Fact-finding and evaluating the different reasons for action consume time and effort, and these are costs which even under conditions of infallibility will often outweigh the marginal benefits which in many cases ensue from engaging in a complete assessment of the situation on its merits.”¹⁰⁸ The natural habitat of heuristics is the common law.

Blackstone explains the common law as essentially the ratification of custom by judicial decisions. The common law consists of legal maxims and customs that are, he says, “of higher antiquity than memory or history can reach: nothing being more difficult than to ascertain the precise beginning and first spring of an ancient and long established custom.”¹⁰⁹ To our usual way of thinking, this “difficulty” would seem to count against the authority of a custom whose origins are so murky; but Blackstone draws exactly the opposite conclusion in his next sentence: “Whence it is” (implying that what comes next follows logically) “that in our law the goodness of a custom depends upon its having been used time out of mind; or, in the solemnity of our legal phrase, time whereof the memory of man runneth not to the contrary. This it is that gives it its

104. *Id.* (emphasis added).

105. *Id.* (emphasis added).

106. See Charles W. Collier, *Intellectual Authority and Institutional Authority*, 42 J. LEGAL EDUC. 151, 161-66 (1992). The term *rule of thumb*, per the *Oxford English Dictionary*, is “probably so called on account of the thumb being used as a reference for approximate measurements of various kinds” (cloth, grains, etc.). OXFORD ENGLISH DICTIONARY (3d ed. 2011) (online ed.). There is also a persistent belief or legend that at Anglo-American common law a husband was permitted to beat his wife, so long as he used a stick or rod or switch or whip no thicker than his thumb. But the much more recent suggestion, that the term *rule of thumb* actually derives from this alleged practice, “cannot be substantiated.” *Id.*; see generally Henry Ansgar Kelly, *Rule of Thumb and the Folklaw of the Husband’s Stick*, 44 J. OF LEGAL EDUC. 341 (1994).

107. See John Stuart Mill, *A System of Logic Ratiocinative and Inductive*, bk. 6, ch. 12, § 3, at 549 (London, 9th ed. 1875):

By a wise practitioner . . . rules of conduct will only be considered as provisional. Being made for the most numerous cases, or for those of most ordinary occurrence, they point out the manner in which it will be least perilous to act, where time or means do not exist for analysing the actual circumstances of the case, or where we cannot trust our judgment in estimating them.

108. Joseph Raz, *Practical Reason and Norms* 60 (Princeton 1990); cf. Lola L. Lopes, *The Rhetoric of Irrationality*, 1 Theory & Psychology 65, 68 (1991) (“In broad terms, heuristic methods are quick-and-not-too-dirty procedural tricks that usually yield acceptable solutions to problems at noticeably less cost than is required by alternative methods (called algorithms) that guarantee optimal solutions. In other words, heuristics are methods that achieve efficiency by risking failure.”).

109. 1 William Blackstone, *Commentaries* *67.

weight and authority.”¹¹⁰

The affirmative enactment of a legislative or executive-agency rule (“positive law”) would represent only the opinions and ideology of a specific political class at a particular time and place. The common law, by contrast, transcends such limitations; it stretches back so far as to represent the considered, collective opinion of the ages. Accordingly, no one in particular “supervises” the development of the common law—just as no one (in Hayek’s idealization) supervises the use or functioning of the economic price system. In both cases their development is the unplanned, organic product of individual decision making (by judges in the various courts, and by market participants in economic exchanges).

But the individual’s vaunted and cherished freedom to “choose his pursuits and consequently freely use his own knowledge and skill”¹¹¹ is barely implicated in the rote application of a rule of thumb or in the reflexive response to the signals of the price system. Indeed, as Amar Bhidé argues,

[S]tandard economic theories accord no more freedom to decentralized decision-makers than belongs to robots or software programs that process whatever data they are given in a completely mechanistic way. Effective adaptation to unpredictable but repeated patterns of changes does not require much creativity of imagination. “On the spot” knowledge in conjunction with skill in detecting patterns (filtering the signal from the noise) and familiarity with responses that have worked well in the past may suffice.¹¹²

110. *Id.* A normative premise seems to be implied here: These maxims and customs have been observed for so long (so long that “the memory of man runneth not to the contrary”) that they ought to be—deserve to be—observed *now* too. In this sense it is neither circular nor paradoxical to assert that “the only method of proving, that this or that maxim is a rule of the common law, is by showing that it hath been always the custom to observe it.” *Id.* at 68. In a slightly different formulation Blackstone says elsewhere that these legal maxims and customs “receive their binding power, and the force of laws . . . by their universal reception throughout the kingdom.” *Id.* at 64. That last phrase is amplified as follows: “the authority of these maxims rests entirely upon general reception and usage.” *Id.* at 68. Here the emphasis is on breadth of acceptance, which implies a second normative premise: These maxims and customs have been observed so widely and universally that they ought to be observed *here* too. The common law is in this sense “a law *common* to all the realm, the *jus commune*.” *Id.* at 67. An implied argument for these two normative premises of the common law can also be reconstructed. The older and more widely accepted the custom, so goes the argument, the more it represents the objective, accumulated wisdom of the ages, and the less it represents someone’s (anyone’s) subjective, personal choice. Legal and political legitimacy are classically tied to “the consent of the governed,” but universal suffrage is not the only way that consent can be expressed. “For where is the difference,” asks the Emperor Julian, “whether the people declare their assent to a law by suffrage, or by a uniform course of acting accordingly?” *Id.* at 73 (citing Dig. 1.3.32 (Julian, Digest 84)). In this sense the common law has been, as Sir Edward Coke put it, “*proved and approved* by continual experience to be good and profitable for the common wealth.” SIR EDWARD COKE, LE QUART PART DES REPORTES DEL (1604), sig. B2 (emphasis added).

111. Hayek, *supra* note 70, at 528.

112. BHIDÉ, *supra* note 80, at 29, 33-34.

Going beyond such basic forms of decision-making means entering realms of more important free choices, where significant public policies are debated and decided. Yet here one immediately encounters suggestions--quite contrary to Hayek's whole scheme--that markets in goods and services should routinely be "supervised" and ultimately regulated, in the name of some broader conception of the public good.

In the United States, the Securities Exchange Act of 1934 provides the main statutory basis for the prohibition and criminalization of securities trading based on material, non-public information ("insider trading"). Prior to that, a 1909 U.S. Supreme Court opinion invoked *common-law fraud* in holding against a corporate director who bought shares of his company's stock at a small fraction of what he knew (based on material, non-public information) would soon be their much higher price.¹¹³ Even prior to 1909, and more generally, a certain degree of supervision and regulation was always inherent in the very nature and role of a market.¹¹⁴

One would have to go very far back in time, or to a correspondingly remote place, to find a form of economic exchange that was completely free of any supervision or enforceable regulation. Such a quest "leads from the highways to the byways of social life."¹¹⁵ "At the beginning life was lived very close to the soil, a standard hardly up to subsistence prevailed, the list of necessities which demanded protection was short, the wares which came to an intermittent market and fell under control were few."¹¹⁶ In those pastoral and agrarian times, "commerce and piracy had not been clearly distinguished, and an irregular trade was carried on with a potential enemy . . . [T]rade was a scant province as yet unsubdued to legal control."¹¹⁷ Amid those adventitious dealings, wares and sales alike were of dubious repute. Here one meets:

[T]he wayfaring palmer with his relics and trinkets, the peripatetic peddler with gew-gaws and ornaments, strangers here today and there tomorrow, wayfaring men of no place and without the law. . . There, too, was to be discovered the seller-by-trade, no good merchant of the realm, but a rogue anxious to be rid of stolen chattels, or horses from far away, or valuables from a ship which after all might not have been wrecked.¹¹⁸

113. *Strong v. Repide*, 213 U.S. 419, 426 (1909).

114. BLACKSTONE, *supra* note 109.

115. Walton H. Hamilton, *The Ancient Maxim Caveat Emptor*, 40 YALE L.J. 1133, 1162 (1931).

116. *Id.* at 1142.

117. *Id.* at 1157.

118. *Id.* at 1162-63.

C. *The Early Legal Framework for Market Regulation*

All this began to change as trade and commerce assumed greater importance and demanded regular and reputable channels of exchange. These came first in the form of seasonal trade fairs and then as established town markets. Here is Blackstone's description of the medieval market:

[I]t is expedient that the buyer, by taking proper precautions, may at all events be secure of his purchase; otherwise all commerce between man and man must soon be at an end. And therefore the general rule of law is, that all sales and contracts of any thing vendible, in fairs or markets overt, (that is, open) shall not only be good between the parties, but also be binding on all those that have any right or property therein. And for this purpose . . . were tools established in markets, viz. to testify the making of contract; for every private contract was discountenanced by law. Wherefore our Saxon ancestors prohibited the sale of any thing above the value of twenty pence, unless in open market, and directed every bargain and sale to be contracted in the presence of credible witnesses. But if my goods are stolen from me, and sold, out of market overt, my property is not altered, and I may take them wherever I find them.¹¹⁹

A number of special legal protections helped ensure the integrity of the market. "As the crafts increased in number and claimed more followers, the scrutiny of the community was progressively extended." The intent of the folkways, which were just passing into law, was to ensure an open market, a fair price, an honest measure, and a quality good after the fashion of the day.¹²⁰ Only such wares were to be sold as were publicly displayed in the main body of a fair or in shops which had frontage. Sales of goods in private, or in secret places ("a clandestine trade," as Blackstone puts it, with suitable intrigue),¹²¹ were strictly prohibited. Likewise, "[t]here were to be no sales by candlelight or after the bell had rung for sunset."¹²² In addition, the following practices were specifically prohibited by law:

Forestalling: "To intercept (goods, etc.) before they reach the public markets; to buy (them) up privately with a view to enhance the price."¹²³

119. 2 WILLIAM BLACKSTONE, COMMENTARIES 449 (Oxford, Clarendon, 1st ed. 1765-69) (footnotes omitted).

120. Hamilton, *supra* note 115, at 1142.

121. BLACKSTONE, *supra* note 119.

122. Hamilton, *supra* note 115, at 1147.

123. *Forestall*, OXFORD ENGLISH DICTIONARY (1897), [\(online ed.\).](https://www-oed-com.libproxy.wustl.edu/view/Entry/73195?isAdvanced=false&result=2&rskey=ZN0adW&.)

Regrating: To “buy at wholesale and sell in the same market at retail.”¹²⁴

Engrossing: “To deal with ‘in the gross’; [to] buy up wholesale; *esp.* to buy up the whole stock, or as much as possible, of (a commodity) for the purpose of ‘regrating’ or retailing it at a monopoly price.”¹²⁵

These rules and regulations were for the benefit of all: the buyer, the seller, and the prospering commercial society at large. As late as Elizabethan times, the *view of the frankpledge*, a kind of medieval honor system among the craft guilds (whose members were held responsible for each other’s good behavior), “was skillfully turned to the regulation of trade.”¹²⁶ A violation of the frankpledge could, in legal terms, be considered “a communal tort. For it was a device contrived to protect the folk and the offense was against them.”¹²⁷

In an early American case out of New Orleans, a potential buyer and seller had been negotiating for some time over the terms of a large transaction in tobacco.¹²⁸ Then the buyer learned that the Treaty of Ghent had just been signed, which was seemingly bound to enhance the value and price of tobacco (as it in fact it did).¹²⁹ He arose at dawn on a Sunday morning, arranged to meet with the seller, and agreed to his terms.¹³⁰ Before the sale was consummated, however, the seller (not knowing about the Treaty of Ghent) “asked if there was any news which was calculated to enhance the price or value of the article about to be purchased.”¹³¹ According to the seller’s (vendor’s) own legal counsel, “[i]n answer to the question, whether there was any news calculated to enhance the price of the article, the vendee was silent.”¹³² The sale went through anyway; evidently, the seller did not “insist[] on an answer to his question,” as he might have.¹³³

Subsequently, the seller argued in court that the purchase had been fraudulent. But the trial judge directed a verdict for the buyer, “[t]here being no evidence that the [buyer] had asserted or suggested any thing to the [seller], calculated to impose upon him with respect to said news, and to induce him to think or believe that it did not exist.”¹³⁴ On appeal, the

124. Louis L. Jaffe & Mathew O. Tobriner, *The Legality of Price-Fixing Agreements*, 45 HARV. L. REV 1164, 1168 n.14 (1932).

125. *Engross*, OXFORD ENGLISH DICTIONARY (1891), <https://www-oed-com.libproxy.wustl.edu/view/Entry/62325?redirectedFrom=engross#eid>. (online ed.).

126. Hamilton, *supra* note 115, at 1143.

127. *Id.* at 1144.

128. Laidlaw et al. v. Organ, 15 (2 Wheat.) U.S. 178, 183 (1817).

129. *Id.*

130. *Id.*

131. *Id.*

132. *Id.* at 188-89.

133. *Id.* at 193.

134. *Id.* at 183.

U.S. Supreme Court (*per* Marshall, C.J.) reversed, holding that the jury should have been allowed to decide whether, under the circumstances, the buyer's silence could have amounted to an "imposition" upon the seller.¹³⁵ So much for *laissez-faire*.

Almost a century later, the Supreme Court faced a structurally analogous case arising in the Philippine Islands.¹³⁶ The managing director of a corporation in the Philippines had been negotiating (secretly, or at least very discretely) a sale of the corporation's land—practically its only asset—to the Philippine Government, for millions of dollars.¹³⁷ This would greatly enhance the value of the corporation's stock, and the decision whether to accept the Government's standing offer lay entirely in the hands of the director.¹³⁸

But first, after extended negotiations, the director bought 800 shares of the corporation's stock that he knew were held by a certain Mrs. Strong. The director did this through a third-party broker-intermediary, who never mentioned the ongoing negotiations with the Government and never disclosed or revealed the identity of the actual buyer—the director.¹³⁹

The defendant thus obtained the 800 shares for about one tenth of the amount they became worth by the sale of the lands between two and three months thereafter. In all the negotiations in regard to the purchase of the stock from Mrs. Strong, through her agent Jones, not one word of the facts affecting the value of this stock was made known to plaintiff's agent by defendant but, on the contrary, perfect silence was kept. . . . The probable value of the shares in the very near future was thus unknown to anyone but defendant, while the agent of the plaintiff had no knowledge or suspicion that defendant was the one seeking to purchase the shares.¹⁴⁰

The director presumably believed that by thus distancing and removing himself from any occasion for, or even possibility of, affirmative representations—as to the present state or future prospects of the corporation, or even as to his own identity as buyer—he would be effectively insulated from liability for fraud or misrepresentation.

The Supreme Court held that the applicable law in the case was the Civil Code, which provided that the *consent* of the parties was requisite for a contract,¹⁴¹ that "[c]onsent given by . . . *deceit*, shall be void,"¹⁴² and

135. *Id.* at 194.

136. *Strong v. Repide*, 213 U.S. 419, 426 (1909).

137. *Id.*

138. *Id.*

139. *Id.*

140. *Id.*

141. Civil Code § 1261.

142. *Id.* § 1265 (emphasis added).

that,

“[T]here is deceit when by words or insidious machinations on the part of one of the contracting parties, the other is induced to execute a contract which, without them, he would not have made.”¹⁴³ The meaning of the words “insidious machinations” may be said to be a deceitful scheme or plot with an evil design, or, in other words, with a fraudulent purpose. Thus, the deceit which avoids the contract need not be by means of misrepresentations in words. . . .*This is the rule of the common law also.*¹⁴⁴

Once again, the Court found fraud *on the buyer’s part* (turning *caveat emptor* on its head), even in the absence of any express or affirmative misrepresentation.¹⁴⁵ It was not a matter of protecting the buyer against substantial and unjustified losses, but of protecting the seller against the unjustified failure to realize substantial gains. Still, the Court upheld these regulations of exchange: “In such cases concealment is equivalent to misrepresentation.”¹⁴⁶

The above cases arose in relatively limited markets. The transactions at issue could be viewed as essentially private placements. For an interpretation of the Securities Exchange Act in the context of global commodities markets, the case of *Securities and Exchange Commission v. Texas Gulf Sulphur Co.*¹⁴⁷ offers substantial guidance.

The SEC had long been concerned about speculation in Canadian mining companies, and the *Texas Gulf Sulphur* case shows why.¹⁴⁸ Texas

143. *Id.* § 1269.

144. *Strong*, 213 U.S. at 430 (emphasis added). The facts that the Court found most salient were as follows:

The agent of the plaintiff . . . would not have sold [the shares] at the price he did had he known the actual state of the negotiations as to the lands, and that it was the defendant who was seeking to purchase the stock. Concealing his identity when procuring the purchase of the stock, by his agent, was in itself strong evidence of fraud on the part of the defendant. Why did he not ask Jones, who occupied an adjoining office, if he would sell? . . . He kept up the concealment as long as he could, by giving the check of a third person for the purchase money. *Id.* at 432-33; cf. *Id.* at 433: (“[T]he giving of the check . . . was proper evidence as tending to show that the concealment of identity was not a mere inadvertent omission, an omission without any fraudulent or deceitful intent, but was a studied and intentional omission, to be characterized as part of the deceitful machinations to obtain the purchase without giving any information whatever as to the state and probable result of the negotiations, to the vendor of the stock, and to, in that way, obtain the same at a lower price.”).

145. *Id.* at 430

146. *Id.* at 430; *see also* *Stewart v. Wyoming Cattle Rancho Co.*, 128 U.S. 383, 388 (1888): (“[A] suppression of the truth may amount to a suggestion of falsehood; and if, with intent to deceive, either party to a contract of sale conceals or suppresses a material fact, which he is in good faith bound to disclose, this is evidence of and equivalent to a false representation, because the concealment or suppression is, in effect, a representation that what is disclosed is the whole truth.”)

147. *SEC v. Tex. Gulf Sulphur Co.*, 401 F.2d 833 (2d Cir. 1968) (en banc) (hereinafter *Texas Gulf Sulphur*).

148. *Texas Gulf Sulphur*, 401 F.2d at 844.

Gulf Sulphur Co. (“TGS”) was engaged in extensive efforts—covering some 15,000 square miles—to buy up the mineral rights to lands in Canada with substantial base metal deposits.¹⁴⁹ This enterprise depended on a certain discretion (for the benefit of the company and its shareholders) as to promising locations under scrutiny, so as not to drive up their prices.¹⁵⁰

That exact situation arose with a parcel of land located near Timmins, Ontario. Exploratory drilling there by one of TGS’s teams produced core samples of extraordinary potential.¹⁵¹ “These results were so remarkable that neither Clayton, an experienced geophysicist, nor four other TGS expert witnesses, had ever seen or heard of a comparable initial exploratory drill hole in a base metal deposit.”¹⁵² Later assessments by independent sources confirmed TGS’s initial impressions.¹⁵³ To facilitate the acquisition of surrounding lands, TGS President Stephens instructed the exploration group to keep these results confidential and undisclosed even as to other officers, directors, and employees of TGS.¹⁵⁴ “The hole was concealed and a barren core was intentionally drilled off the anomaly.”¹⁵⁵

Before news of this discovery could spread, TGS officers, directors, and employees who knew about the preliminary drilling results began buying shares and call options on the company’s stock.¹⁵⁶ “[T]he timing . . . [of] their purchases of *short-term* calls—purchases in some cases by individuals who had never before purchased calls or even TGS stock,” did not seem coincidental when the case came before the Second Circuit; indeed, it “virtually compel[led] the inference that the insiders were influenced by the drilling results.”¹⁵⁷ In addition, a number of highly-compensated company officers and employees who knew of the drilling results accepted TGS stock options issued to them, without informing the Board of Directors or its Stock Option Committee of those results.¹⁵⁸ (All of the above securities and financial instruments are essentially bets that

149. *Id.*

150. *Id.*

151. *Id.*

152. *Id.* at 843.

