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FABLES OF THE RECONSTRUCTION*: HUMAN EMOTION AND BEHAVIORAL HEURISTICS IN ENVIRONMENTAL ECONOMICS

Quantitative risk management guides policy across many domains, from the regulation of systemically important financial institutions to natural disaster prevention, mitigation, and recovery. Much of the edifice of contemporary mathematical finance, from the capital asset pricing model to the Black-Scholes model of option pricing[1], Merton's distance-to-default model of credit risk[2], the original RiskMetrics specification of value-at-risk[3], and the Gaussian copula[4], is built on the Gaussian "normal" distribution[5]. These elegant models – absent elaborate modifications that ruin their spare, symmetrical form – are treacherously wrong in their reporting of the true nature of risk. Many of the predictive flaws in contemporary finance arise from reliance on the mathematically elegant but practically unrealistic construction of "beautifully Platonic models on a Gaussian base"[6]. Gaussian mathematics suggests that financial returns are smooth, sym-

* *Hear* R.E.M., Fables of the Reconstruction, 1985.

[1] See F. Black, M. S. Scholes, *The Pricing of Options and Corporate Liabilities*, J. Pol. Econ. 1973, No. 81, pp. 637–654; R. C. Merton, *The Theory of Rational Option Pricing*, Bell J. Econ. 1973, No. 4, pp. 141–183.

[2] See R. C. Merton, *On the Pricing of Corporate Debt: The Risk Structure of Interest Rates*, J. Fin 1974, No. 29, pp. 449–470.

[3] See J. Mina, J. Yi Xiao, *Return to RiskMetrics: The Evolution of a Standard*, New York 2001; J. Berkowitz, J. O'Brien, *How Accurate Are Value-at-Risk Models at Commercial Banks?*, J. Fin. 2002, No. 57, pp. 1093–1111.

[4] See R. B. Nelsen, *An Introduction to Copulas*, New York 1999; D. X. Liu, *On Default Correlation: A Copula Function Approach*, J. Fixed Income March 2000, pp. 43–54.

[5] See *generally* B. B. Mandelbrot, R. L. Hudson, *The (Mis)Behavior of Markets: A Fractal View of Risk, Ruin, and Reward*, New York 2004.

[6] N. N. Taleb, *The Black Swan: The Impact of the Highly Improbable*, New York 2007, p. 279.

metrical, and predictable. In reality, returns are skewed[7] and exhibit heavier than normal tails[8].

Despite their shortcomings, Gaussian models continue to wield considerable influence throughout all domains of risk management. A wide range of policy judgments continue to rest on the assumption that risks and returns follow the visually supple and analytically pliable curves of the Gaussian distribution. Indeed, the metaphysical arc of mathematical finance exhibits the seductive symmetry of "beauty supreme – a beauty cold and austere, like that of sculpture, without any appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show"[9]. The attraction in law, finance, and economics to formal elegance reflects a love affair with the Gaussian mathematics that dominates the culture of contemporary business and science[10].

Multiple financial crises have shaken confidence in these formal economic models. Mathematical finance often finds that it "can no longer understand [itself] because the theories (…) of [its] former age no longer work and the theories of the new age are not yet known"[11]. Recovery from these crises offers exactly one path forward: to "start afresh as if [we] were newly come into a new world"[12]. The traditional economic preference for order must give way to pragmatic exigencies. When at last we grasp the uncomfortable truth that Gaussian models of risk and return belong to "a system of childish illusions", our affair with the

[7] See, e.g., J. Y. Campbell, A. W. Lo, A. C. MacKinlay, *The Econometrics of Financial Markets*, Princeton 1997, pp. 17, 81, 172, 498; F. M. Aparicio, J. Estrada, *Empirical Distributions of Stock Returns: European Securities Markets, 1990–95*, Eur. J. Fin. 2001, No. 7, pp. 1–21; G. Bekaert, C. Erb, C. R. Harvey, T. Viskanta, *Distributional Characteristics of Emerging Market Returns and Asset Allocation*, J. Portfolio Mgmt. 1998, pp. 102–116; P. Chunhachinda, K. Dandepani, S. Hamid, A. J. Prakash, *Portfolio Selection and Skewness: Evidence from International Stock Markets*, J. Banking & Fin. 1997, No. 21, pp. 143–167; A. Peiró, *Skewness in Financial Returns*, J. Banking & Fin. 1999, pp. 847–862.

[8] See, e.g., J. B. Gray, D. W. French, *Empirical Comparisons of Distributional Models for Stock Index Returns*, J. Bus. Fin. & Accounting 1990, No. 39, pp. 451–459; S. J. Kon, *Models of Stock Returns – A Comparison*, J. Fin. 1984, No. 39, pp. 147–165; H. M. Markowitz, N. Usmen, *The Likelihood of Various Stock Market Return Distributions*, Part 1: *Principles of Inference*, J. Risk & Uncertainty 1996, No. 13, pp. 207–219; H. M. Markowitz, N. Usmen, *The Likelihood of Various Stock Market Return Distributions*, Part 2: *Empirical Results*, J. Risk & Uncertainty 1996, No. 13, pp. 221–247; T. C. Mills, *Modelling Skewness and Kurtosis in the London Stock Exchange FT-SE Index Return Distributions*, Statistician 1995, No. 44, pp. 323–332.

[9] B. Russell, *The Study of Mathematics*, (in:) *Mysticism and Logic, and Other Essays*, Totowa 1988, pp. 58, 60; J. Chen, *Truth and Beauty: A Legal Translation*, U. Toledo L. Rev. 2010, No. 41, pp. 265.

[10] See N. N. Taleb, *The Black Swan*…, p. 279.

