MATHEMATICS, PSYCHOLOGY, AND LAW:
THE LEGAL RAMIFICATIONS OF THE EXPONENTIAL GROWTH BIAS

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I. INTRODUCTION

According to an ancient legend, the ruler Shirhàm was full of joy and admiration when presented with the game of Chess. To show his gratitude, he offered the inventor, Sissa Ibn Dàhir, whatever he wished for. In response, Sissa asked that a grain of wheat be placed on the first square of the chessboard, two on the second, four on the third, and so on, progressively doubling that the number of grains, until the last, 64th square is attained—and the total amount be given to him. The king reproached Sissa for asking so little—only to discover that all the wheat in the world would not suffice to fulfill Sissa's request.[1]

While it is impossible to verify the authenticity of this story, it nicely demonstrates the mathematical notion of *exponential growth*. Quantities may grow in various ways. When they grow exponentially, the rate of change is proportional to the quantity, as in the wheat

[1] 3 IBN KHALLIKAN'S BIOGRAPHICAL DICTIONARY, part 1 71–72 (William MacGuckin De Slane trans., Oriental Translation Fund of Great Britain and Ireland, 1845). The total amount of grains is 18,446,744,073,709,551,615.

and chessboard legend. Exponential growth characterizes various natural, social, and economic processes—from the growth of bacterial cultures and the spread of viral diseases (and memes on the internet), to the accumulation of debt or wealth due to compound interest. However, the wheat and chessboard legend demonstrates yet another phenomenon—namely, people's difficulty in grasping the notion of exponential growth, and their tendency to underestimate it. This is known as the *exponential growth bias* (EGB). As described below, a considerable body of behavioral studies have examined this phenomenon since the 1970s. Thus, for example, one experimental study of people's estimations of exponential growth found that 90% of the participants gave estimates that were less than half the correct answer; and two-thirds gave estimates that were less than 10% of the correct answer.[2]

Given its prevalence and significance, it is little wonder that the notion of exponential growth has been discussed in various contexts in the legal literature.[3] However, despite its direct relevance to several pressing legal issues, the exponential growth *bias* has hardly been mentioned—let alone analyzed systematically—in the legal scholarship.[4] Thus, for example, in his formative, behaviorally informed studies of consumer credit, Oren Bar-Gill discusses various cognitive biases—including hyperbolic discounting and over-optimism—but makes no mention of the EGB. Even when he cites articles that deal with the EGB, Bar-Gill does so in the context of the (often-limited) efficacy of corrective measures that are used to overcome cognitive limitations and biases, and does not discuss the EGB as such.[5] In fact, the EGB is not even mentioned in any of the major books, handbooks, or collections of studies on behavioral law and economics (including our

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[2] William A. Wagenaar & Sabato D. Sagaria, *Misperception of Exponential Growth,* 18 PERCEPTION & PSYCHOPHYSICS 416, 416–17 (1975).

[3] *See, e.g.,* James M. Chen, *Leaps, Metes, and Bounds: Innovation Law and Its Logistics*, 2015 MICH. ST. L. REV. 845 (discussing various models of exponential growth and their relevance to innovation law); Robert D. Cooter & Uri Y. Hacohen, *Progress in the Useful Arts: Foundations of Patent Law in Growth Economics*, 22 YALE J.L. & TECH. 191 (2020) (discussing the exponential economic growth triggered by innovation); Brian J. Love, David J. Love & James V. Krogmeier, *Like Deck Chairs on the Titanic: Why Spectrum Reallocation Won't Avert the Coming Data Crunch but Technology Might Keep the Wireless Industry Afloat*, 89 WASH. U. L. REV. 705 (2012) (considering the policy implications of the exponential growth of wireless data traffic).

[4] For a brief mention of the EGB in the legal literature, see Patrick M. Corrigan, *"Abusive" Acts and Practices: Dodd-Frank's Behaviorally Informed Authority over Consumer Credit Markets and Its Application to Teaser Rates*, 18 N.Y.U. J. LEGIS. & PUB. POL'Y 125, 166–67 (2015) (discussing teaser rates and the EGB); Ward Edwards & Detlof von Winterfeldt, *Cognitive Illusions and their Implications for the Law*, 59 S. CAL. L. REV. 225, 258 (1986) (mentioning the EGB along with other cognitive biases); Peter H. Huang, *Boost: Improving Mindfulness, Thinking, and Diversity*, 10 WM. & MARY BUS. L. REV. 139, 176 (2018) (same). A more substantive discussion (about one-page long) of the EGB in the narrow context of consumer credit can be found in Jonathan Zinman, *Consumer Credit: Too Much or Too Little (or Just Right)?*, 43 J. LEGAL STUD. S209, S224–S225 (2014). A few studies do not use the term EGB, but relate to a specific manifestation of it in a particular context. *See, e.g.*, Ryan Bubb & Richard H. Pildes, *How Behavioral Economics Trims Its Sails and Why*, 127 HARV. L. REV. 1593, 1641–42 (2014) (describing people's difficulty to understand compound interest).

[5] *See* OREN BAR-GILL, SEDUCTION BY CONTRACT 176 & n.125 (2012) (hereinafter BAR-GILL, SEDUCTION BY CONTRACT) (citing an early version of Victor Stango & Jonathan Zinman, *Fuzzy Math, Disclosure Regulation, and Market Outcomes: Evidence from Truth-in-Lending Reform*, 24 REV. FIN. STUD. 506 (2011) (hereinafter – Stango & Zinman, *Fuzzy Math*); Oren Bar-Gill, *The Law, Economics, and Psychology of Subprime Mortgage Contracts,* 94 CORNELL L. REV. 1073, 1128 n.190 (2009) (hereinafter Bar-Gill, *Subprime Mortgages*) (citing an earlier version of Victor Stango & Jonathan Zinman, *Exponential Growth Bias and Household Finance,* 64 J. FIN. 2807 (2009) (hereinafter – Stango & Zinman, *Exponential Growth Bias*)); Oren Bar-Gill & Elizabeth Warren, *Making Credit Safer*, 157 U. PA. L. REV. 1, 25 n.44 (2008) (citing Stango & Zinman, *Exponential Growth Bias*, and mentioning consumers' EGB in the context of consumers' failure to seek advice).

own).[6] It is hard to say why behavioral-law-and-economics has had such a blind spot with regard to the EGB. Perhaps it is because the EGB has largely been overlooked by behavioral economists, as well.[7] Be that as it may, this Article aims to fill this large and surprising gap in legal scholarship.

A key example discussed in this Article is that of financial decisions involving compound interest, which by their very nature entail an understanding of exponential processes. Individuals affected by the EGB may fail to fully grasp the long-term impact of compound interest, and consequently save too little to finance their post-work years,[8] or borrow too much to finance their present consumption.[9] Such imprudent decisions may significantly diminish individual welfare, and may even have macro-level and global ramifications, as in the case of the 2007-08 subprime mortgage crisis.[10] Similarly, the EGB may hamper the national and international handling of global challenges that involve exponential growth.[11] For example, governments tend to postpone their legal response to phenomena such as pandemics, because they fail to grasp the magnitude of the underlying threat. This delay may lead to catastrophic consequences, since early response is critical where exponential growth is involved.

Legal policymakers around the world have long struggled with these issues, and an immense body of legal scholarship has discussed the causes, social ramifications, and existing and potential tools for improving the situation. While focusing on the EGB does not offer easy and straightforward solutions to these challenges, the current disregard of the EGB hinders the legal response to them. Paying heed to the EGB sheds light on the legal measures that are already in use, and highlights new ways to alleviate these problems. More specifically, the focus on the EGB calls for the introduction of new disclosure duties that would assist people in overcoming this bias; the imposition of new mandatory rules that would minimize the exploitation of the EGB by savvy profit-maximizing entrepreneurs; and the adoption of new debiasing techniques that would improve policymakers' decisions.

The Article proceeds as follows. After this brief introduction, Part II sets the stage by explaining the mathematical notion of exponential growth and the psychological phenomenon of the EGB. Part III then analyzes the ramifications of the EGB for the law—with particular focus on several key issues, such as insufficient savings for

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[6] These include, in chronological order, BEHAVIORAL LAW AND ECONOMICS (Cass R. Sunstein ed., 2000); RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS (rvsd. ed. 2009); THE BEHAVIORAL FOUNDATIONS OF PUBLIC POLICY (Eldar Shafir ed., 2013); THE OXFORD HANDBOOK OF BEHAVIORAL ECONOMICS AND THE LAW (Eyal Zamir & Doron Teichman eds., 2014); NUDGES AND THE LAW: A EUROPEAN PERSPECTIVE (Alberto Alemanno & Anne-Lise Sibony eds., 2015); EUROPEAN PERSPECTIVES ON BEHAVIOURAL LAW AND ECONOMICS (Klaus Mathis ed., 2015); RESEARCH HANDBOOK ON BEHAVIORAL LAW AND ECONOMICS (Joshua C. Teitelbaum & Kathryn Zeiler eds., 2018); EYAL ZAMIR & DORON TEICHMAN, BEHAVIORAL LAW AND ECONOMICS (2018) (hereinafter – Zamir & Teichman, BLE).

[7] See Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2808 n.3 ("Exponential growth bias does not appear in any of the many reviews of psychological evidence for economists").

[8] *See infra* Section III.A.

[9] *See infra* Section III.B.

[10] On the personal and social costs of overconsumption of credit, see generally Robert D. Manning, *Credit Card Nation: The Consequences of America's Addiction to Credit* (2000); Teresa A. Sullivan, Elizabeth Warren & Jay Lawrence Westbrook, *The Fragile Middle Class: Americans in Debt* (2020). On the subprime mortgage crisis, see generally RICHARD A. POSNER, A FAILURE CAPITALISM: THE CRISIS OF '08 AND THE DESCENT INTO DEPRESSION (2009).

[11] *See infra* Section III.D.

retirement, excessive consumer borrowing, and people's participation in pyramid schemes (Sections III.A, III.B, and III.C, respectively). Part III also examines how the EGB adversely affects the decision-making not only of the addressees of legal norms, but also of policymakers (Section III.D). It shows how policymakers may be slow in reacting to new threats that grow at an exponential rate, and discusses ways to address this problem. Finally, Part IV concludes and highlights potential paths for future research.

II. APPLIED MATHEMATICS AND COGNITIVE PSYCHOLOGY
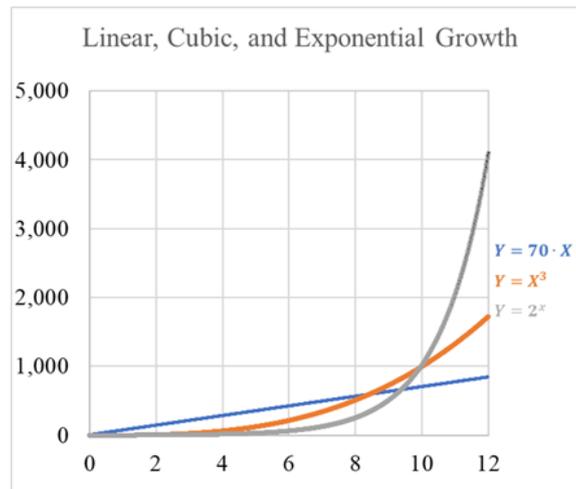
A. Exponential Growth

Quantities may grow over time in various ways. The growth of some quantities is best represented by a linear function, where the change in quantity is proportional to elapsed time. For example, if an author adds five pages to a manuscript every day, the number of pages equals the number of days times five ($f_{(x)} = 5x$), and the series of quantities is therefore: 0, 5, 10, 15… If the manuscript is already 6 pages long at the start, the number of pages would equal $5x + 6$ (or, more generally, $f_{(x)} = ax + b$), and the series would be 6, 11, 16, 21…

In other cases, the growth might accelerate over time, and is best represented by a polynomial function in which the highest power is greater than 1. For example, a quantity may be proportional to the square of the function argument—$f_{(x)} = x^2$ (or, more generally, $f_{(x)} = ax^2 + bx + c$). In this example of a quadratic function, if $a = 1$, and both b and c equal 0, the series would be 1, 4, 9, 16, 25… (and if $a = 1$, $b = 0$, and $c = 6$, then the series would be 7, 10, 15, 22, 31…). Such a function might possibly describe the daily output of a production unit if, thanks to increasing expertise, the produced quantity increases every day.

Sometimes, however, the *rate of change* is proportional to the *quantity* itself. For example, if a microorganism splits into two daughter microorganisms in three seconds, then the growth of a culture of these organisms, starting with a single organism, is best represented by the exponential function $f_{(x)} = 2^x$ (or, more generally, $f_{(x)} = a^x$). Thus, the growth of culture of bacteria may be represented by the series 1, 2, 4, 8, 16, 32… Needless to say, there are innumerable linear, quadratic, cubic, exponential, and other growth functions.[12] Most significantly, as the figure below illustrates, exponential growth tends to surpass both polynomial and linear growth.

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[12] For a general introduction to nonlinear functions and their varied applications, see STEVEN H. STROGATZ, NONLINEAR DYNAMICS AND CHAOS, WITH APPLICATIONS TO PHYSICS, BIOLOGY, CHEMISTRY, AND ENGINEERING (2d ed. 2015).

Exponential growth functions approximate—or at least serve as a first approximation of—a large range of physical, chemical, biological, medical, economic, and social phenomena. These include nuclear chain reactions;[13] the growth of bacterial cultures;[14] the development of a fertilized egg into a baby during pregnancy;[15] the spread of contagious diseases;[16] the spread of technological innovations and of economic growth induced by innovation;[17] the effect of compound interest on savings and loans;[18] the viral spread of videos on the internet;[19] and more.[20]

To be sure, the question of whether a given growth dynamic is actually exponential—as opposed to, say, polynomial—is often debated.[21] Moreover, unlike the world of

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[13] Carey Sublette, *Nuclear Weapons Frequently Asked Questions (NWFAQ),* Sec. 2.0: Introduction to Nuclear Weapon Physics and Design, in THE NUCLEAR WEAPON ARCHIVE: A GUIDE TO NUCLEAR WEAPONS (updated Feb. 20, 2019), available at: http://nuclearweaponarchive.org/Nwfaq/Nfaq2.html.

[14] Jacques Monod, *The Growth of Bacterial Cultures,* 3 ANN. REV. MICROBIOLOGY 371 (1949) (reviewing the early research on the subject).

[15] Krzysztof Dudek et al., *Mathematical Modelling of The Growth of Human Fetus Anatomical Structures*, 92 ANATOMICAL SCI. INT'L 521 (2017) (examining the adequacy of various growth functions for modeling fetal development).

[16] Gerardo Chowell et al., *Mathematical Models to Characterize Early Epidemic Growth: A Review*, 18 PHYSICS OF LIFE REV. 66 (2016) (reviewing various mathematical models that capture the early stages of the transmission of pathogens); Solomon Hsiang et al., *The Effect of Large-Scale Anti-Contagion Policies on the COVID-19 Pandemic*, 584 NATURE 262 (2020) (empirically evaluating the effect of anti-contagion policies).

[17] *See* Chen, *supra* note 3 (discussing the diffusion of technological innovations); Cooter & Hacohen, *supra* note 3 (arguing that innovations trigger exponential economic growth, and discussing the implications for patent law).

[18] W.D. WALLIS, MATHEMATICS IN THE REAL WORLD 208–14 (2013) (explaining how compound interest is calculated). *See also infra* Sections III.A (savings) and III.B. (loans).

[19] For an analysis of the role of emotional response and video source on the likelihood of videos "going viral," see Rosanna E. Guadagno et al., *What Makes a Video Go Viral? An Analysis of Emotional Contagion and Internet Memes*, 29 COMPUTERS HUM. BEHAV. 2321 (2013).

[20] *See, e.g.,* Catherine Picart et al., *Molecular Basis for the Explanation of the Exponential Growth of Polyelectrolyte Multilayers.* 99 PROC. NAT'L ACAD. SCI. (USA) 12531 (2002) (describing the progressive formation of micrometer-thick films through the alternating dipping of a charged surface into different solutions); Frank Thorn, Jane Gwiazda & Richard Held, *Myopia Progression is Specified by a Double Exponential Growth Function,* 82 OPTOMETRY & VISION SCI. E286 (2005) (demonstrating that a double exponential growth function describes the progression of myopia in children).

[21] *See, e.g.,* MARC GALANTER & THOMAS M. PALAY, TOURNAMENT OF LAWYERS: THE TRANSFORMATION OF THE BIG LAW FIRM (1991) (arguing that big law firms grow exponentially); Vincent R. Johnson, *On Shared Human Capital, Promotion Tournaments, and Exponential Law Firm Growth*, 70 TEX. L. REV. 537, 547–62 (1991) (criticizing the claim that law firms grow exponentially); John M. Golden, *Innovation Dynamics, Patents, and Dynamic-Elasticity*

mathematical functions and abstract models, in the real world, processes of growth and decline are typically affected by multiple factors, and therefore, often cannot be described by a simple mathematical function. Rather, they may change over time.[22] For example, in closed systems, exponential growth does not continue indefinitely. Rather, it stops at a certain point; or corresponds to an S-shape (sigmoidal) function;[23] or goes through different phases, such as exponential growth, retardation, stationary, and decline.[24] Thus, the exponential spread of a virus within the community might end once a significant part of the population has been infected by the virus, and the number of potential hosts declines.

Nevertheless, the basic notion of exponential growth is key to understanding a whole host of situations. It follows that when people (and policymakers) cope with such situations, systematic misperceptions of exponential growth are likely to have adverse, or even ruinous, effects. Alas, as the next section explains, such systematic misperceptions are all too common.