153. *See id.* at 850-51:

The Northern Miner, a trade publication in wide circulation among mining stock specialists, called . . . the discovery hole, “one of the most impressive drill holes completed in modern times.” [A] Canadian broker whose firm specialized in mining securities, characterized the importance to investors of the results . . . He stated that the completion of “the first drill hole” with “a 600-foot drill core is very very significant . . . anything over 200 feet is considered very significant and 600 feet is just beyond your wildest imagination.”

154. *Id.*

155. *Id.* at 84.

156. *Id.*

157. *Id.* at 851.

158. *See id.* at 856.

the share price of TGS common stock would rise sharply in the near term—as in fact it did.)

As per usual in the mining business, rumors started flying wildly throughout Canada, aided and abetted by the American press. The *New York Herald Tribune* and the *New York Times* published “unauthorized reports of the TGS drilling which seemed to infer a rich strike from the fact that the drill cores had been flown to the United States for chemical assay.”¹⁵⁹ Amidst all this speculative frenzy, and as a means of quelling the accelerating rumors and media reports, TGS finally issued a press release, which soberly cautioned in part:

During the past few days, the exploration activities of Texas Gulf Sulphur in the area of Timmins, Ontario, have been widely reported in the press, coupled with rumors of a substantial copper discovery there. These reports exaggerate the scale of operations, and mention plans and statistics of size and grade of ore that are without factual basis and have evidently originated by speculation of people not connected with TGS. . . .

Recent drilling on one property near Timmins has led to preliminary indications that more drilling would be required for proper evaluation of this prospect. . . .

The work done to date has not been sufficient to reach definite conclusions and any statement as to size and grade of ore would be premature and possibly misleading.¹⁶⁰

As Judge Friendly responded in concurrence, “[t]o say that the drilling at Timmins had afforded only ‘preliminary indications that more drilling would be required for proper evaluation of this prospect,’ was a wholly insufficient statement of what TGS knew.”¹⁶¹

The SEC brought an enforcement action under SEC Rule 10b-5 against several TGS officers, directors, and employees for insider trading; and against TGS for issuing a press release that partly facilitated the insider trading and disadvantaged outside investors. SEC Rule 10b-5 (promulgated pursuant to Section 10(b) of the Securities Exchange Act of 1934) states:

It shall be unlawful for any person, directly or indirectly, by the use of any means or instrumentality of interstate commerce, or of the mails or of any facility of any national securities exchange,

- (a) To employ any device, scheme, or artifice to defraud,
- (b) To make any untrue statement of a material fact or to omit to state a material fact necessary in order to make the statements made,

159. *Id.* at 844.

160. *See id.* at 845.

161. *Id.* at 866 (Friendly, J., concurring).

in the light of the circumstances under which they were made, not misleading, or

(c) To engage in any act, practice, or course of business which operates or would operate as a fraud or deceit upon any person, in connection with the purchase or sale of any security.¹⁶²

In upholding the SEC action, the U.S. Court of Appeals for the Second Circuit, sitting *en banc*, explored both the legislative history of the Securities Exchange Act and its implications for public policy.

The 1934 Act seems to be premised on a basic notion or theory of market “efficiency”:

The idea of a free and open public market is built upon the theory that competing judgments of buyers and sellers as to the fair price of a security brings about a situation where the market price reflects as nearly as possible a just price. Just as artificial manipulation tends to upset the true function of an open market, so the hiding and secreting of important information obstructs the operation of the markets as indices of real value.¹⁶³

However, this form of efficiency is not self-executing or ensured solely through the unsupervised and unregulated workings of markets. There is an inherent “tug of conflicting interests” that must constantly be neutralized in order for the theory to work:

Manipulation and dishonest practices of the marketplace thrive upon mystery and secrecy. The disclosure of information materially important to investors may not instantaneously be reflected in market value, but despite the intricacies of security values truth does find relatively quick acceptance on the market. That is why in many cases it is so carefully guarded. Delayed, inaccurate, and misleading reports are the tools of the unconscionable market operator and the recreant corporate official who speculate on inside information.¹⁶⁴

For this reason, the SEC “has been charged by Congress with the responsibility of *policing* all misleading corporate statements.”¹⁶⁵

Only if this “policing” is actively and effectively pursued can Congress’s policy ideals be realized; such enforcement “is based in policy on the justifiable expectation of the securities marketplace that all investors trading on impersonal exchanges have relatively equal access to

162. SEC Rule 10b-5, 17 C.F.R. § 240.10b-5 (2021).

163. H.R. REP. NO. 73-1383, at 11, 73rd Cong., 2d Sess. 11 (1934).

164. *Id.*

165. *Texas Gulf Sulphur*, 401 F.2d at 861 (emphasis added).

material information.”¹⁶⁶

The core of Rule 10b-5 is the implementation of the Congressional purpose that all investors should have equal access to the rewards of participation in securities transactions. It was the intent of Congress that all members of the investing public should be subject to identical market risks . . . [I]nequities based upon unequal access to knowledge should not be shrugged off as inevitable in our way of life, or, in view of the congressional concern in the area, remain uncorrected.¹⁶⁷

Hitherto, efforts to achieve these policy goals “[had] been handicapped by the lack of legal power.”¹⁶⁸ The 1934 Act filled that gap. Indeed, the increasingly vigilant enforcement of “the securities laws should be interpreted as an expansion of the common law.”¹⁶⁹ “In an enforcement proceeding for equitable or prophylactic relief, the common law standard of deceptive conduct has been modified in the interests of broader protection for the investing public so that negligent insider conduct has become unlawful.”¹⁷⁰

This view of markets as routinely requiring external intervention—“policing”—lies at a great remove from Hayek’s position that markets function best when left serenely alone. Here, what counts as “best” lies in the eye of the beholder. When the controlling viewpoint is that of the investing public at large, considerations of a new order arise. No longer is it tenable—under the securities laws developed in the wake of the Great Depression—to “leav[e] matters of price and quality to be determined by the operation of the laws of supply and demand in the market.”¹⁷¹

III. AN INEFFICIENT TRUTH

Assuming a legal regime that prohibits all forms of market fraud (including trading on material, non-public information), should organized economic markets be subjected to any further supervision or regulation?

“Economists generally agree that rather than regulate behavior, it is more effective to allow individuals to choose their actions, as long as the prices appropriately reflect the costs, including the risks posed by climate change.”¹⁷² Economists confidently rely on “unsupervised” (unregulated)

166. *Id.* at 848.

167. *Id.* at 851-52.

168. *Id.* at 859 (quoting H.R. Rep. No. 73-1383).

169. *Id.* at 855.

170. *Id.* at 854-55.

171. Hamilton, *supra* note 115, at 1156 n.162.

172. Bob Litterman, *The Very High Costs of Climate Risk*, N.Y. TIMES, (Jan. 29, 2019), <https://www.nytimes.com/2019/01/29/opinion/climate-wildfires-bankruptcy-california.html> [<https://perma.cc/D5FM-JDJW>].

markets as the most *efficient* means (in some sense yet to be defined) of arriving at an optimal allocation of capital and other resources, which may then be put to their best possible use in producing goods and services. This confidence is based largely on an extensive literature explicating and advocating the *Efficient Market Hypothesis*.¹⁷³

This hypothesis changed the terms of debate over “the effects of information on markets.” Markets respond not to physical, causal forces but to *information*—or more precisely, its meaning. Information as such does not move markets; and market participants do not function essentially as robots or computer programs—blindly reacting, without knowing why, to information they do not understand.

Instead, that information must first be *interpreted*, so that its meaning—its intellectual content—provides an intelligible basis for exchange. The debate over the effects of information on markets can be conducted only at the conceptual level; and it is the prevailing opinions—among the totality of market participants—that end up moving markets.

All the central allocative functions depend on market-clearing exchanges, which occur only at agreed-upon prices. The efficient market hypothesis builds on Hayek’s analysis in asserting that the free, unsupervised (unregulated) marketplace is itself the best possible arbiter of prices.

Most notably, the theory holds that exceedingly few—if any—individuals can consistently outperform the returns of the overall market on a risk-adjusted basis. Thus, the market’s “judgment” on the allocation of capital and other resources should presumptively be followed. The “allure of free markets” thereby takes a positive form: “Free” markets provide for a more efficient allocation of capital and resources than any known form of regulation or market intervention could achieve.

A. *The Efficient Market Hypothesis*

Here are some of the most influential formulations of the Efficient Market Hypothesis:

[1] [W]hen . . . shares become publicly known in an open market, the value which they there acquire may be regarded as the judgment of the best intelligence concerning them.¹⁷⁴

[2] In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflect the effects of

173. See generally, Charles W. Collier, *An Inefficient Truth*, 23 CRITICAL REV. 29 (2011).

174. GEORGE RUTLEDGE GIBSON, *THE STOCK EXCHANGES OF LONDON, PARIS, AND NEW YORK* 11 (New York, G. P. Putnam’s Sons 1889).

information based both on events that have already occurred and on events which, as of now, the market expects to take place in the future.¹⁷⁵

[3] An “efficient” market for securities [is] a market where, given the available information, actual prices at every point in time represent very good estimates of intrinsic values . . . best estimates of intrinsic values.¹⁷⁶

[4] An efficient capital market is a market that is efficient in processing information. The prices of securities observed at any time are based on “correct” evaluation of all information available at that time. In an efficient market, prices “fully reflect” available information.¹⁷⁷

[5] In an efficient market all predictable things have already been built into the prices. It is the arrival of new information that affects stock or commodity prices. Moreover, the news must be random and unpredictable (or else it would be predictable and therefore not truly news).¹⁷⁸

Economic exchange takes place under what might be called—very generally—an “investment” paradigm. Transactions are pursued with an eye to the realization of economic values *in the future*. Rationally, no one would plan to buy something today, only to sell it back tomorrow at a lower price; implicitly, the entire market continually makes just this sort of calculation from the (imagined) perspective of the continually advancing future.

Seizing the high ground of the future, market participants look back and, belatedly, set prices for the present. The validity of today’s price is assessed from that (imagined) vantage point of the future. “The market” (i.e., all the individuals trading in it) sets current, actual prices on the basis of projections or forecasts of future prices.

All the innumerable market participants peer dimly into the foreseeable future and reach a collective judgment on today’s best price, based on their collective judgment as to what—tomorrow—will turn out to have been the best price for today. Current information must be parsed for what it portends about the future, because that projected future will, in turn, soon be reflected in current prices. But nothing is more uncertain than the future; these are obviously matters of interpretation, evaluation, and subjective judgment, any or all of which could go seriously awry at any time. Remarkably, the efficient market hypothesis claims that, in the

175. Eugene F. Fama, *Random Walks in Stock Market Prices*, 21 FIN. ANALYSTS J. 55, 55-56 (Sept.-Oct. 1965) [hereinafter Fama (1965b)].

176. Eugene F. Fama, *The Behavior of Stock-Market Prices*, 38 J. BUS. 34, 90, 94 (1965) [hereinafter Fama (1965a)].

177. EUGENE F. FAMA, FOUNDATIONS OF FINANCE 133 (1976) [hereinafter FAMA (1976)].

178. PAUL A. SAMUELSON & WILLIAM D. NORDHAUS, ECONOMICS 469-70 (19th ed. 2010).

aggregate, this seemingly contingent—even precarious—process never goes seriously awry.

Three factors should be noted already. First, the market is driven not by supply, demand, or the like, but by *meaning*; or rather, by the interpretation and evaluation of (the meaning of) information. “An efficient capital market,” writes Eugene Fama, “is a market that is efficient in processing information.”¹⁷⁹ Second, in maintaining that the process of setting prices—despite its seeming contingency and precariousness—never goes seriously awry, the efficient market hypothesis seems to make an empirical claim: The market *might* actually have gone awry . . . but it does not. Third, a normative claim is also involved: “The prices of securities observed at any time are based on ‘correct’ evaluation of all information available at that time.”¹⁸⁰

In an efficient market, says Fama, “prices ‘fully reflect’ available information.”¹⁸¹ Evidently, market “efficiency” is simply an expression of the idea that prices “fully reflect” *all* available information; but, as Fama acknowledges, “[t]he statement that prices in an efficient market ‘fully reflect’ available information . . . is too general to be testable.”¹⁸² “Since the goal is to test the extent to which the market is efficient, the proposition must be restated in a testable form. This requires a more detailed specification of the process of price formation, one that gives testable content to the term ‘fully reflect.’”¹⁸³

A normative claim proposes a standard, benchmark, “norm,” or ideal against which those things subject to the claim—in this case, actual, current market prices—are measured. On the basis of a forecasted “joint distribution” of future prices (call this the “ideal distribution”), the market sets actual, current prices (call this the “actual distribution”). The ideal joint distribution, says Fama, is the “true” distribution of (projected future) prices “*implied by*” the “correct[] assess[ment]” of all information now available.¹⁸⁴

We assume that one of the things that is knowable about the process is the implication of the current state of the world for the joint probability distributions of security prices at future times. . . [T]hat is, *the market understands the implications* of the available information for the joint distribution of returns.¹⁸⁵

In summary, “an efficient market correctly uses all available information

179. FAMA (1976), *supra* note 17, at 133.

180. *Id.*

181. *Id.*

182. *Id.* at 134

183. *Id.* at 134.

184. *Id.* (emphasis added).

185. *Id.* at 135–36 (emphasis added).

in assessing the joint distribution of future prices, which is the basis of current equilibrium prices.”¹⁸⁶

But the ideal standard cannot simply be left as a matter of definition; it must be restated or translated or converted into commensurable, quantifiable terms. For that, we need an “asset-pricing model” that says “what the current prices of securities . . . *should be* in light of the correctly assessed joint distribution of security prices” for the future.¹⁸⁷ The model explains how supply and demand, buying and selling, arrive at an equilibrium in the form of actual, market-clearing prices. And again, it does so on the basis of the “true” distribution of (projected future) prices “*implied by*” the “correct [] assess[ment]” of all information now available.¹⁸⁸

True, implied by, and correct are all logical terms; they describe logical inferences. The standard set by an asset-pricing model is not an empirical one; it is ideal or “normative.” But empirical evidence does enter in—and crucially so—when we compare what the model projects with what the market actually delivers. “Tests of market efficiency are concerned with whether or not the market does correctly use available information in setting security prices.”¹⁸⁹

So, suppose, upon comparison, actual security prices are *not* in fact what the model says they should be. Can we then confidently pronounce the market “inefficient”? Fama says,

This is the rub in tests of market efficiency. Any test is simultaneously a test of efficiency and of assumptions about the characteristics of market equilibrium. If the test is *successful*—that is, if the hypothesis that the market is efficient cannot be rejected—then this also implies that the assumptions about market equilibrium are not rejected. If the tests are *unsuccessful*, we face the problem of deciding whether this reflects a true violation of market efficiency (the simple proposition that prices fully reflect available information) or poor assumptions about the nature of market equilibrium.¹⁹⁰

In other words, the “norm” or “standard” of efficiency—the model used to define and specify “what constitutes an ‘efficient’ price response to information”¹⁹¹—might *itself* be faulty. In a later paper Fama puts these

186. *Id.* at 137.

187. *Id.* (emphasis added). In Fama’s formulation, prices are set for time $t - 1$ on the basis of forecasts or projections of prices at time t , which lies farther in the future: “[T]he market” assesses a joint distribution of security prices for time t and then uses the characteristics of its assessed distribution to determine equilibrium prices for securities at $t - 1$. . .” *Id.* at 135.

188. *Id.* at 134–36 (emphasis added).

189. *Id.* at 136.

190. *Id.* at 137 (emphasis added).

191. Ray Ball, *The Global Financial Crisis and the Efficient Market Hypothesis: What Have*

points rather more forcefully:

*[M]arket efficiency per se is not testable. It must be tested jointly with some model of equilibrium, an asset-pricing model. . . As a result, when we find anomalous evidence on the behavior of returns, the way it should be split between market inefficiency, or a bad model of market equilibrium is ambiguous.*¹⁹²

Thus, a *successful* test of the efficient market hypothesis implies that the relevant model of market equilibrium is not rejected. But if the test is *unsuccessful*, we are left unsure whether to blame market inefficiency or a bad model of market equilibrium. *In neither case* is the hypothesis of market efficiency directly falsified; in other words: regardless of the empirical evidence—and whatever it implies—the hypothesis of market efficiency is never directly falsified.

There is a subtle but important difference between a statement of the form: In setting prices, the market never goes seriously awry, and one of the form: In setting prices, the market cannot go seriously awry.

The first is merely an empirical report; the second is a logical, definitional, or categorical proposition. The first could presumably be refuted or disproved (“falsified”) by something so simple as an instance where the market indeed goes “seriously awry.” For that, we need criteria of what it would mean for the market to go awry. If *nothing* the market does (e.g., plunging 23 percent in one day) counts as “going awry,” then nothing could fail the test and no true testing is at hand. (If we do not know what “failing” the test means, then we do not know what “passing” means either, since these outcomes have to be defined—somehow—in relation to each other.)

The second proposition makes a much stronger claim; furthermore, it seems not to contemplate any testing at all. It seems to suggest that any attempted testing would reflect a basic misunderstanding, a fundamental “category mistake.” It would be like “testing” the proposition: “It is always either raining or not raining.” No conceivable state of affairs could disprove such a proposition; and since it cannot be disproved, it cannot be proved or confirmed either—at least not by empirical testing. “Simply put,” explains William Sharpe, “the thesis is this”:

[I]n a well-functioning market, the prices of capital assets (securities) will reflect predictions based on all relevant and available information. This seems almost trivially self-evident to most professional economists—so much so, that testing seems

We Learned?, 21:4 J. APPLIED CORP. FIN. 8, 14 (2009).

192. Eugene F. Fama, *Efficient Capital Markets: II*, 46 J. FIN. 1575-76 (1991) [hereinafter Fama (1991)] (emphasis added).

rather silly.¹⁹³

Yet, paradoxically, the best defense of the efficient market hypothesis might be to produce instances where markets were in fact *not* efficient. Then, one could begin to understand how the hypothesis could be tested, and to conceptualize what it would mean for markets to fail the test for efficiency. Until then, one can only assume that the efficient market hypothesis says that markets *cannot* go awry.

Only in relation to inefficiency can we understand (in any detail) “efficiency.” To say that there is, and can be, no market inefficiency is to say that “whatever the market does” counts as evidence of efficiency. It is to say that markets are, and can be, only what they are. These are tautologies or truisms that admit of no meaningful, empirical interpretation or testing.