[11] W. Percy, *The Delta Factor*, (in:) *The Message in the Bottle: How Queer Man Is, How Queer Language Is, and What One Has to Do with the Other*, New York 1986, pp. 3–45.

[12] *Ibidem*, p. 7.

seductive symmetry of traditional risk modeling shall pass "like first love (…) into memory"[13].

The making of environmental law and policy is likewise a species of risk management, one where the vectors of physical uncertainty and emotional reaction differ from those of finance in degree more than in kind[14]. To extend the contributions of physics to financial evaluations of abnormal markets[15], complete understanding of human economic behavior demands knowledge of neuroscience, evolutionary biology, and epidemiology. Among branches of economics, environmental economics provides an especially rich source of insights into the impact of emotion, cognitive bias, and behavioral heuristics on risk assessment and management.

In environmental economics, as in other domains, risk is experienced and understood in emotional terms[16]. And the primary forces that appeal to emotion take verbal, visual, and narrative form: "much of the human thinking that results in action is not quantitative, but instead takes the form of *storytelling* and *justification*"[17]. When making financial decisions, investors "weigh a story, which has no quantitative dimension, against the observed quantity of financial wealth that they have available for consumption"[18]. Environmental economics reflects many of the same dynamics. I now evaluate the behavioral element of environmental economics as a fable. A powerful fable operates as "the opposite of a stage magician": rather than crafting "illusion that has the appearance of truth", a fable "give[s] you truth in the pleasant disguise of illusion"[19].

For purposes of contrasting environmental economics with its purely financial counterpart, I begin with a quick examination of modern portfolio theory[20], one of the foundational components of mathematical finance[21]. The most rigid forms of risk management make "no attempt to explain [the] underlying structure

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[13] D. Berlinski, *A Tour of the Calculus*, New York 1995, p. 239.

[14] See, e.g., C. R. Sunstein, R. Zeckhauser, *Overreaction to Fearsome Risks*, Envtl. & Resource Econ. 2011, No. 48, pp. 435–449.

[15] See *generally* S. Sinha, A. Chatterjee, A. Chkraborti, B. K. Chakrabarti, *Econophysics: An Introduction*, Weinheim 2011.

[16] See, e.g., G. F. Loewenstein, *Emotions in Economic Theory and Economic Behavior*, Am. Econ. Rev. 2000, No. 65, pp. 426–432; G. Loewenstein, E. U. Weber, C. K. Hsee, N. Welch, *Risk as Feelings*, Psych. Bull. 2001, No. 127, pp. 267–286.

[17] R. J. Shiller, *Irrational Exuberance*, 3rd ed., Princeton 2015, p. 168 (emphases in original).

[18] *Ibidem*, p. 168.

[19] T. Williams, *The Glass Menagerie*, New York 1999.

[20] See generally, e.g., E. J. Elton, M. J. Gruber, S. J. Brown, W. N. Goetzmann, *Modern Portfolio Theory and Investment Analysis*, 9th ed., Hoboken 2014; E. J. Elton, M. J. Gruber, *Modern Portfolio Theory, 1950 to Date*, J. Banking & Fin. 1997, No. 21, pp. 1743–1759; H. M. Markowitz, *Portfolio Selection*, J. Fin. 1952, No. 7, pp. 87–91.

[21] For an extended application of modern portfolio theory to disaster law, see J. Chen, *Modern Disaster Theory: Evaluating Disaster Law as a Portfolio of Legal Rules*, Emory Int'l L.J. 2011, No. 25, p. 1121–1143.

[of] price changes"[22]. Modern portfolio theory goes no further than "simply" to "give probabilities" for "[v]arious outcomes"[23]. At its weakest, modern portfolio theory tautologically restates the capital asset pricing model[24], insofar as *any* mean-variance efficient portfolio is mathematically equivalent to the expected return predicted by the capital asset pricing model (CAPM)[25]:

$$E(R_t) = R_f + \beta_{ip}[E(R_p) - R_f].$$

This objection, that modern portfolio theory tautologically restates the CAPM, is called Roll's critique. The proponent of this view, Richard Roll, is better known for his second claim. The second half of Roll's critique asserts that the true market portfolio is unobservable, inasmuch as it fails to address all components of net worth[26]. The capital asset pricing model neglects assets that cannot be easily liquidated and marked-to-market on a publicly regulated exchange. The CAPM therefore omits every alternative source of wealth, from real estate to jewelry and other personal effects. In the financial context, Roll speculated that a mixture of "bonds, human capital, and real estate in reasonable proportions" with "all-equity proxies" might better reflect the efficiency of the market, but conceded that this hypothesis could not be tested, "for the simple reason that the true market portfolio has an unknown composition"[27]. These omissions force observers to test hypotheses about the CAPM on the publicly traded fraction of an investor's over-

[22] See D. W. Hubbard, *The Failure of Risk Management*, Hoboken 2009, p. 67 (distinguishing the simple assignment of probabilities in modern portfolio theory from more comprehensive structural analyses of risk in probabilistic risk assessment).

[23] *Ibidem*, p. 67.

[24] See R. Roll, *A Critique of the Asset Pricing Theory's Tests – Part I: On Past and Potential Testability of the Theory*, J. Fin. Econ. 1977, No. 4, pp. 136; see also E. F. Fama, J. D. MacBeth, *Risk, Return, and Equilibrium: Empirical Tests*, J. Pol. Econ. 1973, No. 81, pp. 610.