B. Exponential Growth Bias

Behavioral research of people's misperception of exponential growth—the so-called *exponential growth bias* (EGB)—dates back to the 1970s. In a seminal study, William Wagenaar and Sabato Sagaria presented participants with indices of air pollution for five consecutive years (e.g., 1970–1974)—either numerically (e.g., 3, 7, 20, 55, and 148) or graphically.[25] Some of the participants were asked to intuitively predict the level of pollution in five years (1979), and others were asked to estimate when the pollution would reach a certain level of pollution units (25,000) if nothing is done to stop it. In this example, the correct answer to the first question was 25,000, and the correct answer to the second was 1979. The study included numerous variations of this basic design. It was found that people not only make large mistakes when estimating exponential growth, but do so in a systematic and predictable way. More specifically, the study found that people tend to greatly underestimate exponential growth. As previously noted, in some of the conditions, 90% of the participants gave estimates that were less than half of the correct answer; and two-thirds—less than 10% of the correct answer. Moreover, the accuracy of the estimates did not improve when the participants were asked to produce estimates for each of the following five years (rather than for the fifth year only), or when the growth was presented graphically with a curve.[26]

EGB was similarly evident when the exponential growth was presented not by a numerical series or a curve, but simulated on a computer screen, where a 10x10 cm square

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Tests for the Promotion of Progress, 24 HARV. J.L. & TECH. 47 (2010) (arguing, contrary to previous arguments, that technological progress usually follows a pattern of power-law, rather than exponential, growth).

[22] *See generally* HORST R. THIEME, MATHEMATICS IN POPULATION BIOLOGY (2003) (describing various mathematical models used in population biology).

[23] *See, e.g.* Michal Shur-Ofry, *Popularity as a Function in Copyright Law,* 59 U. TORONTO L.J. 525, 531 (2009) (describing the diffusion of successful copyright-protected works)

[24] *See, e.g.,* Monod, *supra* note 14, at 373–74 (discussing the growth of bacterial cultures). *See also infra* Section III.C.

[25] Wagenaar & Sagaria, *supra* note 2.

[26] In fact, presenting the data graphically exacerbated the bias, irrespective of the length-to-width ratio of the graphs. *Id.* at 420–21.

(representing the surface of a pond) was gradually covered by small squares at an exponential rate (representing the expansion of duckweed), and the participants were asked to predict how much more time it would take for the duckweed to cover the entire pond.[27] This experiment demonstrated another consequence of the EGB, which we return to below: when exponential growth occurs in a closed environment, underestimation of the growth rate results in overestimation of the time it would take the growth to come to a halt.[28]

Numerous subsequent studies, involving various experimental designs, types of participants, and vignettes, have corroborated these findings.[29] The bottom line of these studies is nicely encapsulated by the observation that "exponential progression does not appear to be part of the repertory of basic intuitions of the majority of individuals."[30] As further discussed below, several studies have also found correlations between people's susceptibility to the EGB and their actual behavior—for example, in the contexts of retirement savings and borrowing.[31]

Scholars have developed several mathematical models of the EGB—some of which aim to reflect the thought process that induce people to underestimate exponential growth, and others that offer a mathematical representation of people's estimations, without necessarily trying to reflect their actual reasoning. Thus, Wagenaar and Sagaria hypothesized that people understand the meaning of exponential growth, yet still underestimate the exponent (and insufficiently compensate for this underestimation by

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[27] Willem A. Wagenaar & Han Timmers, *The Pond-and-Duckweed Problem: Three Experiments on the Misperception of Exponential Growth*, 43 ACTA PSYCHOLOGICA 239 (1979).

[28] *See infra* Section III.C.

[29] *See, e.g.,* Uri Benzion, Alon Granot & Joseph Yagil, *The Valuation of the Exponential Function and Implications for Derived Interest Rates,* 38 ECON. LETTERS 299 (1992) (studying students' estimations of the future value of investments that yield compound interest, and finding that the EGB increases with the duration of the period and the level of the interest rate); Fabian Christandl & Detlef Fetchenhauer, *How Laypeople and Experts Misperceive the Effect of Economic Growth,* 30 J. ECON. PSYCHOL. 381 (2009) (investigating estimations of economic growth by students with and without relevant training, and finding that both groups display the EGB); Craig R.M. Mckenzie & Michael J. Liersch, *Misunderstanding Saving Growth: Implications for Savings Behavior,* 48 J. MARKETING RES. S1 (2011) (establishing the existence of the EGB in the context of savings, and discussing its policy implications); Annamaria Lusardi & Peter Tufano, *Debt Literacy, Financial Experiences, and Overindebtness,* 14 J. PENSION ECON. & FIN. 332 (2015) (finding that people with a lower understanding of the meaning of exponential growth in the context of debt tend to resort to high-cost borrowing).

[30] Maria Teresa Munoz Sastre & Etienne Mullot, *Evolution of the Intuitive Mastery of the Relationship Between Base, Exponent, and Number Magnitude in High School Students*, 4 MATHEMATICAL COGNITION 67 (1998). The unintuitiveness of exponential growth is also manifested by the common mistake people make when asked how many days it would take for a patch of lily pads to cover half of a lake, if every day the patch doubles its size and it takes 48 days to cover the entire lake (the correct answer is 47; the intuitive one is 24). This question is part of the *Cognitive Reflection Test* (CRT), which is often used to test people's disposition to use an analytic, rather than intuitive, mode of thinking. *See* Shane Frederick, *Cognitive Reflection and Decision Making,* 19 J. ECON. PERSP. 25 (2005) (developing the original, three-item CRT); Maggie E. Toplak, Richard F. West & Keith E. Stanovich, *Assessing Miserly Information Processing: An Expansion of the Cognitive Reflection Test,* 20 THINKING & REASONING 147 (2014) (proposing the seven-item scale).

[31] *See* Stango & Zinman, *Exponential Growth Bias, supra* note 5 (finding that more biased households borrow more, save less, and resort to and benefit more from financial advice); Matthew Levy & Joshua Tasoff, *Exponential-Growth Bias and Lifetime Consumption,* 14 J. EUR. ECON. ASS'N 545, 566–67 (2016) (finding that people who display greater EGB accumulate less assets); Gopi Shah Goda et al., *Predicting Retirement Savings Using Survey Measures of Exponential Growth Bias and Present Bias,* 57 ECON. INQUIRY 1636 (2019) (establishing a correlation between the EGB and savings when controlling for cognitive ability, financial literacy, and various demographic characteristics).

multiplying the result by a constant).[32] Gregory Jones has rightly observed that if the only information given to people is the first few values in a numerical series, there can be any number of extrapolations of the ensuing values.[33] He suggested that people's estimates can best be described by a simple polynomial function, such as a quadratic function (e.g., $f_{(x)} = ax^2 + bx + c$), which (as previously noted), also results in considerable underestimation. Finally, Matthew Levy and Joshua Tasoff developed a third model of the EGB, which allows for differences between individuals.[34] They modeled an agent's perception such that an asset is divided into two accounts: a fraction that grows with a given compounding interest rate, and a complementary fraction that grows with simple interest. Thus, if the first fraction consists of the entire asset, the agent displays no bias; if this fraction equals 0, then the agent misperceives the growth as linear rather than exponential; and agents may lie anywhere between these two extremes. The insight that some people misperceive exponential growth as linear is in line with the findings of studies, especially in the field of mathematics education, that have identified a so-called *illusion of linearity*—namely, a general tendency to assume that functions and graphs are linear.[35]

Ultimately, the questions of how people think about exponential growth, and how biased they are in their estimations, are empirical rather than theoretical—and there is indeed no reason to assume that all people use the same thought process, or make the same errors.[36] In fact, when Fabian Christandl and Detlef Fetchenhauer asked participants in one of their studies to describe their thoughts while making the estimation, they found that people use various processes.[37] About one-third of the participants ignored the exponential element altogether, and simply multiplied the growth rate per period by the number of periods (as if it were a linear growth).[38] Other participants calculated this product and added some (often insufficient) value on account of the exponential growth. Still others made quite arbitrary guesses or incorrect calculations (which could, however, result in accurate estimates by chance).[39]

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[32] Wagenaar & Sagaria, *supra* note 2, at 417, 419–20. *See also* Gregory V. Jones, *A Generalized Polynomial Model for Perception of Exponential Growth,* 25 PERCEPTION & PSYCHOPHYSICS 232 (1979) (criticizing Wagnaar & Sagaria's theoretical model); Gideon Keren, *Cultural Differences in the Misperception of Exponential Growth,* 34 PERCEPTION & PSYCHOPHYSICS 289 (1983) (adopting Wagnaar & Sagaria's model) (hereinafter – Keren, *Cultural Differences*); Gregory V. Jones, *Perception of Inflation: Polynomial Not Exponential,* 36 PERCEPTION & PSYCHOPHYSICS 485 (1984) (hereinafter – Jones, *Perception of Inflation*) (criticizing Keren's theoretical analysis); Gideon Keren, *Do Not Inflate Exponentially the Evidence for the Polynomial Model: A Reply to Jones,* 36 PERCEPTION & PSYCHOPHYSICS 488 (1984) (replying to Jones' criticism).

[33] Jones, *Perceptions of Inflation, supra* note 32. Note, however, that people display the EGB even when presented with the exponential function that produces the initial values (e.g., that each value is twice as large as the previous one).

[34] Levy & Tasoff, *supra* note 31, at 549–59.

[35] *See, e.g.*, DIRK DE BOCK ET AL., THE ILLUSION OF LINEARITY: FROM ANALYSIS TO IMPROVEMENT (2007); Dirk De Bock et al., *Improper Use of Linear Reasoning: An In-Depth Study of the Nature and the Irresistibility of Secondary School Students' Errors*, 50 EDUCATIONAL STUD. MATHEMATICS 311 (2002).

[36] On individual differences in judgment and decision-making, see generally ZAMIR & TEICHMAN, BLE, *supra* note 6, at 111–14.

[37] Christandl & Fetchenhauer, *supra* note 29, at 388–91.

[38] A similar result was obtained in a survey of a sample of U.S. population. *See* Levy & Tasoff, *supra* note 31, at 547, 548, 564.

[39] The last observation is in line with the finding that some people provide estimates of exponential growth that are even lower than that of a linear growth, or higher than that of the correct exponential growth. *See, e.g.,* Levy & Tasoff, *supra* note 31, at 564–65 (reporting that 15% of the participants in their survey belonged to this group). In

Various factors affect the accuracy of people's predictions of exponential growth. One such factor is the saliency of the change. Thus, it was demonstrated that when, in addition to the series of values, people are presented with the successive differences between those values, they assess growth more accurately.[40] Making the change more salient does not even require to explicitly state the differences between the values. Simply reducing the number of data points (for example, by substituting the series of 3, 5, 10, 20, 39, 76, 148, with the series 3, 20, 148) obtained a similar effect, because it made the change look more dramatic (even when keeping constant the time that elapsed between the first and last data points—in this example, 3 and 148).[41]

Another factor is the context in which an estimation is made. Some people make better estimates in certain contexts than in others, even if the underlying growth function is the same. For example, it has been found that people make more precise estimations with regard to financial investments than in the context of economic growth.[42] Relatedly, it has been found that in the context of inflation, Israelis made better estimates of exponential growth than Canadians—possibly owing to the former's experience with runaway inflation, which provided them with continuous feedback.[43]

EGB is not necessarily eliminated by training. Thus, advanced students of economics and business administration, who have studied relevant courses, still exhibited the EGB, albeit to a lesser degree than other students.[44]

There is mixed evidence as to whether or not the EGB is associated with various demographic and personal characteristics. Thus, while a large-scale survey found strong (and expected) correlations between people's EGB and their retirement savings, it found no significant correlation between people's EGB and their income.[45] Another study found no association between people's EGB and their age, race, or education.[46] In some studies (but not others), female participants exhibited a more pronounced EGB than their male counterparts.[47] It has also been found that a higher *need for cognition*—i.e., the tendency to engage in effortful cognitive endeavors, as measured by people's self-

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fact, in several studies conducted by Christandl and Fetchenhauer (*supra* note 29, at 388) in the context of forecasting economic growth, the mean estimation for a 5% annual growth over five years was lower than 125%—below the linear growth. As the authors concede, however, this result may reflect participants' familiarity with the real world, where economic growth seldom endures for many years.

[40] Paul B. Andreassen & Stephen J. Kraus, *Judgmental Extrapolation and the Salience of Change,* 9 J. FORECASTING 347, 353–57 (1990).

[41] Han Timmers & Willem A. Wagenaar, *Extrapolation of Exponential Time Series is Not Enhanced by Having More Data Points*, 24 PERCEPTION & PSYCHOPHYSICS 182 (1978).

[42] Christandl & Fetchenhauer, *supra* note 29, at 383–85.

[43] Keren, *Cultural Differences*, *supra* note 32.

[44] *See* Christandl & Fetchenhauer, *supra* note 29, at 385–88. On cognitive biases and expertise, see generally ZAMIR & TEICHMAN, BLE, *supra* note 6, at 114–17 (2018).

[45] Goda et al., *supra* note 31, at 1653.

[46] Levy & Tassof, *supra* note 31, at 549, 566.

[47] *See, e.g.,* Christandl & Fetchenhauer, *supra* note 29, at 385–88 (finding such difference); Levy & Tasoff, *supra* note 31, at 566, 578 (finding no such difference); Goda et al., *supra* note 31, at 1646 & Table B.3 in the supplementary online appendix (stating that women exhibited greater EGB, but according to the table, this result was not even marginally statistically significant).

characterization—is negatively correlated with the EGB.[48] Finally, one study found an inverse relationship between exhibited EGB and people's IQ and higher education.[49]

The extent to which people display the EGB is influenced by other biases, such as *motivated reasoning* and the *confirmation bias*.[50] Such influences may explain, for example, the finding that in the United States, conservatives were more likely than liberals to underestimate the spreading of the coronavirus during the COVID-19 pandemic.[51] Importantly, notwithstanding the fact that the EGB may exacerbate the effect of other cognitive limitations and biases (such as myopia, bounded willpower, and procrastination),[52] the EGB must not be confused with other phenomena, as they may have independent, or even contrasting, effects. Thus, for example, a large-scale survey that tested the effect of the EGB and the *present bias* (myopia) on people's retirement savings and other aspects of financial behavior (including investing in housing, borrowing, and bankruptcy filing) found that while both biases affect some of those aspects, only one of them is correlated with others.[53] More surprisingly, a study conducted with a representative sample of Swedish adults found that the magnitude of the EGB is negatively correlated with standard measures of financial literacy (although subsequent studies have not replicated this result).[54] As further discussed below, distinguishing between the EGB and other phenomena is important, because they may each warrant different interventions.[55]

Given the potentially large adverse effects of the EGB on individual welfare and on the welfare of society at large, several studies have examined ways in which it might be counteracted, or at least mitigated. As previously noted, presenting the data graphically, rather than as a series of numbers, has not proven useful.[56] Monetary incentives to make correct estimations have also failed to mitigate the EGB.[57] In another study, increasing the

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[48] Christandl & Fetchenhauer, *supra* note 29, at 385–88. On the *Need for Cognition* scale, see generally John T. Cacioppo & Richard E. Petty, *The Need for Cognition,* 42 J. PERSONALITY & SOC. PSYCHOL. 116 (1982).

[49] Goda et al., *supra* note 31, Table B.3 in the supplementary online appendix. No statistically significant association was found in this study between the EGB and ethnicity.

[50] *Motivated reasoning* is the tendency to acquire and process information, and use other strategies that yield a desired conclusion. A key manifestation of motivated reasoning is the *confirmation bias*—namely, the inclination to seek and process information in a manner that supports one's interests, beliefs, and expectations. *See generally* ZAMIR & TEICHMAN, BLE, *supra* note 6, at 58–61 (summarizing the literature).

[51] Joris Lammers, Jan Crusius & Anne Gast, *Correcting Misperceptions of Exponential Coronavirus Growth Increases Support for Social Distancing*, 117 PROC. NAT'L. ACAD. SCI. USA 16264 (2020).

[52] *Myopia* (a.k.a. the *present bias*, or *hyperbolic discount rate*) is the tendency to overly discount future costs and benefits compared with immediate ones. This tendency is related to impulsiveness and lack of self-control. *Procrastination* involves voluntarily putting off and decisions—even while realizing that such delay will be detrimental. For a short survey of the literature, see ZAMIR & TEICHMAN, BLE, *supra* note 6, at 87–93.

[53] *See* Goda et al., *supra* note 31, at 1646–51.

[54] *See* Johan Almenberg & Christer Gerdes, *Exponential Growth Bias and Financial Literacy,* 19 APPLIED ECON. LETTERS 1693 (2012). Using different measures of financial literacy, neither Levy & Tasoff (*supra* note 31, at 565) nor Goda et al. (*supra* note 31, Table B.3 in the supplementary online appendix) replicated this result.

[55] *See* Goda et al., *supra* note 31, at 1637 (explaining that while pre-commitment measures may mitigate procrastination on retirement savings, it may actually exacerbate the harmful effects of the EGB); *infra* subsection III.A.(2) and text accompanying notes 172–186.

[56] Wagenaar & Sagaria, *supra* note 2, at 420–21; Levy & Tasoff, *supra* note 31, at 560–61, 569.

[57] Christandl & Fetchenhauer, *supra* note 29, at 385–88 (finding that offering prizes for the most accurate estimations significantly increased the time participants spent on making the estimations, but had no effect on their accuracy).

incentive for accuracy—from considerable (up to $15) to very considerable (up to $75) sums of money—produced no effect.[58]

In the last study, in a bid to enhance the external validity of the findings, the participants were allowed to use any decision aid—including pencil and paper, calculators, and spreadsheets—which many of them actually did.[59] Even then, however, the EGB was not eliminated. In another study, a direct comparison between participants who were told to calculate their answers with a calculator or with pencil and paper, and others who were forbidden to do so, revealed no difference between the two groups.[60] However, another study suggests that using a computer-based, decision-support system may somewhat mitigate the EGB.[61]

Another potential debiasing technique is to provide people with feedback on their estimations. Wagenaar and Sagaria found that giving people feedback and guiding them about the EGB increases their accuracy in an estimation task they performed immediately thereafter.[62] In another study, participants were asked to make 100 consecutive predictions of the values of a single series, each referring to the next item in the series, and provided with the correct answer immediately after each of their predictions. As expected, the predictions were very accurate.[63] However, in real-life contexts, more often than not people make predictions for the longer term, and very rarely do they receive immediate feedback on dozens of their short-term predictions. Indeed, when subjects were asked to make predictions for two consecutive periods rather than one, and received feedback only after making the two predictions—their mean errors were still very small, but larger by an order of magnitude.[64]

Finally, there is mixed evidence regarding the efficacy of financial education. Some studies have found that educating people about exponential growth and the expected outcomes of varying levels of savings for retirement results in a large increase in savings.[65] However, the overall picture from a meta-analysis of 201 effect sizes of financial education is rather bleak. While such education may influence immediate decisions, it has almost no impact in the long run.[66]

The above survey of the behavioral research on the EGB is far from exhaustive. Among other things, we did not describe studies that compared estimations of exponential

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[58] Goda et al., *supra* note 31, at 1641.

