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Bioprospect Theory

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Conventional wisdom treats biodiversity and biotechnology as rivalrous values. The global south is home to most of earth's vanishing species, while the global north holds the capital and technology needed to develop this natural wealth. The south argues that intellectual property laws enable pharmaceutical companies and seed breeders in the industrialized north to commit biopiracy.[1] By contrast, the United States has characterized calls for profit-sharing as a threat to the global life sciences industry.[2] Both sides magnify the dispute, on the apparent consensus that commercial exploitation of genetic resources holds the key to biodiversity conservation.

Both sides of this debate misunderstand the relationship between biodiversity and biotechnology.[3] Both sides have overstated the significance of bioprospecting. It is misleading to frame the issue as whether intellectual property in the abstract can coexist with the international legal framework for preserving biodiversity. As a matter of legal gymnastics, any lawyer can reconfigure intellectual property to embrace all of the intangible assets at stake, including raw genetic resources, advanced agricultural and pharmaceutical research, and ethnobiological knowledge.[4]

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1. *See generally* Jim Chen, *There's No Such Thing as Biopiracy . . . And It's a Good Thing Too*, 37 MCGEORGE L. REV. 1 (2006).

2. *See id.*

3. *See generally* Jim Chen, *Biodiversity and Biotechnology: A Misunderstood Relation*, 2005 MICH. ST. L. REV. 51.

4. *See* Joseph Straus, *Bargaining Around the TRIPS Agreement: The Case for Ongoing*

The real challenge lies in directing the law of biodiversity conservation and the law of intellectual property toward appropriate preservation and exploitation of the global biospheric commons.[5] Commercial development aids biodiversity primarily by overcoming perverse economic incentives to consume scarce natural resources that may turn out to have greater global, long-term value. We contest these issues not because we are rational, but precisely because we are not.

Indeed, legal approaches to biodiversity and biotechnology are so twisted that they represent an extreme application of prospect theory. Nearly half a century before Daniel Kahneman and Amos Tversky published *Prospect Theory: An Analysis of Decision Under Risk*,[6] the 1979 article that became the foundational work of behavioral economics and the principal basis for Kahneman's 2002 Nobel Prize in Economics,[7] the Supreme Court of the United States succinctly summarized a core tenet of prospect theory: "Threat of loss, not hope of gain, is the essence of economic coercion."[8] In plainer terms, "losing hurts worse than winning feels good."[9] Stated in formal terms, prospect theory posits that most individuals, as an expression of innate risk aversion, fear potential losses far more than they covet potential gains.[10]

The law of biodiversity and biotechnology appears to reverse this presumption. Although humans innately fear losses more than they value gains, worldwide policy appears to assign relatively little value to biodiversity as an invaluable, incommensurate, and indefinitely important component of global ecological health.[11] Biodiversity loss is staggering and undeniable.[12] Humans are responsible for the sixth great

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Public-Private Initiatives to Facilitate Worldwide Intellectual Property Transactions, 9 DUKE J. COMP. & INT'L L. 91, 104 (1998).

5. *See generally* Jim Chen, *Webs of Life: Biodiversity Conservation as a Species of Information Policy*, 89 IOWA L. REV. 495 (2004).

6. Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263 (1979).

7. Daniel Kahneman, *Maps of Bounded Rationality: A Perspective on Intuitive Judgment and Choice*, *in* LES PRIX NOBEL: THE NOBEL PRIZES 2002 449 (Tore Frangsmyr ed., 2002), *available at* http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002/kahnemann-lecture.pdf. Amos Tversky presumably would have shared Kahneman's award, but he had flunked a core eligibility criterion for a Nobel Prize by dying.

8. United States v. Butler, 297 U.S. 1, 81 (1936).

9. *See generally* LEWIS GRIZZARD, KATHY SUE LOUDERMILK, I LOVE YOU (1979); *accord* JOE GARAGIOLA, IT'S ANYBODY'S BALLGAME (1988).

10. For Kahneman's own summary of prospect theory, *see* DANIEL KAHNEMAN, THINKING, FAST AND SLOW 278-88 (2011).

11. And human health, too. *See* Jim Robbins, *The Ecology of Disease*, N.Y. TIMES, July 14, 2012, http://www.nytimes.com/2012/07/15/sunday-review/the-ecology-of-disease.html.