[25] See generally, e.g., F. Black, *Capital Market Equilibrium with Restricted Borrowing*, J. Bus. 1972, No. 45, pp. 444–455; E. F. Fama, K. R. French, *The Capital Asset Pricing Model: Theory and Evidence*, J. Econ. Persp. 2004, pp. 25–46; J. Lintner, *Security Prices, Risk and Maximal Gains from Diversification*, J. Fin. 1965, No. 20, pp. 587–615; J. Lintner, *The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets*, Rev. Econ. & Stats. 1965, No. 73, pp. 13–37; J. Mossin, *Equilibrium in a Capital Asset Market*, Econometrica 1966, No. 34, pp. 768–783; W. F. Sharpe, *Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk*, J. Fin. 1964, No. 19, pp. 425–442; J. L. Treynor, *Toward a Theory of Market Value of Risky Assets*, (in:) R. A. Korajczyk (eds.), *Asset Pricing and Portfolio Performance: Models, Strategy and Performance Metrics*, London 1999, pp. 15–22.

[26] Compare R. Roll, *A Critique of the Asset Pricing Theory's Tests*…, p. 138 (stating that tests of asset pricing theory assume that "the market portfolio must be identifiable") with *ibidem*, p. 146 (noting the concession made by M. E. Blume, I. Friend, *A New Look at the Capital Asset Pricing Model*, J. Fin. 1973, No. 28, pp. 22–23, that the CAPM "cannot explain the observed returns of all financial assets", but "may be (…) adequate (…) for a subset (…) such as common stocks on the NYSE").

[27] R. Roll, *A Critique of the Asset Pricing Theory's Tests*…, p. 155.

all portfolio. "Tests of the CAPM are extremely sensitive to which market proxy is used" to assess the efficiency with which the market reacts to new information, "even though returns on most market proxies (…) are highly correlated"[28]. The failure of any asset pricing model to demonstrate market efficiency could arise *either* from the *ex ante* inefficiency of the true market portfolio or from the inefficiency of the chosen market proxy[29].

Beyond identifying methodological limitations on the ability to verify or falsify claims made by the capital asset pricing model, Roll's critique has deeper implications for the persuasive power of economic theory. An approach to mathematical finance that narrowly addresses the market in publicly traded assets will struggle with emotions and experiences beyond that tightly bounded framework. For instance, a growing body of economic and psychological research connects subjective well-being with discretionary purchases of experiences rather than material possessions[30]. A purported theory of everything in mathematical finance cannot afford to omit consequential assets, even if they are illiquid or difficult to price.

Intriguingly, environmental economics levels an analogous criticism at the use of conventional econometrics as a baseline for evaluating environmental policy[31]. Conventional measures of social welfare such as gross domestic product (GDP), it is alleged, give little or no weight to ecosystem services[32]. In place of GDP, or least alongside it, ecological economists have devised a wide variety of measures intended to capture elements of human and ecological welfare that carry no weight in standard national income and product accounts[33]. These measures include the genuine progress indicator[34] and the human development

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[28] S. M. Focardi, F. J. Fabozzi, *The Mathematics of Financial Modeling and Investment Management*, Hoboken 2004, p. 521.

[29] *Ibidem*.

[30] See, e.g., T. J. Carter, T. Gilovich, *The Relative Relativity of Material and Experiential Purchases*, J. Personality & Soc. Psych. 2010, No. 98, pp. 146–159; R. G. Howell, P. Pchelin, R. Iyer, *The Preference for Experiences over Possessions: Measurement and Construct Validation of the Experiential Buying tendency Scale*, J. Positive Psych. 2012, No. 7, pp. 57–71; M. Millar, R. Thomas, *Discretionary Activity and Happiness: The Role of Materialism*, J. Research in Personality 2009, No. 43, pp. 699–702.

[31] See, e.g., M. Max-Neef, *Economic Growth and Quality of Life: A Threshold Hypothesis*, Ecol. Econ. 1995, No. 15, pp. 115–118.

[32] See, e.g., S. Zhao, H. Hong, L. Zhang, *Linking the Concept of Ecological Footprint and Valuation of Ecosystem Services: A Case Study of Economic Growth and Natural Carrying Capacity*, Int'l J. Sustainable Dev. & World Ecol. 2008, No. 15, pp. 448–456.

[33] See, e.g., I. Kubiszewski, R. Costanza, C. Franco, P. Lawn, J. Talberth, T. Jackson, C. Aylmer, *Beyond GDP: Measuring and Achieving Global Genuine Progress*, Ecol. Econ. 2013, No. 93, pp. 57–68.

[34] See, e.g., P. A. Lawn, *A Theoretical Foundation to Support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and Other Related Indexes*, Ecol. Econ. 2003, No. 44, pp. 105–118.

index[35]. The adoption of gross national happiness by the Himalayan kingdom of Bhutan connects the quest for proper economic measurement with human emotion, a link that environmental economics seeks to complete[36].

Roll's second critique issues a straightforward, twofold challenge to quantitative risk management. First, we must count everything, for wealth and risk depend on the full portfolio. Second, we must remember that there are different ways of accounting, and different actors will resort to some of these methods, even if the government or some abstract ledger treats only one system of accounting as "correct".

The realm of environmental protection and conservation, where "beauty and mystery (…) seized us at the beginning" and continues to inspire "the human intellect that masters [it] all"[37], serves as an apt reminder that neither finance nor any other branch of economics can be severed from aesthetic judgment and human emotion[38]. Homebuyers "do not just see a house"; they "see a handsome house, an ugly house, or a pretentious house"[39]. The recognition that even the briefest introduction to a subject – mere exposure – alters emotional reactions to novel stimuli[40] opens the door to complete economic consideration of the so-called "affect heuristic"[41]. Instantaneous, automatic "feelings associated with [such] stimulus words [as] *treasure* or *hate*"[42] motivate entire branches of busi-

[35] See, e.g., F. Noorbaksh, *A Modified Human Development Index*, World Dev. 1998, No. 26, pp. 517–528; A. D. Sagar, A. Najam, *The Human Development Index: A Critical Review*, Ecol. Econ. 1998, No. 25, pp. 249–264.