[59] *Id. id.*

[60] Mckenzie & Liersch, *supra* note 29, at S3–S4.

[61] David Arnott & Peter O'Donnell, *A Note on Experimental Study of DSS and Forecasting Exponential Growth,* 45 DECISION SUPPORT SYSTEMS 180 (2008).

[62] Wagenaar & Sagaria, *supra* note 2, at 421–22.

[63] Andrew J. Mackinnon & Alexander J. Wearing, *Feedback and the Forecasting of Exponential Change,* 76 ACTA PSYCHOLOGICA 177, 180–85 (1971).

[64] *Id.* at 185–88.

[65] *See, e.g.,* Changcheng Song, *Financial Illiteracy and Pension Contributions: A Field Experiment on Compound Interest in China,* 33 REV. FIN. STUD. 916 (2020) (reporting the encouraging results of a field experiment conducted in rural China). *See also* Bryan Foltice, *How to Decrease the Amortization Bias,* 43 J. FIN. EDUC. 273 (2017) (experimentally examining the effect of various learning methods on the EGB exhibited by business students, immediately after the tutorial and three weeks afterwards); *supra* notes 136–142 and accompanying test.

[66] Jack B. Soll, Ralph L. Keeney & Richard P. Larrick, *Consumer Misunderstanding of Credit Card Use, Payments, and Debt: Causes and Solutions,* 32 J. PUB. POL'Y & MARKETING 66 (2013).

growth with estimations of *exponential decline*,[67] nor the literature that compared the performance of children of various ages and adults.[68] Neither have we discussed closely related phenomena, such as people's difficulties in estimating the magnitude of expressions of the type a^n (such as 9^5 or 5^9),[69] or the so-called *MPG illusion* (people's failure to understand the difference between describing fuel efficiency in terms of miles per gallon, versus gallons per 100 miles, and such like).[70] Nonetheless, this survey should suffice in laying the groundwork for examining the legal implications of this prevalent bias.

Before proceeding to this examination, it should be noted that the abovementioned studies focused on people's misperceptions of exponential growth, while paying little attention to other nonlinear processes. We surmise that a similar misperception may characterize other nonlinear processes (such as the one presented by the function $f_{(x)} = x^4$, which produces the series 1, 16, 81, 256, 625…). Insofar as this is true, the following discussion may possibly be relevant to other contexts, as well. However, given the scarcity of behavioral studies of such misperceptions, we are focusing here on phenomena involving exponential growth.

III. LEGAL RAMIFICATIONS

Having presented the concept of exponential growth and the psychological phenomenon of exponential growth bias in Part II, this Part looks at the legal ramifications of the EGB. It discusses several contexts in which the EGB (often coupled with other biases and limitations) causes serious social problems. These include insufficient saving for retirement; excessive consumer indebtedness; participation in pyramid schemes; and sluggish responses to medical, natural, and social hazards that grow exponentially. While each of these problems has been extensively discussed in the past, the role the EGB plays in them has been largely overlooked. Recognizing the key role of the EGB offers new insights and points to new legal interventions.

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[67] *See, e.g.*, Han Timmers & Willem A. Wagenaar, *Inverse Statistics and Misperception of Exponential Growth*, 21 PERCEPTION & PSYCHOPHYSICS 558 (1977); Mirjam Ebersbach et al., *Forecasting Exponential Growth and Exponential Decline: Similarities and Differences*, 127 ACTA PSYCHOLOGICA 247 (2008).

[68] *See, e.g.,* Ebersbach et al., *supra* note 67.

[69] Munoz Sastre & Mullot, *supra* note 30.

[70] Richard P. Larrick & Jack B. Soll, *The MPG Illusion,* 320 SCI. 1593 (2008) (demonstrating that people falsely believe that the amount of gasoline consumed by a car decreases as a linear function of its MPG, when in fact the relationship is curvilinear).

A. Retirement Savings

1. The Retirement Crisis and the Exponential Growth Bias

It is widely acknowledged that the United States is facing a major retirement crisis.[71] In fact, this crisis extends well beyond the United States.[72] As a result of "chronic under-saving,"[73] many American baby boomers experience significant financial distress as they grow older.[74] According to one prominent study, 50% of American households may not be able to sustain their standard of living after retirement,[75] and it is estimated that out of current American workers between the ages of fifty and sixty-four, 48% will be poor or near poor when they retire.[76] On aggregate, the latest projection suggests that the deficit in savings for American households, as of 2019, is a staggering $3.83 trillion.[77]

One of the main contributing factors to this crisis is the shift in American retirement savings from *Defined Benefits* (DB) plans, to *Defined Contributions* (DC) plans.[78] DB plans require little involvement on the part of savers, since they guarantee participants a fixed annuity based on their years of employment.[79] In contrast, DC plans require participants to make critical decisions about their savings.[80] Thus, participants in DC plans must routinely decide whether to participate in a plan; how much to contribute to the plan; actively manage their savings throughout their working years; and cautiously spend their savings once they have retired.[81]

A large body of behavioral research has highlighted that the reliance of DC plans on the decisions by savers who are not perfectly rational has led people to under-save for retirement. This body of work has focused mostly on peoples' inability to optimize over long time horizons, and have highlighted phenomena such as myopia, present bias, *hyperbolic discounting*, and procrastination as the main driving forces behind insufficient

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[71] *See e.g.*, Bubb & Pildes, *supra* note 4, at 1612 ("The weight of the evidence shows that many households do save too little"); Paul M. Secunda, *The Behavioral Economic Case for Paternalistic Workplace Retirement Plans*, 91 IND. L.J. 505 (2016) ("The American retirement security system hangs treacherously on a precipice"); Adi Libson, *Confronting the Retirement Savings Problem: Redesigning the Saver's Credit*, 54 HARV. J. ON LEGIS. 207, 220 (2017) ("There is ample data regarding the insufficient private savings for retirement"). *But see* John Karl Scholz, Ananth Seshadri & Surachai Khitatrakun, *Are Americans Saving "Optimally" for Retirement?*, 114 J. POL. ECON. 607, 609 (2006) (finding that 80% of American households have sufficient savings, and that for the remaining households the magnitude of the deficit is small).

[72] *See* Shlomo Benartzi & Richard H. Thaler, *Behavioral Economics and the Retirement Savings Crisis*, 339 SCI. 1152, 1152 (2013) (noting that "[m]any countries are facing a retirement savings crisis").

[73] Daniel Shaviro, *Multiple Myopias, Multiple Selves, and the under-Saving Problem*, 47 CONN. L. REV. 1215, 1240–41 (2015) (citing evidence supporting the chronic under-saving hypothesis).

[74] Secunda, *supra* note 71, at 507.

[75] *See* Alicia H. Munnell, Wenliang Hou & Geoffrey T. Sanzenbacher, *National Retirement Risk Index Shows Modest Improvement in 2016* (Ctr. for Retirement Research at Boston Coll., 2018), https://crr.bc.edu/wp-content/uploads/2018/01/IB_18-1.pdf.

[76] *See* Teresa Ghilarducci, *Retirement Security Worse on ERISA's 40th Anniversary*, 6 DREXEL L. REV. 453, 453 (2014).

[77] Dana M. Muir, *How Behavioral Science Ultimately Fails Retirement Savers: A Noble Experiment*, 56 AM. BUS. LAW J. 707 (2019) (citing a study published by the Employee Benefit Research Institute).

[78] *See* Secunda, *supra* note 71, at 518; Benartzi & Thaler, *supra* note 72, at 1152.

[79] Secunda, *supra* note note 71, at 513.

[80] *Id.* at 514–15.

[81] To be sure, the policy choice between DB and DC is complex and involves many considerations that go well beyond the scope of this Article. For an analysis, see Edward A. Zelinsky, *The Defined Contribution Paradigm*, 114 YALE L.J. 451 (2004).

saving.[82] Other behavioral phenomena noted within this body of work include over-optimism, *omission bias*, and inattentiveness.[83] Notably, despite its tremendous volume, this body of work has yet to incorporate the findings regarding the EGB.[84]

Since retirement savings involve long-term investments in which compound earnings play a central role, the EGB may cause people to err systematically when making decisions relating to their retirement savings.[85] In particular, biased individuals will underestimate the future value of their savings.[86] As a result, when balancing between present consumption and saving for future consumption, they may place excessive weight on present consumption, and not save enough. Consequently, they begin to save for retirement too late, or contribute too little to their retirement savings account—or both.[87]

To be sure, the tendency to underestimate the value of long-term savings might also cause people to save *too much* for retirement. People who fail to grasp the speed at which their wealth accumulates may erroneously divert too many resources into their retirement savings. However, the empirical results suggest that the under-saving hypothesis is more prevalent.[88] Note that, insofar as some of the population does tend to over-save due to the EGB, the extent of under-saving by those who are prone to do so is even greater than currently acknowledged.

While empirical research on the EGB and retirement savings is still in its infancy, preliminary findings corroborate the link between that bias and insufficient saving. In a groundbreaking paper, Victor Stango and Jonathan Zinman introduced the EGB to the finance literature.[89] Using responses from past consumer finance surveys to construct a proxy of participants' EGB,[90] they regressed participants' savings on this proxy, while controlling for many other factors—such as income, homeownership, age, and race.[91] They found that the EGB is associated with a large decrease in savings.[92]

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[82] *See* Andrew Hayashi & Daniel P. Murphy, *Savings Policy and the Paradox of Thrift*, 34 YALE J. ON REG. 743, 752 (2017) (noting that "[t]he most common explanation offered by economists who study this phenomenon is that people tend to discount the future costs and benefits of their actions more than even they think appropriate"). *See also* Bubb & Pildes, *supra* note 4, at 1613 (hyperbolic discounting); Secunda, *supra* note note 71, at 522–23 (present bias and procrastination); Shaviro, *supra* note 73, at 1246–48 (myopia).

[83] *See* Colleen E. Medill, *Transforming the Role of the Social Security Administration*, 92 CORNELL L. REV. 323, 331 (2007) (excessive optimism); Libson, *supra* note 71, at 225–26 (omission bias); Shaviro, *supra* note 73, at 1249–51 (inattentiveness).

[84] While some legal scholars have incorporated findings on financial literacy into the retirement debate, these discussions do not include any reference to the EGB—which is a distinct phenomenon. *See, e.g.*, Bubb & Pildes, *supra* note 4, at 1611–14 (focusing on present bias and hyperbolic discounting, and making no reference to the EGB); Shaviro, *supra* note 73, at 1246–53 (presenting a "taxonomy of possible explanations for unduly low retirement saving," and making no reference to the EGB).

[85] *See* Levy & Tasoff, *supra* note 31, at 545 ("[p]roper computation of exponential functions is thus at the heart of many economic decisions such as lifecycle consumption").

[86] *See* Goda et al., *supra* note 31, at 1637 ("a person with EGB will underestimate the returns to saving"). *See also* Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2811; Levy & Tasoff, *supra* note 31, at 547–48.

[87] *See* Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2819 (arguing that the EGB has a large effect on retirement planning); Mckenzie & Liersch, *supra* note 29, at S5–S6 (presenting results suggesting that people put off retirement saving due to the EGB).

[88] *See infra* notes 89–97 and accompanying text.

[89] Stango & Zinman, *Exponential Growth Bias, supra* note 5.

[90] *Id.* at 2812–16.

[91] *Id.* at 2826–31.

[92] *Id.* at 2837–40.

Later studies augmented this finding by eliciting participants' EGB directly and by focusing more specifically on retirement.[93] For example, Gopi Shah Goda and colleagues developed a five-question survey to construct an EGB scale, and collected data on participants' retirement savings.[94] They then examined the correlation between the two, using a rich set of controls.[95] With this observational data, their study documented a statistically significant association between the EGB and low retirement savings: specifically, an increase of one standard deviation of the EGB was associated with an 11% decrease in retirement savings.[96] Notably, this effect was independent of the effect of the present bias (that was also examined in this study), and is actually somewhat larger.[97]

2. Policy Implications

Recognizing that people tend to save too little for retirement, policymakers have long since attempted to tackle this issue. Without delving into the fine details of retirement law, these policies have generally used three measures. One is mandated savings through social security.[98] This federal program is funded by a 12.4% payroll tax, and promises people a basic annuity that is loosely tied to their income.[99] A second measure involves tax rules that incentivize people to save by subsidizing that choice.[100] The most notable examples are Individual Retirement Accounts (IRAs) and 401(k) programs that offer income tax exemption.[101] The final category of measures used involve choice-preserving nudges that foster greater saving.[102] Policymakers can encourage employers to adopt such measures, as Congress did when it included in the Pension Protection Act of 2006 a safe harbor that shielded from fiduciary liability employers that set a default of automatic enrolment into their 401(k) programs.[103] These policies were enacted amidst a fierce ongoing academic and political debate over whether or not government should be involved in peoples' saving decisions, and the limits of paternalistic legislation.[104]

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[93] *See* Goda et al., *supra* note 31. *See also* Levy & Tasoff, *supra* note 31; Mckenzie & Liersch, *supra* note 29.

[94] Goda et al., *supra* note 31, at 1641–44 (describing study design and data).

[95] *Id.* at 1645 (reporting on controls such as gender, age, marital status, number of household members, state of residence, ethnicity, work status, education, and occupation).

[96] *Id.* at 1648.

[97] *Id.* (reporting that an increase of one standard deviation in the measure of the present bias is associated with a 10% decrease in retirement savings).

[98] *See* Shaviro, *supra* note 73, at 1128–30.

[99] *Id.*

[100] *See id.* at 1124–27.

[101] *Id.*

[102] For an overview of different behavioral measures, see Shlomo Benartzi & Richard H. Thaler, *Heuristics and Biases in Retirement Savings Behavior*, 21 J. ECON. PERSP. 81, 99–102 (2007).

[103] *See* 29 U.S.C. § 1104(c)(5); 29 C.F.R. § 2550.404c-5 (2000). *See also* Brigitte Madrian & Dennis Shea, *The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior,* 66 Q.J. ECON. 1149 (2001) (proposing this technique and empirically demonstrating its efficacy); Dana M. Muir, *Choice Architecture and the Locus of Fiduciary Obligation in Defined Contribution Plans*, 99 IOWA L. REV. 30–32 (2013) (reviewing the legislative provisions).

[104] For an early notable criticism of mandatory saving for retirement from a libertarian perspective, see MILTON FRIEDMAN, CAPITALISM AND FREEDOM 182–89 (1962). For later contributions, see Bubb & Pildes, *supra* note 4, at 1607–37 (incorporating behavioral analysis into the welfare analysis); Hayashi & Murphy, supra note 82, at 758–64 (highlighting the macro-economic implications of savings policy); Bernhard Ebbinghaus, *The Politics of Pension Reform: Managing Interest Group Conflicts*, *in* THE OXFORD HANDBOOK OF PENSIONS AND RETIREMENT INCOME 759 (2006) (reviewing the political debate).

Introducing the EGB into the retirement-savings policy debate curtails some of the criticisms levied against the case for legal interventions. As previously noted,[105] this case currently focuses on arguments regarding the present bias and hyperbolic discounting. While such arguments convincingly demonstrate that people make time-inconsistent choices, they still require a moral judgment as to which vantage point is superior—the one of the present self, who wishes to consume now, or the one of the future self, who would prefer more savings.[106] Opponents of regulatory interventions geared toward bolstering retirement savings have argued that balancing between present and future consumption is equivalent to any other preference that a decision-maker might have.[107] Thus, they argue that directing people to save more for retirement is tantamount to directing them "to buy new sneakers instead of a new lawn mower."[108]

While we believe there is a normative case to be made for viewing the long-term self as the benchmark for policy purposes, such a move arguably requires shifting the analysis from revealed preferences to ideal preferences[109]—and such a shift is "fraught with epistemological difficulties."[110] Incorporating the EGB into the retirement policy debate makes it possible to sidestep this normative challenge—at least to some extent. As its name suggests, the EGB is a *bias*—meaning that it reflects a clear error in judgment *from the vantage point of the decision-maker.*[111] Decision-makers who do not properly grasp the exponential aspect of their long-term savings will fail to optimize their lifecycle consumption-savings calculus. Thus, regulation that encourages people to save more for retirement should not be viewed as an attempt to dictate to people a choice between chocolate and vanilla ice cream, but rather primarily as an attempt to help them maximize the amount of ice cream they get to enjoy over time.[112]

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[105] *See supra* notes 82–84 and accompanying text.

[106] *See e.g.,* Todd J. Zywicki, *Do Americans Really Save Too Little and Should We Nudge Them to Save More: The Ethics of Nudging Retirement Savings*, 14 GEO. J.L. & PUB. POL'Y 877, 901 (2016) (arguing that the crucial question is "which of the person's 'selves' is his authentic self?"); Hayashi & Murphy, *supra* note 82, at 750 (noting that "there remains the thorny question of which vantage point to privilege"); Shaviro, *supra* note 73, at 1254 (highlighting that in the case of hyperbolic discounting raises "the question of which self's welfare should win").

[107] *See e.g.*, Zywicki, *supra* note 106, at 903–04 (arguing that intertemporal balancing of consumption is inherently subjective and should be viewed like any other preference).

[108] *Id.* at 904. Notably, Zywicki makes no reference to the EGB throughout his paper. This is also the case with other critics of the behavioral approach to retirement-savings policy. *See e.g.*, Joshua D. Wright & Douglas H. Ginsburg, *Behavioral Law and Economics: Its Origins, Fatal Flaws, and Implications for Liberty*, 106 NW. U. L. REV. 1033, 1056–57 (2012).