12. *See generally* Jim Chen, *Across the Apocalypse on Horseback: Imperfect Legal*

extinction spasm of the Phanerozoic Eon, a unit of geologic time spanning half a billion years.[13] Cataclysmic loss of biological diversity is merely one of several ecological threats looming over Holocene humanity.[14]

In assembling this brief analysis, I hasten to add this observation: so far I have assigned no weight to global climate change, a threat that has raised the probability of human extinction to a non-negligible value. Risks as grandiose as these, sufficient in their magnitude to portend the end of civilization, possibly even the survival of humans as a species, support the most dismal of theorems in the dismal science of economics: "the catastrophe-insurance aspect of such a fat-tailed unlimited-exposure situation, which can never be fully learned away, can dominate the social-discounting aspect, the pure-risk aspect, and the consumption-smoothing aspect."[15] In plainer language, the dismal theorem posits that "under limited conditions concerning the structure of uncertainty and societal preferences, the expected loss from certain risks such as climate change is infinite and that standard economic analysis cannot be applied."[16]

By contrast, the global north and the global south alike have reached an apparent consensus that the primary object of the international debate over "biopiracy" is the appropriate profit-sharing protocol (including the possibility of no redistributive mechanism whatsoever) for gains from bioprospecting.[17] Such gains, at best, are highly speculative.[18] Even if profits from bioprospecting are ever

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Responses to Biodiversity Loss, 17 WASH. U. J.L. & POL'Y 12 (2005); Jim Chen, *Legal Mythmaking in a Time of Mass Extinctions: Reconciling Stories of Origin with Human Destiny*, 29 HARV. ENVTL. L. REV. 279 (2005).

13. *See generally* RICHARD LEAKEY & ROGER LEWIN, THE SIXTH EXTINCTION: PATTERNS OF LIFE AND THE FUTURE OF HUMANKIND (1995).

14. *See* Roy Scranton, *Learning How to Die in the Anthropocene*, N.Y. TIMES, (Nov. 10, 2013, 3:00 PM), http://opinionator.blogs.nytimes.com/2013/11/10/learning-how-to-die-in-the-anthropocene.

15. Martin L. Weitzman, *On Modeling and Interpreting the Economics of Catastrophic Climate Change*, 91 REV. ECON. & STAT. 1, 18 (2009).

16. William D. Nordhaus, *The Economics of Tail Events with an Application to Climate Change*, 5 REV. ENVTL. ECON. & POL'Y 240, 240 (2011).

17. *See, e.g.*, David Conforto, *Traditional and Modern-Day Biopiracy: Redefining the Biopiracy Debate*, 19 J. ENVTL. L. & LITIG. 357, 382 (2004).

18. *Cf.* Mark Sagoff, *Muddle or Muddle Through? Takings Jurisprudence Meets the Endangered Species Act*, 38 WM. & MARY L. REV. 825, 844 (1997) ("[N]o plausible scientific argument at present supports the claim that the extinction of species . . . courts environmental disaster. It is far more plausible that rare and endangered species [are] affected by the environment but hav[e] little effect upon it. Moral, aesthetic, and spiritual arguments amply may justify [biodiversity conservation], but an instrumental or economic rationale appears beyond reach.").

realized, they will be extremely concentrated. No champion of redistributive justice on a global scale could defend a system of transferring northern wealth that would favor Brazil, Costa Rica, and Madagascar while neglecting Bolivia, Mali, and Afghanistan.

There simply is no defensible basis for treating ethnobiological knowledge as the foundation of a globally coherent approach to economic development. Yet the global community continues to spend its extremely small and fragile storehouse of political capital on this contentious corner of international environmental law.[19] Global economic diplomacy should be made of saner stuff. The fact that it is not invites us to treat the entire charade as a distinct branch of behavioral law and economics: bioprospect theory.