[36] See S. Preisner, *Gross National Happiness: Bhutan's Vision of Development and Its Challenges*, (in:) P. Nath Mukherji, C. Sengupta (eds.), *Indigeneity and Universality in Social Science: A South Asian Response*, New Dehli 2004, pp. 212–232.

[37] E. O. Wilson, *Consilience: The Unity of Knowledge*, New York 1998, p. 237.

[38] See, e.g., J. Wei Zhang, R. T. Howell, R. Iyer, *Engagement with Natural Beauty Moderates the Positive Relation Between Connectedness with Nature and Psychological Well-Being*, J. Envtl. Psych. 2014, No. 38, pp. 55–63.

[39] R. B. Zajonc, *Feeling and Thinking: Preferences Need No Inferences*, Am. Psychologist 1980, No. 35, pp. 154; M. Statman, K. L. Fisher, D. Anginer, *Affect in a Behavioral Asset-Pricing Model*, Fin. Analysts J. 2008, No. 64, pp. 20–29.

[40] See R. B. Zajonc, *Mere Exposure: A Gateway to the Subliminal*, Current Directions in Psych. Sci. 2001, No. 10, pp. 224–228.

[41] See generally, e.g., M. L. Finucane, A. Alhakami, P. Slovic, S. M. Johnson, *The Affect Heuristic in Judgments of Risks and Benefits*, J. Behav. Decision Making 2000, No. 13, pp. 1–17; P. Slovic, E. Peters, M. L. Finucane, D. G. MacGregor, *Affect, Risk, and Decision Making*, Health Psych. 2005, No. 24, pp. S35–S40; M. Statman, K. L. Fisher, D. Anginer, *Affect in a Behavioral Asset-Pricing Model*…, pp. 20–29; R. B. Zajonc, *Feeling and Thinking*…, pp. 151–175.

[42] See P. Slovic, M. Finucane, E. Peters, D. G. Macgregor, *The Affect Heuristic*, (in:) T. Gilovich, D. Griffin, D. Kahneman (eds.), *Heuristics and Biases: The Psychology of Intuitive Judgment*, Cambridge 2002, pp. 397–420.

ness and economics associated with advertising, marketing, and publicity[43]. We should likewise expect the affect heuristic to affect evaluations of risk.

This is the sense in which Roll's second critique holds the key to a behaviorally sensitive understanding of economics. Emotions drive the price of the assets that are putatively invisible to conventional pricing models. Art[44], collectibles[45], anything beautiful[46]. Ye gods, real estate[47]. No less than prices for wine[48], stock market prices reflect investor sentiment as well as rational factors[49]. What does come at a price is relaxing the supposition, embedded in "standard financial theory", that "affect plays no role in the pricing of financial assets"[50]. Human emotion and behavior do affect financial markets and portfolios, and the corresponding recognition that "affect plays a role in pricing models of financial assets" gives rise to the development of "a behavioral asset-pricing model"[51].

Many of the behavioral quirks that hound financial markets have been observed in environmental contexts. Scientific receptivity to the role of behavioral psychology does differ. In contrast with the ambivalent reception of behavioral economics in financial circles, the impact of emotion and innate heuristics on environmental decision-making has never been doubted. During the formative stages of modern behavioral economics, agricultural economists leapfrogged the rest of the "axiomatically minded" profession in acknowledging both "risk and risk aversion" and in connecting "behavior to need by a simple rule called the safety-first principle"[52]. In other words, agricultural economics was one of the first branches of economics to embrace Roy's safety-first criterion, a financial optimization rule that minimizes the probability that an investor would realize actual

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[43] See, e.g., B. Shiv, A. Fedorikhin, *Heart and Mind in Conflict: The Interplay of Affect and Cognition in Consumer Decision Making*, J. Consumer Research 1999, No. 26, pp. 278–292.

[44] See, e.g., G. David, K. Oosterlinck, A. Szafarz, *Art Market Inefficiency*, Econ. Letters 2013, No. 121, pp. 23–25; P. Erdos, M. Ormos, *Random Walk Theory and the Weak-Form Efficiency of the US Art Auction Prices*, J. Banking & Fin. 2010, No. 34, pp. 1062–1076.

[45] See, e.g., E. Dimson, C. Spaenjers, *Ex Post: The Investment Performance of Collectible Stamps*, J. Fin. Econ. 2011, No. 110, pp. 443–458.

[46] See, e.g., L. Renneboog, C. Spaenjers, *Buying Beauty: On Prices and Returns in the Art Market*, Mgmt. Sci. 2013, No. 110, pp. 36–53.

[47] See E. L. Glaeser, *A Nation Of Gamblers: Real Estate Speculation And American History*, NBER Working Paper No. 18825, 2013, at http://www.nber.org/papers/w18825.

[48] See O. Ashenfelter, *How Auctions Work for Wine and Art*, J. Econ. Perspectives 1989, No. 3, pp. 23–26.

[49] See M. Baker, J. Wurgler, *Investor Sentiment in the Stock Market*, J. Econ. Perspectives 2007. No. 21, pp. 129–151.

[50] M. Statman, K. L. Fisher, D. Anginer, *Affect in a Behavioral Asset-Pricing Model*…, p. 20.

[51] *Ibidem*.