[109] Economic analysis ordinarily measures people's welfare (utility) by the extent to which their *actual preferences*—revealed by the choices they make—are fulfilled. In contrast, *ideal preferences* theories posit that human welfare is enhanced by the fulfillment of the preferences people would have had if they were "thoroughly, clearly, and calmly deliberating all possible alternatives and their consequences with full, relevant information and no reasoning errors." Daphna Lewinsohn-Zamir, *The Objectivity of Well-Being and the Objectives of Property Law,* 78 NYU L. REV. 1669, 1680 (2003). For a general discussion of theories of human welfare, see JAMES GRIFFIN, WELL-BEING: ITS MEANING, MEASUREMENT AND MORAL IMPORTANCE (1986).

[110] Bubb & Pildes, *supra* note 4, at 1633.

[111] *See* Goda et al., *supra* note 31, at 1639 (noting that the welfare implications of EGB's status is a perceptual error, rather than a preference). *Cf.* Jacob H. Russell, *Misbehavioral Law and Economics,* 51 U. MICH. J.L. REFORM 549 (2018) (drawing a comparable distinction between *tastes* and *circumstances*, and considering how regulators could try to tell them apart).

[112] To be sure, to the extent decision makers can be characterized as naïve hyperbolic discounters—that is, they err in their understanding of their own future preferences—their mistakes can also be categorized as cognitive in nature, as well. *See* Ted O'Donoghue & Matthew Rabin, *Doing It Now or Later*, 89 AM. ECON. REV. 103, 106 (1999)

From a different angle, curtailing people's freedom in a bid to increase their welfare is much more justifiable when the problem lies in deficiencies in people's cognitive rationality, as opposed to their motivational one.[113] This is true from an economic perspective, which generally takes people's preferences as a given.[114] It is all the more true from a deontological, liberal perspective, which views the thwarting of people's choices on the grounds of alleged motivational irrationality as "a much more blatant assault on people's autonomy, as it refers to ends and not merely to means."[115] While the choice between present and future consumption may well be seen as pertaining to the goals people set for themselves—that is, to their motivational rationality—EGB is a computational bias that is clearly a matter of cognitive (ir)rationality. It is therefore easier to justify measures that are designed to increase saving for retirement once it is understood that insufficient saving is due largely to the EGB.

In light of the systematic errors associated with the EGB, this bias tilts the balance of the debate toward widening the scope of mandatory saving programs, rather than relying on voluntary programs that preserve personal choice.[116] Such an approach could be achieved by increasing social security benefits,[117] or by making private 401(k) programs universal and mandatory,[118] thereby negating the effect of the EGB on the decisions when to begin saving, and how much to save. That said, while the EGB can certainly add an important dimension to the debate, it is not expected to end it entirely. Choosing the optimal legal regime requires striking a delicate balance between a host of policy considerations.[119]

Aside from this conceptual insight regarding the overall legal regime, the EGB also sheds light on numerous specific features of the existing regulatory framework of retirement savings, which relies heavily on individual choice. For one, the impact of the EGB on savings is most pronounced among young people with a long saving horizon, who consequently err the most with respect to compound earnings, and might mistakenly postpone saving.[120] While current policies such as automatic enrolment may help such individuals to start saving, they may also lock in inert young savers at relatively low

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(discussing the concept of naïve decision makers who misunderstand their own preferences); Libson, *supra* note 71 at 223–24 (discussing naïve decision makers and retirement savings).

[113] Cognitive (or *thin*) rationality refers to the structure of people's set of preferences and their strategy of decision-making. It includes elements such as transitivity of preferences and correct use of the rules of probability. It does not pertain to *the content* of one's preferences, which is a matter of motivational (or *thick*) rationality. *See* Eyal Zamir, *The Efficiency of Paternalism,* 84 VA. L. REV. 229, 248–49 (1998).

[114] *Id.* at 254–67 (constructing a model for assessing paternalistic policies that aim to overcome people's cognitive—but not motivational—deviations from rational decision-making).

[115] EYAL ZAMIR & BARAK MEDINA, LAW, ECONOMICS, AND MORALITY 340 (2010). *See also* JOSEPH RAZ, THE MORALITY OF FREEDOM 422–23 (1986) (making a similar claim).

[116] For voices supporting this line of reasoning, see Bubb & Pildes, *supra* note 4, at 1632–37 (highlighting the importance of mandated savings); Secunda, *supra* note note 71, at 540–41 (same).

[117] *See* Bubb & Pildes, *supra* note 4, at 1637 (discussing reforms to social security that would enlarge payoffs at retirement).

[118] Secunda, *supra* note note 71, at 510–11 (advocating for such a reform, inspired by the Australian retirement saving program).

[119] Shaviro, *supra* note 73, at 1218 (acknowledging that "[g]iven the large and complicated set of plausible causes for underserving, no single response to the problem is likely to be optimal").

[120] *See* Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2818 (noting that the impact of the bias is more severe on long-term saving).

contribution rates.[121] Thus, to overcome both people's EGB and their omission bias, savers should be encouraged to increase their savings over time. This may be achieved by defaulting savers to automatic escalation of their contributions to their 401(k) program—as is currently the case in some programs.[122]

While automatic escalation provisions may help savers, they are no panacea. First, since such provisions are not mandatory, many programs fail to adopt them.[123] In addition, the effectiveness of such provisions is significantly curtailed in mobile labor markets, since when employees move to a new workplace, their contributions revert to a new (low) default.[124] Hence, as long as policies continue to rely on individual choice with respect to savings, efforts should be made to help people understand the effect of compound interest.

One tool that may serve this purpose are the financial statements that savers periodically receive from the institutions managing their retirement plan. While tinkering with the statements is not expected to affect those who do not save, it may improve the decisions of those who do. Recent research has demonstrated that pointing out to investors the long-term consequences of their decisions by describing the effect of those decisions on their income in retirement years encourages investors to boost their contribution rate.[125] According to a large body of research on financial (and other) disclosures,[126] however, the impact of such disclosures on decisions appears to be small.[127]

After a decade-long debate, Congress has recently moved forward on this front, by enacting the Setting Every Community Up for Retirement Enhancement (SECURE) Act.[128] The SECURE Act mandates that retirement-saving statements incorporate a lifetime income disclosure that describes "the amount of monthly payments the participant or beneficiary would receive if the total accrued benefits of such participant or beneficiary were used to provide lifetime income streams."[129] Perhaps even more important than this mandate is the safe harbor created by the SECURE Act, that shields financial institutions from liability regarding these projections, as long as they follow the

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[121] Goda et al., *supra* note 31, at 1637 ("precommitment locks in exponential-growth biased agents' most distorted choices").

[122] Secunda, *supra* note note 71, at 528 (highlighting the potential of automatic escalation to increase savings). The groundbreaking study of automatic escalation is Richard H. Thaler & Shlomo Benartzi, *Save More Tomorrow^{TM}: Using Behavioral Economics to Increase Employee Saving*, 112 J. POL. ECON. S164 (2004).

[123] Secunda, *supra* note note 71, at 528 (noting that auto-escalation provisions are rare).

[124] *See* Bubb & Pildes, *supra* note 4, at 1622–23.

[125] *See* Gopi Shah Goda, Colleen Flaherty Manchester & Aaron J. Sojourner, *What Will My Account Really Be Worth? Experimental Evidence on How Retirement Income Projections Affect Saving*, 119 J. PUB. ECON. 80 (2014); Féidhlim P. McGowan & Peter D. Lunn, *Supporting Decision-Making in Retirement Planning: Do Diagrams on Pension Benefit Statements Help?*, 19 J. PENSION ECON. & FIN. 323 (2020); Mckenzie & Liersch, *supra* note 29, at S8–S9.

[126] For overviews of the limited impact of disclosures on choice, see OMRI BEN-SHAHAR & CARL E. SCHNEIDER, MORE THAN YOU WANTED TO KNOW: THE FAILURE OF MANDATED DISCLOSURE (2014); ZAMIR & TEICHMAN, BLE, *supra* note 6, at 171–77, 314–18. *See also infra* note 151 and accompanying text (describing the modest impact of the Truth in Lending Act).

[127] *See* Goda, Manchester & Sojourner, *supra* note 125, at 81 (noting that their findings "suggest that on average, individuals contribute more, albeit a small amount, when provided with information about how current saving translates into income in retirement").

[128] Further Consolidated Appropriations Act, 2020, Pub. L. No. 116-94, Div. O, (2020), https://bit.ly/3evdkXH.

[129] 29 U.S.C. §1025(a)(2)(D)(II).

rules set out by the Department of Labor.[130] This safe harbor may help financial institutions incorporate projections into their statements that help savers understand the pertinent tradeoffs between present and future consumption. For example, the statement could delineate the expected impact of each additional dollar invested on the monthly income at retirement.[131] Note that, unlike the case of lending (as discussed in the next section)—where financial institutions are incentivized to exploit the EGB in a manner that harms borrowers—when it comes to savings the incentives of savers and financial institutions are better aligned, and the latter could play a constructive role in debiasing savers.[132]

Another aspect of the regulatory framework with regard to retirement savings that could be revisited in light of the EGB are the fees collected from savers. Researchers have documented the adverse impact of high fees on the accumulation of wealth for retirement.[133] The assumption underpinning this discussion is that people "are unable to understand the effect of higher fees on long-term returns."[134] The EGB makes it easier to understand peoples' inattention to fees in their retirement accounts. Unlike other prices, fees attached to retirement savings do not reduce people's current consumption, but rather their future consumption. Just as people systematically underestimate the power of compound earnings, they also systematically underestimate the cost of fees in terms of their diminished future consumption.

At the policy level, this insight lends further support to a long list of proposed strategies geared toward reducing fees in retirement programs. Examples include the creation of low-cost default funds, and limiting the tendency of investors to rollover their retirement savings into relatively expensive IRAs.[135] Moreover, this insight could guide the creation of new and more effective cost disclosures that assist savers impacted by the EGB. Just as earnings disclosures should highlight the long-term effects of investment decisions, cost disclosures should point to the long-term impact of fees on available income during retirement. For example, they might state the dollar amount of fees charged during the statement period, and present a projection as to how this amount translates into lost income at the expected time of retirement. Financial institutions, of course, have little incentive to draw attention to such fees in saving statements, so such disclosures need to be mandated.

Finally, the existing literature tends to link the errors associated with long-term savings with financial literacy, and consequently advocates for public education campaigns geared

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[130] 29 U.S.C. §1025(iv).

[131] For an illustration, see Goda, Manchester & Sojourner, *supra* note 125, at 84 (graphics depicting to subjects how much additional annual income at retirement they can expect to have if they raise their saving contributions).

[132] *See* Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2810 (noting that "firms selling saving and investment products have incentives to debias consumers"). *See also* Michael S. Barr, Sendhil Mullainathan & Eldar Shafir, *Behaviorally Informed Regulation, in* THE BEHAVIORAL FOUNDATIONS OF PUBLIC POLICY, *supra* note 6, at 440, 444–446 (distinguishing between contexts in which firms seek to overcome customers' bias, and contexts where they seek to exploit it).

[133] *See e.g.*, Ian Ayres & Quin Curtis, *Beyond Diversification: The Pervasive Problem of Excessive Fees and "Dominated Funds" in 401(k) Plans*, 124 YALE L.J. 1476 (2015); Secunda, *supra* note 71, at 520.

[134] Muir, *supra* note 77, at 729. *See also* Medill, *supra* note 83, at 336 (noting that investors with short-term planning horizon tend to disregard fees).

[135] *See* Ayres & Curtis, *supra* note 133, at 1524–31 (proposing low cost investment tools as defaults); Muir, *supra* note 77, at 765–69 (discussing rules that would impede rollovers into IRAs).

toward enhancing people's knowledge on the topic.[136] But research on the EGB suggests that merely explaining the concept of compound interest to people is not enough, since simply understanding the concept does not, in and of itself, mitigate the impact of the EGB.[137] And while a recent randomized field experiment in China did demonstrate that educating savers about the value of compound earnings in the long term can increase their contributions to a retirement savings program by as much as 40%,[138] implementing the procedure set out in that study in the United States may prove difficult. Participants in the study were approached personally just prior to making their contribution decision by agents with no conflict of interest; given an explanation on the concept of compound interest; and provided with the calculated benefit for each contribution level.[139] At present, it is difficult to see American employers offering such advice to their employees, since their incentives are not aligned.[140] Indeed, employers might want to minimize employees' contributions to savings plans to lower their own matching obligations,[141] while encouraging employees to purchase high-fee investment tools—since those fees finance the costs of the financial services that the employer receives.[142]

B. Consumer Credit

The phenomenon of insufficient saving for the future, as discussed in the previous section, means that people consume too much in the present. However, in the current consumer culture, people not only spend too much of their existing resources, but their future income, as well, by buying goods and services on credit, and taking out loans to finance current consumption. This section discusses the adverse effect of the EGB on consumer credit behavior, and highlights numerous novel regulatory responses. After examining these issues in general, the analysis focuses on a specific type of transaction that epitomizes the exploitation of consumers' EGB by lenders—*consumer litigation funding* (CLF).

1. General

The sphere of consumer credit is vast and complex. Along with mortgages (which account for the lion's share of total household debt), Americans use various other types of credit—including credit cards, student loans, payday loans, installment loans, auto title loans, rent-to-own, and consumer litigation funding (CLF).[143] Thus, people obtain credit both by

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[136] *See e.g.*, Medill, *supra* note 83, at 348–61 (promoting a financial literacy campaign led by the federal government).

[137] Mckenzie & Liersch, *supra* note 29, at S6. *See also supra* notes 62–66 and accompanying text.

[138] *See* Song, *supra* note 65, at 932.

[139] *Id*. at 925 (describing the treatment in the financial education group of the experiment).

[140] *See* Ryan Bubb, Patrick Corrigan & Patrick L. Warren, *A Behavioral Contract Theory Perspective on Retirement Savings*, 47 CONN. L. REV. 1317, 1364 (2015) (arguing that "employers do not have good incentives to design choice architectures that address the mistakes households make in planning and saving for retirement").

[141] *Id*. at 1354.

[142] *Id*. at 1357–58.

[143] On mortgages and their regulation, see generally ANDREW G. PIZOR ET AL., MORTGAGE LENDING: LOAN ORIGINATION, PREEMPTION, AND LITIGATION (3rd ed. 2019). On the various types of non-mortgage consumer credit and their regulation, see generally CAROLYN L. CARTER ET AL., CONSUMER CREDIT REGULATION: CREDIT CARDS, PAYDAY LOANS, AUTO FINANCE, AND OTHER NON-MORTGAGE CREDIT (3rd ed. 2020).

taking (secured or unsecured) loans and by purchasing goods and services on credit; and by using both open- and closed-end credit.[144] According to the Household Debt and Credit Report published by the Federal Reserve Bank of New York, in the third quarter of 2020 the total household debt in the United States was 14.35 trillion dollars ($14,350,000,000,000).[145] Even if one subtracts student loans (which are incurred to enhance one's human capital), and loans for purchasing homes (which serve the dual role of consumption and investment)—which together total around 80% of household debt—the average household debt is still extremely high. Divided by the number of households in the United States, which is nearly 130 million, the mean household debt exceeds $100,000, and the mean household debt excluding student loans and mortgages is over $20,000.

Borrowing can help smooth out consumption over one's life cycle, as well as increase one's long-term welfare, by investing in human and other capital. Thus, consumer credit can play a positive role in people's lives, and contribute to economic growth. But over-borrowing can be detrimental to individuals, families, and the entire economy. The higher a household's debt burden, the smaller the proportion of its income that can be used for purposes other than servicing debt. This may result in a downward spiral that ends with consumer insolvency and bankruptcy—not to mention its adverse effect on retirement savings.[146] Typically, the outcomes of excessive consumer debt are harsher for poorer (often minority) borrowers, thus raising distributional concerns as well. As the subprime mortgage crisis made painfully apparent, micro-level inability to repay loans can have devastating macro-level ramifications.[147]

Neoclassical economics, which is founded on the premise that market players, including consumers, are rational maximizers, tends to attribute the malfunctioning of the consumer credit market to familiar market failures—in particular, consumer information problems. Accordingly, the primary cure that it advocates is disclosure duties.[148] In fact, as early as 1968, the federal Truth in Lending Act (TILA) imposed detailed disclosure duties on lenders, including about the total annual cost of the credit, dubbed the *annual percentage rate* (APR).[149] The TILA regulates not only the substance of the disclosure, but also its form, with a view to making important terms of the transaction conspicuous

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[144] On these distinctions, see CARTER ET AL., *supra* note 143, at 26–27.

[145] *See* FED. RESERVE BANK OF N.Y., QUARTERLY REPORT ON HOUSEHOLD DEBT AND CREDIT, 2020: Q3 (Nov. 2020), *available at:*
https://www.newyorkfed.org/medialibrary/interactives/householdcredit/data/pdf/HHDC_2020Q3.pdf.
The rise in the third quarter of 2020 more than offsets the decline in the second quarter due to the COVID-19 pandemic.

[146] One might assume that lenders would have strong incentives to ensure that borrowers have the means to repay their debt. While this is true of some lenders, it is not true of others, such as the major credit card companies, whose business model is based on debt-servicing revenue, and whose "most profitable customers are sometimes the least likely to ever repay their debts in full." *See* Ronald J. Mann, *Bankruptcy Reform and the "Sweat Box" of Credit Card Debt*, 2007 U. ILL. L. REV. 375, 384–92 (describing the business model of the major credit card issuers). *See also infra* note 200 and accompanying text (alluding to a similar phenomenon in consumer litigation funding).

[147] *See supra* note 10.

[148] *See* Matthew A. Edwards, *Empirical and Behavioral Critiques of Mandatory Disclosure: Socio-Economics and the Quest for Truth in Lending,* 14 CORNELL J.L. & PUB. POL'Y 199, 200–203, 205–06 (2005) (describing the standard economic perspective); Andrea Freeman, *Payback: A Structural Analysis of the Credit Card Problem,* 55 ARIZ. L. REV. 151, 169 (2013) (criticizing the neoclassical perspective).

[149] 15 U.S.C. § 1601. *See also* Regulation Z, 12 C.F.R. pt. 226 (2020) (implementing TILA).

and clear.[150] However, more than fifty years later, the TILA appears to have had only a modest impact on the market.[151] Arguably, this suggests that more intrusive steps—such as mandatory regulation of the content of credit transactions—are needed to overcome the information problem,[152] or that the malfunctioning of this market is not exclusively due to information problems (or both).