Upon closer examination, prospect theory and related branches of behavioral economics do supply a powerful explanation for international economic law's systematic failure to reach the optimal solutions for biodiversity conservation. Prospect theory arises from three basic features of human beings' core cognitive system:[20]

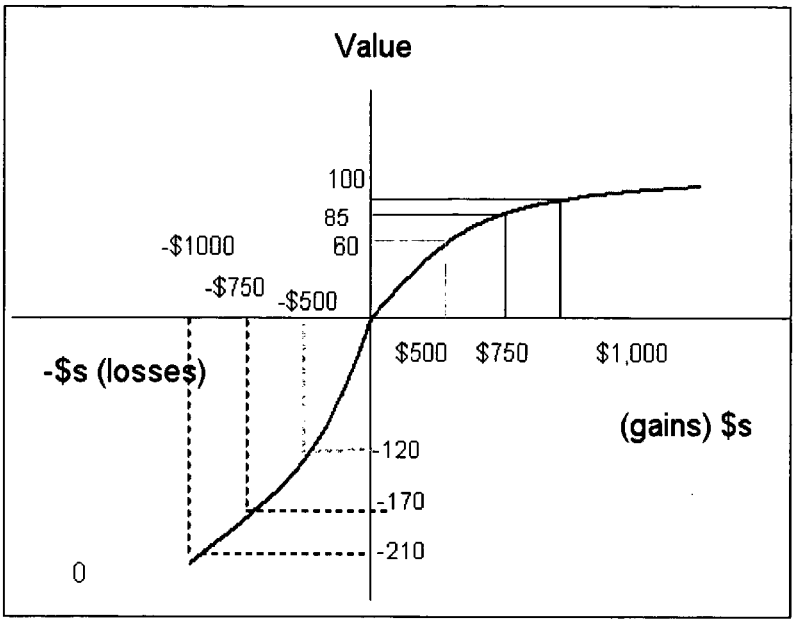
1. All decisionmaking takes place relative to a *neutral reference point*, or "adaptation level." Outcomes exceeding this reference point are gains. Outcomes below the reference point are losses.
2. *Loss aversion* means that losses, when directly weighted or compared against gains, loom larger.
3. *Diminishing sensitivity* applies to upward and downward perceptions and to evaluation of changes of wealth.

In concert, these three principles — neutral reference point, loss aversion, diminishing sensitivity — can be illustrated through a graph showing an asymmetrical sigmoid curve whose inflection point occurs at the neutral adaptation level, whose steeper slope below the adaptation level demonstrates loss aversion, and whose declining rate of change in both directions reflects diminishing sensitivity to gains and losses:[21]

19. *See* Chen, *supra* note 5, at 506.

20. *See* KAHNEMAN, *supra* note 10, at 282.

21. *Id.* at 282-83. One readily implemented way of parametrically modeling prospect theory with closed-form expressions and elementary functions is the cumulative distribution function of the log-logistic distribution. *See generally* Peter R. Fisk, *The Graduation of Income Distributions*, 29 ECONOMETRICA 171 (1961).



"If prospect theory had a flag, this image would be drawn on it."[22] The asymmetrical utility curve that emerges from prospect theory's reevaluation of conventional accounts of expected economic utility leads to some apparent contradictions.[23] In mixed gambles, for instance, where a decisionmaker may realize either a gain or a loss, loss aversion leads to extreme, even costly risk aversion. This is the primary conclusion of prospect theory, the one most readily summarized by the slogan, "losing hurts worse than winning feels good."[24]

But prospect theory predicts affirmatively risk-*seeking* behavior in other circumstances. When a decisionmaker is confronted with nothing but "bad choices" — specifically, those "where a sure loss is compared to a larger loss that is merely probable" — diminishing sensitivity to losses will generate a greater willingness to absorb risk.[25]

Prospect theory therefore rests on two principal insights. First, humans "attach values to gains and losses rather than to wealth."[26] Second, humans making decisions assign "weights . . . to outcomes [that] are different from

22. KAHNEMAN, *supra* note 10, at 282. Graph reproduced from *Basic Concepts: Prospect Theory*, THE DICKINSON COLLEGE WIKI, http://wiki.dickinson.edu/index.php/Basic_Concepts#Prospect_Theory (last modified May 3, 2007).

