

QUANTUM ECONOMICS, NEWTONIAN ECONOMICS, AND LAW

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ABSTRACT

Just as Newtonian mechanics breaks down when we look at the constituent pieces of our universe—subatomic particles—neoclassical economics breaks down when we look at the constituent pieces of our society—individual people. At the scale of subatomic particles, quantum mechanics provides new foundations for understanding the physical world; at the scale of individual decision-making, behavioral economics promises new foundations for understanding the social, economic, and legal worlds. As this Article explains, this analogy between Newtonian and quantum physics, on the one hand, and neoclassical and behavioral economics, on the other hand, has much to reveal about law and economics.

With the help of numerous examples of key findings in behavioral law and economics, I take three principles from quantum mechanics (the uncertainty principle, the correspondence principle, and the quantum principle) and show how analogous principles in economics help illuminate the future trajectory of law and economics. I then seek to accelerate this trajectory by proposing an agenda for strengthening behavioral law and economics through a stronger grounding in theory and specifically a “quantum” theory of decision-making.

Along the way, the analysis leads me to challenge some common misconceptions about law and economics: Behavioral and neoclassical approaches to law and economics are not rivals, but partners; simplistic and artificial assumptions about human behavior remain a problem in law and economics, but perhaps most acutely in

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behavioral law and economics; and the notion that neoclassical economics promotes a deregulatory agenda and behavioral economics promotes a pro-regulatory agenda is, as often as not, exactly backwards.

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INTRODUCTION

The traditional, neoclassical approach to law and economics is under attack. The challenger is behavioral law and economics. A tsunami of empirical findings documenting how individuals behave in puzzling and sometimes paradoxical ways has washed away the foundations of the neoclassical approach, which was built upon simplistic assumptions about human rationality.

A century ago, Newtonian mechanics was under attack. The challenger was quantum mechanics. Astounding empirical findings that documented how matter behaved in puzzling and sometimes paradoxical ways undermined the Newtonian framework, which had described the physical world in simplistically deterministic terms.

This analogy between quantum physics and Newtonian physics, on the one hand, and behavioral economics and neoclassical economics, on the other hand, reflects the similarity of the underlying paradigm shifts in physics and economics. Just as Newtonian mechanics breaks down when we look at the constituent pieces of our universe (subatomic particles), neoclassical economics breaks down when we look at the constituent pieces of our society: individual people. In this way, just as quantum mechanics challenged the nano-foundations for Newtonian mechanics, behavioral economics challenges the nano-foundations for neoclassical economics. And just as quantum mechanics superseded Newtonian mechanics, we might expect that neoclassical economics is headed for the same fate as Newtonian physics.

But which fate is that? If an engineer or a scientist wants to build a state-of-the-art bridge, design a supersonic jet engine, or extract a core sample from under two miles of Antarctic ice, she doesn't use quantum physics. She uses Newtonian physics. She might not even *know* quantum physics, although she probably knows enough quantum physics to know that Newtonian mechanics is more-or-less wrong. How can this be?

The reason is the “Correspondence Principle,” which describes the relationship between quantum mechanics and Newtonian mechanics. The concept is twofold. On the one hand, quantum mechanics has shown us that many of the premises and predictions of classical mechanics are wrong. But on the other hand, while individual particles may behave in ways that defy classical theory, it is also the case that when we aggregate those individual particles up to the scale of human society, classical physics still gets the job done *most* of the time. Newtonian physics builds bridges, but we need quantum physics to have iPhones.¹ The Correspondence Principle reminds us that as a practical matter quantum mechanics and Newtonian mechanics are not competing visions of the universe, but complementary methods of understanding the physical world.

The central claim of this Article is that the analogy between physics and economics can be extended to this concept of correspondence: I argue that an equivalent Correspondence Principle describes the relationship between behavioral (“quantum”) economics and neoclassical (“Newtonian”) economics. The future of law and economics will not be a process of the behavioral replacing the neoclassical. The shift will be more subtle. The question law and economics faces today is about the proper *division of labor* between neoclassical and behavioral approaches. When is law trying to build a bridge? When is law trying to build an iPhone?

Now, the behavioral approach to law and economics is under attack too. The challenge here comes from within the behavioral sciences. In recent years, the social sciences have been rocked by a litany of revelations that prominent, sometimes landmark, empirical findings could not be replicated in later studies. The seminal results appear to have been the product of poor experimental design or random chance. This crisis of credibility has nowhere been more acute than in behavioral psychology, a field that has supplied many of the insights upon which behavioral law and economics has relied.² In his best-selling book on behavioral psychology and economics, *Thinking Fast and Slow*, Daniel Kahneman devoted an entire chapter to “priming effects,”³ citing twelve articles finding that subtle, unconscious primes have dramatic effects on behavior—for example,

1. See *infra* Section I.B.

2. See, e.g., Open Science Collaboration, *Estimating the Reproducibility of Psychological Science*, 349 SCI. MAG. 943, 944 (2015) (attempting to replicate the results of 100 studies published in three top psychology journals and observing successful replication of only 36.1% to 47.4% of results, depending on criteria).