In fact, there is growing recognition in recent years that the malfunctioning of the consumer credit market is largely due to *behavioral* market failures, rather than traditional ones. Leading scholars, such as Cass Sunstein and Oren Bar-Gill, have highlighted the role played by several cognitive biases in this regard.[153] These include the inability of individuals to process large and complex information—which is exacerbated by lenders' deliberate use of complex terms, in a bid to hide the true cost of credit.[154] Another key phenomenon is the present bias, which induces consumers to overestimate immediate benefits, and underestimate the future costs, of credit.[155] This bias is often coupled with over-optimism, which causes people to underestimate the risk of future economic hardship that results from job loss, medical problems, and the like.[156] It may also be coupled with bounded willpower and self-control problems.[157] Other relevant cognitive limitations and biases are inattention to the aggregate effect of a large number of small borrowing decisions (resulting in the accumulation of a large credit-card debt);[158] procrastination that leads to late payments;[159] *anchoring*, that results in excessively low

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[150] *See, e.g.* 15 U.S.C. §§ 1632; 12 C.F.R. §§ 226.5, 226.17 (2020).

[151] *See, e.g.,* BAR-GILL, SEDUCTION BY CONTRACT, *supra* note 5, at 174–80; George S. Day & William K. Brandt, *Consumer Research and the Evaluation of Information Disclosure Requirements: The Case of Truth In Lending*, 1 J. CONSUMER RES. 21 (1974) (finding that the "improved knowledge of credit rates and charges that could reasonably be attributed to TIL had relatively little effect on credit search and usage behavior"; *id*. at 31); Edward L. Rubin, *Legislative Methodology: Some Lessons from the Truth-in-Lending Act,* 80 GEO. L.J. 233 (1991) (describing the failure of the TILA and its policy implications).

[152] *Cf.* Eyal Zamir (featuring Ian Ayres), *A Theory of Mandatory Rules: Typology, Policy, and Design*, 99 TEX. L. REV. 283, 299–300 (2020) ("Just as regulators set minimal standards for the safety of physical products—such as toys, drugs, and cars—rather than content themselves with the imposition of disclosure duties, they should set such standards for the safety of contractual products, which may be just as risky").

[153] *See* BAR-GILL, SEDUCTION BY CONTRACT, *supra* note 5, at 78–97 and 156–64 (discussing a long list of pertinent behavioral biases in the contexts of credit card and mortgages, respectively); Cass R. Sunstein, *Boundedly Rational Borrowing,* 73 U. CHI. L. REV. 249, 251–53 (2006) (discussing various cognitive biases affecting borrowing decisions); Susan Block-Lieb & Edward J. Janger, *The Myth of the Rational Borrower: Rationality, Behavioralism, and the Misguided Reform of Bankruptcy Law,* 84 TEX. L. REV. 1481, 1534–48 (2006) (same); Bubb & Pildes, *supra* note 4, at 1640–44 (same); Freeman, *supra* note 148, at 175–79 (same).

[154] *See, e.g.,* BAR-GILL, SEDUCTION BY CONTRACT, *supra* note 5, at 79–81 (pointing out that in the context of credit cards, cardholders "ignore certain price dimensions, miscalculate others, and, as a result, fail to appreciate the total cost of the credit card product"). The same holds true for mortgages (Bar-Gill, *Subprime Mortgages, supra* note 5, at 1102–06) and other credit transactions (on consumer litigation funding, see *infra* notes 193–202 and accompanying text).

[155] BAR-GILL, SEDUCTION BY CONTRACT, *supra* note 5, at 81–87; Gustavo Barboza, *I Will Pay Tomorrow, or Maybe the Day After. Credit Card Repayment, Present Biased and Procrastination*, 47 ECON. NOTES 455 (2018) (describing the results of a field study); Block-Lieb & Janger, *supra* note 153, at 1543–48.

[156] BAR-GILL, SEDUCTION BY CONTRACT, *supra* note 5, at 88, 157; Sunstein, *supra* note 153, at 252; Block-Lieb & Janger, *supra* note 153, at 1540–42.

[157] Oren Bar-Gill, *Seduction by Plastic*, 98 NW. U. L. REV. 1373, 1395–96 (2004); Sunstein, *supra* note 153, at 252. On contractual designs, including credit-card contracts, that exploit consumers' limited self-control, see also Stefano DellaVigna & Ulrike Malmendier, *Contract Design and Self-Control: Theory and Evidence*, 119 Q.J. ECON. 353 (2004).

[158] BAR-GILL, SEDUCTION BY CONTRACT, *supra* note 5, at 87–88; Sunstein, *supra* note 153, at 251.

[159] *See* Barboza, *supra* note 155; Sunstein, supra note 153, at 251–52.

monthly repayments of credit-card debt;[160] *loss aversion* and *framing*, that are manipulated by lenders to induce excessive borrowing;[161] and *mental accounting*.[162]

These behavioral analyses of consumer credit rarely, if ever, allude to the EGB.[163] Nevertheless, the EGB is clearly relevant in this context. According to an urban legend, Albert Einstein once said that compound interest "is the eighth wonder of the world. He who understands it, earns it; he who doesn't, pays it."[164] If compound interest sparks a feeling of wonder, it must be because it grows exponentially; and if people do not fully understand it (as indeed appears to be the case), it must be due to the EGB. For example, many people would be surprised to learn that if one takes out a loan of $1,000 to be repaid in full in one year, with a monthly compound interest of 10%, one would have to repay a sum of $3,138. Many people would be similarly surprised to learn that a borrower who takes out a loan of $1,000 with the same compound interest, and repays it with monthly installments of $100 (totaling $1,200) would still owe the lender, at the end of the year, $1,000.

To be sure, the EGB is irrelevant when debtors pay simple (as opposed to compound) interest. In many jurisdictions, the default is that lenders cannot charge compound interest unless the contract clearly entitles them to do so, and courts do not view compound interest favorably.[165] Nonetheless, many consumer credit transactions explicitly include compound interest, which are generally presumed to be valid.[166] When considering the implications of the EGB for these transactions, two distinctions are paramount. The first is between cases in which debts are repaid on time, and in full, and cases in which they are not.[167] Note that the latter category includes both consumers who rightfully pay only part of their revolving credit, and consumers who fall behind with their payments. The other distinction is between contracts in which the periods for calculating the compound interest are shorter than the repayment period(s), and contracts in which they are not. The latter category includes loans that are repaid in one payment at the end of the agreed period—

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[160] *See, e.g*., Neil Stewart, The *Cost of Anchoring on Credit-Card Minimum Repayments,* 20 PSYCHOL. SCI. 39 (2009) (finding that that the minimum required payment on a monthly credit card statement induces consumers to make lower monthly repayments).

[161] *See, e.g.,* Yoav Ganzach & Nili Karshai, *Message Framing and Buying: A Field Experiment*, 32 J. BUS. RES. 11 (1995) (finding that loss-framed messages sent by a credit card company had a stronger impact on credit card use than gain-framed messages).

[162] *See* Rob Ranyard et al., *The Role of Mental Accounting in Consumer Credit Decision Processes,* 27 J. ECON. PSYCHOL. 571 (2006) (comparing consumer decision-making when the cost of borrowing is presented either per period, through APR, or in terms of the overall, total cost).

[163] The main exception to this observation outside the legal literature is Stango & Zinman, *Exponential Growth Bias* (*supra* note 5). Within the legal literature, the notable exception is Bubb & Pildes (*supra* note 4, at 1641–42).

[164] *See, e.g.,* Candice Elliot, *Compound Interest: The 8th Wonder of the World* (2020), https://www.listenmoneymatters.com/compound-interest.

[165] *See* CARTER ET AL., *supra* note 143, at 228–33.

[166] This is the case, for example, in the credit card industry, where most issuers compound interest on a daily basis. *See* Mark J. Furletti, *Credit Card Pricing Developments and Their Disclosure* 15 (Payment Cards Center, Federal Reserve Bank of Philadelphia, Discussion Paper No. 03-02, 2003), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=572585). The Consumer Financial Protection Bureau maintains a dataset of credit card agreements of hundreds of card issuers (available at: https://www.consumerfinance.gov/credit-cards/agreements/). Cursory examination of some of these agreements— such as the Credit Agreement for Bank of America® Secured Mastercard® and Visa® Accounts (as of June 30, 2020), and the American Express® Gold Card Agreement (as of January 8, 2020)—confirms Furletti's observation.

[167] In the case of credit cards and other types of open-end credit, paying on time and in full means that at the end of each payment period, there is no outstanding debt.

say one year (a so-called *balloon loan*)—and the interest is compounded on a shorter (say, monthly) basis; as well as loans that are repaid in monthly installments and the interest is compounded daily.

Whenever borrowers repay their debts on time and in full, and the periods in which the compound interest is calculated are not shorter than the repayment period(s), no compound interest is ever due, so the EGB does not come into play.[168] Such transactions may be problematic for other reasons, but do not raise the difficulty associated with the EGB. The EGB *is* relevant whenever the debtor does pay compound interest—either (1) because the compounding periods are shorter than the payment intervals, or (2) because the debtor pays only part of the debt, (or both).[169] In all these cases, the EGB is likely to result in imprudent decision-making by the borrower, both at the contracting stage and during the performance of the contract (when deciding how much debt to incur in open-end credit transactions, and how much effort to exert to avoid defaults).

When considering regulatory responses to the EGB, the distinction mentioned in the context of retirement savings,[170] between subjective preferences and the choice of rational means of fulfilling those preferences (and the associated distinction between motivational and cognitive rationality), is equally apposite. People legitimately vary in their discount rates and risk aversion, but if the reason they accumulate debt lies in their misunderstanding of compound interest, then regulatory intervention may be called for. Without delving into theoretical discussions, the ensuing analysis therefore assumes that protecting consumers from their own cognitive biases, and preventing the exploitation of those biases by lenders, are in principle desirable and legitimate—an assumption that has been shared by legal policymakers in recent years.[171]

In general, measures that are already in place, or have been advocated, to alleviate information problems and cognitive biases other than the EGB in the context of consumer credit, can help protect consumers from their EGB, as well. Inasmuch as such measures cause consumers to avoid unnecessary debt, they reduce the harmful effects of the EGB. The prevalence of the EGB lends support to those measures, and calls for additional ones. However, our main interest (and contribution) is in policy responses that are specifically geared to handle the EGB. In the following paragraphs we briefly consider disclosure duties, other choice-preserving measures (such as debiasing techniques, nudges, and educational campaigns), and mandatory rules that aim to cope with the particular challenges posed by the EGB.

As previously noted, the predominant method of dealing with failures in the consumer credit market has been, and still is, to impose disclosure duties. While there are growing doubts about the efficacy of disclosures (especially when the main problem is not lack of information, but cognitive limitations and biases), they may be helpful to some extent

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[168] CARTER ET AL., *supra* note 143, at 228–30; Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2808 n.4.

[169] As previously noted, the latter possibility encompasses both instances where the debtor is contractually entitled to pay only part of the debt, and instances in which the debtor breaches her obligation to repay in full.

[170] *See supra* notes 105–115 and accompanying text.

[171] *See, e.g.,* Oren Bar-Gill & Ryan Bubb, *Credit Card Pricing: The CARD Act and Beyond*, 97 CORNELL L. REV. 967, 972 (2012) ("While the rational choice theory has trouble justifying many of the CARD Act rules, the rules make perfect sense under the behavioral economics theory"); Corrigan, *supra* note 2 (arguing that in authorizing the Consumer Financial Protection Bureau to take actions to prevent "abusive" acts and practices, the Dodd-Frank Act rejected the traditional neoclassical economic logic and adopted the behavioral-economics perspective).

(and the shaping of the disclosures may benefit from behavioral insights).[172] Indeed, one may even argue that borrowers are entitled to such information even if it does not affect their decisions. In the specific context of the EGB, timely, clear, and conspicuous information about compound interest may have a beneficial effect. As suggested in the context of retirement savings,[173] such disclosures should provide consumers with the explicit cost of borrowing for a designated period of time, in simple monetary terms. This type of disclosure should be given at the outset, when the contract itself entails compounding interest, as well as at the point when contractual payments become exponential—for example, when a payment is missed, and interest begins to accrue.

Another set of measures comprises nudges and debiasing techniques—such as fair and efficient default rules, educational campaigns, and vivid warnings about the perils of over-borrowing.[174] However, the available evidence about the success of such debiasing techniques in general, and in the context of the EGB in particular, does not give rise to much optimism.[175] The prospects of nudges are particularly dim when sophisticated suppliers (here, the lenders) have a strong incentive to negate their effect.[176] People can, of course, avail themselves of professional advice when handling their financial affairs, and there is evidence to suggest that such advice can be highly valuable.[177] But many consumers cannot afford such advice, are unaware of its importance, and would not seek it even if urged to do so.

If consumers are unlikely to seek advice on their own, can lenders be entrusted with the task of ensuring that borrowers are able to repay the loan on time? This technique is currently employed in the residential mortgage sector, where lenders are required to make a reasonable determination of applicants' ability to repay before extending credit.[178] However, as long as lenders make extra profits (in some cases, most of their profit) from delinquent borrowers,[179] they have a strong incentive to render this requirement ineffectual. A more effective step, therefore, may be to forbid or drastically limit lenders' right to charge increased (simple or compound) interest on sums in arrears and to charge high late fees. Such restrictions eliminate—or at least reduce—lenders' incentive to extend credit to borrowers who are likely to fall behind (or have already fallen behind) on

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[172] Barr, Mullainathan & Shafir, *supra* note 132, at 447–49; Sunstein, *supra* note 153, at 260–61. On the limitations of disclosures, see *supra* notes 126, 151, *infra* note 258, and accompanying text. On the contribution of psychological insights to the design of disclosure duties, see Cass R. Sunstein, & Russell Golman, *Disclosure: Psychology Changes Everything,* 6 ANN. REV. ECON. 391 (2014).

[173] *See supra* notes 125–132 and accompanying text.

[174] Sunstein, *supra* note 153, at 261–67; Bubb & Pildes, *supra* note 4, at 1646–47; Freeman, *supra* note 148, at 177–78.

[175] On debiasing, see generally ZAMIR & TEICHMAN, BLE, *supra* note 6, at 127–34.

[176] *See* Barr, Mullainathan & Shafir, *supra* note 132, at 440–46 (highlighting the distinction between situations in which firms seek to overcome customer biases and situations in which they seek to exploit them); Lauren E. Willis, *When Nudges Fail: Slippery Defaults*, 80 U. CHI. L. REV. 1155, 1200–10 (2013) (arguing that default rules are unlikely to be sticky when consumers lack clear preferences, and suppliers are able to contract around the defaults); Stephanie Stern, *Outpsyched: The Battle of Expertise in Psychology-Informed Law,* 57 JURIMETRICS 45 (2016) (arguing that business and interest groups are better than government officials at deploying psychological insights); ZAMIR & TEICHMAN, BLE, *supra* note 6, at 177–85 (discussing the promise and pitfalls of nudges).

[177] Stango & Zinman, *Exponential Growth Bias, supra* note 5, at 2840–42.

[178] *See* Dodd-Frank Wall Street Reform and Consumer Protection Act §§ 1411–12, 15 U.S.C. § 1639c. On the enactment and implementation of the ability-to-repay rule, see Patricia A. McCoy & Susan M. Wachter, *Why the Ability-to-Repay Rule Is Vital to Financial Stability*, 108 GEO. L.J. 649, 665–80 (2020).

[179] *See supra* note 146.

their payments. Indeed, under the Home Ownership and Equity Protection Act (HOEPA), a high-cost mortgage (as defined in the Act) "may not provide for an interest rate applicable after default that is higher than the interest rate that applies before default."[180] The HOEPA also sets caps and imposes procedural limitations on the charging of late fees in high-cost mortgages[181]—as does the CARD Act with regard to credit cards.[182] The findings with regard to the EGB suggest that comparable rules should apply to other consumer credit transactions, as well.

Two additional mandatory rules may directly address the EGB. First, whenever a borrower pays the debt by installments—be it with regard to an open-end credit (as in credit cards) or a closed-end one—the law can mandate that each installment be at least equal to the accumulated interest. Very often, it would be in the borrower's best interests to pay much higher installments to avoid a debt spiral, but such minimal payment would, at the very least, prevent such *negative amortization*, and exclude compound interest. In fact, the HOEPA provides that a high-cost mortgage "may not include terms under which the outstanding principal balance will increase at any time over the course of the loan because the regular periodic payments do not cover the full amount of interest due."[183] Again, given what we know about the EGB and other cognitive biases, this rule should apply to *any* consumer credit transaction. Even if such a mandate might preclude a few mutually beneficial transactions, its overall effect is most likely to be very positive.

A more drastic measure would be to mandate that the periods for which the compound interest is calculated must not be shorter than the repayment period(s). Thus, no compound interest would be charged in *balloon loans* if the loan is repaid on time. The lender may legitimately charge compound interest in the case of default: had the borrower paid back the full amount (principal plus simple interest) on time, that amount could have been used to extend credit to other borrowers. But during the loan period itself, the lender has no such opportunity. Most likely, the reason why lenders charge such interest is to exploit borrowers' EGB and other cognitive limitations. The same holds for credit card agreements, where cardholders pay on a monthly basis, but the interest is compounded daily.[184] In those contracts, the daily interest is the declared APR divided by 365—but due to the daily compounding, the effective interest is higher than the stated APR.[185] Since the only reason for, or at least the primary effect of, using this formula is to mislead debtors, it should not be allowed.

We are then left with transactions in which the debt is repaid periodically, and the borrower determines how much he or she pays in each installment (usually, beyond a certain minimum)—as is usually the case with credit cards (setting aside the issue of shorter compounding periods). In these cases, a borrower who does not repay the outstanding debt in full is not in breach of any contractual obligation—but if he or she were to pay a higher amount, the lender could use it to extend credit to others. In such

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[180] 15 U.S.C. § 1639(d). High-cost mortgage is defined in 15 U.S.C. § 1602(bb) [and not in § 1602(aa) as erroneously stated in § 1639(d).

[181] 15 U.S.C. § 1639(k).