23. *See* KAHNEMAN, *supra* note 10, at 285.

24. GRIZZARD, *supra* note 9; *accord* GARAGIOLA, *supra* note 9.

25. KAHNEMAN, *supra* note 10, at 285.

26. *Id.* at 316-17.

probabilities."[27] The combination of these two heuristics generates "a distinctive pattern of preferences" that Kahneman and Tversky have called the "fourfold pattern":[28]

The four-fold pattern	Gains	Losses
High probability (certainty effect)	*E.g.*, a 95% chance to win $10,000 leads to . . . *Risk aversion* (annuities and sinecures)	*E.g.*, a 95% chance to lose $10,000 leads to . . . **Risk seeking** (rogue trading and other reckless gambles)
Low probability (possibility effect)	*E.g.*, a 5% chance to win $10,000 leads to . . . **Risk seeking** (lotteries)	*E.g.*, a 5% chance to lose $10,000 leads to . . . *Risk aversion* (insurance)

Let us examine more closely each of the four vanes in prospect theory's pinwheel of fortune. Three of these four behavioral possibilities have long been understood; prospect theory merely provided the means by which to describe them formally.[29] The cell at top left describes how risk aversion leads people to lock in a sure gain below the expected value of a gamble. Annuities work on this principle, as do employment guarantees in unionized trades or on tenure-protected university faculties.

The cell at lower right describes insurance: individuals will pay much more than the expected value of a loss to insure themselves against the disturbing prospect of a catastrophic loss.[30] On the flip side of that transaction, insurance companies can pool risks assigned to them by risk-averse policyholders and profit from the spread between expected losses and premium payments. These risk-averse decisions reflect the core instinct of prospect theory.

But there is also a risk-seeking side to this account of human behavior. Lotteries routinely exploit the possibility effect. When the potential payout is enormous, ticket buyers become indifferent to their miniscule chances of winning. This is the behavioral pattern reflected by the lower left cell. It is

27. *Id.* at 317.

28. *Id.*

29. *See id.* at 317-18.

30. *See, e.g.*, Jim Chen, *Modern Disaster Theory: Evaluating Disaster Law as a Portfolio of Legal Rules*, 25 EMORY INT'L L. REV. 1121 (2011); Jim Chen, *Postmodern Disaster Theory* (Mich. State Univ. Coll. of Law Legal Studies Research Paper Series, Paper No. 11-17, 2012), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2141591.

sufficiently powerful that banks and credit unions have resorted to depositor lotteries to induce lower- to middle-income customers to open and fund savings accounts.[31]

What Kahneman and Tversky found most surprising was the fourth possibility, the one described in the risk-seeking cell at upper right. When humans face the high probability of severe losses, they engage in affirmatively riskier behavior. Prospect theory identifies two reasons for this sudden shift in strategy.[32] First, diminishing sensitivity means that humans react very adversely to a sure loss: "the reaction to a loss of $900 is more than 90% as intense as the reaction to a loss of $1,000."[33] Second and perhaps even more significant, humans assign a much lower decision weight to an extreme loss than its rationally expected value as calculated by the laws of probability. The certainty effect, coupled with diminishing sensitivity, enhances the aversiveness of a sure loss and reduces the aversiveness of the gamble.

This is the ugly corner of human decisionmaking where otherwise responsible parties find themselves tempted to take risks that can "turn[] manageable failures into disasters."[34] "Rogue traders" who have amassed appalling losses let it all ride on a single act of reckless arbitrage. That gamble may destroy a systemically important financial institution.[35] "Because defeat is so difficult to accept," chief executive officers and field marshals suffer from a comparable inability to cut their losses and salvage what is left of their companies and armies.[36]

Bioprospect theory helps explain why international economic and environmental law reaches such perverse outcomes in its approach to

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31. *See* Tina Rosenberg, *Playing the Odds on Savings*, N.Y. TIMES (Jan. 15, 2014, 11:00 AM), http://opinionator.blogs.nytimes.com/2014/01/15/playing-the-odds-on-saving; *cf.* Charles T. Clotfelter, Philip J. Cook, Julie A. Edell & Marian Moore, *State Lotteries at the Turn of the Century: Report to the National Gambling Impact Study Commission* 13 (April 23, 1999), *available at* http://govinfo.library.unt.edu/ngisc/reports/lotfinal.pdf (reporting that "lottery expenditures represent a much larger burden on the household budget for those with low incomes than for those with high incomes").