At least as early as Kant, however, progress in science has meant advancing beyond mere (“analytic”) truths of logic to propositions that have meaningful, empirical content and that make claims about the real world (claims that could then conceivably be falsified). Popper adds that, “A theory which is not refutable by any conceivable event is non-scientific.”¹⁹⁴

In a scientific context, a fundamental proposition like “The market is efficient” cannot simply be accepted on faith; instead, it must be checked or tested (and the proposition must be specific enough to have a determinate meaning and make an ascertainable claim).¹⁹⁵ Now, testing is meaningless if nothing can fail the test. We have to prepare a mental space for the eventuality that our proposition might fail the test and be replaced by “The market is *not* efficient.” In short, we must be able to imagine and describe in some detail how the world would differ if markets were *not* efficient. We must be able to say what would count as an inefficient market.

Judged against these standards, the efficient market hypothesis cannot be viewed as a meaningful, scientific hypothesis. It is another “unempirical dogma of empiricists, a metaphysical article of faith.”¹⁹⁶

193. William F. Sharpe, *Efficient Capital Markets: A Review of Theory and Empirical Work: Discussion*, 25 J. FIN. 418, 418 (1970).

194. KARL POPPER, *CONJECTURES AND REFUTATIONS* 36 (5th ed. 1989).

195. *See, e.g., id.* at 33-65.

196. W.V. Quine, *Two Dogmas of Empiricism*, 60 PHIL. REV. 20, 34 (1951).

B. Empirical Hypotheses and the Principle of Significance

We refer to the “invisible hand” and the efficient market hypothesis as “metaphysical” articles of faith as a way of saying they do not make scientific claims that can be empirically tested. Here is how P.F. Strawson (interpreting Kant) puts it:

[T]here can be no legitimate, or even meaningful, employment of ideas or concepts which does not relate them to empirical or experiential conditions of their application. If we wish to use a concept in a certain way but are unable to specify the kind of experience-situation to which the concept, used in that way, would apply, then we are not really envisaging any legitimate use of that concept at all. In so using it, we shall not merely be saying what we do not know; we shall not really know what we are saying.¹⁹⁷

By its own terms, Adam Smith’s “invisible hand” is not an empirical concept; as befits a mystery, it makes no direct (visible) appearance. By pursuing his own interest,

[E]very individual] intends only his own gain, and he is in this, as in many other cases, *led by an invisible hand* to promote an end which was no part of his intention. . . . By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.¹⁹⁸

No doubt, if Smith could have pointed to an observable basis for his optimism, he would have done so. Much is left to the imagination.

More recently, the invisible hand has been analyzed in the prevailing terms of modern economic theory. But the relevant conceptual landscape is still populated by unobservable entities like “the market,” “competition,” “shortages,” “gluts,” “supply,” and “demand.”

Who tells all the specialized producers what goods to supply, and in what quantities? Who prevents them from overcharging for their wares? Smith’s answer was that no individual or authority has to carry out these tasks: the competitive market accomplishes them on its own. . . . If a shortage develops, prices rise and supply expands. If a glut occurs, prices fall and production contracts until supply and demand come into balance.¹⁹⁹

Here, the issue is not so much whether unobservable entities and forces

197. P.F. STRAWSON, *THE BOUNDS OF SENSE* 16 (1966).

198. ADAM SMITH, *WEALTH OF NATIONS*, *supra* note 20, at 456 (emphasis added).

199. JOHN CASSIDY, *HOW MARKETS FAIL* 30 (2009). This was Hayek’s answer too; *see e.g.*, Part II, *supra* note 70.

(e.g., gravitation) can be studied scientifically; the narrower issue is whether such study produces empirical claims that can actually be tested. In terms of the principle of significance,

[I]n order for a newly introduced or problematic concept (or concept-extension) to have significant employment, it is necessary that it should be possible to state or indicate types of observable situation[s] in which it has application –which is not to say that its *objects* must be observable. It is further necessary that its application in such a situation should have consequences or implications. . . .The temptation here is to say “testable consequences or implications”; and that addition . . . is no doubt on the right lines in so far as we are concerned with the concepts we call scientific.²⁰⁰

Like the “invisible hand,” market efficiency is not directly observable either.²⁰¹ It is a conclusion based on assumptions about how the use of information ideally plays out in economic markets. Yet here one meets with little doubt that claims of market efficiency can, after all, be empirically tested. Indeed, the conceptual basis for testing the efficient market hypothesis is widely assumed to be unproblematic. Here is how Eugene Fama describes the premises for such testing:

In an efficient market . . . the actions of the many competing participants should cause the actual price of a security to wander randomly about its intrinsic value. . . .
 ...[T]he “instantaneous adjustment” property of an efficient market implies that successive price changes in individual securities will be independent. [Such a] market . . . is, by definition, a random walk market. . . .
 ...The main concern of empirical research on the random walk model has been to test the hypothesis that successive price changes are independent.²⁰²

If successive price changes were *not* independent (i.e., if the discrepancies between actual prices and intrinsic values were systematic rather than random), “then knowledge of this should help intelligent market participants to better predict the path by which actual prices will move towards intrinsic values.”²⁰³ In a later paper Fama contemplates the possibility that some experts might have “keener insight into the implications of publicly available information than is implicit in market prices.”²⁰⁴ Neither of these should happen in an efficient market.

200. STRAWSON, *supra* note 197, at 270.

201. *See generally* Collier, *supra* note 173.

202. Fama (1965b), *supra* note 176, at 56 (emphasis added).

203. *Id.*

204. Eugene F. Fama, *Efficient Capital Markets: A Review of Theory and Empirical Work*, 25

Thus, the “test” for market efficiency becomes a test as to whether anyone can outperform (or “beat”) the market: In other words, if the analyst can make meaningful judgments concerning the purchase and sale of individual securities, his choices should consistently outperform randomly selected securities of the same general riskiness²⁰⁵ (which, again, would count against market efficiency).

But what, exactly, is being tested here? And what is the connection between market efficiency and the difficulty of beating the market? Fama says that the latter is “a major empirical *implication*” of the former.²⁰⁶ For Benoit Mandelbrot, the prevalence of large, discontinuous price changes in a ‘fair game’ market means that “certain systems of speculation, which would have been advantageous if one could implement them, cannot in reality be followed.”²⁰⁷

We take these writers to be referring to *implications* of market efficiency, so that the argument may be summarized as:

- (i) *If* markets were efficient, *then* it would be difficult if not impossible to outperform them consistently (on a risk-adjusted basis).
- (ii) It is indeed difficult if not impossible to outperform markets consistently (on a risk-adjusted basis).
- (iii) *Therefore*, markets are efficient.

This is an instance of a formal logical fallacy known as “affirming the consequent.”²⁰⁸ The premises (even if true) do not ensure the truth of the conclusion.²⁰⁹ For another example of this logically invalid inference, consider:

- (i) If I were on Pluto, then I would be cold.
- (ii) I am cold.
- (iii) Therefore, I am on Pluto.

The fact that I am cold supports, but in no way proves, the notion that I am on Pluto. The argument does not tell us about the *only* sufficient condition for being cold; I might, for example, be experiencing a cold day right here on Earth. Likewise, the fact that markets are difficult if not impossible to outperform consistently (on a risk-adjusted basis) might be a consequence

J. FIN. 383, 410 (1970) [hereinafter Fama (1970)].

205. Fama (1965b), *supra* note 144, at 58.

206. Fama (1970), *supra* note 204, at 385 (emphasis added).

207. Benoit Mandelbrot, *The Variation of Certain Speculative Prices*, 36 J. BUS. 394, 416 (1963).

208. See, e.g., ERNEST LEPORÉ, MEANING AND ARGUMENT, CH. 7 79-105 (rev. ed. 2003); MARK SAINSBURY, LOGICAL FORMS 54-121, CH. 2 (2d ed. 2001).

209. See, e.g., IRVING M. COPI & CARL COHEN, INTRO. TO LOGIC §§ 7.7, 8.7(B) (13th ed. 2009).

of something other than market efficiency. “Concluding that a hypothesis is proven true by the discovery that one of its implications is true amounts to committing the fallacy of affirming the consequent.” Where *H* stands for a hypothesis and *I* for an implication, such an argument has the invalid form:

If *H*, then *I*
I
*H*²¹⁰

Scientific inquiry proceeds by testing implications and thereby – gradually – narrowing possibilities. But, in the real world, no single implication can be conclusive (that, again, is the fallacy of affirming the consequent). The facts could always unfold some other way. For example, “If it rained last night (hypothesis), then the streets would be wet (implication).” True enough, but the streets could have gotten wet in any number of other ways not involving rain.

Only in the logical world - the conceptual world - can a single implication be conclusive. But there we are dealing with definitions, not empirical facts. The supporting implication is not truly “independent” of that which it is supposed to prove. For example:

- (i) *If I lived in New York, then I would be a New Yorker* (where *New Yorker* is defined as “someone who lives in New York”).
- (ii) I am a New Yorker.
- (iii) *Therefore, I live in New York.*

Or consider the theory that the planets possess some sort of “intelligence” by which they intentionally move in their observed orbits. The best (and perhaps only) evidence for this theory is the fact that the planets do indeed move in their observed orbits.

For the unscientific hypothesis there is no other directly testable proposition that can be deduced from it. Any scientific explanation of a given phenomenon, on the other hand, will have directly testable propositions deducible from it *other than the proposition stating the fact to be explained*. This is what we mean when we say that an explanation is *empirically verifiable*.²¹¹

And this is precisely what the efficient market hypothesis lacks.

The problem in the above examples is that the hypotheses are not distinguished from their (testable) implications. A hypothesis *has* implications (or consequences); it *is not* those implications itself (or a

210. PATRICK J. HURLEY, A CONCISE INTRO. TO LOGIC 569 (7th ed. 2000).

211. COPI & COHEN, *supra* note 209, at § 13.1.

paraphrase of them). “Whether it is applied in philosophy, science, or ordinary life, the hypothetical method involves four basic stages”:

1. Occurrence of a problem
2. Formulating a hypothesis
3. Drawing [“independent”] implications from the hypothesis
4. Testing the implications²¹²

Like detectives, we seek independent, factual implications of the hypothesis, such as: “If the suspect stole the car (hypothesis), then maybe the car keys are in his apartment (implication)--go check that out!”

Thus, *two* questionable assumptions plague efficient markets theory:

(1) “Efficiency” (“fully reflecting” all available information) is simply *defined as* the difficulty of beating market returns. But being “hard to beat” is either merely a paraphrase (a definitional reformulation) of the market efficiency concept itself—a concept that otherwise has no meaningful, empirical content—or simply one implication of it. “Concluding that a hypothesis is proven true by the discovery that one of its implications is true amounts to committing the fallacy of affirming the consequent.”²¹³ Thus, showing that it is difficult if not impossible to outperform markets consistently (on a risk-adjusted basis) is an inconclusive test of the efficient market hypothesis.²¹⁴ (Call this the *logical problem*.)

(2) The efficient market hypothesis is not directly falsifiable. Some model of equilibrium expected returns (an asset-pricing model, as described in the previous section) is always tested jointly with the hypothesis of market efficiency; so any systematic “anomalies” (as compared to what the model projects) may always indicate defects of the model rather than an actual falsification of the efficiency hypothesis. (Call this the *methodological problem*.)

But we will give Prof. Fama the last word:

212. HURLEY, *supra* note 210, at 568.

213. *Id.* at 569.

214. Paul Samuelson derives his ingenious theoretical proof of the Efficient Market Hypothesis from certain implications of price-setting in futures markets: “[T]he probability of an event’s [including the setting of commodity spot prices] happening is the sum of the probabilities of the different mutually-exclusive ways by which it could happen. . . . When the due date for [a] futures contract arrives, arbitrage will ensure that [the futures price converges on the terminal spot price]. . . . [In general,] a futures price [is set] by competitive bidding at the now-expected level of the terminal spot price. . . . This means that there is no way of making an expected profit by extrapolating past changes in the futures price.” Paul A. Samuelson, *Proof That Properly Anticipated Prices Fluctuate Randomly*, 6 INDUS. MANAGEMENT REV. 41, 43, 44 (1965). Yet even Samuelson, *Id.* at 42, notes that:

You never get something for nothing. From a nonempirical base of axioms you never get empirical results. Deductive analysis cannot determine whether the empirical properties of the stochastic model I posit come at all close to resembling the empirical determinants of today’s real-world markets.

[T]he assumption that the conditions of market equilibrium can be stated in terms of expected returns elevates the purely mathematical concept of expected value to a status not necessarily implied by the general notion of market efficiency. The expected value is just one of many possible summary measures of a distribution of returns, and market efficiency per se (i.e., the general notion that prices “fully reflect” available information) does not imbue it with any special importance. Thus, the results of tests based on this assumption depend to some extent on its validity as well as on the efficiency of the market. But some such assumption is the unavoidable price one must pay to give the theory of efficient markets empirical content.²¹⁵

215. Fama (1970), *supra* note 192, at 383, 384. A hypothesis must be distinguished from its (testable) implications. The Efficient Market Hypothesis says that markets always “fully reflect” all available information, as evidenced by their conformity with the “expected returns” projected by an appropriate asset-pricing model. (And, as Fama notes in the above passage, it is not strictly inherent in the concept of “efficiency” that it should even be measured in terms of expected returns.) A direct implication of the Efficient Market Hypothesis is that we should observe market-clearing prices adjusting in conformity with the projections of an appropriate asset-pricing model. This implication would be testable--except that it depends, in turn, on the assumed validity of the asset-pricing model itself. The notion that markets are “hard to beat” (outperform) is not even a direct implication of the Efficient Market Hypothesis. At best it is an indirect implication. It implies simply that those who strike out on their own, ignoring the projections of appropriate asset-pricing models, should expect their returns to differ correspondingly (for better or for worse) from those of the market as a whole. But this is something that, upon reflection, we would already have known, without even considering “market efficiency” at all. Let us make even more charitable assumptions. Assume that “the market” is nothing more, or other, than the totality of exchanges made by individual market participants. Then, the Efficient Market Hypothesis posits simply that none of those individual market participants can outperform the weighted, mean market return, on a long term, risk-adjusted basis. But this result is implausible on its face. It amounts to saying that no one is above average. Instead, the returns of individual market participants should form a normal distribution around the weighted mean--something that we would already have known, without even considering “market efficiency” at all.

IV. ECONOMIC MODELS OF REGULATION AND DEREGULATION

Many nations, perhaps most notably the United States, are entering the climate crisis at high-water levels of economic deregulation, including the substantial reduction or elimination of regulatory constraints involving fossil fuel industries and the environment. At the same time, a new style of theorizing has changed the intellectual trajectory of debate over economic regulation. Friedrich Hayek's *The Use of Knowledge in Society*,²¹⁶ for example, is a classic of descriptive economics, written in the Grand Style of Adam Smith, Marx, and Keynes. It could not be published in the *American Economic Review* (where it appeared in 1945)—or any comparable journal—today. To see why, a little discussion of current economic models may be useful.

A. *Limitations of Economic Models*

Economic theorizing at the highest levels has taken a distinctly quantitative, mathematical turn in recent years, which has given rise to a new paradigm for economic research and scholarship.²¹⁷ Briefly, the prevailing way of proving a theory in economics today is to draw up a model of the economy (or part of the economy) and then show—under specified conditions—how the model generates the result that the theory predicts.²¹⁸ The use of this new paradigm may be elaborated as follows.¹²

(1) An economic “phenomenon” is observed, provisionally identified, and described in general terms. For example, high interest rates or an inverted yield curve are commonly seen as harbingers of declines in the equity markets or even of recession.

(2) The process responsible for producing the phenomenon is then analyzed and “modeled.” That is, the researcher proposes a mechanism or causal sequence of events that could have led to the phenomenon in question. This involves identifying relevant economic factors that could play outcome-determining roles, and then combining them in a plausible formula. Sometimes, only the most salient and important factors can realistically be taken into account; in that case, the generality of the results is acknowledged to be correspondingly limited.

(3) The model is then tested or “run,” in the way a complicated equation is solved. Empirical values are substituted for constants and for those variables that are thought to produce the phenomenon in question. The model is successful (again, to the degree of generality claimed) if the

216. Hayek, *supra* note 70, 35 AMERICAN ECON. REV. 519 (1945).

217. Robert E. Lucas, Jr., *Econometric Policy Evaluation: A Critique*, 1 CARNEGIE-ROCHESTER CONFERENCE SERIES ON PUB. POL'Y 19, 20 (1976).

218. *Id.*

formula produces empirical values that are reasonably close to those by which the phenomenon was originally identified and quantified.

As an illustration of rudimentary economic modeling, consider *Robinson Crusoe*, “the great early document of radical individualism, the story of an ordinary person’s practical and psychic survival in profound isolation.”²¹⁹ Here is how von Neumann and Morgenstern model the “Robinson Crusoe economy.”

[T]he type of economy which is represented by the “Robinson Crusoe” model . . . is an economy of an isolated single person or otherwise organized under a single will. This economy is confronted with certain quantities of commodities and a number of wants which they may satisfy. . .

Crusoe is given certain physical data (wants and commodities) and his task is to combine and apply them in such a fashion as to obtain a maximum resulting satisfaction. There can be no doubt that he controls exclusively all the variables upon which this result depends—say the allotting of resources, the determination of the uses of the same commodity for different wants, etc.

Thus, Crusoe faces an ordinary maximum problem, the difficulties of which are of a purely technical—and not conceptual—nature.²²⁰

For example, given a quantity of fencing material, Crusoe might need to determine: “[W]hat four-sided figure will make it surround the largest area?”²²¹

Since economic models are the mainstay of contemporary economic theorizing at the highest levels, economists like Robert Lucas are generally attentive to potential shortcomings of their models (departures from reality that affect validity), and sometimes they attempt to preempt criticism of their models:

[A]s is true with any technically difficult and novel area of science, econometric model building is subject to a great deal of ill-informed and casual criticism. Thus models are condemned as being “too big” (with equal insight, I suppose one could fault smaller models for being “too little”), too messy, too simplistic (that is, not messy enough), and, the ultimate blow, inferior to “naive” models. Surely the increasing sophistication of the “naive” alternatives to the major forecasting models is the highest of tributes to the remarkable success of the latter.²²²

219. Jonathan Franzen, *Farther Away*, THE NEW YORKER, (Apr. 18, 2011.).

220. JOHN VON NEUMANN & OSKAR MORGENSTERN, THEORY OF GAMES AND ECONOMIC BEHAVIOR 9-10 §§ 2.2.1.-2.2.2. (Sixtieth-Anniversary ed. 2004) (1944).

221. *Id.* at 675 (quoting Paul Samuelson).