[182] 12 CFR §§ 226.52(b), 1026.52(b). *See also* Sunstein, *supra* note 153, at 269 (tentatively supporting restrictions on late fees); Bar-Gill & Bubb, *supra* note 171, at 969–73, 988–92 (discussing the CARD Act effects on the credit card market, and finding that it modestly lowered late payment fees).

[183] 15 U.S.C. § 1639(f).

[184] *See supra* note 166.

[185] *See* Furletti, *supra* note 166, at 15.

instances, it is more difficult to argue that there is no economic rationale for charging compound interest on the outstanding debt. That said, it is highly likely that borrowers who are susceptible to the EGB make suboptimal decisions in this context. Between the extremes of fully enforcing and totally banning compound interest in these cases, legal policymakers may consider interim arrangements—such as setting minimal and standardized periods for compounding, and imposing strict disclosure duties.

Finally, as is often the case with consumer contracts—especially where the parties' bargaining power is extremely unequal and consumers suffer from acute information problems and systematic cognitive biases—the law should not content itself with mandatory rules about the parties' substantive rights and obligations. The regulation should also mandate the wording of the contract (because borrowers are likely to assume that the contractual terms are legally valid, even when they are not), and back up such mandates with civil, administrative, or even criminal, penalties (because mere unenforceability of terms is unlikely to deter lenders from including them in the contract).[186]

Having discussed the impact of the EGB on consumer credit in general, the following two subsections discuss in greater detail two concrete contexts in which the EGB might play a significant role. The first is consumer litigation funding, which provides a striking example of exploitation of borrowers' EGB. The second is mortgage forbearance, which illustrates the importance of the EGB in a timely context.

2. Consumer Litigation Funding

Third-party litigation funding—a rapidly growing industry—comprises various types of transactions.[187] For present purposes, two related distinctions are of particular importance. One is between commercial and consumer plaintiffs.[188] Our focus is on *consumer litigation funding* (CLF)—namely, the funding of individuals who typically claim damages for personal injuries. The other distinction is between the provision of funds to cover litigation costs (such as court fees and expert-witness expenses), and the provision of funds to cover other, unrelated purposes. The latter may include daily needs and medical expenses, that may have arisen due to the accident that caused the injuries and its adverse impact on the plaintiff's earnings. Usually, tort plaintiffs hire an attorney on a contingent-fee basis—which means that the attorney finances the litigation costs, in return for a share of the proceeds (very often, one-third).[189] In these cases, which are at the heart of our discussion, the term *litigation funding* is somewhat misleading, as the funding is not for the litigation. Rather, the expected proceeds of the claim are used as collateral for

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[186] *See* Zamir & Ayres, *supra* note 152, at 325–30 (discussing the pros and cons of such measures).

[187] For an overview of the third-party litigation funding market, emphasizing the differences between various types of transactions, see STEVEN GARBER, ALTERNATIVE LITIGATION FUNDING IN THE UNITED STATES: ISSUES, KNOWNS, AND UNKNOWNS 7–16 (2010).

[188] *See* Ronen Avraham & Anthony Sebok, *An Empirical Investigation of Third Party Consumer Litigant Funding,* 104 CORNELL L. REV. 1133, 1135, 1137, 1168–69 (2019) (discussing this distinction and its implications); Suneal Bedi & William C. Marra, *The Shadows of Litigation Finance,* __ VAND. L. REV. __, [13–14] (forthcoming 2021), *available at*: https://ssrn.com/abstract=3666498 (same).

[189] On the contingency-fee market, see generally HERBERT M. KRITZER, RISKS, REPUTATIONS, AND REWARDS: CONTINGENCY FEE LEGAL PRACTICE IN THE UNITED STATES (2004).

a general-purpose loan.[190] Like other types of third-party litigation funding, CLF offers borrowers a non-recourse loan: the lender recovers from the proceeds of the claim; and if these proceeds do not cover the principal and interest, the lender recovers only partially, or not at all.

Most theoretical and policy analyses of CLF have estimated the APR in CLF anywhere between 80 and 425 percent, based on imprecise assessments and anecdotes.[191] Recently, however, Ronen Avraham and Anthony Sebok conducted a large-scale empirical analysis, based on a dataset of approximately 200,000 loan applications handled by one of the largest providers of such funding, to produce a much more reliable picture of these transactions (although it is unclear how representative this firm is of the market as a whole).[192] Avraham and Sebok found that only about half of the applications submitted to the financing firm were approved, and that the average loan was around 7% of the estimated case value.[193] The median interest was 3% per month—and in the great majority of cases it was compounded on a monthly basis. In most of the contracts, there was a minimal period for which interest was charged, irrespective of the actual duration of the funding—usually three months. Beyond that period, the compound interest was commonly calculated by means of *interest buckets*—namely, minimal periods (usually of three months) for which interest was charged, even if the loan was paid back before the end of that period.[194] The average period of the loans was 14 months. Most borrowers took out only one loan per case, but a sizeable minority received two, three, or even more loans per case.[195] Only applicants whose requests were approved were charged a processing fee, which was paid along with the principal and interest at the end of the loan period (subject to the same compound interest and buckets). The most frequent fee for the first funding request was $250, with an additional fee of $75 for each additional request in the same case.[196] The average total amount of funding was approximately $7,000, and the median – around $2,250.[197]

Given what we know about the EGB, one can reasonably surmise that most borrowers believed that the effective APR was 36% (the stipulated monthly rate multiplied by 12), or somewhat higher. In fact, due to the complex calculation of the monthly compound interest, including the use of so-called "buckets" (buried in the fine print of the agreement), the median APR was over three times higher—115%.[198] Truth be told, according to Avraham's and Sebok's findings, 12% of the borrowers paid back only the principal, or even less than the principal, and many more paid only part of the sum due, as

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[190] According to one dataset, consumer litigation funding is usually used for daily expenses, repayment of mortgage, and the like. *See* Paige Marta Skiba & Jean Xiao, *Consumer Litigation Funding: Just Another Form of Payday Lending?*, 80 LAW & CONTEMP. PROB. 117, 124–26 (2017)

[191] *See* Avraham & Sebok, *supra* note 188, at 1137–38 (reviewing a wide range of estimates of the interest rates charged in CLF and observing that the debate on the subject "has been conducted in an environment of anecdote and speculation"); Skiba & Xiao, *supra* note 190, at 119 (2017) (noting "the lack of empirical research upon which policymakers can make effective and educated decisions" in this sphere).

[192] Avraham & Sebok, *supra* note 188.

[193] *Id.* at 1141.

[194] *Id.* at 1151–54.

[195] *Id.* at 1144.

[196] *Id.* at 1154–57.

[197] *Id.* at 1156.

[198] *Id.* at 1142.

the lender had not insisted on repayment in full (so-called *haircuts*). However, even taking these cases into account, the median effective APR collected by the lender was still very high—approximately 43%.[199] In fact, the lender made greater profits on the transactions in which it agreed to take a haircut than those in which it did not.[200]

While the EGB is key to understanding borrowers' decision-making in the context of CLF, it is by no means the only pertinent behavioral phenomenon. Closely related to the EGB, the exceedingly complex formulae described above make it all the more difficult for borrowers to assess the true cost of the loan.[201] This difficulty is exacerbated by the fact that the people who use CLF are often in financial distress, and possibly in poor health, as well, due to the injury for which they are suing—which impairs their cognitive performance.[202]

Given its key features—including the socio-economic characteristics of the borrowers and the prevailing high interest rates—it is hardly surprising that CLF is controversial. On the one hand, some commentators have highlighted the difficulties associated with CLF, and have called to ban it altogether, or at least heavily regulate the content of the transaction.[203] On the other hand, it has been argued that, along with other subprime industries, CLF serves an important social goal. Therefore, the funders should be subject to licensing and transparency requirements, but the substance of the agreements should not be paternalistically regulated.[204]

Some states already regulate CLF transactions—mostly by imposing disclosure duties similar to those imposed by TILA, or by capping interest rates and fees.[205] However, these techniques are problematic. With regard to disclosures, Paige Skiba and Jean Xiao have cogently observed that "[p]laintiffs do not have legal expertise and likely lack the financial sophistication necessary to estimate when a nonrecourse advance will be due and how much the eventual interest and fees will amount to. Even for the savviest plaintiffs, such computations would be difficult."[206]

A potentially more effective disclosure duty may be to require lenders to provide borrowers with statistical information (based on the data they collect) of the expected

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[199] *Id.* at 1142, 1171.

[200] *Id.* at 1158. For a comparable phenomenon in the credit card market, see *supra* note 146.

[201] *Id.* at 1172–73 (analyzing the various aspects of the "unnecessary complexity" of the transaction as a manifestation of sophisticated firms' effort to widen the gap between the transaction's perceived and actual price).

[202] On the adverse effects of financial distress on decision-making, see generally SANDHIL MULLAINATHAN & ELDAR SHAFIR, SCARCITY: WHY HAVING TOO LITTLE MEANS SO MUCH (2013); ZAMIR & TEICHMAN, BLE, *supra* note 6, at 483–85. This concern is mitigated inasmuch as plaintiffs consult with their attorneys before taking out the loan. Another possible explanation for plaintiffs' willingness to pay high interest rates in CLF is their *loss aversion*. This arrangement decreases their *gains* from the lawsuit in return for an assurance that they would not be exposed to the risk of having to repay the loan from their own pocket, if the claim is dismissed (perceived as *a loss*). *Cf.* Eyal Zamir & Ilana Ritov, *Revisiting the Debate over Attorneys' Contingent Fees: A Behavioral Analysis,* 39 J. LEGAL STUD. 245 (2010) (experimentally establishing a similar point about clients' preference for contingency fees). Other cognitive biases that may affect borrowers' decision-making in the context of CLF include over-optimism, mental accounting, salience, and framing. *See* Skiba & Xiao, *supra* note 90, 126–29.

[203] *See, e.g.,* Julia H. McLaughlin, *Litigation Funding: Charting a Legal and Ethical Course*, 31 VT. L. REV. 615 (2007) (concluding that legislators should regulate these loans in order to bar profiteering).

[204] *See* Susan Lorde Martin, *Litigation Financing: Another Subprime Industry that Has a Place in the United States Market*, 53 VILL. L. REV. 83 (2008); Terrence Cain, *Third Party Funding of Personal Injury Tort Claims: Keep the Baby and Change the Bathwater*, 89 CHI.-KENT L. REV. 11 (2014).

[205] *Id.* at 144–45 (summarizing states' regulations as of 2016).

[206] *Id.* at 120. *See also* Avraham & Sebok, *supra* note 188, at 1174 (expressing similar concerns).

length and total payment of similar loans. In addition, the borrowers' attorneys could be asked to confirm in writing that this information has been disclosed to their clients.[207]

As for the capping of interest rates, one problem is that if the cap is set too low, it may eliminate CLF altogether, or drastically curtail its availability, especially to the neediest plaintiffs who can hardly get credit anywhere else (payday loans may be even more harmful to borrowers, and in any case are not available to the unemployed).[208] Another problem is that lenders can be expected to find ingenious ways of evading such caps.[209]

A more promising intervention, therefore—which takes the bull by the horns, and neutralizes the EGB as well as some of the other cognitive limitations of borrowers—is to ban all forms of compounded interest, minimal periods, buckets, and fees paid upon repayment of the loan, leaving only a simple interest rate. As Avraham and Sebok point out, it is not at all clear what the economic rationale of these features is, besides obfuscating the true cost of the loan (and, we would add, exploiting borrowers' EGB).[210] Such mandated simplification of the transaction could be backed by punitive damages and administrative, or even criminal, sanctions.[211] Such a measure would likely be not only more effective than capping interest rates, but also more respectful of the parties' freedom of contract. It aims to facilitate, rather than restrict, rational contracting, which is key to the efficient functioning of the market.

3. Mortgage Forbearance

As previously noted,[212] when consumers decide to put off payments (either because they are entitled to do so, or because they are in default) this may trigger compound interest. In such instances, consumers may fail to grasp the full long-term costs of their decisions due to the EGB. One concrete example of such decisions is mortgage forbearance—the temporary suspension of mortgage payments.

Mortgage forbearance can be beneficial for borrowers and lenders alike.[213] Borrowers facing temporary financial difficulties can use the deferral time to reorganize their finances, and avoid the tremendous damage caused by defaulting (such as loss of home and adverse credit rating).[214] From the lenders' perspective, forbearance may also be the lesser evil, since foreclosure entails significant costs (e.g., due to litigation and real-estate depreciation).[215] At the societal level, in cases of macro downturns in the economy,

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[207] Skiba & Xiao, *supra* note 190, at 134–37 (advocating these measures); Avraham & Sebok, *supra* note 188, at 1174–75 (questioning the efficacy of these measures); Cain, *supra* note 204, at 45–49 (advocating more conventional disclosure duties and attorneys' acknowledgement).

[208] Skiba & Xiao, *supra* note 190, at 133.

[209] *Id.* at 134.

[210] Avraham & Sebok, *supra* note 188, at 1167, 1169–71.

[211] *See* Zamir & Ayres, *supra* note 152, at 325–30 (discussing ways to deter suppliers from including unenforceable terms in their contracts); *supra* note 186 and accompanying text.

[212] *See supra* note 167 and accompanying text.

[213] *See e.g.*, John Y. Campbell, Nuno Clara & João F. Cocco, *Structuring Mortgages for Macroeconomic Stability*, NBER Working Paper 27676, August 2020, https://www.nber.org/papers/w27676 (highlighting the mutual advantages of mortgages that allow borrowers to pay only interest on their loan during a recession).

[214] *See* Luigi Guiso, Paola Sapienza & Luigi Zingales, *The Determinants of Attitudes Toward Strategic Default on Mortgages*, 68 J. FIN. 1473, 1479–81 (2013) (analyzing borrowers' costs of defaulting).

[215] *See* Charles A. Capone, *Cost-Benefit Analysis of Single-Family Foreclosure Alternatives*, 13 J. REAL ESTATE FIN. ECON. 105, 106 (1996) (noting that "[f]rom the lender's perspective, foreclosure is the most costly post-default outcome").

forbearance can help prevent real-estate prices from spiraling downward, thus deepening the economic crisis.[216]

That said, borrowers who exhibit the EGB can make systematic mistakes when deciding whether or not to defer mortgage payments. To the extent that interest continues to accrue during the forbearance period, compound interest kicks in, leading to borrowers possibly underestimating the cost of postponing payments. Regulators should therefore strive to create a decision-making environment that ensures that borrowers make decisions that serve their long-term interests.

One way to counteract the EGB is to ban compound interest entirely during the forbearance period. For example, in the wake of the COVID-19 crisis, the Coronavirus Aid, Relief, and Economic Security (CARES) Act required lenders of federally backed mortgages to temporarily suspend mortgage payments for six months (with a possible extension to twelve months), at the borrower's request.[217] Notably, this program did not entail compound interest, as lenders were instructed to transfer all principal and interest payments deferred during the forbearance period into a non-interest-bearing balance.[218]

While banning compound interest is possible in transactions in which the government is involved, it is less feasible with respect to private loans. Deferment of loan repayments creates a real loss to lenders, who cannot relend the collected sums of money to other borrowers, and in effect provides borrowers with free credit.[219] As a result, banning compound interest may undercut lenders' incentives to show leeway to borrowers in distress. Thus, tailoring disclosure policies that are geared toward tackling the EGB may be a more constructive path in such cases. Since forbearance is granted for a specific period of time for an existing loan, lenders can easily calculate the precise cost that the forbearance will engender over the duration of the loan. Regulators may therefore require that this explicit dollar amount be presented to borrowers in a simple and salient way before they choose to defer their mortgage payments. This recommendation is in line with empirical findings from the context of payday loans, which suggests that a simple disclosure of the dollar cost of a loan is likely to have the greatest impact on borrowers decisions.[220]

C. Pyramid Schemes

Having discussed two major spheres in which the EGB strongly affects people's decision-making—insufficient savings and excessive borrowing—we turn next to a more specific issue: pyramid schemes. A pyramid scheme is a perpetual recruitment network "that transfers funds from new recruits to those higher in the organization."[221] Every year,

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[216] *See* Adam M. Guren & Timothy J. McQuade, *How Do Foreclosures Exacerbate Housing Downturns?*, 87 REV. ECON. STUD. 1331, 1335–38 (2020) (reviewing data consistent with the price-default spiral hypothesis).

[217] 15 U.S.C. § 9056(b)(2).

[218] Fanie Mae, Lender Letter (LL-2020-07) at 5; https://singlefamily.fanniemae.com/media/22916/display.

[219] *See* Jackson T. Anderson, David M. Harrison & Michael J. Seiler, *Strategic Forbearance and Unintended Consequences of the CARES Act* (unpublished manuscript on file with author) (arguing that the low costs of forbearance under the CARES Act create a moral hazard problem).

[220] *See* Marianne Bertrand & Adair Morse, *Information Disclosure, Cognitive Biases, and Payday Borrowing*, 66 J. FIN. 1865, 1881–88 (2011) (reporting results on the effectiveness of different disclosure types).

[221] *See* Peter J. Vander Nat & William W. Keep, *Marketing Fraud: An Approach for Differentiating Multilevel Marketing from Pyramid Schemes*, 21 J. PUB. POL'Y & MARKETING 139, 142 (2002).

hundreds of thousands of Americans lose considerable amounts of money in such schemes.[222] Aside from their financial cost, pyramid schemes can inflict broader societal harm, since they build upon trust within families and social networks. In one infamous case, an entire country was plunged into chaos nearing civil war, when numerous pyramid schemes involving a large part of the population collapsed.[223]

While pyramid schemes differ in detail, the basic structure is similar: participants are required to pay upfront to join the scheme, recruit additional participants, and receive payment once enough members have been recruited. A simple case in point is the so-called *Airplane Game*.[224] Players enter this game at the fourth tier of the pyramid as "passengers," after paying an enrollment fee (which may be as high as $5,000). Each passenger is then required to recruit two (or more, in some versions) additional players into the game. Based on their recruitment and the recruitment carried out by the people whom they recruit, players are promoted to the third tier ("Crew"), the second tier ("Co-pilot"), and eventually the top tier ("Pilot"). At this point, the Pilot receives the payments made by the eight new passengers recruited to the base of the pyramid, and exits the game. The pyramid then splits into two pyramids—with each Co-pilot assuming the position of Pilot in one of the pyramids, and all other members promoted by one tier. Notice that the payoff structure of this game is built exclusively on the transfer of resources within the pyramid—from those who joined last, to those who joined first.