3. DANIEL KAHNEMAN, *THINKING FAST AND SLOW* 1, 50-58 (2011).

exposure to words associated with old age (e.g., Florida, bald, gray, wrinkle) leads people to walk more slowly, and smiling while reading leads people to find cartoons funnier.⁴ These results, striking and numerous, led Kahneman to conclude, “The results are not made up, nor are they statistical flukes. You have no choice but to accept that the major conclusions of these studies are true.”⁵

Yet over the past few years, a series of careful studies have failed to replicate these key findings.⁶ For example, *seventeen* independent labs attempted to replicate the finding that smiling would lead individuals to find comics funnier, and *not one* found evidence of an effect.⁷ A meta-analysis of all twelve of the priming studies cited in *Thinking Fast and Slow* reached the opposite conclusion from the book: “You should not accept any of the conclusions of these studies as true.”⁸ Prominent behavioral researchers, including Kahneman himself, have described this replicability crisis as a “train wreck” and called for reforms to empirical methods in experimental research.⁹

With confidence in decades’ worth of empirical findings in behavioral science shaken, one might ask whether the ascendancy of behavioral economics in law should be reconsidered. No: There are simply too many compelling—and well replicated—findings from behavioral economics for law and economics not to embrace those insights. Instead, we should ask: What is the path forward for behavioral law and economics, a field which established itself by casting doubt on the assumptions of neoclassical economics, but which now faces a healthy dose of skepticism about its own premises?

4. *Id.*

5. *Id.* at 57.

6. See Stéphane Doyen et al., *Behavioral Priming: It’s All in the Mind, but Whose Mind?*, 7 PLOS ONE 1 (2012) (finding no evidence to support the result that exposure to words associated with old age leads people to walk slower).

7. Ulrich Shimmack, Moritz Heene & Kamini Kesavan, *Reconstruction of a Train Wreck: How Priming Research Went off the Rails*, REPLICABILITY-INDEX BLOG (Feb. 2, 2017), <https://replicationindex.wordpress.com/2017/02/02/reconstruction-of-a-train-wreck-how-priming-research-went-of-the-rails/> [<https://perma.cc/8TZR-VARJ>].

8. *Id.*

9. Open E-mail from Daniel Kahneman, *A Proposal to Deal with Questions About Priming Effects* (Sept. 26, 2012 9:32 AM), cited in Ed Yong, *Nobel Laureate Challenges Psychologists to Clean Up Their Act*, NATURE (Oct. 3, 2012), <http://www.nature.com/news/nobel-laureate-challenges-psychologists-to-clean-up-their-act-1.11535> [<https://perma.cc/8ML9-YWAE>]; Shimmack, Heene & Kesavan, *supra* note 7 (“I placed too much faith in underpowered studies.”).

Here, again, the analogy to quantum mechanics becomes useful. To the Correspondence Principle I add two more concepts from quantum physics that suggest useful analogies in economics. I label these concepts the Uncertainty Principle and the Quantum Conjecture.¹⁰

The Uncertainty Principle is the most familiar concept from quantum physics. It reflects the idea that it is impossible to observe a particle without affecting the particle. The analogous concept in social sciences is often called the “observer effect,” and I explore how it plays out in experimental work on the endowment effect and social (other-regarding) preferences—cognitive phenomena of central importance in behavioral law and economics. The Uncertainty Principle for law and economics unpacks the methodological limitations inherent in much existing work upon which behavioral law and economics relies. By doing so, it helps clarify the way to more robust and policy-relevant experimental work. Much of this work is already underway, and I identify examples of key innovations scholars in behavioral law and economics have made.

One of the key moves for behavioral law and economics that I advocate is to connect empirical findings to *theories* of human decision-making. A set of theories that incorporate and make coherent the many results from the laboratory lays the groundwork for *predicting* how behavioral effects will manifest outside the lab—i.e., in the real-world settings relevant to legal policy.

The Quantum Conjecture is my tentative step toward one such theory. In physics, the Quantum Principle says that matter and energy cannot always be subdivided; they exist in discrete, indivisible chunks called *quanta*. This provides a rough but powerful analogy: My Quantum Conjecture for behavioral law and economics is that human attention cannot be perfectly and infinitely divided (as traditional models of economic decision-making assume), but can only be parceled out in discrete chunks. As I will explain, a model of decision-making as rationing a limited number of packets of mental effort out among a multitude of important choices may help unify

10. See *infra* note 15 and accompanying text. As I will note at greater length below as well, analogies between law and physics are not new, although the specific applications I identify and lessons I draw from them are. The one exception is that Tom Ulen alluded to the Correspondence Principle (although not in so many words) some years ago. See Thomas S. Ulen, *Firmly Grounded: Economics in the Future of Law*, 1997 WIS. L. REV. 433, 461-62 (1997). I discuss his brief but incisive take on this idea below. See *infra* note 84 and accompanying text.

various behavioral phenomena that we currently treat as distinct (e.g., the “certainty effect” and “choice overload”) and legal phenomena from diverse areas (e.g., “unfair prejudice” in evidence and the “precautionary principle” in regulation).

The analogy to physics offers one more contribution. By casting law and economics in a different light, the analogy to physics overturns some prevalent misconceptions about law and economics. I have already challenged the notion that behavioral and neoclassical approaches are rivals rather than two faces of the same coin. To this I add that behavioral law and economics, not just neoclassical economics, must face up to the critique that it relies on simplistic and artificial assumptions about human behavior. Finally, I reject the stereotype that neoclassical economics is ideologically right-wing or anti-regulatory and that behavioral economics is ideologically left-wing or pro-regulatory. (Indeed, I will argue that there is a sense in which the reverse is true.)

In short, the contributions of this Article are threefold. First, the analogy to quantum and Newtonian physics, and specifically the Uncertainty and Correspondence Principles, helps to organize and reframe the relationship between behavioral and neoclassical law and economics. Second, the Quantum Conjecture suggests a direction toward more broadly applicable theories in behavioral law and economics. This is a necessary next step for the field to overcome concerns that its mish-mash of empirical findings yields indeterminate behavioral predictions and is therefore not policy-relevant. Third, delving deeper into the analogy reveals further lessons for law and economics—lessons that I hope will disrupt some of the generalizations about the field that we’ve become too comfortable with.