222. Robert E. Lucas, Jr., *Econometric Policy Evaluation: A Critique*, 1 CARNEGIE-

Consider for example a model that seems to make “unrealistic assumptions” about the capacities of individual market participants to assimilate detailed economic data when forming expectations and making decisions. As Robert Shiller puts it, toward the end of a lengthy critique,

[I]n the natural rate [of unemployment] literature . . . unemployed individuals are themselves supposed to take into account optimally all sorts of published economic data in forecasting today’s prices (or money supply) . . . If anyone believes this, he should take a trip to the nearest unemployment compensation office and ask people standing in line for the latest data on the growth of the money supply, the government surplus, or the latest inflation forecast of an econometric model.²²³

“While entirely natural and understandable,” respond Milton Friedman and L.J. Savage, “*this objection is not strictly relevant.*”²²⁴ Models are judged (tested) not by their “assumptions” but by their *implications*—in particular, those that are “susceptible to empirical contradiction.”²²⁵ Thus, criticism of “unrealistic” assumptions ““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.”²²⁶ In the absence of such evidence, Shiller’s suggested questions (for the unemployed people waiting in line) are “about on a par with testing theories of longevity by asking octogenarians how they account for their long life.”²²⁷

A significant theory “explains more by less.”²²⁸ It asserts that certain factors are important in understanding certain phenomena; and it proceeds

ROCHESTER CONF. SERIES ON PUB. POL’Y. 19, 20 (1976). Lucas himself demonstrates the conceptual power of modeling in an earlier work in which he derives important results on the neutrality of money (independence of real and nominal magnitudes) from a model boldly postulating:

Exchange in the economy studied takes place in two physically separated markets. . . . Information on the current state of . . . real and monetary disturbances is transmitted to agents only through prices in the market where each agent happens to be. In the particular framework presented . . . prices convey this information only imperfectly, forcing agents to hedge on whether a particular price movement results from a relative demand shift or a nominal (monetary) one.

“This hedging behavior,” he notes, is “similar in nature to that which we observe in reality.” *Expectations and the Neutrality of Money*, 4 J. OF ECON. THEORY 103, 103 (1972).

223. Robert J. Shiller, *Rational Expectations and the Dynamic Structure of Macroeconomic Models: A Critical Review*, 4 J. OF MONETARY ECON. 1, 36 (1978).

224. Milton Friedman & L.J. Savage, *The Utility Analysis of Choices Involving Risk*, 56 J. OF POL. ECON. 279, 297-98 (1948) (emphasis added).

225. Milton Friedman, *The Methodology of Positive Economics*, in *ESSAYS IN POSITIVE ECONOMICS* 3, 12-15, 38 (1953).

226. *Id.* at 31.

227. *Id.*

228. *See id.* at 14-15, 34 (“If a class of ‘economic phenomena’ appears varied and complex, it is, we must suppose, because we have no adequate theory to explain them.”).

to construct an abstract and highly simplified world, populated by abstract and highly simplified assumptions (“ideal types”) that draw attention to just those features deemed important.²²⁹ As Friedman famously asks: Why not predict the shots made by an expert billiard player on the hypothesis that:

the billiard player ma[kes] his shots *as if* he knew the complicated mathematical formulas that would give the optimum directions of travel, could estimate accurately by eye the angles, etc., describing the location of the balls, could make lightning calculations from the formulas, and could then make the balls travel in the direction indicated by the formulas?²³⁰

Now, of course, these suppositions do not accurately or “realistically” describe the actual thought processes of any actual billiard players, expert or not. They are a “fiction” (not unlike the fiction - the “mathematical expectation” - that every player in a fair, ten-person lottery will win one-tenth of the prize). Confidence in the hypothesis is justified because it *works*: “[U]nless in some way or other [the billiard players] were capable of reaching essentially the same result, they would not in fact be *expert* billiard players.”²³¹ In short, the assumptions of economic models should be judged by their results—and nothing else.²³²

B. Models and Theories of Regulation

The following three models of regulation have been especially influential:

*Public Interest Model.*²³³ Think of the political process as a (civic republican) “deliberative democracy” in which ideas are the coin of the realm. The political process produces legislators, executives, and their regulator-agents, who—by definition (i.e., as a function of

229. *See id.* at 36, 40-41.

230. *Id.* at 21.

231. *Id.*

232. Some important qualifications of Friedman’s analysis are suggested by Amar Bhidé:

First, unrealistic assumptions may well have value . . . in making positive theories concise. . . . But cutting back on practice to learn complicated math is likely to lower—not increase—a player’s performance. . . .

Second, if the crucial assumptions of a hypothesis are totally far-fetched, it is impossible to derive sensible predictions. If expert billiard players who make good shots most of the time don’t exist . . . then the theory of how experts make their shots cannot lead to any testable predictions.

AMAR BHIDÉ, A CALL FOR JUDGMENT: SENSIBLE FINANCE FOR A DYNAMIC ECONOMY 99-100 (2010).

233. *See* United States v. Carolene Products Co., 304 U.S. 144, 152 n.4 (1938); Frank I. Michelman, *Supreme Court, 1985 Term—Foreword: Traces of Self-Government*, 100 HARV. L. REV. 4 (1986); Cass R. Sunstein, *Beyond the Republican Revival*, 97 YALE L.J. 1539 (1988); United States v. Carolene Products Co., 304 U.S. 144, 152 n.4 (1938).

the process by which they were selected)—reflect and represent the public interest. Regulators set rules for producers (safety, quality, price, entry control) that protect and benefit consumers and, ultimately, the public at large.

*Interest Group Model.*²³⁴ Think of the political process as primarily involving bargaining; in this model “economic regulation is not about the public interest at all.”²³⁵ Self-interested groups seek to advance their own (private) interests by bargaining (rather than debating) with other such groups. The composition of the legislature, the executive, and (indirectly) the regulatory agencies reflects the outcome of this bargaining process. Likewise, “the regulatory process is . . . viewed as the outcome of implicit (sometimes explicit) bargaining between the agency and the regulated firms.”²³⁶

*Economic Model of Regulation.*²³⁷ Think of all actors in the regulatory scheme—regulators, producers, and consumers—as wanting something (demand) and as having something to offer (supply). “The suppliers . . . are unspecified political actors [legislators, executives, and their regulator-agents]...What they have to sell is power . . . over the wealth of a regulated industry’s buyers and sellers. These two groups compete for access to this power, and the high bidder wins. The currency with which the demanders bid . . . includes votes delivered in support of politicians, campaign contributions, jobs in the political afterlife, and so forth. The prototypical result of the competition is the triumph of the cohesive producer interest over the diffuse consumer interest.”²³⁸ The *regulator* is thereby effectively “captured” by the *regulated*.

234. See A.F. BENTLEY, *THE PROCESS OF GOVERNMENT* (1908); D.B. TRUMAN, *THE GOVERNMENT PROCESS: POLITICAL INTERESTS AND PUBLIC OPINION* (1951); R. DAHL, *A PREFACE TO DEMOCRATIC THEORY* (1956); cf. George J. Stigler, *The Theory of Economic Regulation*, 2 *BELL J. ECON. AND MANAG. SCI.* 3, 3 (1971):

[T]he political process defies rational explanation: “politics” is an imponderable, a constantly and unpredictably shifting mixture of forces of the most diverse nature, comprehending acts of great moral virtue (the emancipation of slaves) and of the most vulgar venality (the congressman feathering his own nest).

235. Richard A. Posner, *Theories of Economic Regulation*, 5 *BELL J. ECON. AND MANAGEMENT. SCI.* 335, 341 (1974).

236. *Id.* at 342.

237. See George J. Stigler, *The Theory of Economic Regulation*, 2 *BELL J. ECON. AND MANAG. SCI.* 3 (1971); Sam Peltzman, *The Economic Theory of Regulation After a Decade of Deregulation*, *BROOKINGS PAPERS ON ECON. ACTIVITY (MICROECONOMICS)* 1 (1989).

238. Sam Peltzman, *George Stigler’s Contribution to the Economic Analysis of Regulation*, 101 *J. POL. ECON.* 818, 823 (1993).

In the case of environmental regulation, some version of the latter two models is undoubtedly ascendant. But the evidence is ambiguous, and the theories are vague. “Most of the evidence” supporting the economic theory of regulation, writes Richard Posner, “is consistent with *any version* of the interest group theory.”²³⁹ Moreover, the effects of economic regulation may be difficult to trace: “We do not know whether to regard automobile emission controls as a sign of the industry’s inability to ward off adverse regulation or as a token of how limited, and late, government regulation of the automobile industry has been.”²⁴⁰ George Stigler’s influential argument for an economic theory of regulation proceeds on the following key premise: “When an industry receives a grant of power from the state, the benefit to the industry will fall short of the damage to the rest of the community.”²⁴¹ Structurally, this premise reflects nothing more, or less, than “the tragedy of the commons” all over again—the concerted and inefficient exploitation of the common good by a legally, strategically, and economically insulated special interest. This would not happen in a rational world. Stigler acknowledges as much in conceding that “our theory of rational political processes would be contradicted” if “a direct and informed vote” on oil import quotas, for example, did not reject the scheme outright.²⁴²

If regulatory “capture” leads to irrational results, like a tragedy of the commons, why does it persist? “To explain why many industries are able to employ the political machinery to their own ends,” says Stigler, “we must examine the nature of the political process in a democracy”²⁴³ (primarily through a comparison with economic markets).

In a competitive economic market, preferential “voting” is direct, immediate, and continuous. “A consumer chooses between rail and air travel, for example, by *voting with his pocketbook*: he patronizes on a given day that mode of transportation he prefers. . . . The market accumulates these economic votes, predicts their future course, and invests accordingly.”²⁴⁴

By contrast, voting in a political democracy takes place only at appointed times and places—and addresses general policies that, if enacted, will apply to everyone.²⁴⁵ “[T]he political process does not allow participation in proportion to interest and knowledge.”²⁴⁶ Preferences are communicated only in diffuse form, as it would be stupendously

239. Posner, *supra* note 201, at 352.

240. *Id.* at 355.

241. George J. Stigler, *The Theory of Economic Regulation*, 2 BELL J. ECON. AND MANAG. SCI. 3, 10 (1971).

242. *Id.*

243. *Id.*

244. *Id.* (emphasis added).

245. Stigler, *supra*, at 12.

246. *Id.* at 11.

inconvenient (and thus inefficient) to have a vote “whenever a number of . . . citizens desired to register their views on railroads versus airplanes.”²⁴⁷ Instead, one votes for *representatives* who have wide discretion, thereby diffusing preferences even further.²⁴⁸

The channels of political decisionmaking may thus be described as “gross or filtered or noisy,” concludes Stigler: “The system is calculated to implement all strongly felt preferences of majorities and many strongly felt preferences of minorities but to disregard the lesser preferences of majorities and minorities.”²⁴⁹ To all the impediments to collective action chronicled by Mancur Olson,²⁵⁰ one might add the counter-majoritarian control of the U.S. Senate, the Electoral College, and (by implication) the U.S. Supreme Court. In other words, liberal democracy—as presently constituted, conceptualized, and constitutionalized—does not work as advertised.²⁵¹

Chances are, the farther we pursue this analysis, the farther we will leave behind the most interesting and important (“primary”) regulatory questions.

Consider, as an example of [pre-1971 empirical research on regulation] the Stigler-Friedland article. The main line of inquiry here is, Did regulation accomplish its stated goal (lower rates)? The Stigler of 1962 armed with his theory of 1971 instead might have asked, Which influential interest groups would the utility commission plausibly serve?²⁵²

—a distinctly derivative question. A focus on derivative questions goes hand-in-hand with a certain complacency about our current regulatory regime. So, why not simply don the rose-colored glasses through which Andrei Shleifer apparently views the world? Certainly, they are offered with the kind of serene assurance that generally accompanies unimpeachable evidence:

[T]oday we live in a much richer, more benign, but also more regulated society, and . . . as consumers *we are generally happy* with most of the regulations that protect us. We are happier

247. *Id.* at 10.

248. See Gary S. Becker, *Competition and Democracy*, 1 J. L. AND ECON. 105, 108 (1958) (“[I]t does not ‘pay’ to be well-informed and thoughtful on political issues, or even to vote” . . . “[T]he incentives to act wisely are greater [in the marketplace] than in the political sector.”)

249. Stigler, *supra* note 207/203, at 12.

250. See *generally* MANCUR OLSON, JR., *THE LOGIC OF COLLECTIVE ACTION* (revised ed. 1971).

251. See Charles W. Collier, *The Unwritten Rules of Liberal Democracy*, 15 U. OF MASS. L. REV. 197 (forthcoming 2020).

252. Sam Peltzman, *George Stigler’s Contribution to the Economic Analysis of Regulation*, 101 J. Pol. Econ. 818, 824–25 (1993).

knowing that *trains and airplanes are safe* than savouring the thought of a fortune which our loved ones would collect in a trial should we die in a fiery crash. . . . A more nuanced theory, which incorporates the powerful Chicago critiques of the public interest approach to government, but also recognises the benefits of public involvement in at least some activities, is clearly needed to keep the logic and the facts together.²⁵³

In this Keynote Address, published in 2005, Shleifer does not mention the words “global warming” or “climate change,” even in passing.²⁵⁴ We are, all of us, children of our time to some extent.

In the next section we discuss 346 people who were “generally happy” with their respective regulatory regimes—until suddenly they weren’t.

C. Regulatory “Capture” Under Late Capitalism: A Case Study

The Boeing Company is the largest aerospace manufacturer in the United States and the nation’s leading manufacturing exporter.²⁵⁵ The Boeing 737, introduced in the 1960s, is the best-selling commercial jetliner of all time; its latest iteration, the 737 Max, is Boeing’s top-selling plane today.²⁵⁶ Boeing exerts considerable influence on the American economy.²⁵⁷ It has been estimated that curtailing production of the 737 Max could “shave about six-tenths of a percent off the gross domestic product growth rate, the financial equivalent of a prolonged government shutdown or a significant natural disaster.”²⁵⁸

The first Boeing 737 was christened in 1967.²⁵⁹ Few complicated, high-technology products are still in service more than fifty years after being introduced. Yet, even today, “nearly one in every three domestic flights in the United States is on a 737, more than any other line of aircraft.”²⁶⁰ The key to the 737’s phenomenal success is its continual “updating,” rather than replacement by a newly designed plane.²⁶¹ This

253. Andrei Shleifer, *Understanding Regulation*, 11 Eur. Fin. Mgmt. 439, 441–42 (2005) (emphasis added).

254. *Id.*

255. David Gelles, *Boeing May Halt 737 Max Production As Economic Fallout Spreads*, N.Y. Times (July 24, 2019), <https://www.nytimes.com/2019/07/24/business/boeing-earnings-737-max.html> [<https://perma.cc/RG4W-WLZD>] [hereinafter Boeing 6].

256. *Id.*

257. *Id.* Boeing has more than 140,000 employees, annual sales of some \$100 billion, and a stock market capitalization of about \$190 billion. *Id.*

258. *Id.*

259. *Id.*

260. Jack Nicas & Julie Creswell, *Boeing’s 737 Max: 1960s Design, 1990s Computing Power and Paper Manuals*, N.Y. TIMES (Apr. 8, 2019), <https://www.nytimes.com/2019/04/08/business/boeing-737-max.html> [<https://perma.cc/NYE2-8RAW>] [hereinafter Boeing 1].

261. *Id.*

has had a number of important advantages: “Airlines wanted new 737s to match their predecessors so pilots could skip expensive training in flight simulators and easily transition to new jets. Boeing’s strategy worked. The Federal Aviation Administration never required simulator training for pilots switching from one 737 to the next.”²⁶²

Further, the certification process is easier for a “derivative” model. “Over the years, the F.A.A. has implemented new and tougher design requirements”—often involving safety— “but a derivative gets many of the designs grandfathered in”²⁶³

Over the years, market and technological forces pushed the 737 into ever-larger versions with increasing electronic and mechanical complexity. . .

Most of those market and technical forces are on the side of economics, not safety. They work as allies to relentlessly drive down what the industry calls “seat-mile costs”—the cost of flying a seat from one point to another.²⁶⁴

Still, the Boeing 737 would probably have died a natural death but for a series of events starting in 2010. That year Boeing’s main rival, the European Airbus consortium, announced the development of a directly competing airplane, the A320, that would utilize larger, more fuel-efficient engines.²⁶⁵ By all accounts, Boeing did not take this threat seriously until the spring of 2011, when American Airlines considered placing its largest-ever order of new aircraft exclusively with the more fuel-efficient Airbus.²⁶⁶ To win over American, Boeing ditched the idea of developing a new passenger plane, which would take a decade. Instead, it decided to update its workhorse 737, promising the plane would be done in six years. The 737 Max was born roughly three months later.”²⁶⁷ Ultimately,

262. *Id.*

263. Ralph Vartabedian, *Boeing Is Haunted by a 50-Year-Old Feature of 737 Jets Must Reads: How a 50-year-old Design Came Back to Haunt Boeing with its Troubled 737 Max Jet*, L.A. TIMES, (Mar. 15, 2019, 6:00 AM), <https://www.latimes.com/local/california/la-fi-boeing-max-design-20190315-story.html> [<https://perma.cc/4JRY-MDRV>] [hereinafter *L.A. Times*]. There are also disadvantages with the “updating” approach. The original Boeing 737 had a unique, low-slung frame that enabled passengers to board by climbing folding stairs attached to the fuselage and allowed ground crews to load heavy baggage by hand. That low-to-the-ground design was an advantage in the days before jetways for boarding and motorized conveyor belts for loading baggage; “but it has proved to be a constraint that engineers modernizing the 737 have had to work around ever since.” *Id.*

264. Gregory Travis, *How the Boeing 737 Max Disaster Looks to a Software Developer*, IEEE SPECTRUM, (Apr. 18, 2019), <https://spectrum.ieee.org/how-the-boeing-737-max-disaster-looks-to-a-software-developer> [<https://perma.cc/K775-Q68K>].

265. David Gelles, Natalie Kitroeff, Jack Nicas & Rebecca R. Ruiz, *Boeing Was ‘Go, Go, Go’ To Beat Airbus with the 737 Max*, N.Y. TIMES, (Mar. 23, 2019), <https://www.nytimes.com/2019/03/23/business/boeing-737-max-crash.html> [<https://perma.cc/3FNJ-ZECU>] [hereinafter Boeing 2].

266. *Id.*

267. *Id.*

American Airlines hedged its bet, placing large orders with both Boeing and Airbus.

Boeing quickly mobilized: “Months behind Airbus, Boeing had to play catch-up. The pace of the work on the 737 Max was frenetic.”²⁶⁸ Technical drawings and designs were demanded of Boeing engineers in roughly half the usual time. “Sloppy” blueprints were delivered by rushed designers; and some omissions (“like not specifying which tools to use to install a certain wire, a situation that could lead to a faulty connection”) were never corrected.²⁶⁹ The first 737 Max was completed in November 2015; deliveries began in 2017, as promised.²⁷⁰

Boeing’s swift progress would not have been possible without a heavily deregulated certification process at the Federal Aviation Administration. For decades, Congress had encouraged the F.A.A. to delegate more certification work to manufacturers. Starting in 2005, a program known as “Organization Designation Authorization” allowed Boeing to select company employees who would work for the F.A.A. to help certify their own aircraft.²⁷¹ “By 2018, the F.A.A. was letting [Boeing] certify 96 percent of its own work.”²⁷² This “deregulated” approach came to assume defining importance: “At crucial moments in the Max’s development, the agency operated in the background, mainly monitoring Boeing’s progress and checking paperwork. The nation’s largest aerospace manufacturer, Boeing was treated as a client, with F.A.A. officials making decisions based on the company’s deadlines and budget.”²⁷³ Obviously, many of those decisions involved safety.²⁷⁴ Most notably, the 737 Max’s larger, more powerful engines (and their placement) increased lift (and the “angle of attack”) to such an extent that a counteracting computer program (called MCAS) was needed to push the nose back down to avoid stalling.²⁷⁵ “Boeing’s solution to its hardware

268. *Id.*

269. *Id.*

270. *Id.*

271. Natalie Kitroeff, David Gelles & Jack Nicas, *The Roots of Boeing’s 737 Max Crisis: A Regulator Relaxes Its Oversight*, N.Y. TIMES, (July 27, 2019) (online ed.) (emphasis added) [hereinafter *Boeing 4*].