[52] L. L. Lopes, *Between Hope and Fear: The Psychology of Risk*, Advances Experimental Soc. Psych. 1987, No. 20, pp. 255–295; see also, e.g., Q. Shahabuddin, D. Butterfield, *The Impact of Risk on Agricultural Production Decisions: Tests of a Safety-First Model in Bangladesh*, Bangladesh Dev. Stud. 1986, No. 14, pp. 13–37.

returns below some minimally acceptable baseline[53]. Recognizing the behavioral lessons of environmental economics may help finance transcend the perceived rigor and the admittedly romantic allure of the efficient markets hypothesis.

Vigilance against downside risk animates the most temperamentally (if not politically) conservative principle in environmental law and safety regulation. As a counterweight to conventional cost-benefit analysis, the precautionary principle discourages risk-taking that may hurt the public at large, or an especially vulnerable segment of it[54]. The need to accumulate and safeguard wealth for immediate, safety- or survival-oriented consumption is likelier to consume a deeper portion of a poor family's total wealth[55]. This sensitivity to unforeseen, even unforeseeable, risk and to wealth effects finds a welcome home in the normative toolkit of environmental economics.

On the other hand, the risk of excessive social consumption in disregard for environmental disruption and other long-term consequences does appear to reach its apex during periods of nominal economic growth. Environmental "hazards that are viewed as familiar, commonplace, everyday risks are often underestimated", especially by local residents who rely (mistakenly) on the "perceived collective judgment" of others around them who have seemingly concluded that their community is "safe enough"[56]. Too often, public responses to environmental risk falls under the sway of the gambler's fallacy[57] and "overinvest[s] in reconstruc-

[53] See A. D. Roy, *Safety First and the Holding of Assets*, Econometrica 1952, No. 20, pp. 431–449.

[54] See, e.g., U.N. Conference on Environment and Development, Rio de Janeiro, June 3–14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF. 151/26, Vol. 1, annex 1, principle 15, August 12, 1992 ("Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".); J. Applegate, *The Precautionary Preference: An American Perspective on the Precautionary Principle*, Hum. & Ecol. Risk Assessment 2000, No. 6, p. 413. For efforts to reconcile the precautionary principle with cost-benefit analysis, see D. H. Cole, *Reconciling Cost-Benefit Analysis with the Precautionary Principle*, March 5, 2012, at https://www.law.upenn.edu/blogs/regblog/2012/03/reconciling-cost-benefit-analysis-with-the-precautionary-principle.html; D. A. Kysar, *It Might Have Been: Risk, Precaution and Opportunity Costs*, J. Land Use & Envtl. L. 2006, No. 22.

[55] Compare J. Haug, T. Hens, P. Woehrmann, *Risk Aversion in the Large and in the Small*, Econ. Letters 2013, pp. 310–313 with M. S. Kimball, *Precautionary Saving in the Small and in the Large*, Econometrica 1990, No. 58, p. 53–73.

[56] L. Grow Sun, *Smart Growth in Dumb Places: Sustainability, Disaster, and the Future of the American City*, BYU L. Rev. 2011, pp. 2192–2193; see also *ibidem*, p. 2193 ("Individuals who live in cities vulnerable to natural disasters may adopt the attitude that every place is risky in some way and (…) view that vulnerability as just one of the many risks of modern life".); *cf.* J. Pidot, *Deconstructing Disaster*, BYU L. Rev. 2013, pp. 213 (observing that the public may fall into a dangerous state of complacency about environmental risks after "a long period of calm", "as though (…) natural hazards no longer exist").

[57] See generally T. McPherson, *Moorean Arguments and Moral Revisionism*, J. Ethics & Soc. Phil. 2009, No. 3, pp. 2, 20; S. P. Stitch, R. E. Nisbett, *Justification and the Psychology of Human Reasoning*, 4Phil. Sci. 1988, No. 47, pp. 192–193.

tion in the wake of disaster based on a mistaken assumption that a period of repose and relative safety will follow"[58]. At the same time, many individuals ignore ecosystem services and other positive environmental externalities – for example, "flourishing forests, healthy wetlands, thriving honeybee populations, and a stable climate" – until the loss of such "societal benefits" becomes "the face of (…) disaster"[59].

These mistakes in environmental judgment arise from what behavioral economists call the availability heuristic[60]. The salience of data, rather than a scientifically sober account of its significance, ultimately drives decision-making[61]. The interconnected nature of human society quickly compounds the power of narratives whose plausibility and vividness exceed their validity into "availability cascades" that overwhelm proper, critical evaluation[62]. Availability cascades have created an entire "disaster mythology" in which catastrophic events prompt looting, violence, and general lawlessness[63]. Availability cascades bedevil other domains of public health and environmental policy, such as acceptance of the safety of vaccines[64] and of the science demonstrating the anthropogenic nature of climate change[65].

Informational cascades are even more devastating when they validate ideas that the audience is already predisposed to favor. Behavioral economics calls this problem "confirmation bias"[66]. As if these problems were not demoralizing enough, increased levels of literacy, numeracy, and scientific sophistication do not change minds or hearts about pressing issues of risk management. Instead, they merely

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[58] J. Pidot, *Deconstructing Disaster*…, p. 138.

[59] L. Grow Sun, B. Daniels, *Mirrored Externalities*, Notre Dame L. Rev. 2014, No. 90, pp. 135, 161–162.

[60] See generally, e.g., H. Fennema, P. Wakker, *Original and Cumulative Prospect Theory: A Discussion of Empirical Differences*, J. Behav. Decision Making 1997, No. 10, p. 53.