Some iterations of the pyramid scheme attempt to mask their activity by incorporating product marketing into the program.[225] Such pyramids present themselves as legitimate multilevel-marketing organizations, which focus on the distribution of a product through a network of representatives who earn bonuses. However, the key distinguishing factor between pyramid schemes and multilevel-marketing programs is simple: the source of the bonuses.[226] In legitimate multilevel marketing programs, there is an actual product market, and therefore bonuses mostly come from product sales to end-consumers who are not part of the program. Conversely, in camouflaged pyramid schemes, bonuses are paid primarily for recruiting new people into the scheme.

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[222] KEITH B. ANDERSON, MASS-MARKET CONSUMER FRAUD IN THE UNITED STATES: A 2017 UPDATE 25 (Fed. Trade Comm'n, 2019), https://www.ftc.gov/reports/mass-market-consumer-fraud-united-states-2017-update.

[223] *See* Christopher Jarvis, *The Rise and Fall of Albania's Pyramid Schemes*, 37 FIN. & DEV. 46 (2000).

[224] *See* Corey Matthews, *Using A Hybrid Securities Test to Tackle the Problem of Pyramid Fraud*, 88 FORDHAM L. REV. 2045, 2046–47 (2020) (describing the airplane game). Some schemes use a different terminology, but employ the same framework. *See e.g.*, Eric Witiw, *Selling the Right to Sell the Same Right to Sell: Applying the Consumer Fraud Act, the Uniform Securities Law and the Criminal Code to Pyramid Schemes*, 26 SETON HALL L. REV. 1635, 1636 (1996) (describing the Network Game).

[225] *See* William W. Keep & Peter J. Vander Nat, *Multilevel Marketing and Pyramid Schemes in the United States: An Historical Analysis*, 6 J. HIS. RES. MARKETING 188, 197 (2014) (a pyramid scheme may introduce a product "to fool people into thinking that they are engaged in a business"). A well-known recent case in point is Advocare, which ultimately agreed to end its multilevel marketing operation and pay $150,000,000 in compensation. *See* FTC v. Advocare International, Case No. 4:19-cv-715-SDJ. For an overview of the distinguishing factors, see FED. TRADE COMM'N, BUSINESS GUIDANCE REGARDING MULTILEVEL MARKETING (2018), https://www.ftc.gov/tips-advice/business-center/guidance/business-guidance-concerning-multi-level-marketing; Vander Nat & Keep, *supra* note 221, at 145–50.

[226] *See* Sergio Pareja, *Sales Gone Wild: Will the FTC's Business Opportunity Rule Put an End to Pyramid Marketing Schemes?*, 39 MCGEORGE L. REV. 89 n.37 (2008) ("[t]he overriding characteristic of all pyramid schemes … is that most of the money used to pay recruits comes from later recruits to the scheme").

The requirement to recruit an ever-growing number of additional players into the pyramid implies that the base of the pyramid will grow exponentially.[227] This process, however, cannot continue indefinitely.[228] Rather, as the population in which the pyramid scheme operates becomes saturated with people who have already been recruited into the scheme, finding additional members becomes increasingly difficult. In line with the general observation that in closed systems exponential growth stops at a certain point,[229] the stream of new recruits dwindles, and the pyramid collapses—leaving the most recent entrants unable to recoup their enrollment fee. The ultimate result is that the vast majority of those who invest in pyramid schemes (by some accounts, over 99%) fail to reach the higher echelons of the program, and end up losing significant amounts of money.[230]

As the foregoing analysis suggests, people who are invited to join a pyramid scheme are required to assess an exponential growth function. If they join the pyramid early enough, they can make a quick profit from the scheme. However, if they join close to the saturation point, they will lose money, because they will fail to recruit additional members into the scheme. Studies on the EGB suggest that when facing this assessment task, people err systematically. Since people fail to appreciate the speed at which exponential functions grow, they also neglect to realize how quickly growth will end. In a classic early EGB study using a digital simulation, Wagenaar and Timmers asked subjects to estimate the speed at which a pond would be filled to capacity by duckweed that is growing exponentially.[231] Even though participants in this study could clearly observe that exponential growth was constrained by the size of the pool, the results demonstrate that they could not appreciate the speed with which the pool would be filled by the duckweed.[232]

More recently, behavioral economists have directly examined peoples' decision-making in a pyramid game, through a stylized experimental setting.[233] Participants in the study were offered to join a pyramid game that simulated a four-tier airplane game, in which each participant was required to recruit three more players into the pyramid. The experiment was incentive-compatible, and participants needed to pay $5 to join the pyramid. Joining the game entailed a 1% chance of winning $10 and a 99% chance of winning $1 (*i.e.,* for a net loss of $4) given the parameters of the game. Notably, participants in the experiment were presented with complete and accurate information about the rules of the game, the number of participants who have already joined, and the size of the population in which the game can spread. Moreover, participants were not

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[227] *See* Vander Nat & Keep, *supra* note 221, at 141 (observing that "the number of new recruits grows rapidly, often at an exponential rate").

[228] *See, e.g*., Pareja, *supra* note 226, at 86–87 (2008) (highlighting the connection between exponential growth and the collapse of pyramids); Vander Nat & Keep, *supra* note 227, at 141–42 (same).

[229] *See* text accompanying *supra* note 28.

[230] *See* JOHN M. TAYLOR, THE 5 RED FLAGS: FIVE CAUSAL AND DEFINING CHARACTERISTICS OF PRODUCT-BASED PYRAMID SCHEMES, OR RECRUITING MLM'S 14 (2006), https://www.ftc.gov/system/files/documents/public_comments/2006/07/522418-12585.pdf. *See also* Heidi Liu, *The Behavioral Economics of Multilevel Marketing*, 14 HASTINGS BUS. L.J. 109, 112 (2018) (reviewing empirical findings on large losses of participants in pyramid schemes).

[231] *See* Wagenaar & Timmers, *supra* note 27, at 241–45 (describing experiment 1).

[232] *Id.* at 244. *See also* Wagenaar & Sagaria, *supra* note 2, at 416–17 (showing that people significantly underestimate the time in which pollution will reach a given threshold).

[233] *See* Stacie A. Bosley et al., *Decision-Making and Vulnerability in a Pyramid Scheme Fraud*, 80 J. EXPERIMENTAL & BEHAV. ECON. 1 (2019).

subjected to any form of aggressive marketing, as is often the case with real pyramid schemes,[234] and half of them were even clearly advised to "think carefully about your odds of winning each option before choosing."[235]

In these somewhat idealized conditions, 44.2% of the participants chose to pay to join the pyramid scheme.[236] Apparently, this was due to a host of factors. Some subjects did not comprehend how many more players they would be competing against in the pyramid, while others could not properly calculate how many people they would have to recruit into the pyramid to achieve "Pilot" status. Interestingly, however, even among those who properly understood the scope of competition that they faced, and correctly calculated the number of people they would have to recruit, only one third managed to correctly assess their probability of success in the game.[237] Even with complete information, and after fully understanding the parameters of the game, many participants failed to foresee just how quickly the population of potential entrants would dry up.

By design, in all of these studies, subjects were clearly informed of the upper limit of exponential growth, yet still failed to translate that into an accurate estimate—suggesting that the source of the error of judgment was the EGB. In the real world, people do not usually have that advantage. For example, the size of the population in which the scheme can grow may be unclear, and the number of people who have already joined it may be unknown. Consequently, other cognitive phenomena might interact with the EGB, and exacerbate its impact on decisions.[238] For example, over-optimism about one's ability to recruit others into the program may be bolstered by the EGB—causing people to perceive offers as more attractive than they really are.

The insight that the EGB impairs peoples' decision-making with respect to pyramid schemes can shed new light on the ongoing legal debate over how such schemes should be treated.[239] In the United States, pyramid schemes are governed by a complex web of regulation. At the federal level, there is no anti-pyramid statute.[240] Rather, enforcement is built mostly upon the existing legal framework that empowers the FTC and the SEC.[241] The FTC generally targets pyramid schemes based on Article 5 of the FTC Act, that prohibits "unfair or deceptive acts or practices in or affecting commerce."[242] The SEC similarly engages in enforcement activity against pyramid schemes, on the theory that such schemes are securities whose sale involves prohibited deceptive practices.[243] Thus,

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[234] *See* Liu, *supra* note 230, at 123–26 (2018) (describing recruitment events).

[235] Bosley et al., *supra* note 233, at 3.

[236] *Id.* at 5.

[237] *Id.*

[238] *See supra* notes 50–55 and accompanying text (discussing the interaction between the EGB and other behavioral phenomena).

[239] Consistent with the lack of attention to the EGB in other contexts, legal scholars have not examined its relevance to pyramid schemes. The most recent comprehensive legal article dedicated to a behavioral analysis of pyramid schemes makes no reference to the EGB. *See* Liu, *supra* note 230.

[240] *See* Matthews, *supra* note 224, at 2059.

[241] The Department of Justice may also prosecute pyramid schemes that engage in mail fraud or money laundering, though such cases are relatively rare. *See* Pareja, *supra* note 226, at 103–04.

[242] 15 U.S.C. § 45(a)(1). For an overview of the legal framework under the FTC Act, see Pareja, *supra* note 226, at 89–96.

[243] 15 U.S.C. § 77x. For an overview of the legal conditions for SEC enforcement, see Pareja, *supra* note 226, at 96–103.

federal enforcement hinges mostly on proof of fraud or deception.[244] At the state level, legislation differs between jurisdictions. Whereas some states follow the federal framework and focus on fraud and deception, other states have enacted specific anti-pyramid statutes that ban the practice altogether, without delving into the details of the representations made by the marketers of pyramids.[245]

The overall success of these legal measures is limited.[246] According to one study, between 1997 and 2005 the FTC received 17,858 complaints against pyramid schemes—yet between 1990 and 2006, it prosecuted only twenty such cases.[247] While this inaction may be due to a variety of factors, one key issue is the need to prove fraud or deception. This extremely costly process requires a detailed case-by-case analysis of recruitment events, which hinders enforcement efforts.[248] The lack of meaningful federal enforcement on this front is important, since state regulation cannot offer an adequate response to pyramid schemes, given the mobility of such programs across state lines.[249]

The focus of federal law on fraud and deception in the context of pyramid schemes seems unwarranted. The findings on the EGB reviewed above demonstrate that many people systematically err when faced with a pyramid scheme, even if they are presented with complete and accurate information.[250] Thus, the core deception in pyramid schemes lies in their very structure, and in how they prey on peoples' systematic tendency to underestimate the speed with which they will collapse, due to exponential growth.[251] As noted, some states have incorporated this insight into their regulatory framework, and have moved toward eliminating the need to prove fraud or deception in such cases.[252] For example, the Oregon Court of Appeals explicitly rejected the theory that proof of deception or misrepresentation is required, on the grounds that the scheme itself is

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[244] *See* Pareja, *supra* note 226, at 95 & 97 (noting that the only way to prosecute a pyramid scheme under the FTC Act "is to prove that a company has misrepresented its earnings potential," and that "SEC enforcement also focuses on misleading information").

[245] For an overview, see DEE PRIDGEN & RICHARD M. ALDERMAN, CONSUMER PROTECTION AND THE LAW §3:14 (2019).

[246] *See* Matthews, *supra* note 224, at 2058 ("FTC enforcement actions charging unfair and deceptive practices have thus far not proved especially effective at deterring pyramid scheme formation").

[247] Pareja, *supra* note 226, at 94. To be sure, numerous complaints may refer to a single scheme. And yet, the FTC's activity in this sphere appears to be very limited.

[248] *See* Matthews, *supra* note 224, at 2062 (proving misrepresentation by a scheme "is a highly fact-intensive process that requires significant agency resources"); Pareja, *id.* at 94 ("observing that [b]ecause gathering evidence of 'unfair' or 'deceptive' acts is extremely difficult, the FTC does not use this provision frequently"); Pareja, *supra* note 226, at 103.

[249] *See* Matthews, *supra* note 224, at 2061 (noting that on the whole, state-level regulation "is not a particularly effective tool for combatting this national problem"); Pareja, *supra* note 226, at 103 (arguing that there is a "need for a comprehensive federal rule").

[250] In actuality, participants are "never told on which level they are entering the pyramid," and are therefore even less aware of how close the scheme is to its saturation point. *See* Witiw, *supra* note 224, at 1637.

[251] *See e.g.*, Bosley et al., *supra* note 233, at 2 (noting that "[t]he exponential structure [of the pyramid] is designed to pass money from losers to winners"); *See* Matthews, *supra* note 224, at 2055 (arguing that "[p]yramids are deliberately designed to grow exponentially" and consequently "the large majority of participants lose money simply because they enter the scheme after it has already become unsustainable"), Pareja, *supra* note 226, at 96 ("it is mathematically impossible for later participants to earn large profits because of the exponential number of new recruits needed to sustain a profit").

[252] *See* PRIDGEN & ALDERMAN, *supra* note 245, at §3:14. The European Union adopted a similar policy in 2005. The Unfair Commercial Practices Directive views all pyramid schemes as unfair in all circumstances. *See* Item 14 of Annex I of Directive 2005/29/EC on Unfair Business-to-Consumer Commercial Practices in the Internal Market (2005).

"inherently deceptive."[253] The findings on the EGB offer concrete empirical support for this thesis.

Finally, in legislative debates and in academic writing alike, some attention has been drawn to the possibility of mending the deficiencies of current policies with regard to pyramid schemes by enacting a more robust disclosure regime.[254] However, if people fail to appreciate exponential growth, providing them with more information will not fix the problem.[255] Given the complexity of the compensation structure in many pyramid schemes,[256] carefully crafted disclosures may ultimately be truthful, yet not very useful.[257] Indeed, emphasizing disclosure may even turn out to be counterproductive, as it will enable sophisticated pyramid organizers to shield themselves from legal liability. This echoes more general concerns over the futility of mandated disclosure as a means of overcoming entrenched cognitive biases.[258]

D. Policymakers

So far, our analysis has focused on the effect of the EGB on market actors who make choices that hinge on their understanding of exponential growth. This subsection shifts the focal point of the analysis to policymakers, who may similarly need to design legal policies regarding phenomena that entail exponential growth. The discussion first highlights how the EGB might affect policy decisions, and then reviews some real-world examples in which the EGB appears to have influenced the design of legal policies, and draws some tentative normative conclusions.

1. Behavioral Public Choice Theory and the Exponential Growth Bias

Shifting the analysis from decision-making by individuals to that of states poses a challenge. The research that behavioral law and economics is founded on focuses mostly on the decisions made by individuals. And while some behavioral research has examined decisions made in small groups,[259] the methods used by behavioral research are generally unsuitable for studying decision-making in large institutional settings, such as the administrative state.[260] Research on the EGB is no exception in this regard: all of the behavioral studies reviewed in this Article examined individual decision-making.[261]

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[253] Nielson v. Myers, 193 Or. App. 388, 400 (2004).

[254] *See* Pareja, *supra* note 226, at 105–19 (analyzing proposed FTC rules enhancing disclosure); Liu *supra* note 230, at 122–27, 134–35 (presenting a behavioral analysis of disclosure in the context of pyramids and calling for a simplified disclosure regime).

[255] *See* Pareja, *supra* note 226, at 107 (arguing that disclosure alone is unlikely to stop pyramid schemes).

[256] *See e.g.*, FTC v. BurnLounge, Inc., 753 F.3d 878, 882 (9th Cir. 2014) (describing the bonus program).

[257] *See* Pareja, *supra* note 226, at 95–6 (highlighting how pyramid operators may circumvent disclosure limitations regarding expected earnings).

[258] *See* sources cited *supra* note 126.

[259] *See e.g.*, ZAMIR & TEICHMAN, BLE, *supra* note 6, at 120–24 (reviewing the behavioral literature on group decision-making).

[260] Samuel Issacharoff, *Behavioral Decision Theory in the Court of Public Law*, 87 CORNELL L. REV. 671, 671–73 (2001); William N. Eskridge, Jr., & John Ferejohn, *Structuring Lawmaking to Reduce Cognitive Bias: A Critical View,* 87 CORNELL L. REV. 616, 620–21 (2002).

[261] *See supra* Section II.B. Note, however, that the subjects in one of the studies reviewed were members of the Pennsylvania Joint Conservation Committee. *See* Wagenaar & Sagaria, *supra* note 2, at 422.

Nonetheless, recent studies in the field of behavioral public choice theory have applied insights from behavioral economics to the decisions made by states.[262] This body of work has highlighted two channels in which heuristics and biases may affect policy decisions.[263] First, political decision-makers, like everyone else, may be susceptible to cognitive biases and heuristics. Second, even if policymakers are perfectly rational, political motivations may drive them toward policies that appeal to their boundedly rational constituency.[264] While the behavioral literature has not even begun to untangle these two mechanisms, they both suggest a similar outcome: policies that are swayed by a host of psychological phenomena.

Incorporating the EGB into this line of reasoning suggests that the law may be systematically late in reacting to processes involving exponential growth. People—be they the policymakers themselves, or the population that the politicians are accountable to—do not appreciate the gravity of risks that grow exponentially. This lack of appreciation may be greatest with respect to *new* risks, which are difficult to grasp without relevant experience (note that unlike deliberately designed growth patterns, such as the charging of compound interest in loans, natural and social process entail far greater uncertainty). Consequently, the legal response to such new risks may be deferred until the scope of harm is overwhelming. It is for this reason that Albert Allen Bartlett famously noted that "[t]he greatest shortcoming of the human race is our inability to understand the exponential function."[265]

2. Applications

In light of the methodological challenges described, it is impossible to make strong causal claims about the influence of the EGB on legal policies. There are nevertheless numerous examples that are consistent with the late-response hypothesis. It is worth noting at the outset that the EGB is clearly not the single driving force in any of the cases reviewed below—much as it was not the single driving force in the contexts discussed above.[266] Nonetheless, examining these cases in light of the EGB can enhance our understanding of the complex political decision-making process that results in legal change.