272. *Id.*

273. Natalie Kitroeff, David Gelles & Jack Nicas, *The Roots of Boeing’s 737 Max Crisis: A Regulator Relaxes Its Oversight*, N.Y. TIMES, (July 27, 2019), <https://www.nytimes.com/2019/07/27/business/boeing-737-max-faa.html> (online ed.) (emphasis added) [hereinafter *Boeing 4*].

274. *Id.*

275. The main premise of the 737 Max was that it would utilize larger, more powerful, and more fuel-efficient engines. But, for decades the low frame of the 737 had “repeatedly complicated efforts to fit bigger engines under the wing” —complications that only intensified with the 737 Max. *Boeing 1*. Boeing’s “solution” was to move the engines *forward*, where—clear of the wing at their greatest diameter—they could then also be positioned *higher*, thereby maintaining the necessary ground clearance.

Meanwhile, however (back in the Department of Unintended Consequences), “[t]he change . . . affected the plane’s aerodynamics. Boeing discovered the new position of the engines increased the

problem was software.”²⁷⁶

On October 29, 2018, a brand new Lion Air Boeing 737 Max fell out of a clear blue sky, minutes after takeoff, killing all 189 people aboard.²⁷⁷ It appears that faulty data from a single angle-of-attack sensor triggered the MCAS computer program to push the plane’s nose down repeatedly—despite the pilots’ best efforts to wrestle it up.²⁷⁸ The 737 Max is “the only modern Boeing jet without an electronic alert system that explains what is malfunctioning and how to resolve it. Instead, pilots have to check a manual” (from which all mention of the MCAS system had been removed, anyway).²⁷⁹ “In the doomed Indonesia flight, as the Lion Air pilots struggled with MCAS for control, the pilots consulted the manual moments before the jet plummeted into the Java Sea.”²⁸⁰

After the Lion Air crash, Boeing revealed to the world (and especially to the world’s airline pilots) the existence of the MCAS system, along with detailed, arduous procedures for disengaging the system.²⁸¹ But less than five months later, a brand new Ethiopian Airlines Boeing 737 Max fell out of a clear blue sky, minutes after takeoff, killing all 157 people aboard.²⁸² “Investigators in Ethiopia said the pilots on that flight repeatedly used procedures outlined by Boeing to disengage the MCAS system, but the

lift of the aircraft, creating a tendency for the nose to pitch up.” L.A. Times. This is an ominous “tendency.” A passenger airplane, unlike a fighter jet, cannot fly straight up; if it did, it would stall -- and then fall out of the sky like a rock. Stalling is a classic plot-element of aviation nightmares.

Boeing’s “solution” to this second, self-imposed problem was to add a special computer program called the “Maneuvering Characteristics Augmentation System” (MCAS). If even one sensor monitoring the “angle of attack” (the angle at which air flows over the wings) detected too high an angle, the MCAS program would automatically activate the rear stabilizer, pushing the nose down. “The F.A.A. eventually handed over responsibility for approval of MCAS to the manufacturer. After that, Boeing didn’t have to share the details of the system with the two agency engineers.” Boeing 4. To avoid the need for additional pilot training, Boeing even asked if it could simply remove all references to MCAS from the pilot’s manual; the F.A.A. readily agreed.

276. “The 737 Max saga teaches us not only about the limits of technology and the risks of complexity, it teaches us about our real priorities. Today, safety doesn’t come first—money comes first, and safety’s only utility in that regard is in helping to keep the money coming. The problem is getting worse because our devices are increasingly dominated by something that’s that is all too easy to manipulate software. Hardware defects, whether they are engines placed in the wrong place on a plane or O-rings that turn brittle when cold, are notoriously hard to fix. And by hard, I mean expensive. Software defects, on the other hand, are easy and cheap to fix. . .”.

“I believe the relative ease—not to mention the lack of tangible cost—of software updates has created a cultural laziness within the software engineering community. Moreover, because more and more of the hardware that we create is monitored and controlled by software, that cultural laziness is now creeping into hardware engineering—like building airliners. Less thought is now given to getting a design correct and simple up front because it’s so easy to fix what you didn’t get right later.” Gregory Travis, *How the Boeing 737 Max Disaster Looks to a Software Developer*, *supra* note 224.

277. Boeing 1.

278. *Id.*

279. Boeing 1, *supra* note 221.

280. *Id.*

281. *Id.*

282. David Gelles & Zach Wichter, *Boeing 737 Max: The Latest on the Deadly Crashes and the Fallout*, N.Y. TIMES, July 18, 2019.

plane still wound up in an unrecoverable nose-dive.”²⁸³ “In both doomed flights, pilots struggled as a single damaged sensor sent the planes into irrecoverable nose-dives within minutes, killing 346 people and prompting regulators around the world to ground the Max.”²⁸⁴

There is no shortage of blame to allocate in this sad saga. “‘Having two crashes in rapid succession with no survivors is really unprecedented in modern aviation industry,’ said Chesley B. Sullenberger III,” the veteran pilot who safely landed a disabled jet in the Hudson River.²⁸⁵ Going forward, the urgent question becomes: Can a modern commercial jetliner—that, *per* design, has an inherent tendency to stall—truly be deemed “safe”? The answer will tell us a lot about our regulatory regime.²⁸⁶

Initial indications are not auspicious. At the same time as European regulators were grounding the 737 Max because they could not determine what was causing its crashes, the F.A.A. was declining to ground the plane *for the same reason*.²⁸⁷

Britain . . . explain[ed] that it was grounding the Boeing planes because authorities did not know the cause of the most recent crash, of an Ethiopian Airlines plane on Sunday.²⁸⁸

The Federal Aviation Administration, by contrast, said until Wednesday that the absence of information was the reason it was letting domestic airlines keep the planes in the air.²⁸⁹

In other words, the F.A.A. extended a “presumption of safety” (*safe* until actually proven otherwise) to the 737 Max, thereby putting additional lives at risk. If our regulators cannot protect us from something so straightforward and salient as airplane crashes, how can they protect us from a looming climate catastrophe they barely comprehend? These may be viewed as long-term consequences of abandoning the Public Interest Model of regulation.

283. *Id.*

284. Jack Nicas, Natalie Kitroeff, David Gelles & James Glanz, *Boeing Built Deadly Assumptions Into 737 Max, Blind to a Late Design Change*, N.Y. TIMES, (June 1, 2019), <https://www.nytimes.com/2019/06/01/business/boeing-737-max-crash.html> [<https://perma.cc/87GD-8J8X>].

285. David Gelles, *Costs for Boeing Start to Pile Up As 737 Max Remains Grounded*, N.Y. TIMES, (Apr. 12, 2019), <https://www.nytimes.com/2019/04/12/business/boeing-planes-economy.html> [<https://perma.cc/W4TM-Y8SP>].

286. See Joint Authorities Technical Review, *Boeing 737 MAX Flight Control System, Joint Authorities Technical Review: Observations, Findings, and Recommendations, Submitted to the Associate Administrator for Aviation Safety*, U.S. FED. AVIATION ADMIN. (Oct. 11, 2019), https://www.faa.gov/news/media/attachments/Final_JATR_Submittal_to_FAA_Oct_2019.pdf [<https://perma.cc/95AS-KQ5F>].

287. Editorial Board, *Why Does the U.S. Tolerate So Much Risk?*, N.Y. TIMES (Mar. 15, 2019), <https://www.nytimes.com/2019/03/15/opinion/federal-aviation-administration-boeing.html> [<https://perma.cc/T3XG-Y6EA>].

288. *Id.*

289. *Id.*

V. WHAT KIND OF PROBLEM IS CLIMATE CHANGE?

The world shall burn, and from her ashes spring
 New heaven and earth, wherein the just shall dwell,
 And after all their tribulations long
 See golden days, fruitful of golden deeds,
 With joy and love triumphing, and fair truth.

--*Paradise Lost*²⁹⁰

Even the most obvious economic approaches to the problem(s) of climate change have met with intractable resistance. The reasons are not hard to find—they are the very same reasons that climate change developed into a crisis in the first place: biases of cognitive psychology, limitations of instrumental rationality, and the economic assumptions reflecting these most salient human characteristics of the post-industrial age. Under these circumstances, it is not entirely clear *what kind of problem* climate change truly represents. The following sections explore some of the more plausible possibilities—and their corresponding solutions.

A. *Climate Change as a Scientific Problem*

1. *Greenhouse Effect*

All bodies give off radiation and the amount of radiation emitted is dependent on the temperature of the body.²⁹¹ This relationship is known as Planck's law. Radiation coming off all bodies is described by its wavelength.²⁹² Based on Wien's displacement law, the wavelength is inversely proportional to the body's temperature, so the higher the temperature the shorter the wavelength.²⁹³ The sun, which has a higher temperature, mostly emits radiation in the visible light wavelengths while the earth, which is cooler, mostly emits radiation in the infrared wavelengths.²⁹⁴ The temperature of the sun's layer that emits most earth-bound radiation is 5780°K, and the average irradiance of solar radiation reaching the earth is 1380 Watts/meter² (W/m²).²⁹⁵ Taking into account the geometry, the earth absorbs the sun's radiation as a disk or circle but emits energy as a sphere, so the area of the earth emitting energy is four

290. JOHN MILTON, *PARADISE LOST* III, 334–38, (1674), reprinted in *THE OXFORD AUTHORS: JOHN MILTON* 355, 410 (Stephen Orgel & Jonathan Goldberg eds., Oxford Univ. Press 1990) (1674).

291. See generally JOHN M. WALLANCE AND PETER HOBBS, *ATMOSPHERIC SCIENCES: AN INTRODUCTORY SURVEY* (Renata Dmowska et al. eds., Academic Press, 2nd ed. 2006)

292. *Id.*

293. *Id.*

294. *Id.*

295. *Id.*

times larger than the area absorbing the sun's radiation (area of a circle: πr^2 vs. area of a sphere: $4\pi r^2$).²⁹⁶ Also, the earth reflects about 30 percent of all incoming solar radiation.²⁹⁷ Therefore, in order to remain in energy balance or equilibrium, the earth must emit approximately 241 W/m^2 radiation (so that the earth is neither heating up nor cooling down).²⁹⁸ The Stefan-Boltzmann law for blackbody (an idealized radiating body) emission states that the amount of radiation emitted from a body is the temperature of that body to the fourth power times a constant.²⁹⁹ Therefore, based on the Stefan-Boltzmann law, the earth's average temperature needs to be at 255°K or -18°C to be in energy equilibrium.

But we know that only a few locations on earth have an average temperature as cold as -18°C and most of the earth is much warmer. The average temperature of the earth is closer to 288°K or 15°C .³⁰⁰ Based on the Stefan-Boltzmann law, the earth at 288°K is equivalently emitting blackbody radiation of 390 W/m^2 or 150 W/m^2 higher than is required simply to balance the incoming solar radiation. This difference in the earth's theorized temperature—from the theory of blackbody radiation needed to balance incoming solar radiation—and the earth's actual temperature is the "greenhouse effect."

The earth is covered by a layer of gases called the atmosphere. Most of the atmospheric gases are transparent to radiation emitted by the earth, predominantly in the infrared wavelengths; but some of the gases absorb infrared radiation and are referred to as greenhouse gases.³⁰¹ The most important greenhouse gases are water vapor, carbon dioxide (CO_2), and ozone.³⁰² The greenhouse gases are mostly transparent to solar radiation, which passes through them undisturbed to the earth's surface. Therefore, greenhouse gases only warm the earth's surface. Clouds made up of water droplets and ice also absorb infrared radiation and re-emit it back down to the earth's surface. However, clouds are not transparent to visible radiation but instead reflect some of the incoming solar radiation. Clouds can therefore both warm and cool the earth's surface.

So as the earth emits radiation, some is absorbed by the greenhouse gases and clouds, and they then re-emit the radiation back to the earth's surface. Because only a fraction of the radiation emitted by the earth escapes into space, while much of the radiation is absorbed by greenhouse gases and emitted back to the earth's surface, the earth's temperature is higher than the temperature calculated from blackbody considerations alone. A warmer earth emits more radiation, enough so that even if a

296. *Id.*

297. *Id.*

298. *Id.*

299. *Id.*

300. *Id.*

301. *Id.*

302. *Id.*

fraction is absorbed in the atmosphere by greenhouse gases, still enough radiation escapes into space to balance the incoming solar radiation.

2. *Discovery*

The French mathematician and physicist Jean-Baptiste Joseph Fourier first recognized the greenhouse effect during the early nineteenth century. He calculated that the earth should be colder than it was based on incoming solar radiation alone. He searched for physical reasons for the additional heat, and one of his proposed mechanisms was that the earth's atmosphere acted as an insulator for earth's heat.

In 1896, Svante Arrhenius, a Swedish scientist, was the first to argue that the earth's temperature is sensitive to the amount of greenhouse gases in the earth's atmosphere.³⁰³ In a theory to explain the large temperature swings associated with the advance and retreat of ice sheets during glacial and interglacial cycles, Arrhenius theorized that increasing and decreasing levels of CO₂ in the atmosphere could explain the large temperature swings. When CO₂ is less abundant in the atmosphere, temperatures are colder and ice sheets advance; and when CO₂ is more abundant in the atmosphere, temperatures are warmer and ice sheets retreat. Arrhenius further predicted that the release of CO₂ through burning of fossil fuels by humans would increase both the atmospheric CO₂ and the average temperature of the earth.

This warming of the earth with increasing atmospheric CO₂ is called the "greenhouse effect," since it is analogous to how greenhouses trap heat to grow plants. Greenhouses are made of glass that is transparent to incoming solar radiation but opaque to outgoing infrared radiation. This is somewhat of a misnomer, since the earth most efficiently cools down due to convection of hot air from the surface to higher altitudes, whereas the greenhouse or hothouse warms up because it inhibits convection.

3. *Venus--Extreme Greenhouse Effect*

Venus, the planet after the earth in the direction of the sun, has an atmosphere with a much higher concentration of greenhouse gases than the earth. The Venusian atmosphere, which is much greater than the earth's atmosphere, is composed mostly of CO₂, which is only a small fraction of the earth's atmosphere (currently only about 0.04% of the atmosphere).³⁰⁴ Venus is covered by dense clouds and very little incoming solar radiation

303. Svante Arrhenius, *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground*, 41 PHIL. MAG. & J. SCI. 237(fifth series) 237-276 (1896).

304. Antony D Del Genio and M.J. Way, *Venusian Habitable Climate Scenarios: Modeling Venus Through Time and Applications to Slowly Rotating Venus-Like Exoplanets*, 125 J. GEOPHYSICAL RES. 5 (2020).

actually reaches the surface, yet the temperature on Venus is estimated at 450°C.³⁰⁵ The extreme high temperature of Venus is attributed to the abundance of CO₂ in the atmosphere, which is efficient at trapping heat from the little solar radiation that penetrates the atmosphere.³⁰⁶ The atmosphere and heat of Venus are referred to as a “runaway greenhouse effect.”³⁰⁷ On Venus, positive feedback between high temperatures and the evaporation of water vapor and carbon dioxide into the atmosphere has rendered the planet inhospitable to life.³⁰⁸ It is believed that the earth can, to a much smaller extent, experience a runaway greenhouse effect as well.³⁰⁹ Burning of fossil fuels increases the atmospheric concentration of CO₂ that leads to warmer temperature that in turn leads to increasing water vapor—also a greenhouse gas—in the atmosphere.³¹⁰ In contrast Mars, which has a much thinner atmosphere than Earth, is much colder, with the atmosphere contributing little greenhouse effect to the overall temperature of the planet.³¹¹

4. *Increasing Greenhouse Gases in Our Atmosphere*

Extrapolating from geological data, scientists have been able to pinpoint large temperature swings in the earth’s past.³¹² For example, millions of years ago during the period of the dinosaurs, the earth was much warmer than today with no ice at the poles.³¹³ On the other extreme, as recently as 20,000 years ago the Northern Hemisphere was cold enough to support heavy glaciation with ice a mile thick as far south as New York City.³¹⁴ One explanation for the earth’s large temperature swings is the amount of CO₂ in the atmosphere. When CO₂ is relatively abundant in the earth’s atmosphere, temperatures are high and ice is scarce; and when CO₂ is relatively less, temperatures are much colder and glaciers more widespread than today.³¹⁵

Up until the Industrial Revolution, most of the past changes in CO₂ are thought to be natural.³¹⁶ Since the Industrial Revolution, however, increases in CO₂ are likely due to human activities, especially burning of organic material including biomass, coal, oil, and gas.³¹⁷ The combustion

305. *Id.*
 306. *Id.*
 307. *Id.*
 308. *Id.*
 309. *Id.*
 310. *Id.*
 311. *Id.*
 312. *Id.*
 313. *Id.*
 314. *Id.*
 315. *Id.*
 316. *Id.*
 317. *Id.*

of organic compounds produces CO₂ and water vapor into the atmosphere.³¹⁸ At the start of the Industrial Revolution CO₂ concentration in the atmosphere was approximately 285 parts per million (ppm).³¹⁹ Currently the concentration of CO₂ is more than 400 ppm. Over the instrumental record (1880--present) the global temperature warming trend has averaged about 0.07°C per decade, but a more accelerated 0.17°C per decade since 1981.³²⁰ All of the top ten warmest years have occurred since 1998 and the top five warmest years have all occurred in the past five years.³²¹ Plots of global temperature trends since the early twentieth century show nearly universal warming in both the oceans and the continents (Figure 1). The lone exception is cooling in the northern North Atlantic south of Greenland that is hypothesized to be a manifestation of the slowdown of the global thermohaline circulation (ocean currents driven by differences in temperature and salinity).³²² Global temperature anomalies broken down by month also show steady warming since the beginning of the twentieth century, with the warming accelerating over the past five years (Figure 2).

318. *Id.*

319. *Id.*

320. Rebecca Lindsey & LuAnn Dahlman, *Climate Change: Global Temperature*, CLIMATE.GOV NOAA (Mar. 15, 2021), <https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature> [<https://perma.cc/E6XZ-DFY3>]; *Assessing the Global Climate in 2018*, NAT'L CTRS. FOR ENV'T INFO. (Feb. 6, 2019), <https://www.ncei.noaa.gov/news/global-climate-201812> [<https://perma.cc/XLC5-5LKG>].