[61] See C. Jolls, C. R. Sunstein, R. H. Thaler, *A Behavioral Approach to Law and Economics*, Stan. L. Rev. 1998, No. 50, pp. 1471, 1477–1478.

[62] See generally M. K. Brunnermeier, *Herding and Informational Cascades*, (in:) *Asset Pricing Under Asymmetrical Information: Bubbles, Crashes, Technical Analysis, and Herding*, Oxford 2001, pp. 147–164; T. Kuran, C. R. Sunstein, *Availability Cascades and Risk Regulation*, Stan. L. Rev. 1999, No. 51, pp. 683–768.

[63] See L. Grow Sun, *Disaster Mythology and Availability Cascades*, Duke Envtl. L. & Pol'y F. 2012, No. 23, pp. 73, 77–81; L. Grow Sun, *Disaster Mythology and the Law*, Cornell L. Rev. 2011, No. 96, pp. 1131, 1150–1152.

[64] See, e.g., J. Bonhoeffer, J. U. Heininger, *Adverse Events Following Immunization: Perception and Evidence*, Current Opin. in Infectious Diseases 2007, No. 20, pp. 237–246; M. B. Pepys, *Science and Serendipity*, Clin. Med. 2007, No. 7, pp. 562–578.

[65] See, e.g., A. M. McCright, R. E. Dunlap, *Challenging Global Warming as a Social Problem: An Analysis of the Conservative Movement's Counter-Claims*, Soc. Probs. 2000, No. 47, pp. 499–522.

[66] See generally R. S. Nickerson, *Confirmation Bias: A Ubiquitous Phenomenon in Many Guises*, Rev. Gen. Psych. 1998, No. 2, pp. 175–220.

entrench all parties even more deeply in their predispositions and biases[67]. Cultural cognition theory[68], though by no means immune to criticism[69], suggests that the public will turn its attention to deep threats such as climate change only when legal and political actors learn how to communicate in ways that resonate with deeply held societal values[70].

Other cognitive biases also hamper judgment in environmental and financial settings. The endowment effect, a bedrock element of humans' innate heuristics for evaluating risk[71], leads private parties and governments to overvalue pre-existing wealth and to take economically unwarranted account of sunk costs[72]. Consider, for example, the choice between *ex ante* investments in disaster preparedness and *ex post* expenditures on disaster relief. By one estimate, each dollar in disaster preparedness is worth roughly $15 in mitigated future damage[73]. Even though an ounce of prevention is almost literally worth a pound of cure, individu-

[67] See D. M. Kahan, E. Peters, M. Wittlin, P. Slovic, L. Larrimore Ouellette, D. Braman, G. Mandel, *The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks*, Nature Climate Change 2012, No. 2, pp. 732–735.

[68] See generally M. Douglas, A. B. Wildavsky, *Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers*, Berkeley 1982 (propounding a cultural theory of risk); P. Slovic, *The Perception of Risk*, New York 2000 (propounding a "psychometric paradigm" for risk management through public policy).

[69] See L. Sjöberg, *World Views, Political Attitudes, and Risk Perception*, 9 Risk: Health, Safety & Env't 1998, No. 9, pp. 137–152 (arguing that cultural cognition theory accounts for only a portion of the diversity in attitudes toward risk).

[70] See R. M. Verchick, *Culture, Cognition, and Climate*, U. Ill. L. Rev. 2015 (forthcoming); *cf.* L. Grow Sun, *Disaggregating Disasters*, UCLA L. Rev. 2013, No. 60, pp. 884, 887 (criticizing the framing of natural and technological disasters within the narrative of war and national security, as though those disasters involved an anthropomorphic "enemy" to be demonized and defeated).

[71] See generally, e.g., Z. Carmon, D. Ariely, *Focusing on the Forgone: How Value Can Appear So Different to Buyers and Sellers*, J. Consumer Research 2000, No. 27, p. 360; H. J. Hovenkamp, *Legal Policy and the Endowment Effect*, J. Leg. Stud. 1991, No. 20, pp. 225–247; D. Kahneman, J. L. Knetsch, R. H. Thaler, *Experimental Tests of the Endowment Effect and the Coase Theorem*, J. Pol. Econ. 1990, No. 98, pp. 1325–1348; J. L. Knetsch, *The Endowment Effect and Evidence of Nonreversible Indifference Curves*, Am. Econ. Rev. 1989, No. 79, pp. 1277–1284; N. Novemsky, D. Kahneman, *The Boundaries of Loss Aversion*, J. Marketing Research 2005, No. 42, p. 119.

[72] See W. Kip Viscusi, *The Hold-Up Problem: Why It Is Urgent to Rethink the Economics of Disaster Insurance Protection*, (in:) E. Michel-Kerjan, P. Slovic (eds.), *The Irrational Economist: Making Decisions in a Dangerous World*, New York 2006, pp. 142, 145.

[73] See A. Healy, N. Malhotra, *Myopic Voters and Natural Disaster Policy*, Am. Pol. Sci. Rev. 2009, No. 103, pp. 387, 396 (estimating "the total benefit of a dollar of preparedness spending" as "all future reductions in damage", while discounting "those benefits (…) for the fact that resources invested today in other ways could have yielded their own return and that preparedness investments will depreciate"); *cf.* M. Ishaq Nadiri, I. Prucha, *Estimation of Depreciation Rate of Physical and R&D Capital in the U.S. Total Manufacturing Sector*, Econ. Inquiry 1996, No. 34, p. 43 (estimating that physical capital in American manufacturing depreciates 5.9% per year). Combining Nadiri and Prucha's 5.9% depreciation rate with their own estimate of a 4% annual interest rate, Healy and Malhotra "estimate the [net present value] of $1 of disaster preparedness to be about $15".

als and governments systematically underinvest in disaster preparedness *ex ante* and overinvest in disaster relief *ex post*[74].