A salient recent example is the legal response to the COVID-19 pandemic.[267] In December 2019, a novel coronavirus (SARS-CoV-2) that causes an acute respiratory

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[262] For an overview of the empirical work in the field, see Jan Schnellenbach & Christian Schubert, *Behavioral Political Economy: A Survey,* 40 EUR. J. POL. ECON. 395 (2015). For notable examples of legal scholarship within this body of work, see Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation,* 51 STAN. L. REV. 683 (1999); W. Kip Viscusi & Ted Gayer, *Behavioral Public Choice: The Behavioral Paradox of Government Policy,* 28 HARV. J.L. & PUB. POL'Y 973, 988–96 (2015).

[263] *See* Doron Teichman & Eyal Zamir, *Nudge Goes International*, 30 EUR. J. INT'L L. 1263, 1266–67 (2020). *See also* Gary M. Lucas, Jr. & Slaviša Tasić, *Behavioral Public Choice and the Law,* 118 W. VA. L. REV. 199, 204–17 (2015).

[264] *Id.* at 408 (reviewing findings on politicians' irrationality).

[265] The opening line of Bartlett's lecture, *Arithmetic, Population and Energy* (1969), available at: https://www.youtube.com/watch?v=sI1C9DyIi_8.

[266] *See supra* notes 50–55, 82–83, 153–162, 210, 238, and accompanying text.

[267] To be sure, several other behavioral phenomena, such as the omission bias and procrastination, may have also affected policymakers' decisions vis-à-vis the pandemic. *See generally* Doron Teichman & Kristen Underhill, *Infected by Bias: Behavioral Science and the Legal Response to COVID-19*, __ AM. J. L. & MED __, __ (2021).

syndrome (COVID-19) appeared in the Chinese province of Wuhan.[268] Given its highly contagious nature, it spread at an exponential rate.[269] By April 24, 2020, 2,626,000 confirmed cases of SARS-CoV-2 were recorded worldwide, and 181,000 deaths were attributed to it.[270]

Generally speaking, countries were late to respond to the spread of the coronavirus in early 2020.[271] In all likelihood, "[o]ne of the reasons that the general public and key decision makers largely ignored the coronavirus in January or February is that they failed to appreciate the looming menace of its exponential growth."[272] Consequently, politicians were reluctant to adopt the necessary legal measures needed to stop the spread of the virus, despite clear recommendations by public health experts to act swiftly. At the federal level, President Trump repeatedly focused on the low numbers of confirmed cases in the initial stages of the pandemic, while downplaying the risks it posed, concluding that "everything's going to be great."[273] Consequently, "[i]n spite of various warnings coming from the health policy community of experts, intelligence agencies, economic council, and the CDC, President Trump was … very slow to institute any actions or policy responses."[274] The tendency of politicians to act slowly in the face of clear expert advice was also evident in administrations that eventually took a more aggressive stance toward the virus. In New York City, for instance, the mayor postponed the closure of public schools until the city's head of disease control threatened to step down if this was not done.[275]

Despite the short time that has lapsed since the outbreak of COVID-19, numerous empirical studies have already documented the effect of the EGB on how people perceive the pandemic's risks.[276] A study conducted in the United States in the second half of March 2020 showed that "participants' averaged estimates of the virus's growth could, for practical purposes, be described as linear."[277] As a result, they underestimated the actual growth rate of the virus by 45.7%.[278] The study also documented a link between the EGB

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[268] *See* Peng Zhou et al., *A Pneumonia Outbreak Associated with a New Coronavirus of Probable Bat Origin*, 579 NATURE 270, 270 (2020).

[269] Shi Zhao et al., *Preliminary Estimation of the Basic Reproduction Number of Novel Coronavirus (2019-Ncov) in China, from 2019 to 2020: A Data-Driven Analysis in the Early Phase of the Outbreak*, 92 INT'L J. INFECTIOUS DISEASES 214 (2020) (modeling the spread of Coronavirus in China).

[270] *See* Ian F. Miller et al., *Disease and Healthcare Burden of COVID-19 in the United States*, 26 NATURE MED. 1212, 1212 (2020).

[271] Lammers, Crusius & Gast, *supra* note 16264 (2020) (noting that a "sizeable opposition among politicians and the general population has delayed, prevented, or terminated early measures to increase social distancing").

[272] Howard Kunreuther & Paul Slovic, *Learning from the COVID-19 Pandemic to Address Climate Change*, 1 MGMT. & BUS. REV. 92, 93 (2021).

[273] Paul E. Rutledge, *Trump, COVID-19, and the War on Expertise*, 50 AM. REV. PUB. ADMIN. 505, 506 (2020) (citing numerous statements by President Trump).

[274] *Id*. at 507.

[275] *See* David Goodman, *How Delays and Unheeded Warnings Hindered New York's Virus Fight*, N. Y. TIMES, April 8, 2020, https://www.nytimes.com/2020/04/08/nyregion/new-york-coronavirus-response-delays.html.

[276] *See* Lammers, Crusius & Gast, *supra* note 271; Ritwik Banerjee et al., *Exponential-Growth Prediction Bias and Compliance With Safety Measures Related to COVID-19*, 268 SOC. SCI. MED. (2021); Alexander Podkul et al., *Understanding Exponential Growth Amid Pandemic: An International Perspective* (August 1, 2020), https://www.raymondduch.com/files/understanding-exponential-growth-amid-pandemic.pdf; Ritwik Banerjee & Priyama Majumdar, *Exponential Growth Bias in the Prediction of COVID-19 Spread and Economic Expectation*, SSRN (September 9, 2020), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3687141.

[277] Lammers, Crusius & Gast, *supra* note 271 at 16265.

[278] *Id*.

and peoples' attitude toward public health policies. When participants' EGB was mitigated (by instructing them to calculate the growth rate of the virus in five intermediate steps of 3 days, rather than in one step of 15 days),[279] their support for social distancing measures and a lockdown grew significantly.[280]

The delay in reaction to the pandemic—plausibly due to the EGB—proved, quite literally, to be lethal. Decisions made in the initial stages of the pandemic had a tremendous impact on the overall death toll. As previously noted, one study estimated that if social distancing measures had been implemented in the United States just one week earlier than they were in March of 2020, 56.5% of reported infections, and 54.0% of reported deaths, as of May 3, 2020, could have been avoided.[281] Similarly, a simulation study of New York City estimated that implementing social distancing measures one week earlier could have reduced the number of cases from 203,261 to 41,366 by May 31st, while delaying the measures by a week could have increased the number of confirmed cases to 1,407,600.[282]

To be sure, the COVID-19 example also demonstrates how public authorities can learn to cope with a new exponential phenomenon. As the pandemic progressed, governments around the world appointed special advisory boards, staffed with epidemiologists, mathematical biologists, biostatisticians, and physicists. These boards quickly developed models that predicted the spread of the virus throughout the population. In the United Kingdom, for example, the government's initial inclination to postpone its legal response to the pandemic in March of 2020 quickly gave way to a national lockdown, when experts at Imperial College published a report that highlighted the catastrophic implications of inaction, given the exponential spread of the virus within the community.[283]

Another context in which policymaking may be affected by the EGB is climate change. Climate change is thought to be "the single greatest threat that societies face."[284] Global warming is projected to have dire consequences on multiple fronts—including human health, the environment, economic growth, and food security.[285]

A voluminous body of legal scholarship has been dedicated to climate change.[286] This literature has examined the design of the optimal legal responses to climate change, and

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[279] *Id.*

[280] *Id.* at 16266.

[281] *See* Sen Pei, Sasikiran Kandula & Jeffery Shaman, *Differential Effects of Intervention Timing on COVID-19 Spread in the United States*, MEDRXIV (May 29, 2020),
https://www.medrxiv.org/content/10.1101/2020.05.15.20103655v2.

[282] Oguzhan Alagoz, *Effect of Timing of and Adherence to Social Distancing Measures on COVID-19 Burden in the United States: A Simulation Modeling Approach*, 174 ANNALS INTERNAL MED. 50 (2020). *See also* Ofer Malcai & Michal Shur-Ofry, *Using Complexity to Calibrate Legal Response to Covid-19*, SSRN (October 29, 2021) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3666498 (discussing the ramifications of the exponential character of the spread of the coronavirus for legal policymaking).

[283] *See* David Conn et al., *Revealed: The Inside Story of the UK's COVD-19 Crisis*, GUARDIAN, 29 Apr. 2020; https://www.theguardian.com/world/2020/apr/29/revealed-the-inside-story-of-uk-covid-19-coronavirus-crisis (reporting on the UK's change of policy, and concluding that "the evidence that appears to have prompted the change of course was contained in the Imperial College paper").

[284] James Gustave Speth, *The Single Greatest Threat*, 27 HARV. INT'L REV. 18, 18 (2005).

[285] For an overview, see Ove Hoegh-Guldberg et al., *Impacts of 1.5°C Global Warming on Natural and Human Systems*, *in*: GLOBAL WARMING OF 1.5°C 175, 177–81 (Valérie Masson-Delmotte et al. eds., 2018).

[286] For book-long treatments of the topic, see DANIEL A. FARBER & CINNAMON P. CARLARNE, CLIMATE CHANGE LAW (2018) (focusing on the United States); DANIEL BODANSKY, JUTTA BRUNNÉE & LAVANYA RAJAMANI, INTERNATIONAL CLIMATE CHANGE LAW (2017) (focusing on international law).

has highlighted various impediments to achieving them. Notably absent from this body of work—even that dealing explicitly with behavioral analysis of law—is the EGB.[287] However, as it turns out, the EGB may in fact be playing a key role in the political process surrounding the enactment of legal policies aimed at tackling climate change.

The process of climate change is highly complex and involves a large number of factors including the atmosphere, the oceans and the ice sheets.[288] Many of these processes are non-linear, and entail feedback effects that amplify temperature change.[289] Furthermore, some of the economic consequences of climate change are non-linear.[290] However, unlike the COVID-19 pandemic, in which exponential growth is measured in days, climate processes are unfolding at a much slower rate.[291] Consequently, the public may fail to grasp the scope of the threat, and is unwilling to incur the necessary costs associated with preventing it. As Howard Kunreuther and Paul Slovic recently noted, "our failure to appreciate the exponential growth of climate-destroying processes has caused political leaders to resist acting to reduce carbon dioxide (CO_2) emissions."[292] And much as in the case of COVID-19, postponing critical legislation is expected to increase the future costs of climate change.[293]

While diagnosing the problem stemming from the EGB in the policy-setting domain appears to be straightforward, prescribing solutions is far more difficult. First, identifying new phenomena as being exponential in nature is a tricky task, since in the early growth stages it may be difficult to distinguish between exponential, other nonlinear, and linear growth patterns.[294] Moreover, even if a novel phenomenon can be identified as exponential, other aspects of it—such as quantifying the harm generated by the phenomenon and predicting the point at which exponential growth will begin to decline— may still obstruct prudent policymaking.[295] Thus, it would be overly cautious to treat every new phenomenon that exhibits rapid growth rates as a threat that requires a swift and fierce regulatory response. Close monitoring of the pace of progress may facilitate increasingly accurate assessments and predictions, based on existing models.

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[287] *See* Jeffrey J. Rachlinski, *The Psychology of Global Climate Change*, 2000 U. ILL. L. REV. 299 (reviewing the various psychological phenomena that impede the response to the threat of climate change).

[288] *See* Ulrich Cubasch et al., *Introduction*, *in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS 119, 123–30 (Thomas F. Stocker et al. eds., 2013) *available at* https://www.ipcc.ch/site/assets/uploads/2017/09/WG1AR5_Chapter01_FINAL.pdf.

[289] *Id.* at 127.

[290] *See, e.g.*, Wolfram Schlenker, Michael J. Roberts, *Nonlinear Temperature Effects Indicate Severe Damages to U.S. Crop Yields Under Climate Change*, 106 PROC. NAT'L ACAD. SCI. 15594, 15594 (2009) (predicting a sharp decline in corn, soy and cotton yields once a threshold temperature is crossed).

[291] Dale Jamieson, *The Nature of the Problem*, *in* THE OXFORD HANDBOOK OF CLIMATE CHANGE AND SOCIETY 38, 48 (John S. Dryzek, Richard B. Norgaard & David Schlosberg, 2011) (noting that "[i]ncrements of climate change are usually barely noticeable").

[292] *See* Kunreuther & Slovic, *supra* note 272, at 95. *See also* HAYDN WASHINGTON, CLIMATE CHANGE DENIAL: HEADS IN THE SAND 92 (2011) (arguing that "[f]ailure to understand exponential growth means a failure to act urgently on environmental problems and aids denial").

[293] *See* EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES, THE COST OF DELAYING ACTION TO STEM CLIMATE CHANGE 4–6 (2014) *available at* https://obamawhitehouse.archives.gov/sites/default/files/docs/the_cost_of_delaying_action_to_stem_climate_change.pdf.

[294] *See supra* notes 21–22 and accompanying text.

[295] On the shift from exponential growth to decline, see *supra* note 24 and accompanying text.

Second, even if policymakers can confidently identify new exponential processes that merit quick interventions, it may be difficult to recruit the public support for costly prevention measures. Communicating complex and unintuitive scientific insights to the general public is a significant challenge, since it is beset by a host of psychological and sociological factors that obstruct the flow of information.[296] In many areas, this challenge may be further exacerbated by *cultural cognition*—namely, peoples' tendency to form perceptions of disputed factual questions to suit the values of their cultural identity.[297] Thus, in the context of COVID-19 policies in the United States, studies have shown that peoples' risk perception of the pandemic was associated with their cultural outlook, rather than by scientific facts—with a commensurate effect on their attitudes toward public-health policies.[298] This is not to say that we are necessarily doomed to make poor policy decisions in the face of exponential challenges. Behavioral research has highlighted mechanisms that may help lay people to grasp exponential growth,[299] even in the context of policy setting.[300] But applying such insights in the field requires tremendous effort and attention to how scientific facts are presented to the public.[301]

Coping with the spread of contagious diseases and with climate change are not the only spheres in which the EGB may adversely affect policymaking. An invasive species may initially inflict little to no harm, but have devastating consequences to the ecosystem as its population grows out of control.[302] Tourism at some destinations appears to be growing at an exponential rate, adversely affecting local communities that are slow to adjust rules relating to issues like zoning.[303] Some technologies—most notably artificial intelligence—are also growing at an exponential rate,[304] raising concerns that regulation may not keep up with the risks that such new technologies generate.[305] Each such example merits in-depth analysis, which is left for future research.

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[296] For overviews of the empirical findings on science communication, see Heather Akin & Dietram A. Scheufele, *Overview of the Science of Science Communication*, in THE OXFORD HANDBOOK OF THE SCIENCE OF SCIENCE COMMUNICATION 25 (Kathleen Hall Jamieson, Dan Kahan & Dietram A. Scheufele eds., 2017); Philipp Schrögel & Christian Humm, *Science Communication, Advising, and Advocacy in Public Debates*, in SCIENCE COMMUNICATION (Annette Leßmöllmann, Marcelo Dascal & Thomas Gloning eds., 2020).

[297] Dan Kahan et al. *The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks*, 2 NATURE CLIMATE CHANGE 732, 732 (2012).

[298] For a review of the findings, see Teichman & Underhill, *supra* note 267.

[299] *See supra* notes 56–66 and accompanying text (reviewing debiasing research).

[300] Lammers, Crusius & Gast, *supra* note 271 at 16265–66 (debiasing with respect to COVID-19 spread rate).

[301] *See e.g.*, John D. Sterman, *Communicating Climate Change Risks in a Skeptical World*, 108 CLIMATE CHANGE 811, 820–25 (2011) (reviewing ways in which communication can be improved in the area of climate change).

[302] On invasive species, see generally Daniel Simberloff, *Invasive Species: What Everyone Needs to Know* (2013).

[303] *See e.g.*, Nicole Gurran & Peter Phibbs, *When Tourists Move In: How Should Urban Planners Respond to Airbnb?*, 83 J. AM. PLANNING ASS'N 80 (2017) (documenting exponential growth in Airbnb listings in Sydney Australia, and examining the policy implications regarding zoning regulation); Gert-Jan Hospers, *Overtourism in European Cities: From Challenges to Coping Strategies*, 20 CESIFO FORUM 20, 22–3 (2019) (reporting data suggesting exponential growth of tourism in Amsterdam, and discussing the legal response).

[304] *See* Gonenc Gurkaynak, Ilay Yilmaz & Gunes Haksever, *Stifling Artificial Intelligence: Human Perils*, 32 COMPUTER L. & SECURITY REV. 749, 752–53 (2016).

[305] *See e.g.*, *id.* at 753–56 (discussing the policy implications); Matthew U. Scherer, *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies*, 29 HARV. J.L. & TECH. 353, 393–98 (2016) (proposing the enactment of the Artificial Intelligence Development Act).

IV. CONCLUSION

This Article introduced the first comprehensive analysis of the EGB in legal scholarship. It highlighted numerous examples in which the law interacts with exponential processes, and examined the normative and policy implications of peoples' systematic tendency to underestimate exponential growth. As the discussion in the Article suggests, the EGB may justify a new generation of disclosure duties, which will help people make better decisions in situations involving exponential growth. It may also necessitate the enactment of new mandatory rules geared toward banning abusive practices that prey on peoples' misperception of exponential phenomena. In addition, the Article highlighted governmental failures to respond promptly to risks involving exponential growth, such as pandemics and climate change. This tendency requires the design and implementation of debiasing tools that will help promote more prudent legal policymaking.

Given the large gap in both the behavioral-economic and the legal scholarships with regard to the EGB, there is room for substantially more research in the area. On the behavioral side, empirical studies should deepen our understanding of questions, such as which model best captures peoples' understanding of exponential phenomena; are different groups of the population disparately affected by the EGB; and what, if any, are the treatments that can effectively debias the EGB. On the legal side, future research should continue to map various domains of the law in which exponential growth affects peoples' choices, and evaluate potential interventions.

Humanity's recent experience with the COVID-19 pandemic caused exponential growth to become a household term. Consequently, we suspect that the number of legal studies dealing with exponential processes will grow exponentially. And just as epidemiologists have, over the years, developed robust models of exponential viral spread, jurists aiming to create sensible legal policies with respect to situations involving exponential growth should be required to come to the table with accurate models of human behavior in such settings, and creative ideas about the legal response.