321. Lindsey & Dahlman, *supra* note 320.

322. Benoit Thibodeau, et al., *Last Century Warming over the Canadian Atlantic Shelves Linked to Weak Atlantic Meridional Overturning Circulation*, 45 GEOPHYSICAL RSCH. LETTERS 12, 376–12,385 (2018); Paul Keil et. al., *Multiple Drivers of the North Atlantic Warming Hole*, NATURE, (June 29, 2020) <https://www.nature.com/articles/s41558-020-0819-8> [<https://perma.cc/699L-HE38>].

5. *Skepticism of Anthropogenic Global Warming*

Until recently it was a matter of debate whether the earth was warming. Skeptics of anthropogenic influence on our climate argued that the warming trend seen in the instrumental record of global temperatures (starting in the late nineteenth century) was an artifact of instrumental bias and the urban heat island. Urban areas are hotter than rural areas since asphalt and concrete retain heat much more than naturally occurring surfaces; and therefore instruments—which are located predominately in populated areas—exhibit warming (even in the absence of ambient warming) due to the buildup of infrastructure over time to accommodate human population growth.³²³

Instrument records are corrected for any instrumental bias, including urban vs. rural locations and change in instrumentation. The argument that warming is an artifact of the urban heat island—or is not occurring at all—is no longer popular among skeptics and for the most part is not an argument that is still pursued.³²⁴ Also, there was a period when warming was showing up in surface observations but not in the free troposphere (the atmosphere above the surface and the boundary layer). However, the warming is no longer confined to the surface and is observed throughout the troposphere.³²⁵ Another argument of those skeptical that humans are significantly contributing to global warming is instead that any observed warming is due to natural cycles. The earth has gone through natural cycles—even dramatic ones—from glacial to interglacial, and the warming over the instrumental record is another natural cycle. But the warming over the instrumental record is much accelerated compared to previous periods of global warming based on paleoclimate data.³²⁶ Another popular argument is that the temperature variations we have observed over the instrumental record can be attributed to solar variability or cycles. But the current solar cycle should be contributing to global cooling, and so far the warming of the earth is only accelerating.³²⁷

323. John C. Price, *Assessment of the Urban Heat Island Effect Through the Use of Satellite Data*, 107 MONTHLY WEATHER REV. 1554 (1979), https://journals.ametsoc.org/view/journals/mwre/107/11/1520-0493_1979_107_1554_aotuhi_2_0_co_2.xml?tab_body=fulltext-display [https://perma.cc/N9ZJ-24SK].

324. Ross M. McKittrick and Patrick J. Michaels, *Quantifying the Influence of Anthropogenic Surface Processes and Inhomogeneities on Gridded Global Climate Data*, 112 J. OF GEOPHYSICAL RES., (2007), <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2007JD008465> [https://perma.cc/B8AG-Q4ES].

325. Benjamin D. Santer et. al., *Tropospheric Warming Over the Past Two Decades*, 7 SCI. REPS., (2017), <https://www.nature.com/articles/s41598-017-02520-7> [https://perma.cc/JQ4Q-BE82].

326. Michael E. Mann et. al, *Northern Hemisphere Temperatures During the Past Millennium: Inferences, Uncertainties, and Limitations*, 26 GEOPHYSICAL RES. LETTERS 759–762 (1999).

327. *Is the Sun Causing Global Warming*, NASA, <https://climate.nasa.gov/faq/14/is-the-sun-causing-global-warming/> [https://perma.cc/3SE7-V6KW]?

6. *Warming Hiatus and the Winter Season*

One phenomenon of the twenty-first century that contributed to skepticism of anthropogenic global warming (AGW) was a warming hiatus: no increase in global warming was observed for about fifteen years, from 1998 through 2014.³²⁸ Over that time atmospheric CO₂ increased, so if there is a direct relationship between the amount of CO₂ in the atmosphere and global temperatures, how can one explain the lack of increased global warming while CO₂ in the atmosphere is increasing? Arguably this relationship is more complicated than portrayed by climate scientists so contributions from natural cycles would dominate over anthropogenic contributions.

El Niño is a warming along the equatorial Pacific Ocean that has a strong impact on global temperatures, and El Niño events—especially the strongest ones—can cause spikes in global temperatures. In 1998 a strong El Niño was observed that caused a global temperature spike; but, in its wake, global temperatures cooled until the next strong El Niño in 2014. Beginning in 2014 a strong and long-duration El Niño occurred, which peaked in 2016; and all the years from 2015--2019 have been the warmest years observed in the instrumental record.³²⁹ Temperatures have failed to return to pre-2014 levels and the warming hiatus no longer exists.

Since 1998 the season that has experienced the most widespread lack of warming and in some regions even cooling is winter across the mid-latitudes, including the population centers of the industrialized nations.³³⁰ From 1998 through 2012, though some cold winters occurred in North America, the cold was focused across the Eurasian continent. Since 2013, however, the cold temperatures in the winter months have been focused across the North American continent.³³¹ In the United States the lack of a strong warming trend is not limited to winter; since the beginning of the twentieth century the Eastern U.S. has experienced some of the least warming of any land region across the globe and is referred to as a “warming hole.”³³² This lack of a robust warming signal in the U.S. has many AGW skeptics asking, Where is the warming?

328. Judah L. Cohen et. al., *Asymmetric Seasonal Temperature Trends*, 39 *GEOPHYSICAL RES. LETTERS*, (2012), <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011GL050582> [<https://perma.cc/JP73-RX6N>].

329. *Global Time Series*, NOAA, <https://www.ncdc.noaa.gov/cag/global/time-series> [<https://perma.cc/HHT3-BLPT>].

330. Judah L. Cohen et. al, *Arctic Warming, Increasing Fall Snow Cover and Widespread Boreal Winter Cooling*, 7 *ENVTL. RES. LETTERS* (2012), <https://iopscience.iop.org/article/10.1088/1748-9326/7/1/014007> [<https://perma.cc/C55J-KUS8>].

331. Judah L. Cohen et. al., 2020: *Divergent Consensuses on Arctic Amplification Influence on Mid-latitude Severe Winter Weather*, *NATURE CLIMATE CHANGE*, 10, 20-29.

332. Trevor F. Partridge et. al., *Mid-20th Century Warming Hole Boosts US Maize Yields*, 14 *ENVTL. RES. LETTERS* (2019), <https://iopscience.iop.org/article/10.1088/1748-9326/ab422b/meta>

The winter season seems to be the greatest flashpoint between those advocating for AGW and those who are skeptical. Winter was the season predicted by global climate models (GCMs) to warm the fastest; yet winter has been the season to warm the least, and forecasts of disappearing snowfalls and bitter cold have not materialized. Many recent winters have been characterized by heavy—even record-setting—snowfalls and historical cold.³³³ The persistence of severe winter weather has many in the media and the public questioning the validity of forecasts predicting rapid warming and ever milder winters.³³⁴

Skeptics of AGW have seized on the surprising durability of severe winters to argue that AGW is mostly incorrect or at least not a challenge worth making large lifestyle and economic changes to address. Many climate scientists have attempted to resolve the incongruity of forecasts of ever milder winter weather and the reality of ongoing harsh winter weather with the argument of chance. They argue that the climate system has large internal or natural variability; so even though there is a strong warming trend overall, a natural cycle favoring colder temperatures can and has offset the warming trend.³³⁵ But the natural cycle will soon fade, and warming winter temperatures will resume.

Another idea advanced by a minority of climate scientists is that severe winter weather is not inconsistent with AGW; in fact, there may be aspects of global warming that favor episodes of severe winter weather. GCMs predict that global warming will not be uniform but will occur at an accelerated rate in the polar regions, especially of the Northern Hemisphere. In fact, the Arctic has warmed at a rate two to three times faster than the remainder of the globe since the early 1990s. Over that same time period large parts of the mid-latitude continents have cooled. It is plausible that the two are unrelated. However, some climate scientists argue that the accelerated warming of the Arctic is related to the recently observed cooling in the mid-latitudes.³³⁶

Rapid Arctic warming has resulted in a decrease in Arctic Sea ice but an increase in Siberian snow cover—mainly in the fall—as warmer temperatures hold more moisture that can precipitate out as snow when temperatures drop below freezing. It is argued that Arctic Sea ice loss in the fall and winter and increasing Siberian snow cover in the fall are

333. Judah Cohen et al., *Recent Arctic Amplification and Extreme Mid-Latitude Weather*, 7 NATURE GEOSCIENCE 627-637 (2014); Judah Cohen et. al., *Linking Arctic Variability and Change with Extreme Winter Weather in the US*, SCIENCE.

334. Tiffany Means, *Global Warming is Real, so Why is it Cold Outside?*, YALE CLIMATE CONNECTIONS, (Dec. 15, 2020), <https://yaleclimateconnections.org/2020/12/if-global-warming-is-real-why-is-it-cold-outside/> [https://perma.cc/2V4E-XR9W]; *Does Cold Weather Disprove Climate Change?*, UNION OF CONCERNED SCI., (Fed. 25, 2011), <https://www.ucsusa.org/resources/does-cold-weather-disprove-climate-change> [https://perma.cc/TK7A-BAX6].

335. Cohen, *supra* note 333.

336. *Id.*

leading to more frequent disruptions of the stratospheric polar vortex (PV). The polar vortex is a deep, low-pressure center in the upper atmosphere that usually sits over the North Pole during the winter months and is encircled or surrounded by a fast-flowing ribbon or river of air. Air flows counterclockwise around low pressure in the Northern Hemisphere or in a west-to-east direction. The polar vortex resides in the stratosphere generally above 50 hPa or about 12 miles above the earth's surface. When the PV is strong, temperatures tend to be mild across the mid-latitude continents; but when the PV is weak or disrupted, severe winters--including cold air outbreaks and heavy snowfalls--are more frequent across the mid-latitude continents. Disappearing Arctic sea ice focused in the Barents-Kara Seas, coupled with increasing Siberian snow cover, favors an anomalous tropospheric wave across the Eurasian continent with ridging (the crest of the wave) across northwest Eurasia, due to anomalous heating from sea ice loss; and troughing (trough of the wave) across northeast Eurasia, due to anomalous cooling from increased snow cover (snow cover is the most reflective naturally occurring surface and the increased reflection of incoming solar radiation cools the surface). This anomalous wave projects onto or amplifies the naturally occurring wave across Eurasia forced by the land-ocean contrast and the topography of the Eastern Hemisphere. Amplification of the natural or climatological wave results in greater vertical energy transfer from the troposphere into the polar stratosphere, leading to more frequent stratospheric PV disruptions. Stratospheric PV disruptions are often followed by an increase in severe winter weather across the mid-latitudes of the Northern Hemisphere, including the Eastern U.S., Europe, and East Asia.³³⁷

7. Summary

Radiation equilibrium between the sun and earth would produce an uninhabitable planet with temperatures well below freezing, leaving water locked up in a frozen state throughout the globe. Greenhouse gases in the atmosphere have raised the earth's temperatures and made life possible. Analyses of past climates show that when CO₂ is less, the earth's temperature has dropped, allowing glaciers to advance across the continents of North America and Europe covering large parts of the Northern Hemisphere. When CO₂ is more, global temperatures are higher, causing the retreat of ice sheets to high altitudes and high latitudes.³³⁸ Until the Industrial Revolution the rise and fall of greenhouse gases was attributable to natural causes or cycles; since the Industrial Revolution,

337. *Id.*

338. J. Jouzel, et. al., *Orbital and Millennial Antarctic Climate Variability over the Past 800,000 Years*, 317 *SCI.* 793 (2007).

however, humans have become a significant contributor to greenhouse gases, including methane but especially CO₂.³³⁹ CO₂ has already increased by more than 33% and will double if the global economy does not wean itself off its dependence on fossil fuels.³⁴⁰ Theory and models show that as greenhouse gases increase, temperatures rise; and observations over the instrumental period are consistent with theory and model projections.

Despite the seemingly strong corroborations among theory, model historical reconstruction of global annual temperatures, and model projections of accelerated global warming, a large fraction of the public remains skeptical of anthropogenic global warming.³⁴¹ This has generated resistance to aggressive legislation curbing fossil fuel emissions as well as resistance to energy conservation and the deployment of renewable energy. One reason for the skepticism was the recent warming hiatus when global temperatures did not warm appreciably between 1998 and the early 2010s. Another contribution to skepticism has been recent severe winter weather, especially in the U.S. Severe winters were not predicted by theory or in model projections.

The warming hiatus is clearly over, however, with the past five years the five warmest years on record. Also, recent theories can explain how severe winter weather is consistent with a warming planet, especially where the warming is accelerated in the Arctic. Extreme weather is increasing, which includes heat waves, flooding, fires, and droughts. These extreme events are taxing our infrastructure, leading to unprecedented economic losses and to loss of ecosystems and human life. There is little reason to believe that global warming will not continue; but will it continue at the rate projected by models? The industrialized world has been slow to respond. Will this continue, and what is required to convince policy makers to act more aggressively to decrease greenhouse gases and reduce the potential for ever-increasing extreme weather? These questions are likely to be among the more important and consequential issues facing society for many years to come.

B. The Signal and the Noise

If climate change were simply a scientific problem, we should be well on our way to solving it. After all, climate researchers have provided both

339. AR6 *Climate Change 2021: The Physical Science Basis*, IPCC, <https://www.ipcc.ch/report/ar6/wg1/> [<https://perma.cc/62LS-3P2C>].

340. *Id.*

341. Jenifer Marlon et. al., *Yale Climate Opinion Maps 2020*, YALE PROGRAM ON CLIMATE CHANGE COMMUNICATION (Sept. 2, 2020), <https://climatecommunication.yale.edu/visualizations-data/ycom-us/> [<https://perma.cc/2RJM-PRWS>]; Antony Leiserowitz et. al., *International Public Opinion on Climate Change*, YALE PROGRAM ON CLIMATE CHANGE COMMUNICATION, <https://climatecommunication.yale.edu/publications/international-public-opinion-on-climate-change/> [<https://perma.cc/67RJ-BVGA>].

a clear diagnosis (“the release of greenhouse gases into the atmosphere is leading increasingly to global warming”) and a straightforward treatment, if not cure (“curtail and—to the extent possible—end the release of greenhouse gases into the atmosphere”). The basic mechanisms of global warming have been understood scientifically for decades. Yet, projections for climate change grow ever more dire, suggesting that the problem is (as Garrett Hardin puts it) not merely a “technical” one and has, therefore, *no technical solution*—i.e., “one that requires a change only in the techniques of the natural sciences, demanding little or nothing in the way of change in human values or ideas of morality.”³⁴²

Recall George Stigler’s analysis of the political process: “The channels of political decision-making can . . . be described as gross or filtered or *noisy*.”³⁴³ “Noisy” is a term borrowed from communication theory. It means that, because of background noise, a “signal” (the message or information) cannot be clearly and distinctly discerned. (Think of a short-wave radio transmission in which, over the static, one can barely make out what is being said.) The term has also been appropriated by astronomers, particularly those seeking signs of intelligent life in other galaxies: “Astronomers interpret very weak signals that are buried in big noisy databases.”³⁴⁴ Considering the scale at which astronomy operates, those databases could be very big and noisy indeed.

Sad to say, the reception of an alien message from a distant galaxy is probably less fraught than the reception of our own scientists’ “message” about climate change. Their message cannot be conceptualized in any important way as technical information, which normally is imparted unproblematically. At the societal level, we can barely make out the message as a coherent description—much less an urgent practical prescription—over the “noise” of human nature.

Granted, human beings are not quintessential scientists, dispassionately dispensing scientific solutions to well defined scientific problems. But, surely (at least), we should be able to think of ourselves as practical (rational) “maximizers of utility.”

Rationally, our concern about future calamities ought to be roughly proportional to their probable severity, discounted by the improbability of their occurrence. This is the famous Hand Formula, proposed here as a basic framework for rational decisionmaking.³⁴⁵ Judge Learned Hand originally articulated the relevant factors in an admiralty case:

342. Garrett Hardin, *The Tragedy of the Commons*, 162 *SCIENCE* 1243 (Dec. 13, 1968).

343. Stigler, *supra* note 203, at 12.

344. Bill Alpert, *Quants Live! The Revenge of the Big Brains*, *BARRON’S*, (Apr. 8, 2002, 12:01 AM), <https://www.barrons.com/articles/SB101805213189218360?tesla=y> [<https://perma.cc/A9E6-N7XS>].

345. *United States v. Carroll Towing Co.*, 159 F.2d 169, 173 (2d Cir. 1947).

Since there are occasions when every vessel will break from her moorings, and since, if she does, she becomes a menace to those about her; the owner's duty, as in other similar situations, to provide against resulting injuries is a function of three variables: (1) The probability that she will break away; (2) the gravity of the resulting injury, if she does; (3) the burden of adequate precautions.³⁴⁶

Assume for example that the severity of earthquakes is roughly proportional to their magnitude on the Richter Scale.³⁴⁷ Peering into the foreseeable future for downtown Los Angeles, suppose it could be determined that an earthquake with a magnitude of 4.0 on the Richter Scale ("shaking of indoor objects, minimal local damage") had an 80% chance of occurring there within a specified time. By the Hand Formula, we should be just as concerned about that eventuality as about a magnitude 8.0 earthquake ("widespread devastation, severe damage and destruction over large areas") that had a 40% chance of occurring within the specified time.

By all accounts, the effects of climate change are much easier to predict than the occurrence of earthquakes. For any range of global warming projections, climate scientists can project a corresponding range of more or less devastating effects on the climate.³⁴⁸

Why, then, does decisionmaking on matters of climate change depart so markedly from the Hand Formula?³⁴⁹ How can we conceptualize this dramatic departure from "rationality"? In tort law, at least, the Hand Formula represents the thought-process of the "reasonable man," writ large.

346. *Id.*

347. The Richter Scale is basically a logarithmic scale of the energy released by earthquakes. The example in the text is for illustration only. (In reality, each increase of 0.2 on the scale represents approximately a doubling of the energy released.) The verbal equivalents of damage are composites of various sources.

348. *See*, Part V (A), *supra*.

349. *See, e.g.*, Lisa Friedman & Coral Davenport, *Curbs on Methane, Potent Greenhouse Gas, To Be Relaxed in U.S.*, N.Y. TIMES, (Aug. 30, 2019) <https://www.nytimes.com/2019/08/29/climate/epa-methane-greenhouse-gas.html> [<https://perma.cc/42XD-84KL>]. The Trump administration laid out on Thursday a far-reaching plan to cut back on the regulation of methane emissions, a major contributor to climate change. . . . The rollback plan is particularly notable because major energy companies have, in fact, spoken out against it — joining automakers, electric utilities and other industrial giants that have opposed other administration initiatives to dismantle climate-change and environmental rules. The weakening of the methane standard is the latest in the march of environmental-policy rollbacks by the Trump administration designed to loosen regulations on industry. Mr. Trump has sought to open millions of acres of public land and water to drilling, including the Arctic National Wildlife Refuge, and has lifted an Obama-era moratorium on new coal mining leases on public land. This month, the Interior Department completed a plan to weaken the Endangered Species Act. Later this year the E.P.A. plans to roll back clean-water regulations affecting streams and wetlands. *Id.*

C. Climate Change as a Pre-Economic Problem

The term “pre-economic” is a neologism patterned on such words as *premise* (logical priority), *prehistory* (temporal priority), and *prejudice* (“prejudgement; preconceived opinion not based on reason or actual experience”).³⁵⁰ A pre-economic problem may be understood as one that economists would formulate as an economic problem; but among the general populace it is not yet sufficiently well defined to be viewed that way. Instead, climate change is largely the subject of “preconceived opinion” - based not on reason or actual experience but on a potpourri of rational and non-rational intuitions.