At worst, the affect heuristic encourages economic agents to evaluate the magnitude of risk and expected loss according to raw likes and dislikes[75]. In more conventional financial settings, after all, the addition or removal of "dot-com" from a company name resulted in abnormally positive returns, depending on whether the name change took place before or after the technology bust of the early 2000s[76]. In cruder terms, human decision-making is thrall to the laws of sympathetic magic – the emotional "laws" dictating that contact with disgusting objects constitutes permanent contamination (food touching a cockroach is repulsive) and that visual similarity constitutes qualitative equivalence (food resembling a cockroach is also repulsive)[77]. Along every spatial, temporal, and behavioral dimension, the political economy of disaster assistance dictates perverse outcomes[78], which we may ruefully but truthfully describe as "accidents waiting to happen"[79], or "catastrophic responses to catastrophic risks"[80].

This narrative bridging finance with environmental economics evokes the fable of the ant and the grasshopper. Both versions of this morally ambiguous fable inform the connection between these branches of economics. Aesop's more traditional version of the tale[81] suggests that we should treat behavioral departures from strict, technocratic rationality as the moral equivalent of the grasshopper's behavior, singing throughout the summer rather than gathering food. A parallel source of ancient wisdom counsels, "Go to the ant, O sluggard; consider her ways, and be wise. Without having any chief, officer or ruler, she prepares her food in

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[74] See B. Depoorter, *Horizontal Political Externalities: The Supply and Demand of Disaster Management*, Duke L.J. 2006, No. 56, pp. 101, 103; H. Kunreuther, *Mitigating Disaster Losses Through Insurance*, J. Risk & Uncertainty 1996, No. 12, p. 171 .

[75] See J. Pidot, *Deconstructing Disaster…*, p. 242.

[76] Compare M. J. Cooper, O. Dimitrov, P. Raghavendra Rau, *A Rose.com by Any Other Name*, J. Fin. 2001, No. 56, pp. 2371–2388 (finding positive value in the adoption of a dot-com name during the technology boom) with M. J. Cooper, A. Khorana, I. Osobov, A. Patel, P. Raghavendra Rau, *Managerial Actions in Response to a Market Downturn: Valuation Effects in the Dot.com Decline*, J. Corp. Fin. 2005, No. 11, pp. 319–335 (finding positive value in the removal of dot-com from corporate names after the technology crash).

[77] See P. Rozin, L. Millman, C. Nemeroff, *Operation of the Laws of Sympathetic Magic in Disgust and Other Domains*, J. Personality & Soc. Psych. 1986, No. 50, pp. 703–712.

[78] See C. Cohen, E. Werker, *The Political Economy of "Natural" Disasters*, J. Conflict Resolution 2008, No. 52, p. 795.

[79] J.-P. Benoît, J. Dubra, *On the Problem of Prevention*, Int'l Econ. Rev. 2013, No. 54, p. 787.

[80] R. A. Epstein, *Catastrophic Responses to Catastrophic Risks*, J. Risk & Uncertainty 1996, No. 12, p. 287. See generally J. M. Chen, *Correlation, Coverage, and Catastrophe: The Contours of Financial Preparedness for Disaster*, Fordham Envtl. L. Rev. 2014, No. 26, pp. 79–85.

[81] See, e.g., B. Snead, *Aesop's Fables*, New York 2003, pp. 65–66.

summer, and gathers her sustenance in harvest"[82]. Approaching the fable of the ant and the grasshopper as a didactic allegory that the kingdom of nature might teach human society suggests that failures in disaster law, public health, and climate change policy demonstrate human disregard of the world whose "'unfathomable complexity [and] sublime beauty'" gave rise to the "human thirst for new ideas" in the first place[83].

But there is a different interpretation of this fable, one that counsels a more cautious, circumspect respect for the power that behavioral heuristics and cognitive biases exert over naked rationality. The French version of the fable by Jean de La Fontaine, *La Cigale et la Fourmi*[84], is celebrated for its moral ambiguity and its veiled critique of the fabulist's own financial imprudence[85]. La Fontaine cast the fable's insects as parties to a failed lending transaction. Said the hungry cicada (never a grasshopper in *la version française*): "On insect's honor, I'll repay you / Well before fall. With interest, too!"[86] *Mais non*: "Our ant – no willing lender she! Least of her faults!"[87]. When the ant at last tells her starving neighbor to dance through the winter, it is far from clear which insect has the moral upper foot. And morality is perhaps the most deeply emotional, least mechanistically "rational" projection of the human mind at work[88].

Among the branches of economics, environmental economics may harbor the richest trove of departures from strict rationality. The valuation of environmental benefits, from individual specimens to entire populations and ecosystem services, is beset by disagreements over methodology and validity. Environmental decision-making rarely offers the numerical clarity of financial problems. For instance, Mark Sagoff defends legal intervention to save endangered species on

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[82] Proverbs 6:6-8 (Revised Standard Version); see also Proverbs 30:24-25 ("Four things on earth are small, but they are exceedingly wise: the ants are a people not strong, yet they provide their food in the summer (…)".).

[83] J. Chen, *Webs of Life: Biodiversity Conservation as a Species of Information Policy*, Iowa L. Rev. 2004, No. 89, pp. 495–608, 603 (quoting D. Takacs, *The Idea of Biodiversity: Philosophies of Paradise*, Baltimore 1996, p. 255).