The remainder of the Article proceeds as follows. In Part I, I introduce the three principles from quantum physics that will frame this Article: the Uncertainty Principle, the Correspondence Principle, and the Quantum Principle. In Part II, I sketch central features of neoclassical economics and behavioral economics, focusing on what will be salient in what follows. In each of the next three Parts, I discuss how each of the three principles from quantum physics has an analogue in behavioral economics. Each time, I provide a set of three examples of the principle applied to concrete questions. Each time, I draw two lessons from each principle.

Before I proceed, I must sound a note of caution. I am not a physicist, and I make no claim that I will characterize quantum physics with great accuracy. My goal is not to expound upon

physics, but upon law and economics. For this purpose, only the rudiments of the principles I borrow from quantum mechanics are sufficient.

I. THREE PRINCIPLES FROM QUANTUM MECHANICS

We are familiar from grade school with some of the basic concepts of physics. We learned about force, mass, and acceleration, the distinction between energy and matter, how certain types of energy such as light and sound travel in waves, and how matter is made up of discrete particles known as atoms. These are among the fundamental principles of what might be called classical, or Newtonian, mechanics.

Although Newtonian mechanics has been very successful at describing the interactions of most of the physical systems that we can see in the world, it breaks down when we look at the tiniest constituent pieces of our universe: subatomic particles.

Once we no longer look at matter in the aggregate, but focus on its smallest individual components, the world starts to look quite a bit different from what the classical model would predict. Matter behaves like energy, and energy behaves like matter. Particles behave like waves, and waves behave like particles. (Or perhaps more accurately, particles are waves.¹¹) Two things can be in the same place at the same time, and the same thing can be in two different places at the same time. (Or perhaps more accurately, nothing is anywhere until you look at it, and then it's somewhere.¹²)

One of the great triumphs of modern science has been the development of a theory of quantum physics, a model of the physical world capable of explaining and predicting the behavior of energy and matter at the subatomic scale.¹³ The term “quantum” refers to a

11. See *Wave-Particle Duality*, WIKIPEDIA, https://en.wikipedia.org/wiki/Wave-particle_duality [<https://perma.cc/H45L-4CDB>] (last visited Oct. 1, 2017).

12. See *Wave Function Collapse*, WIKIPEDIA, https://en.wikipedia.org/wiki/Wave_function_collapse [<https://perma.cc/USN2-FBMS>] (last visited Oct. 1, 2017).

13. To quote Wikipedia (no source more esoteric need be consulted for this discussion):

Quantum mechanics (QM; also known as quantum physics or quantum theory), including quantum field theory, is a branch of physics which is the fundamental theory of nature at the small scales and energy levels of atoms and subatomic particles. Classical physics (the physics existing before quantum mechanics) derives from quantum mechanics as an approximation valid only at large (macroscopic) scales. Quantum mechanics differs from classical physics in that: energy, momentum and

very small but discrete quantity of something.¹⁴ As I will explain, this concept is central to the underlying theory in quantum physics and offers insights into behavioral law and economics as well.

Quantum physics is a well-developed and immensely complex set of theories grounded in decades of experimental observations. I have no hope of summarizing, let alone expounding upon, the field. Rather, my object in this Part is simply to identify three basic concepts that have been crucial to the development of quantum physics. I will refer to them as the Uncertainty Principle, the Correspondence Principle, and the Quantum Principle. Each of these three concepts distinguishes quantum mechanics from Newtonian mechanics in a different way. The concepts are non-technical, and I will argue that the intuitions for these concepts translate neatly to the context of law and economics.

A. Uncertainty

Perhaps the best-known term in quantum mechanics is the Heisenberg Uncertainty Principle. So well-known is this principle, in fact, that a number of law review articles have already noted analogies to it in the field of legal studies!¹⁵ But its relevance extends

other quantities are often restricted to discrete values (quantization), objects have characteristics of both particles and waves (i.e. wave-particle duality), and there are limits to the precision with which quantities can be known (uncertainty principle) Important applications of quantum theory include quantum chemistry, superconducting magnets, light-emitting diodes, and the laser, the transistor and semiconductors such as the microprocessor, medical and research imaging such as magnetic resonance imaging and electron microscopy. Explanations for many biological and physical phenomena are rooted in the nature of the chemical bond, most notably the macro-molecule DNA.

Quantum Mechanics, WIKIPEDIA, https://en.wikipedia.org/wiki/Quantum_mechanics [<https://perma.cc/X2PF-B2TL>] (last visited Oct. 1, 2017).

14. *See id.*

15. This has mainly been in the context of constitutional theory, although scholars have drawn very different lessons from the same analogy. *See* Elise Carter, Comment, *The Particulate Constitution: Uncertainty and New Originalism*, 2015 BYU L. REV. 1051, 1070 (analogizing the Constitution to a particle for which the current position and trajectory cannot be perfectly fixed); Roberto L. Corrada, *Justifying a Search for a Unifying Theory of Unconstitutional Conditions*, 72 DENV. U. L. REV. 1011, 1030 (1995) (arguing that constitutional theories must allow for and account for fundamental uncertainty about observed outcomes); Laurence H. Tribe, *The Curvature of Constitutional Space: What Lawyers Can Learn from Modern Physics*, 103 HARV. L. REV. 1, 20-23 (1989) (arguing that just as observing

beyond analogies with “uncertainty” in the law. It also draws a parallel to the limits of what observation through experimentation (in economics) can reveal.