As for the latter, one could usefully invoke such basic tendencies of human nature as *procrastination* (“Never do today what you can put off until tomorrow”) and *denial*. “[M]ost people who anguish over the population problem,” writes Hardin in a related context, “are trying to find a way to avoid the evils of overpopulation without relinquishing any of the privileges they now enjoy.”³⁵¹ They are trying to “get something for nothing”—a dubious economic proposition at best, but one that resonates at the pre-economic level, where wishful (if not delusional) thinking dominates and “hope springs eternal in the human breast.”³⁵² These pre-economic intuitions are also in an important sense *pre-political*, which means that they inform political thinking in very general terms without yet being attached to particular parties, programs, or policies.

“At the very moment when human ingenuity and collective will are required to stave off serious climate consequences, we have a rising tide of global leadership that believes in nothing.”³⁵³ On the subject of climate change—and the unpleasant measures necessary to avert it—the prevailing thinking of these political classes resembles nothing so much as that of imperial functionaries in the waning days of colonial rule. The coming new order—the inevitable, revolutionary overthrow of imperial rule—can be clearly foreseen, but it is *not quite* upon us. Why not enjoy our comfortable (and comforting) imperial privileges until the barbarians are actually at the gate, and the old order is palpably dead? Or as St. Augustine put it, “Please God, make me good, but not just yet.”³⁵⁴

350. See *Premise*, OXFORD ENGLISH DICTIONARY, <https://www.oed.com/> (3d ed. 2007) (online ed.); *Prehistory*, OXFORD ENGLISH DICTIONARY (3d ed. 2007); *Prejudice*, OXFORD ENGLISH DICTIONARY, <https://www.oed.com/> (3d ed. 2007) (3d ed. 2007).

351. Hardin, *supra* note 21, at 1243.

352. See *id.* at 1247.

353. Elliot Hannon, *Trump Pushes to Open the World’s Largest Remaining Temperate Rainforest to Logging and Mining*, SLATE, (Aug. 28, 2019), <https://slate.com/news-and-politics/2019/08/trump-open-alaskas-tongass-national-forest-worlds-largest-remaining-temperate-rainforest-logging-mining.html> [<https://perma.cc/83TU-74HB>].

354. AUGUSTINE, THE CONFESSIONS, OF SAINT AUGUSTINE, VOLUME I: BOOKS 1-8 389 (Carolyn J.B. Hammond ed., trans., Harvard Univ. Press 2014) (n.d.) bk. 8, ch. 7 (or more precisely,

Judgment and individual decision-making are subject to unique challenges under the conditions of uncertainty posed by climate change. Unlike the (logically) neat, all-or-nothing outcomes of nuclear war or a massive asteroid strike, “[c]limate apocalypse”, writes Jonathan Franzen is “messy.”³⁵⁵ “It will take the form of increasingly severe crises compounding chaotically until civilization begins to fray. Things will get very bad, but maybe not too soon, and maybe not for everyone. Maybe not for me.”³⁵⁶ In general, the more obvious the future appears, the less likely it is to unfold as envisioned, because someone will anticipate and arbitrage away whatever advantages or opportunities it presents—thereby changing it: “[a] future that seems this inevitable may not even happen—precisely because it seems so obvious.”³⁵⁷ (And this much, it seems, is perfectly consistent with efficient markets theory.)

Now add more people:

It is the year 1932. The Last National Bank is a flourishing institution. A large part of its resources is liquid without being watered. Cartwright Millingville has ample reason to be proud of the banking institution over which he presides. Until Black Wednesday. As he enters his bank, he notices that business is unusually brisk. A little odd, that, since the men at the A.M.O.K. steel plant and the K.O.M.A. mattress factory are not usually paid until Saturday. Yet here are two dozen men, obviously from the factories, queued up in front of the tellers’ cages. . . .
 . . . Millingville turns to the pile of documents upon his desk. His precise signature is affixed to fewer than a score of papers when he is disturbed by the absence of something familiar and the intrusion of something alien. The low discreet hum of bank business has given way to a strange and annoying stridency of many voices. . . .
 Cartwright Millingville . . . knew that, despite the comparative liquidity of the bank’s assets, a rumor of insolvency, once believed by enough depositors, would result in the insolvency of the bank. And by the close of Black Wednesday—and Blacker Thursday—when the long lines of anxious depositors, each frantically seeking to salvage his own, grew to longer lines of even more anxious depositors, it turned out that he was right.³⁵⁸

“Oh, Master, make me chaste and celibate—but not yet!”).

355. Jonathan Franzen, *What If We Stopped Pretending?*, THE NEW YORKER, (Sept. 8, 2019), <https://www.newyorker.com/culture/cultural-comment/what-if-we-stopped-pretending> [https://perma.cc/T49D-M32P].

356. Franzen, *supra* note 327.

357. Jason Zweig, *The Debt Crisis: If Treasury Bonds Aren’t Safe, What Is?*, WALL ST. J., (July 16, 2011), <https://www.wsj.com/articles/SB10001424052702304223804576448204190940120> [https://perma.cc/9T6V-LVL8].

358. Robert K. Merton, *The Self-Fulfilling Prophecy*, 8 ANTIOCH REV. 193, 194 (1948).

Robert K. Merton coined the term “self-fulfilling prophecy” to describe this type of situation.³⁵⁹ A self-fulfilling prophecy is a false belief that tends to become true the more widely it is believed.³⁶⁰ (It becomes increasingly “truer,” so to speak.) In the case of the bank, “the misleading rumor *created* the very conditions of its own fulfillment.”³⁶¹

The bank run exhibits an interesting mixture of the subjective and the objective, the rational and the irrational. Clearly, people sometimes take their money—all of their money—out of a bank because of concerns about the bank. Perhaps they believe the bank is “fundamentally” unsound. This belief may be labeled *subjective* for present purposes; broadening Merton’s usage, this belief is not necessarily false. The bank may in fact be tottering on the brink of insolvency, in which case the concerns are valid, and the belief is true.

But now a new concern and a new belief emerge when other people somehow learn about the original concerns and beliefs, and especially when they learn that people (acting on those concerns and beliefs) are withdrawing all their money from the bank. That in itself is instructive. These new concerns and beliefs may be labeled *objective* for present purposes; the mere fact that other people are acting on their concerns and beliefs is itself a valid cause for concern—*whether or not* their original concerns were valid. The new, associated belief is not about the bank as such, but about other people’s beliefs about the bank.

As Merton puts it, “[i]f men define situations as real, they are real in their consequences.”³⁶² There—in one sentence—is the transition from the subjective to the objective. Usually, one does not simply get to “define” what is real. Without further evidence or argument, such a definition usually remains firmly within the realm of the subjective. But in this case *the (re)defining itself* is “real in its consequences.” It is a second-order definition of the real.³⁶³

The stable financial structure of the bank had depended upon one

359. *Id.*

360. *Id.*

361. *Id.* at 196. I prefer to speak of “self-reinforcing” processes or cycles—sometimes known as “positive feedback” cycles. In a sound system, when a microphone is placed too near a speaker, it picks up its own sound and re-amplifies it, and so forth . . .

362. *Id.* at 193 (quoting W.I. Thomas).

363. Roger Farmer has elaborated a version of this idea that is consistent with rational expectations theory; see ROGER E.A. FARMER, EXPECTATIONS, EMPLOYMENT AND PRICES 10–11 (2010). [A]gents are forward looking with rational expectations of future prices. . . .

[S]ome forms of uncertainty cannot be quantified and . . . agents must act on the basis of partial information. Although the agents in my model will be able to form probability distributions over future events, not all of these events will be fundamental in the sense in which that word is now used in general equilibrium theory to describe uncertainty due to changes in preferences, endowments, and technology. . . . [I]n addition, agents will be required to form expectations of the future actions of others. *Id.*

set of definitions of the situation: belief in the validity of the interlocking system of economic promises men live by. Once depositors had defined the situation otherwise, once they questioned the possibility of having these promises fulfilled, the consequences of this unreal definition [were] real enough.³⁶⁴
 (“Such are the perversities of social logic,” adds Merton.³⁶⁵)

It is rational to lose confidence in a bank if and when its economic “fundamentals” deteriorate. It is equally rational to lose confidence in a bank that, though fundamentally sound, has somehow lost the confidence of most everyone else. It is rational to take account of their evident irrationality and plan accordingly. Economic fundamentals do not erode overnight, but confidence can and does. It is fleeting, but no less fundamental.

Classical economists insist that fundamentals drive the market. Keynesians insist that confidence matters. Once we recognize that confidence is a separate independent fundamental just like preferences, endowments, and technology, we can reconcile both points of view.³⁶⁶

Decisionmakers under conditions of climate-change uncertainty are like participants in a volatile and erratic economic market. These “[i]nvestors are not irrational,” says Roger Farmer; rather, “they are undecided about which path will be chosen by future investors,” including their future selves.³⁶⁷ It follows that “swings in confidence are rational,” since they reflect swings in rational expectations, which change frequently.³⁶⁸ “When the facts change, I change my mind,” Keynes is supposed to have said. “What do you do, sir?”

Yet something faintly paradoxical is at work here. Investors are not merely “undecided about which path will be chosen by future investors”; they *are*, collectively, those future investors themselves. Thus, they are collectively undecided about which path they themselves will choose. Certainly, there is an inherently unstable, interactive relationship between expectations and reality in an economic market. But “the market” is nothing more than the weighted sum total of all market participants. It is *their* rational expectations and choices that jointly shape the unfolding reality of the market. A “self-fulfilling prophecy” can readily be identified—as in a bank run or a real estate bubble; but can it be logically derived and systematized, or, in short, rationalized?

It is rational to have confidence in one’s justified true beliefs. In

364. Merton, *supra* note 258, at 194-195.

365. *Id.* at 196.

366. ROGER E.A. FARMER, HOW THE ECONOMY WORKS 113 (2010).

367. *Id.* at 92.

368. *Id.* at 115.

philosophy, this is a standard—if controversial—definition of knowledge.³⁶⁹ For present purposes, the definition could be strengthened by limiting it to “*logically* justified true beliefs.”³⁷⁰ The econometric theory of “rational expectations,” as appropriately modified, provides strong conceptual support for this line of thinking.

The theory is based on the following four, interlocking propositions:

- [1] In “many economic situations . . . the outcome depends partly on what people expect to happen.”
- [2] “The influences between expectations and outcomes flow both ways”; i.e., what people *expect* to happen depends partly on the outcome itself. “In forming their expectations, people try to forecast what will actually occur.”
- [3] “[W]hen people have to forecast a particular price over and over again, they tend to adjust their forecasting rules to eliminate avoidable errors. . . [I]n recurrent situations the way the future unfolds from the past tends to be stable, and people adjust their forecasts to conform to this stable pattern.” This is a subjective claim about “expecting” and learning.
- [4] “The concept of rational expectations asserts that outcomes do not differ systematically (i.e., regularly or predictably) from what people expected them to be.”³⁷¹ This is an objective claim about actual outcomes.

Rational people take actions that appear to be in their own best interests; but the future is unpredictable. Thus, “[t]here is no *right* way to form a belief about the future. . . Whatever market participants believe about the future must be consistent, on average, with what happens.”³⁷² Much as swings in confidence reflect swings in market participants’ rational expectations, the formation and development of beliefs about climate change reflect the rational mediation of *optimism* and *pessimism*. This interactive future of human and societal responses to global warming will indeed take the form of a self-fulfilling prophecy—but one whose content cannot yet be fully determined.

369. See Edmund L. Gettier, *Is Justified True Belief Knowledge?*, 23 ANALYSIS 121 (1963).

370. Otherwise, as Gettier notes, “it is possible for a person to be justified in believing a proposition that is in fact false.” *Id.* at 121. Note also that the standard account is itself (rather severely) limited to *propositional* knowledge (commonly expressed in the form “*S* knows that *p*”).

371. Thomas J. Sargent, *Rational Expectations*, LIBR. OF ECON. & LIBERTY (Aug. 25, 2021) (ed. 2008), <http://www.econlib.org/library/Enc/RationalExpectations.html> [<https://perma.cc/7XKN-HTRG>].

372. Roger E.A. Farmer, *supra* note 264, at 266-67.

D. The Long Goodbye: Saving the Planet by Influencing Expectations

A passage by economist Robert Frank summarizes well the argument thus far:

[1] Humans are impetuous and shortsighted. . . [S]hortsightedness is rooted in our “faulty telescopic faculty.” . . . “The future is an idea we have to conjure in our minds, not something that we perceive with our senses. What we want today, by contrast, we can often feel in our guts as a craving.”

[2] Can we change? [I]mpatience is not an immutable human trait. Decisions about saving money, for instance, are heavily distorted by impatience, which helps explain why so many struggle in retirement. [S]aving might be easier if we could somehow imagine the future more vividly . . .

[3] This problem arises in extreme form in the fishing industry. . . . “What makes sense in the short run because it is *rewarded by the marketplace*, like fishing all the red snapper out of the ocean, is not what’s good for the long run, because it destroys the fishery forever.”

Note, however, that overfishing has little to do with shortsightedness. Even if almost, everyone had perfect foresight and self-discipline, those who restricted their current catch would be rewarded only by seeing the fish they’d left behind harvested instead by others. Problems that have this structure, known as “tragedies of the commons,” are solved by punishing those who violate collectively imposed quotas, not by appeals to show greater respect for the future.

[4] Nor will individual acts of self-discipline parry the biggest existential threat we face—the climate crisis. Because eliminating greenhouse gases is costly and people can now emit them without penalty, the increasingly powerful storms, droughts, floods and wildfires of recent decades would keep growing worse even if we could magically endow everyone with complete foresight. Our only hope is to adopt stiff emissions fees and invest heavily in renewable energy and carbon capture. That’s why many . . . fear that our current political gridlock portends doom.³⁷³

Two distinct though related problems are at issue here. The first is the problem of human “shortsightedness,” impetuosity, and impatience—the well-known human weakness for immediate gratification at the

373. Robert H. Frank, *Humans Are Impetuous and Shortsighted. Can We Change?*, N.Y. TIMES, (Aug. 27, 2019), <https://www.nytimes.com/2019/08/27/books/review/bina-venkataraman-optimists-telescope.html> [https://perma.cc/84G2-DXLC] (emphasis added) (reviewing BINA VENKATARAMAN, *THE OPTIMIST’S TELESCOPE: THINKING AHEAD IN A RECKLESS AGE* (2019)).

expense of more important, long-term goals. This propensity has deep biological and evolutionary roots, discussed further below.

Faced with the equally intractable problem of “faction,” James Madison proposed not to remove its latent *causes*, which are “sown in the nature of man,”³⁷⁴ but to moderate its *effects*.³⁷⁵ Likewise, we can show people digitally altered images of themselves at retirement age; they then turn out to save more diligently for retirement.³⁷⁶ We can take the whole population on virtual-reality tours of the future, thereby making the effects of climate change “more vivid.” We can program organs in cathedrals to play compositions by John Cage (faithfully following his visionary time signature: *As slow as possible*) that will take 600 years to complete; we can even build giant clocks in the high desert that will keep time for 10,000 years.³⁷⁷

Yet all these efforts, however laudable, do little if anything to address the second problem discussed above and in Part I: The Tragedy of the Commons. We do not respond to the bank robber, who views our banks as a “commons,” with appeals to his conscience or sense of civic virtue. Instead, we arrest him and lock him up in prison. (Bank-robbing arises because, as Frank says, “it is rewarded by the marketplace.” But until someone publishes a treatise on “the economics of bank-robbing,” it will remain—in the terminology introduced above—a “pre-economic” problem.)³⁷⁸ The “problem of bank-robbing” can be solved only at the societal level; the solution is laws, in this case, criminal laws, that apply to everyone: “mutual coercion, mutually agreed upon.”³⁷⁹

The problem of climate change is a special case of the tragedy of the commons. It too can be solved only at the societal level. “Solving” the individual, human problem of shortsightedness is not directly relevant here. Yet, the two problems are related, at least in form: Our approach to global warming exhibits all the unmistakable, undeniable, tragic symptoms of an acute *societal* shortsightedness, impetuosity, and impatience. Thus, we might take our cues for solving the societal problem from efforts to “solve” the individual, human problem.

In what follows, the prospects for effectively addressing climate change are viewed through the equally illuminating lenses of pessimism and optimism.

374. James Madison, THE FEDERALIST NO. 10 (1787).

375. *Id.*

376. Frank, *supra* note 345.

377. *Id.*

378. *See*, Part V (B) *supra*.

379. Hardin, *supra* note 21, at 1247.

1. *The Case for Pessimism*

The case for pessimism in the face of climate change is not all that different from the optimistic case. In fact, key elements of the pessimistic case can be drawn from a book entitled *The Optimist's Telescope*.³⁸⁰

Evolution by natural selection proceeds on a grand, glacially slow scale; we still carry the genes of our prehistoric ancestors.

To avoid predators, hunter-gatherers urgently responded to threats . . . and the people who did that successfully survived and reproduced, passing along the trait. As a result, the modern human has inherited the impulse to protect herself from loss more aggressively than she seeks gains. . . [T]he emotional prospect of an immediate loss affects people's decisions far more than a view of what they are likely to win or lose in the long run.³⁸¹

"Thinking fast" ensures our immediate survival; there will be plenty of time later, as in the Greek *polis*, to debate the good life and discuss "the life well lived."³⁸² The implications of this distinction may be illustrated by a few salient examples.

In the famous "marshmallow experiments," preschoolers in the United States and Germany were offered a delicious treat.³⁸³ But they were also given an option: if instead of accepting the immediate treat, they could wait a short while, they would receive *two* treats.³⁸⁴ Fewer than a third of the American and German children could wait that long, thereby validating the ancient maxim that "a bird in the hand is worth two in the bush."³⁸⁵

Actually, the children may intuitively have been onto something more than poor planning. "What lies in the future . . . is murky, mutable, uncertain. It holds none of the surefire satisfaction of the plate of french fries on the diner counter. We rarely know for sure that giving up something today will yield what we want tomorrow."³⁸⁶ Generalizing, "The more distant the consequences of our decisions, the more difficult it becomes to exercise wisdom about them."³⁸⁷ Far-away times, and far-away places, pose special difficulties for imagination and memory because they cannot easily or readily or "vividly" be called to mind. They remain

380. See BINA VENKATARAMAN, *THE OPTIMIST'S TELESCOPE: THINKING AHEAD IN A RECKLESS AGE* (2019).

381. *Id.* at 54.