[84] The original French version of *La Cigale et la Fourmi*, alongside a serviceable if pedantically literal English translation, appears in J. de La Fontaine, *Selected Fables / Fables Choisies: A Dual Language Book*, Mineola 1997.

[85] See A. Calder, *The Fables of La Fontaine: Wisdom Brought Down to Earth*, Geneva 2001, pp. 18–24.

[86] *The Complete Fables of Jean de La Fontaine*, Urbana-Champaign2007.

[87] *Ibidem*. In the original French, these are the pivotal lines: "Je vous paierai, lui dit-elle, / Avant l'août, foi d'animal, / Intérêt et principal". / La fourmi n'est pas prêteuse: / C'est là son moindre défaut". J. de La Fontaine, *Selected Fables…*, p. 2. In Appelbaum's translation, "'I'll pay you (…) / before harvest time, on my word as an animal / both interest and principal.' / The ant wasn't the lending kind; / if she had any fault, it wasn't that one". *Ibidem*, p. 3.

[88] See, e.g., J. Graham, B. A. Nosek, J. Haidt, R. Iyer, S. Koleva, P. H. Ditto, *Mapping the Moral Domain*, J. Personality & Soc. Psych. 2011, No. 101, pp. 366–385; S. P. Koleva, J. Graham, R. Iyer, P. H. Ditto, J. Haidt, *Tracing the Threads: How Five Moral Concerns (Especially Purity) Help Explain Culture War Attitudes*, J. Research in Personality 2012, No. 46, pp. 184–194.

strictly "[m]oral, aesthetic, and spiritual" grounds, finding "an instrumental or economic rationale" to lie "beyond reach"[89]. But it demands almost deliberate disregard of economic reality to insist on valuing polar bears, for instance, strictly on the basis of their value for sport hunting and subsistence. Treating *Ursa maritimus* as so much Arctic bushmeat sets the value of Canada's bear population at $600,000, far below the estimated $6 billion in indirect and passive uses, including bequest and existence value[90]. The polar bear's greatest value to the United States may be its role in providing a basis for dispatching the Endangered Species Act on problems of climate change that the United States Congress has persistently ignored[91].

The incorporation of behavioral psychology into environmental economics is, if nothing else, the story of an intellectual discipline that has come to embrace the richness of analytical tools transcending austerely beautiful but excessively rigid mathematical models. The "long reaches of the peaks of song", whether delivered by La Fontaine's cicada or a human master of music as mathematics made flesh, rebuff the formic formalist of the French fable[92]. If indeed the ant symbolizes the entomological equivalent of poet Edwin Markham's "[s]lave of the wheel of labor", a nuanced approach to ecological as well as financial economics may rightfully ask, "what to [her] / Are Plato and the swing of Pleiades?"[93]. Understanding the impact of investor behavior on the performance of an individual portfolio or perhaps even the financial marketplace as a whole indeed begins with the "rift of dawn, the reddening of the rose"[94].

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[89] M. Sagoff, *Muddle or Muddle Through? Takings Jurisprudence Meets the Endangered Species Act*, Wm. & Mary L. Rev. 1997, No. 38, pp. 825, 844; J. Chen, *Webs of Life*…, pp. 602–608.

[90] See ÉcoRessources Consultants, *Evidence of the Socio-Economic Importance of Polar Bears for Canada*, 2011, at http://www.registrelep.gc.ca/document/default_e.cfm?documentID=2307. See generally J. B. Loomis, D. S. White, *Economic Benefits of Rare and Endangered Species: A Summary and Meta-Analysis*, Ecol. Econ. 1996, No. 18, pp. 197–206.

[91] See generally J. M. Chen, *Αρκτούρος: Protecting Biodiversity Against the Effects of Climate Change Through the Endangered Species Act*, Wash. U. J.L. & Pol'y 2015, No. 47, pp. 11–27.

[92] See E. Markham, *The Man with a Hoe*, (in:) *The Man with a Hoe and Other Poems*, New York 1898, pp. 15–18.

[93] See *ibidem*, p. 16. J. de La Fontaine referred to both insects in his fable, consistent with the rules of the French language, by the feminine gender.

[94] *Ibidem*, p. 16.

FABLES OF THE RECONSTRUCTION: HUMAN EMOTION AND BEHAVIORAL HEURISTICS IN ENVIRONMENTAL ECONOMICS

Summary

Environmental economics provides an especially rich source of insights into the impact of emotion, cognitive bias, and behavioral heuristics on risk assessment and management. In contrast with the ambivalent reception of behavioral psychology within mathematical finance, the impact of emotion and innate heuristics on environmental decision-making has never been doubted. From the affect heuristic to the endowment effect and disaster psychology, environmental choices harbor the richest trove of economic departures from strict rationality.

OPOWIEŚĆ O REKONSTRUKCJI: LUDZKIE EMOCJE I HEURYSTYKA BEHAWIORALNA W EKONOMII ŚRODOWISKOWEJ

Streszczenie

Polityka środowiskowa jest szczególnie ważnym źródłem poznania wpływu emocji, błędu poznawczego i heurystyki behawioralnej na ocenę ryzyka i zarządzania ryzykiem. W przeciwieństwie do ambiwalentnej percepcji psychologii behawioralnej w finansach matematycznych wpływ emocji i wrodzonej heurystyki na podejmowanie decyzji środowiskowych nie został nigdy podany w wątpliwość. Wybory dotyczące kwestii środowiskowych są przykładem i źródłem licznych odstępstw od całkowitej racjonalności.

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KEYWORDS

environmental economics, behavioral finance, Roll's critique, natural disasters, biodiversity

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ekonomia środowiska, finanse behawioralne, krytyka Rolla, katastrofy naturalne, bioróżnorodność