What I focus on here is not, technically, the Heisenberg Uncertainty Principle (although the two are often conflated).¹⁶ The uncertainty principle relevant here is the “observer effect.” The observer effect describes the fact that the mere act of observing the particle affects the particle’s behavior. To identify a particle’s location, you must observe it. But to observe it, you must observe it *with something*. (Visual observation, for example, requires photons.) Thus, the process of observing requires the observer to interact with the observed particle. But by interacting with the particle, we have changed the behavior of the very thing we have attempted to observe. (For example, the interaction between the photons used by the observer and the observed particle will change the momentum of the particle.)

The basic idea here, then, is that the very act of observing a system changes the behavior of the system.

B. Correspondence

Less well known, but perhaps more important for our purposes, is the Correspondence Principle. This principle, simply put, states that quantum theory should generate identical predictions to classical theory when the system being studied is large (relative to the quantum scale).¹⁷

a particle changes its momentum, rendering a legal judgment on the social structure changes the social structure). The indeterminacy implied by uncertainty principles also draws analogies to the jurisprudential indeterminacies identified by legal realists and scholars in the Critical Legal Studies movement. See Elise Porter, Note, *The Player and the Dice: Physics and Critical Legal Theory*, 52 OHIO ST. L.J. 1571, 1571-72 (1991); R. George Wright, *Should the Law Reflect the World?: Lessons for Legal Theory from Quantum Mechanics*, 18 FLA. ST. U. L. REV. 855, 856 (1991).

16. Consistent with (but not because of) the observer effect, the Heisenberg Uncertainty Principle is often described in terms of the impossibility of knowing both the location and momentum of a particle at any given time. See *Correspondence Principle*, WIKIPEDIA, https://en.wikipedia.org/wiki/Correspondence_principle [<https://perma.cc/4SAE-XKG3>] (last visited Oct. 1, 2017).

17. See, e.g., *id.* (“In physics, the correspondence principle states that the behavior of systems described by the theory of quantum mechanics (or by the old quantum theory) reproduces classical physics in the limit of large quantum numbers.”).

Consider the phenomenon of “quantum tunneling.”¹⁸ Quantum physics explicitly rejects the prediction of Newtonian physics that a particle cannot penetrate a barrier that requires more energy to surmount than the particle possesses. Imagine I bounce a basketball against a brick wall. In Newtonian mechanics, the basketball bounces back to me; there is no way that I can impart enough energy to the basketball that the basketball, or even a tiny part of it, could pass through the wall. Yet at the quantum scale, particles always have a probability of passing through such a barrier. In any cluster of particles, some fraction of them will pass through a barrier that Newtonian physics would deem impenetrable. It is as if, when I throw a basketball against a brick wall, a slightly smaller basketball bounces back to me, and a very tiny basketball appears on the far side of the wall and keeps on bouncing away from me.¹⁹

But of course this is not what happens when we throw actual basketballs against actual walls. This is not a refutation of quantum physics. It is merely an affirmation of the fact that the aggregation of countless quantum interactions in the physical world we observe at the human scale results in phenomena that are almost perfectly described by Newtonian physics.

To put it more starkly, the Correspondence Principle means that Newtonian mechanics is fundamentally wrong—its assumptions about the nature of matter and energy simply do not describe the actual makeup of matter and energy—but Newtonian mechanics nonetheless is a remarkably useful approximation of the quantum mechanical reality when we are talking about the everyday world.

Now, this is not to say that quantum mechanics is irrelevant to everyday life—quite the contrary. Virtually every reader of this Article relies on quantum physics throughout the day. The solid-state

18. For excellent illustrations of quantum tunneling and real-world applications of the phenomenon, see *Quantum Tunneling*, WIKIPEDIA, https://en.wikipedia.org/wiki/Quantum_tunneling [<https://perma.cc/5UUR-6HV2>] (last visited Oct. 1, 2017).

19. See *Quantum Tunnelling and the Uncertainty Principle*, PHYSICS OF THE UNIVERSE, http://www.physicsoftheuniverse.com/topics_quantum_uncertainty.html [<https://perma.cc/5RLY-HDXE>] (last visited Oct. 1, 2017) (discussing connections between tunnelling and uncertainty in quantum physics). This phenomenon can be understood as an application of the Heisenberg Uncertainty Principle. Since one can never know with certainty both the location and the momentum of a particle, then if we are sure that the particle does not have enough momentum to penetrate the barrier, then we cannot be sure that the particle is not already on the other side of the barrier. And if we are sure that the particle is not already through the barrier, then we cannot be sure that it lacks sufficient energy to penetrate it. Wild, huh?

memory on which our mobile devices depend—so-called “flash” memory—relies on quantum tunneling to work.²⁰

The point here is twofold: On the one hand, quantum mechanics has shown us that many of the premises and predictions of classical mechanics are wrong. But on the other hand, while individual particles may engage in behaviors that defy classical theory, it is also the case that when we aggregate those individual particles up to the scale of human society, classical physics still gets the job done most of the time—just not all of the time. I do not need to know quantum theory to build a bridge or sharpen a pencil. On the other hand, I do need quantum theory to build a smart phone.

C. Quanta

Third and finally, we have the Quantum Principle. In our ordinary experience, we perceive things like time, space, and energy as flowing smoothly and continuously. Actions and effort, we might also think, can be calibrated smoothly and continuously, like moving a slider or turning a dial, rather than only discretely and discontinuously, like toggling an on/off switch. I can move a little bit faster; I can walk a little bit slower.