32. *See* KAHNEMAN, *supra* note 10, at 318.

33. *Id.*

34. *Id.* at 319.

35. A brief recitation of infamous trading episodes suffices to illustrate the point: Bruno Iksil, better known as the "London Whale" who inflicted a multibillion dollar loss on J.P. Morgan Chase in 2012; Jon Corzine and MF Global; Long-Term Capital Management; and Nick Leeson, whose ill-fated trade destroyed Barings Bank in 1995. *See, e.g.*, Stephen Gandel, *How JPMorgan Made its Multi-Billion Dollar Blunder*, FORTUNE (May 15, 2012, 10:01 AM), http://finance.fortune.cnn.com/2012/05/15/jpmorgan-london-whale-blunder; Roger Parloff, *How MF Global's 'Missing' $1.5 Billion Was Lost—and Found*, FORTUNE (Nov. 15, 2013, 10:00 AM), http://features.blogs.fortune.cnn.com/2013/11/15/mf-global-jon-corzine; Roger Lowenstein, *Long-Term Capital Management: It's a Short-Term Memory*, N.Y. TIMES (Sept. 6, 2008), http://www.nytimes.com/2008/09/07/business/worldbusiness/07iht-07ltcm.15941880.html; *How Leeson Broke the Bank*, BBC NEWS (June 22, 1999, 3:58 PM), http://news.bbc.co.uk/2/hi/business/375259.stm.

36. KAHNEMAN, *supra* note 10, at 319.

biodiversity conservation and bioprospecting. Biodiversity policy is perverse because it disobeys the standard risk-averse pattern of human conduct and follows instead the contrary axis of risk-seeking behavior. The fate of the biosphere presents either (1) a low probability of immense gain (through bioprospecting) or (2) a high probability of immense loss (through global climate change). The lottery effect readily explains the overvaluing of commercial bioprospecting. Pharmaceutical companies and protesters accusing them of biopiracy have this much in common: both sides are bedazzled — irrationally — by the possibility that some lucrative cure for cancer may lurk in a Brazilian rain forest.[37]

The looming loss of global biological diversity, on a geologically significant scale, poses an even more disturbing prospect. The magnitude of ecological losses is increasing at an alarming rate, even more so once we move past the relatively narrow frame of biodiversity and contemplate the possibility of complete disruption of global climatic systems. As the costs and the likely futility of mitigating action increase,[38] humans find their own heuristics shoving their collective decisionmaking processes further onto the frontier of desperation where risk-averse acts such as insurance lose their appeal and yield ground to active risk-seeking. System 1 — the rapid, automatic decisionmaking system that has propelled humanity from Pleistocene competitiveness to Holocene dominance[39] — may be pushing *Homo sapiens sapiens* to the edge of extinction by its own talented hand. The global collapse of biodiversity is the ultimate ecosystem service provided by indicator species: "never send to know for whom the bell tolls; it tolls for thee."[40] Bioprospect theory provides the blueprint by which humanity might eschew the remote prospect of wealth, if only momentarily, and focus on how it might better manage anthropogenic ecological disasters before they become full-blown, irreversible cataclysms of global proportions.

37. *See* Chen, *supra* note 1, at 12-13; Paul J. Heald, *The Rhetoric of Biopiracy*, 11 CARDOZO J. INT'L & COMP. L. 519, 541 (2003).

38. *See generally* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS (2014), *available at* http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_All.pdf.

39. *See generally* Keith E. Stanovich & Richard F. West, *Individual Differences in Reasoning: Implications for the Rationality Debate*, 23 BEHAV. & BRAIN SCI. 645 (2000).

40. JOHN DONNE, *Meditation XVII*, *in* DEVOTIONS UPON EMERGENT OCCASIONS 109 (The Univ. of Mich. Press 1959) (1624).