382. See generally DANIEL KAHNEMAN, *THINKING, FAST AND SLOW* (2011).

383. See Venkataraman, *supra* note 352, at 65-68. In versions of the experiment conducted in Cameroon, about 70 percent of the children waited for the larger payoff, suggesting that social and cultural values or practices might play a role.

384. See Venkataraman, *supra* note 352, at 65-68.

385. See Venkataraman, *supra* note 352, at 65-68.

386. *Id.* Venkataraman, *supra* note 352, at 5.

387. Venkataraman, *supra* note 352, at 4.

relatively “unavailable.”³⁸⁸

Consider, for example, the following problem posed by the behavioral and cognitive scientist Richard Shweder: “[a] piece of paper is folded in half. It is folded in half again, and again . . . After 100 folds, how thick will it be?”³⁸⁹

As Shweder reports, most people estimated “a thickness of a few inches, perhaps a foot.”³⁹⁰ The author of a respected textbook on *Cognition* reports on his own, initial reaction to the problem: “When I first heard this problem, I estimated a thickness of about 3 or 4 inches . . . Intuitively, the required thickness is about that of a large book.”³⁹¹

The problem appears to be “intuitive,” but here intuition fails us. “[The concept] is . . . the product of formal education, and thus [is] not acquired without deliberate instruction and a willingness to learn.”³⁹² The problem appears intuitive because it involves familiar items and everyday activities (a piece of paper, folding the paper, etc.) that are easily and readily “available” in imagination and memory. But it also involves something most people have never encountered and will probably never encounter again: a number with a three-digit exponent. “However, if you actually work out what happens when you fold the paper, then you will see why the thickness becomes so great.”³⁹³

With each fold, the thickness of the paper is doubled. In other words, the problem takes the form: [thickness of paper] · 2.

After only ten folds, the thickness will have increased by a factor of more than one thousand. At this point the thickness will be about what most people estimated for the final thickness, a fairly sizeable 3 to 4 inches. But there are still ninety folds to go! By now most people should begin to sense that they have stumbled upon something other-worldly, something that utterly transcends human experience, imagination, and memory. Indeed, “other-worldly” is just about right, as the final thickness of the paper exceeds the distance from the earth to the moon (over 200,000 miles)!

In 2015, the European Science Foundation published a report entitled *Extreme Geohazards: Reducing the Disaster Risk and Increasing Resilience*.³⁹⁴ It turns out that the greatest natural threats to the human

388. See generally JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES, (pt. 4) (Daniel Kahneman, Paul Slovic & Amos Tversky eds., Cambridge Univ. Press 1982) (discussing the availability heuristic).

389. Richard A. Shweder, *Likeness and Likelihood in Everyday Thought: Magical Thinking in Judgments About Personality*, 18 CURRENT ANTHROPOLOGY 637, 638 n.4 (1977).

390. *Id.*

391. JOHN G. BENJAFIELD, COGNITION 322 (3d ed. 2007).

392. *Id.*

393. *Id.*

394. Hans-Peter Plag et al., *Extreme Geohazards: Reducing the Disaster Risk and Increasing Resilience*, EUROP. SCI. FOUND. (April 2015).

species are so-called “supervolcanoes,” twenty of which are scattered around the planet. And it turns out that the world’s largest supervolcano is located directly beneath Yellowstone National Park in Wyoming.

A Yellowstone eruption “would be like nothing humanity has ever experienced.”

Volcanologists believe a Yellowstone supereruption would bury large swaths of Colorado, Wyoming and Utah in up to three feet of toxic volcanic ash. Depending on the weather patterns, much of the Midwest would receive a few inches, too, plunging the region into darkness. . . . Crops would be destroyed; pastureland would be contaminated. Power lines and electrical transformers would be ruined, potentially knocking out much of the grid.

[A]s the toxic cloud blocked sunlight, global average temperatures could plunge significantly--and not return to normal for several years. Rainfall would decline sharply. That might be enough to trigger a die-off of tropical rain forests. Farming could collapse, beginning with the Midwest. It would be . . . “the greatest catastrophe since the dawn of civilization.”³⁹⁵

Fortunately, super volcanoes erupt very infrequently, somewhere between once every 714,000 years—the low end of the frequency range—and every 45,000 years— (the high end).³⁹⁶ If, as has been estimated, a super eruption might kill 10 percent of the human population, that would equate to an expected annual loss of at least 1,000 people and potentially as many as 17,000.³⁹⁷

Under the Hand Formula, efforts to prevent fatalities in aviation, including 556 deaths worldwide in 2018, should thus receive far less funding (currently \$7 billion annually in the U.S.) than volcano hazard programs (currently \$22 million annually).³⁹⁸ “The difference, of course, is that aviation poses a risk that is relatively constant and known.”³⁹⁹ (Without funding for airplane safety, it seems plausible that many thousands would die annually – a very salient result.)

A . . . problematic assumption of standard economic models is that people are properly attentive to all relevant costs and benefits, even those that are uncertain, or that occur in the distant future. In fact, most people focus on penalties and rewards that are both immediate

395. Bryan Walsh, *A Giant Volcano Could End Human Life on Earth As We Know It*, N.Y. TIMES, (Aug. 21, 2019), <https://www.nytimes.com/2019/08/21/opinion/supervolcano-yellowstone.html> [<https://perma.cc/CK92-XNVL>].

396. *Id.*

397. *Id.*

398. *Id.*

399. *Id.*

and certain. Delayed or uncertain payoffs often get short shrift.⁴⁰⁰

Compared to the threat of supervolcanoes, the risks of climate change are relatively easy to model and predict. Yet, in the approximately thirty years since those risks became generally known and quantified, essentially no progress whatsoever has been made in reducing even the increase in risk. Indeed, during that time about as much carbon dioxide was released into the atmosphere as in the previous two centuries of industrialization.⁴⁰¹

The hapless human species seems cognitively, socially, and politically incapable of saving itself—even from itself. This tragic history is central to “the case for pessimism.” Climate pessimist Jonathan Franzen sets out three conditions that would have to be satisfied before optimism could even be entertained:

[1] The first condition is that every one of the world’s major polluting countries institute draconian conservation measures, shut down much of its energy and transportation infrastructure, and completely retool its economy.

[2] The actions taken by these countries must also be the right ones. Vast sums of government money must be spent without wasting it and without lining the wrong pockets.

[3] Finally, overwhelming numbers of human beings, including millions of government-hating Americans, need to accept high taxes and severe curtailment of their familiar lifestyles without revolting. They must accept the reality of climate change and have faith in the extreme measures taken to combat it. They can’t dismiss news they dislike as fake.⁴⁰²

2. *The Case for Optimism: Preliminary Considerations*

The case for optimism has essentially two prongs: the “best” approach to climate change, and the “second-best” approach.

The best approach is to advance logical, scientific, economic solutions, and to persuade people of the rational merits of those ideas. Strong support, based on the work of British economist Arthur Pigou, is emerging for a direct tax on environmental “externalities.”⁴⁰³ This approach is seen as fairer, less intrusive, and more palatable than

400. Robert H. Frank, *Flaw in Free Markets: Humans*, N.Y. TIMES, (Sept. 13, 2009), <https://www.nytimes.com/2009/09/13/business/economy/13view.html> [<https://perma.cc/3R8Y-X8CH>]; See generally JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES, pt. 4 (Daniel Kahneman, Paul Slovic & Amos Tversky eds., Cambridge Univ. Press 1982).

401. See Nathaniel Rich, *Losing Earth*, N.Y. TIMES MAG., (Aug. 5, 2018).

402. Franzen, *supra* note 327.

403. See ARTHUR C. PIGOU, *THE ECONOMICS OF WELFARE* (1920).

prescriptive regulation or outright prohibition.

An “externality” may be understood as a factor that, while incident to an economic exchange, is not bargained for or against by the parties to the exchange. Effectively, it is not part of the exchange. When I buy a gallon of gasoline from you to use in my car, the resultant pollution harms us both (a little); but neither of us expects that to affect the market price of gasoline—and indeed it does not. The *social cost* of the exchange is absorbed elsewhere.

“Freedom to pollute” is essentially the tragedy of the commons in reverse: putting noxious things into the commons instead of taking valuable things out. But the logic is the same. The purely practical utility *to me*, of driving my car, far outweighs the barely perceptible disutility *to me* of my own car’s pollution. A direct tax on externalities is designed to change this calculus; it literally brings externalities into the exchange, such that their social costs are finally reflected in the exchange price itself.

As virtually all climate scientists and economists agree, a Pigouvian CO₂ tax must be a central pillar of any serious effort to curb greenhouse gas emissions. Such a tax would attack the problem in multiple ways. The most direct effect . . . is that by making the discharge of CO₂ more expensive, it would provide a strong incentive for producers and consumers to emit less of it.⁴⁰⁴

In considering this idea it should be noted, first of all, that every dollar raised by a carbon tax is a dollar by which other taxes (for example, the income tax) may be reduced. All things being equal, taxes on harmful activities (e.g., polluting) are preferable to taxes on socially beneficial activities (e.g., earning income). So, from the very start, this approach takes an important step in the right direction.

The most influential objection to an externalities tax, beyond the usual objections to all taxation in general, might be put as follows: “voters generally, and prosperous voters in particular . . . believe that having to pay higher taxes would make it more difficult to buy what they want [and] would necessitate unpleasant reductions in personal consumption spending.”⁴⁰⁵

This is a powerful cognitive illusion; in reality, economic marketvalue is relative, not intrinsic. “Relative purchasing power is completely unaffected when the wealthy all pay higher taxes.”⁴⁰⁶ The bidding on high-

404. ROBERT H. FRANK, UNDER THE INFLUENCE 166 (forthcoming 2020).

405. *Id.* at 181. Frank’s argument against these beliefs follows logically from only one simple premise--that beyond a point (one that has long since been passed in the West), across-the-board increases in most forms of private consumption do little more than raise the bar that defines what people consider adequate. *Id.* at 190.

406. *Id.* at 189 (emphasis added).

end real estate can continue unabated; the bidders will all simply have slightly less ammunition at their disposal. Perhaps the most telling comparison is suggested by Prof. Frank: [T]he real question is, “Who is happier, someone who drives a \$333,000 Ferrari on roads riddled with foot-deep potholes, or someone driving a \$150,000 Porsche on well-maintained roads?”⁴⁰⁷

Clearly, no serious driver would prefer the former. Moreover, the analogy is eminently fair: Would that the looming environmental disaster could be limited to foot-deep potholes in our roads!

The “relativity of value” is a well-established principle in economic history and theory. In his treatise on *Lowering the Interest and Raising the Value of Money*, John Locke distinguishes use value from exchange value:

1. [T]he intrinsic, natural worth of any thing, consists in its fitness to supply the necessities, or serve the conveniences of human life; and the more necessary it is to our being, or the more it contributes to our well-being, the greater is its worth. But yet,
2. [T]here is no such intrinsic, natural, settled value in any thing, as to make any assigned quantity of it constantly worth any assigned quantity of another.⁴⁰⁸

“Intrinsic value,” as the term implies, looks inward to the inherent properties of things. “Exchange value,” as that term implies, looks at something in relation to something else. Exchange value is the price at which something changes hands for something else on a market.

Here, a whole new range of considerations is introduced. Water is one of the necessities of life; yet because it is plentiful, its price is low. “But as soon as ever water . . . comes any where to be reduced into any proportion to its consumption, it begins presently to have a price, and is sometimes sold dearer than wine.”⁴⁰⁹ And this change in “market value” occurs without any change in the intrinsic value of water.

The change of this marketable value of any commodity, in respect of another commodity, or in respect of a standing, common measure, is not the altering of any intrinsic value, or quality, in the commodity; (for musty and smutty corn will sell dearer at one time than the clean and sweet at another) but the alteration of some

407. *Id.* at 190.

408. JOHN LOCKE, SOME CONSIDERATIONS OF THE CONSEQUENCES OF LOWERING THE INTEREST AND RAISING THE VALUE OF MONEY, in 5 *The Works of John Locke* 42 (1823) (1691) [hereinafter *SOME CONSIDERATIONS OF LOWERING THE INTEREST*].

409. *Id.* at 41.

proportion which that commodity bears to something else.⁴¹⁰

In the example of water, the implied comparison is between a quantity of water and a quantity of money--a commodity that serves as a “standing measure” of exchange value. Decrease the supply of water in relation to its demand, and you raise its price; decrease the buyers of water in relation to the sellers, and you lower its price. And all this has nothing to do with the water itself.

Being rich does not consist in having a lot of gold and silver, “but in having more in proportion than the rest of the world, or than our neighbours.”⁴¹¹ If my fortune is doubled, I am not richer if everyone else’s is tripled; in fact, I am poorer.

Locke’s treatise on *Lowering the Interest and Raising the Value of Money* dates from the late seventeenth century.⁴¹² We do not have another three centuries to convince everyone of the relativity of value. We do not have even the three decades it took to enact the wildly successful cap-and-trade amendments to the Clean Air Act in 1990.⁴¹³ If history is any guide, some form of a carbon tax will eventually be adopted . . . thirty years too late.

The problem . . . is time. One of the reasons why climate change is a “wicked” as opposed to a “normal” problem is that the time horizon in which effective action can be taken is very narrow: every year that passes without *a drastic reduction in global emissions* makes catastrophe more certain.⁴¹⁴

What follows is a brief, preliminary sketch of the required approach.

Not everyone can be convinced of the risks of global warming in time, as some people cannot be convinced of *anything* through rational argumentation. Prudential considerations, thus, counsel recourse to a “second-best” approach, which does not rely on rational arguments or

410. *Id.* at 43.

411. *Id.* at 13.

412. Some Considerations of Lowering the Interest *supra* note 362.

413. See William J. Ripple et al., *Warning of a Climate Emergency*, BIOSCIENCE (Oct. 8, 2018), <https://academic.oup.com/bioscience/article/70/1/8/5610806> [<https://perma.cc/T8NT-A7NB>]. See Special Report on Global Warming of 1.5 °C, Intergovernmental Panel on Climate Change (IPCC) (Oct. 8, 2018).

“The climate crisis has arrived and is accelerating faster than most scientists expected (Figure 2, IPCC 2018). It is more severe than anticipated, threatening natural ecosystems and the fate of humanity (IPCC 2019). Especially worrisome are potential irreversible climate tipping points and nature’s reinforcing feedbacks (atmospheric, marine, and terrestrial) that could lead to a catastrophic “hothouse Earth,” well beyond the control of humans (Steffen et al. 2018). These climate chain- reactions could cause significant disruptions to ecosystems, society, and economies, potentially making large areas of Earth uninhabitable.”

414. AMITAV GHOSH, *THE GREAT DERANGEMENT: CLIMATE CHANGE AND THE UNTHINKABLE* 160 (2016) (emphasis added).

an attempt to persuade people of those arguments' merits.⁴¹⁵ Instead, it employs behavioral techniques to *influence*—through non-rational means—prevailing *expectations*. The econometric theory of rational expectations, discussed in the previous section, provides a conceptual framework for this approach. Under conditions of recurrent forecasting, forecasts do not differ systematically (i.e., regularly or predictably) from what actually occurs. Likewise, actual outcomes do not differ systematically from what people expect.⁴¹⁶

Central to this approach are two powerful forces: “behavioral contagion” and the “architecture of choice.” Behavioral contagion turns expectations into self-fulfilling prophecies—in this case, self-fulfilling prophecies as to various ways global warming might plausibly be solved. Behavioral contagion is somewhat like a “good” bank run, a “good” contagious epidemic, or a “good” stock market bubble, none of which is rational, at least initially.

For another example of behavioral contagion, consider the strong correlation between those who install solar panels and those whose neighbors have already done so. Rationally, the fact that my neighbor has installed a solar panel is not, in and of itself, a reason for me to do the same, assuming neighbors are more or less randomly distributed. (If my neighbor happens to be a leading scientific authority on solar panels, that is another matter.)

The bank run, too, generally starts off irrationally. Then people begin considering what other people are doing (withdrawing all their money from the bank—whether on a rational basis or not), and the bank run can increasingly be viewed as rationally justified. In this way rumors turn into expectations and then into rationally justified choices, even if nothing about the bank itself has changed. “Behavioral contagion influences a variety of choices that affect greenhouse gas emissions—such as the kinds of houses we live in, the vehicles we drive, and the foods we eat.”⁴¹⁷ But whether this influence is styled “herd instinct” or “peer pressure” or mere conformity, it may be viewed, in its initial stages, at least, as overriding or obscuring people’s own, rational decisionmaking—for the greater good of doing what is best for themselves and their planet.

Likewise, the “architecture of choice” influences decisions by changing how options are presented, “using the idea that people are *not fully rational*, and they need a little help sometimes.”⁴¹⁸ The concepts

415. See generally Richard H. Thaler, *Behavioral Economics*, 125 J. POL. ECON. 1799 (2017).

416. See Thomas J. Sargent, *supra* note 269, at 2. Rational Expectations, *Concise Encyclopedia of Economics* (2d ed. 2008), LIBRARY OF ECONOMICS AND LIBERTY, <http://www.econlib.org/library/Enc/RationalExpectations.html> [<https://perma.cc/YHX9-G29S>].

417. Frank, *supra* note 293, at 127.

418. Farmer, *How the Economy Works*, *supra* note 264, at 115 (emphasis added).

involved in understanding climate change are not intuitive. “That is, they are the product of formal education, and thus are not acquired without deliberate instruction and a willingness to learn.”⁴¹⁹ People who do not know what they really want might benefit from a little “nudge” to steer them in the right direction. “Might nudges and improved choice architecture reduce greenhouse gases? Definitely.”⁴²⁰ For example, “if we can find ways to make energy use visible, we’ll nudge people toward reducing their energy use without *mandating* any such reductions.”⁴²¹

For either of these behavioral strategies to work, an initial plunge into the irrational is required. But if enough people and their expectations are thereby influenced, at some point it becomes irrational *not* to follow their lead.⁴²² “Whether arguments command assent or not depends less upon the logic that conveys them than upon the climate of opinion in which they are sustained.”⁴²³

419. Benjafield, *supra* note 283, Cognition at 322 (3d ed. 2007).

420. Richard H. Thaler & Cass R. Sunstein, *Nudge*, YALE U. PRESS 183 (2008).

421. *Id.* at 194 (emphasis added).

422. 2019, like most years before it, ended with massive New Year’s Eve celebrations all around the globe. The arrival of the new year--an artifact of human chronology yet based on the natural rotation of the earth--was greeted unanimously with expressions of jubilation, hope, even solidarity. How could there be any less unanimity on the informed imperative to protect, preserve, and ensure the natural, ecological integrity of the planet Earth, ancestral home of humanity?

423. CARL L. BECKER, *THE HEAVENLY CITY OF THE EIGHTEENTH-CENTURY PHILOSOPHERS* 5 (Yale Univ. Press 2003) (1932). The medieval “climate of opinion,” for example, -- “those instinctively held preconceptions in the broad sense, that *Weltanschauung* or world pattern . . . imposed upon Dante and St. Thomas a peculiar use of the intelligence and a special type of logic.”