But at the subatomic scale, there is a sense in which objects and actions are discrete, not continuous. Mass and energy exist in discrete packets, and in some conditions, a particle’s energy can only increase in certain intervals. An atom can have one electron or two electrons, but it is impossible to have one-and-a-half electrons. Further, an electron in an atom can only have certain amounts of energy. Intermediate energy levels are simply not possible. (Hence, an electron that changes energy levels makes a “quantum leap”—the smallest possible change in energy states.)

It is as if on some surfaces you can walk or run, but it is impossible to jog. This is a Quantum Principle: the principle that certain physical phenomena occur only in discrete quantities or packets, called quanta.

20. See *Flash Memory*, WIKIPEDIA, https://en.wikipedia.org/wiki/Flash_memory [https://perma.cc/XFA9-SFYX] (last visited Oct. 1, 2017).

II. NEOCLASSICAL AND BEHAVIORAL ECONOMICS

In this Part, I briefly introduce neoclassical and behavioral economics before tying them in with the uncertainty, correspondence, and quantum principles.

A. Neoclassical Economics

The methodology of most of the work that has been done in law and economics over the last half-century is neoclassical economics. There is a vast amount that could be said about this field, but I will briefly highlight only two of its most salient concepts, both of which are central to understanding the critique of neoclassical economics by behavioral economists. I will then note a third concept that is more characteristic of neoclassical *law and economics*, not neoclassical economics, and which is perhaps the crux of the assault of behavioral law and economics on neoclassical law and economics.

1. *The Law of Demand*

The single most powerful tool in the economist's toolkit, and the most general and robust of all theoretical predictions in economics, is the Law of Demand. The Law of Demand states that people will consume more of something when its price is lower and less of something when its price is higher. Importantly, "price" is not limited solely to the amount of money something costs, but also the amount of time or energy it takes to realize a goal, or the lost opportunity that one forgoes when choosing to do one thing rather than another.²¹ This notion that human behavior responds to prices in this way allows economists both to understand behavior and to generate useful and consistent predictions about behavior in countless fields of human activity. Application of the Law of Demand to generate models of human behavior is often called "price theory."²² Perhaps the most famous price theorist was Gary Becker,

21. See *Opportunity Cost*, WIKIPEDIA, https://en.wikipedia.org/wiki/Opportunity_cost [<https://perma.cc/7YPQ-QUET>] (last visited Oct. 1, 2017). In other words, "price" is equivalent to "opportunity cost" in this context.

22. See *Price*, WIKIPEDIA, <https://en.wikipedia.org/wiki/Price> [<https://perma.cc/4SHX-LN7Z>] (last visited Oct. 1, 2017). The other main category of neoclassical microeconomic theory is "game theory," which relies on similar assumptions about human decision-making but explores rational, optimizing behavior in strategic settings rather than in contexts of supply and demand. See

for whom the Law of Demand was a unifying principle permitting insight into not just markets, but a wide range of social, legal, and political institutions, including crime, discrimination, fertility, marriage, education, and addiction.²³

Importantly, the Law of Demand is a unifying principle that relates much of the theoretical and empirical work in neoclassical economics. Theoretical work uses the principles of the Law of Demand to develop formal (usually mathematical) models of human behavior that generate predictions about how behavior responds to different incentives. These predictions can then be used to specify empirically testable hypotheses, which subsequent empirical work can then support or refute. To the extent that empirical findings tend to support a model, economists can rely on that model to make predictions of how people and markets will respond to incentives in contexts that have not yet been tested, such as in response to a novel law or policy.

2. *Homo Economicus*

Perhaps the most central, and certainly the most often criticized, characteristic of the neoclassical approach is the assumption that actors behave “rationally.” In formal, mathematical models of behavior, rationality often takes the form of the assumption that actors in the model can calculate with infinitesimal precision and at zero cost the course of action that is optimal given their preferences.²⁴ The actor such models describe is often called,

generally *Game Theory*, WIKIPEDIA, https://en.wikipedia.org/wiki/Game_theory [<https://perma.cc/N8XU-2YND>] (last visited Oct. 1, 2017).

23. See generally GARY S. BECKER, *THE ECONOMICS OF DISCRIMINATION* 10-12 (2d ed. 1971); Gary S. Becker, *A Theory of Marriage: Part I*, 81 J. POL. ECON. 813, 813 (1973); Gary S. Becker, *Crime and Punishment: An Economic Approach*, 76 J. POL. ECON. 169, 170 (1968).

24. Note that this conception of rationality takes as given the individual’s preferences and only asks whether the individual’s behavior is consistently and optimally directed towards those ends. This is the same conception of “rationality” that behavioral economics uses. See Gregory Mitchell, *Why Law and Economics’ Perfect Rationality Should Not Be Traded for Behavioral Law and Economics’ Equal Incompetence*, 91 GEO. L.J. 67, 80 (2002) (“Within behavioral [economics], . . . the rationality concept is one of procedural rationality, or a set of norms for *how* judgments and choices should be made as opposed to a set of norms about what *ends* should be sought.”).

disparagingly, *homo economicus*, in contradistinction from actual human beings: *homo sapiens*.²⁵

The rationality of *homo economicus* is unrealistic, clearly. Indeed, for more than forty years, research in behavioral economics and behavioral psychology has piled up evidence that human beings simply do not behave “rationally” in this sense. But it is important to understand that this conception of rationality has always been something of a straw man.

As a leading figure in behavioral economics, Daniel Kahneman, long ago acknowledged:

No one ever seriously believed that all people have rational beliefs and make rational decisions all the time. The assumption of rationality is generally understood to be an approximation, which is made in the belief (or hope) that departures from rationality are rare when stakes are significant, or that they will disappear under the discipline of the market.²⁶

In other words, adherents to the neoclassical tradition have no illusions that *homo economicus* resembles any human being; rather, they see neoclassical theory as an analytically parsimonious and policy-relevant *approximation* of real-world behavior.²⁷ Neoclassical theory makes this assumption for the convenience of mathematical modeling. It simplifies the math and serves as a rough approximation of a much milder, and more plausible, conception of rationality: A “rational” actor is merely someone who directs her energies toward those things that make her better off and away from those things that make her worse off rather than the other way around.²⁸

25. See, e.g., Robert H. Frank, *If Homo Economicus Could Choose His Own Utility Function, Would He Want One with a Conscience?*, 77 AM. ECON. REV. 593, 593 (1987).

26. Daniel Kahneman, *A Psychological Perspective on Economics*, 93 AM. ECON. REV. 162, 162 (2003). “[B]ehavioral law and economics stresses that conventional law and economics utilizes an empirically false model of behavior—a point already acknowledged within law and economics and championed years ago in regard to positive economics by Milton Friedman, one of the primary methodological influences on law and economics.” Mitchell, *supra* note 24, at 74 (citing Milton Friedman, *The Methodology of Positive Economics*, in *ESSAYS IN POSITIVE ECONOMICS* 3, 3-43 (1953)).

27. Mitchell, *supra* note 24, at 69 (“Proponents of law and economics acknowledge this descriptive inaccuracy but retain the assumption [of perfect rationality] for lack of a better alternative for prediction and policy analysis.”).

28. See, e.g., Gary S. Becker, *Nobel Lecture: The Economic Way of Looking at Behavior*, 101 J. POL. ECON. 385, 386 (1993) (“The analysis assumes that individuals maximize welfare as they conceive it, whether they be selfish altruistic, loyal, spiteful, or masochistic.”).

Nonetheless, there always remains the danger that the use of the stronger version of rationality for the sake of simplifying the math makes the resulting models bad at predicting actual human behavior.²⁹ After all, people may depart from the assumptions of rationality in systematic ways, such that even the milder conception of rationality is not adequate, not even as an approximation. And indeed, much of scholarship in behavioral economics provides evidence of exactly this problem. At least when one looks at individual decision-making, the predictions of neoclassical theory are often simply wrong.

3. *A Normative Commitment to Wealth Maximization?*

There is a second danger that can arise from reliance on stronger assumptions about rationality in positive models of behavior. If used unreflectively, the conception of “rationality” employed as a simplifying device in a model designed to *predict* behavior can be transformed into a normative criterion for *judging* behavior. If such a shift is made without explicit justification,³⁰ the implicit argument looks like this: (1) we have modeled human behavior *as if* people care only about maximizing their own expected money wealth; (2) therefore, in normative and prescriptive analysis, we will declare as “optimal” the policy that maximizes total expected money wealth, because people *actually do* care only about maximizing their own expected money wealth. Obviously, though, conclusion (2) does not follow from the premise (1).³¹

29. See also Christine Jolls, Cass R. Sunstein & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1484 (1998) (“While the assumptions of unbounded rationality, willpower, and self-interest are unrealistic, the force of behavioral economics comes from the difference in its predictions In this sense, our analysis is consistent with the precept originally proposed by Milton Friedman: Economics should not be judged on whether the assumptions are realistic or valid, but rather on the quality of its predictions.”).

30. Russell B. Korobkin & Thomas S. Ulen, *Law and Behavioral Science: Removing the Rationality Assumption from Law and Economics*, 88 CALIF. L. REV. 1051, 1060 (2000) (“Although the use of the assumption that actors behave rationally is pervasive among law-and-economics scholars, the assumption is most often implicit.”).

31. Cf. Russell Korobkin, *What Comes After Victory for Behavioral Law and Economics?*, 2011 U. ILL. L. REV. 1653, 1658 (“In the rational choice world, it was assumed that each individual’s behavior necessarily maximizes his subjective expected utility, given external constraints. This syllogism leads to a close relationship between normative law and economics theory seeking productive and allocational efficiency and a libertarian political philosophy.”).

Now, no serious adherent to neoclassical law and economics ever made this argument, and there may be sensible reasons for making wealth maximization a normative goal in some policy contexts.³² But unlike in economics, where disciplinary norms discourage excessive normativity, law and economics is a field within *law*, which is inherently normative. In the early years of neoclassical law and economics, there was less effort than there is today to sequester *homo economicus* to the realm of positive, rather than normative, models. To many observers throughout the history of the law-and-economics movement, it surely seemed that rational-choice assumptions were not merely empirically problematic, but they had the effect of smuggling ideological commitments (i.e., in favor of wealth creation and against redistribution) into prescriptive models. Whether or not such concerns were entirely justified, there is no question that they generated backlash against neoclassical law and economics and fueled the rise of behavioral economics in law.³³

B. Behavioral Economics

The inauthenticity of the rationality assumption in neoclassical economics has long bothered many economists (and non-economists), and leading economists have long challenged the need for rationality as a simplifying assumption.³⁴ The movement to challenge the rationality assumptions of neoclassical economics took shape beginning in the 1970s with seminal work by, among others, Daniel Kahneman and Amos Tversky, who documented preferences inconsistent with neoclassical assumptions about rationality, such as “loss aversion,”³⁵ and systematic biases in individual decision-

32. For example, one might argue (not without controversy) that legal rules should be designed to maximize wealth, and then taxes and transfers can be used to redistribute wealth to address concerns about equity. This view was defended in Louis Kaplow & Steven Shavell, *Why the Legal System Is Less Efficient than the Income Tax in Redistributing Income*, 23 J. LEGAL STUD. 667, 667 (1994).

33. See, for example, criticisms of neoclassical law and economics’ “thick” conception of rationality in Korobkin & Ulen, *supra* note 30, at 1066.

34. Classic papers calling for economists to incorporate a more nuanced model of human cognition and behavior into economic theory include Albert O. Hirschman, *Against Parsimony: Three Easy Ways of Complicating Some Categories of Economic Discourse*, 74 AM. ECON. REV. 89, 89 (1984), and Amartya K. Sen, *Rational Fools: A Critique of the Behavioral Foundations of Economic Theory*, 6 PHIL. & PUB. AFF. 317, 317 (1977).

35. See generally Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decisions Under Risk*, 47 ECONOMETRICA 263 (1979).

making, such as the “framing effect.”³⁶ Behavioral economics became a major force in law and economics in the late 1990s, heralded by comprehensive critiques of rational-choice law and economics and introductions to behavioral research by Jolls, Sunstein, and Thaler,³⁷ and Korobkin and Ulen.³⁸

Another well-documented behavioral bias is the “anchoring effect.” The anchoring effect has been demonstrated in experiments in which subjects are asked to estimate some numerical quantity after being exposed to an irrelevant number.³⁹ The irrelevant number serves as an “anchor,” drawing the estimates closer to the anchor even though the number is totally uninformative. To make this concrete: Asking people to recite the last two digits of their social security number will affect how much people are willing to pay for a cordless computer keyboard or a box of Belgian chocolates.⁴⁰ Such obvious biases in decision-making are essentially impossible to square with a model of “rational” decision-making.

But no finding in behavioral economics has had a greater impact on law and economics than the “endowment effect,” and if behavioral economics has a mascot, it is without question a souvenir coffee mug emblazoned with the logo of Cornell University. In a famous set of experiments, Kahneman, Knetsch, and Thaler examined whether subjects (undergraduate students at Cornell) who were randomly assigned a coffee mug valued the coffee mug higher than (otherwise identical) students who were not randomly assigned a mug.⁴¹ What they found was a dramatic difference: Students endowed with the mugs valued them twice as much as those not endowed.⁴² In a series of related experiments, they ruled out other

36. See generally, e.g., Amos Tversky & Daniel Kahneman, *Rational Choice and the Framing of Decisions*, 59 J. BUS. S251 (1986).

37. Jolls, Sunstein & Thaler, *supra* note 29, at 1471.

38. Korobkin & Ulen, *supra* note 30, at 1051.

39. For an overview of anchoring theory and a discussion of key findings from the anchoring literature, including in the context of legal decision-making, see Jeffrey J. Rachlinski, Andrew J. Wistrich & Chris Guthrie, *Can Judges Make Reliable Numeric Judgments? Distorted Damages and Skewed Sentences*, 90 IND. L.J. 695, 701-10 (2015).

40. See, e.g., Dan Ariely, George Loewenstein & Drazen Prelec, “Coherent Arbitrariness”: *Stable Demand Curves Without Stable Preferences*, 118 Q.J. ECON. 73, 76 (2003) (finding “the impact of the social security number on stated [willingness to pay] was significant in every product category”).

41. Daniel Kahneman, Jack L. Knetsch & Richard H. Thaler, *Experimental Tests of the Endowment Effect and the Coase Theorem*, 98 J. POL. ECON. 1325, 1325 (1990).

42. *Id.* at 1332-33.

potential causes of the observed difference, such as difficulty understanding or following instructions,⁴³ strategic misrepresentation of values,⁴⁴ income effects,⁴⁵ or perception of the mug as a “prize.”⁴⁶ These experiments have been replicated countless times in many different contexts.⁴⁷ This is the endowment effect: Endow a person with something, and the mere fact of possession makes it more valuable to him than when he did not possess it.

Results such as these have undermined the assumptions of neoclassical economics, and behavioral economics has been immensely influential in the legal academy, in public discourse, and in policy.⁴⁸ Indeed, behavioral law and economics has become probably the dominant policy agenda in both the academy and in many government circles today. Most influential may be “soft paternalism,”⁴⁹ or “libertarian paternalism,”⁵⁰ which emphasizes behavioral “nudges” that preserve individual choice while constructing a “choice architecture” that favors welfare-enhancing decisions.

Now, what I have offered so far is a series of individual findings in behavioral economics, not the big picture for the field. What exactly is “behavioral economics”? Is it nothing more than a collection of empirical results? (Maybe; I will return to this concern shortly.) Here, I will simply highlight a few points of comparison

43. *Id.* at 1329-36.

44. *Id.* at 1336-38.

45. *Id.* at 1338-42. An “income effect” is a change in a person’s valuation of an object due to a change in a person’s wealth. Intuitively, a wealthier person may have greater *willingness* to pay more for something because she has greater *ability* to pay. *Id.* at 1339-41. Income effects are predicted by standard neoclassical theory, and thus a test for the endowment effect would need to rule out income effects as an explanation. *Id.*

46. *Id.* at 1342.

47. For a review of the literature on the endowment effect, see Charles R. Plott & Kathryn Zeiler, *Exchange Asymmetries Incorrectly Interpreted as Evidence of Endowment Effect Theory and Prospect Theory?*, 97 AM. ECON. REV. 1449, 1452-54 (2007).

48. See Ryan Bubb & Richard H. Pildes, *How Behavioral Economics Trims Its Sails and Why*, 127 HARV. L. REV. 1595, 1595-96 (2014) (“Regulatory policies in the United States are already being informed by BLE [(behavioral law and economics)].”).

49. *Id.* at 1604-05.

50. Cass R. Sunstein & Richard H. Thaler, *Libertarian Paternalism Is Not an Oxymoron*, 70 U. CHI. L. REV. 1159, 1162 (2003).

with neoclassical economics.⁵¹ Behavioral economics and neoclassical economics both study human behavior, and they both examine the role of incentives in human interactions. But there are at least three main points of divergence.

First, behavioral economics takes as its starting point a fundamentally empirical rather than theoretical approach. Drawing on the methodologies and insights of psychology and other fields, behavioral economists have conducted a wide range of experimental studies, usually laboratory experiments, testing whether subjects' behavior conforms to the predictions of neoclassical economics.

Second, while neoclassical economics attempts to identify equilibria in markets, firms, and other institutions, most experimental work in behavioral economics focuses on the decision-making behavior of individuals. As Jeff Rachlinski has observed, this makes "behavioral economics" something of a misnomer. Economics is concerned with understanding the behavior of people in the aggregate—markets, corporations, governments, even social networks—but not individuals. The study of individual cognition and decision-making is the work of psychologists.⁵²

Third, and most obviously, these experimental studies of individual behavior do *not* assume rationality! I have already given several examples of research reporting deviations from what one might expect a purely rational actor to do. There are countless others; I'll describe two more (the contrast effect and the certainty effect) later.

Of course, these various effects are not predicted by standard, rational-actor models of neoclassical economics. And so now we see the sense in which behavioral economics is *quantum* economics. Just as Newtonian mechanics breaks down when we look at the constituent pieces of our universe, neoclassical economics breaks down when we look at the constituent pieces of our society: individual people. And just as quantum mechanics challenged the nano-foundations for Newtonian mechanics, behavioral economics challenges the nano-foundations for neoclassical economics.

51. The field of behavioral economics is too vast to summarize here, and I make no attempt. See generally Stephano DellaVigna, *Psychology and Economics: Evidence from the Field*, 47 J. ECON. LITERATURE 315 (2009).

52. Jeffrey J. Rachlinski, *The Psychological Foundations of Behavioral Law and Economics*, 2011 U. ILL. L. REV. 1675, 1675.

And that is not the end of the analogy. In my view, some of the same principles that motivate and organize quantum mechanics can help us understand quantum *economics* as well.

III. AN UNCERTAINTY PRINCIPLE FOR BEHAVIORAL LAW AND ECONOMICS

Laboratory experiments, by their very design, create an artificial environment. This artificiality is desirable because the whole point of the laboratory experiment is to isolate a particular aspect of human behavior so as to study it while holding all else constant. But precisely because lab experiments examine human behavior in an artificial setting, we should be alert to the possibility that the very act of observing subjects will lead them to change their behavior. There are many potential reasons for this: subjects may attempt to conform their behavior to the experimenter's expectations; subjects may feel self-conscious, knowing they are being observed; and so on.

This phenomenon is well understood in behavioral social science and goes by various names in the literature in behavioral economics: observer effect,⁵³ Hawthorne effect,⁵⁴ or demand effect.⁵⁵ In the spirit of the analogy to quantum physics, I will refer to this as the Uncertainty Principle for quantum economics. Although this principle is often acknowledged, its implications for the relationship between behavioral and neoclassical economics, and for the future of law and economics, are not as well recognized. In this Part, I provide examples of important experiments that reveal the profound effect of

53. See, e.g., Timothy N. Cason & Charles R. Plott, *Misconceptions and Game Form Recognition: Challenges to Theories of Revealed Preference and Framing*, 122 J. POL. ECON. 1235, 1241 (2014) (defining the "classical observer effect" as "what is to be measured is influenced by the attempt to measure it").

54. See Steven D. Levitt & John A. List, *Was There Really a Hawthorne Effect at the Hawthorne Plant? An Analysis of the Original Illumination Experiments*, 3 AM. ECON. J.: APPLIED ECON. 224, 227-28 (2011) (describing the various meanings of the Hawthorne effect and the setup of the original experiment).

55. See, e.g., Charles R. Plott & Kathryn Zeiler, *The Willingness to Pay—Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions, and Experimental Procedures for Eliciting Valuations*, 95 AM. ECON. REV. 530, 543 (2005). I doubt that I am the first to connect the dots between uncertainty principles in quantum physics and observer effects in experimental psychology or economics, although none of the articles connecting quantum physics to law cited above do so. See *supra* note 15 and accompanying text.

the Uncertainty Principle in experimental research and then draw out two key lessons for behavioral law and economics.

A. Three Examples

1. *The Endowment Effect, Revisited*

As noted above, a large and impressive literature has reported countless studies documenting the endowment effect in carefully designed experiments.⁵⁶ But rigorously demonstrating the endowment effect is no small feat; the mere fact that individuals would need to be paid more to sell an item (“willingness to accept” or WTA) than they would be prepared to pay to buy the item (“willingness to pay” or WTP) does not prove the presence of an endowment effect.⁵⁷ There are countless other potential explanations that, unless ruled out, would confound any effort to attribute a gap between WTP and WTA to the endowment effect.⁵⁸

For example, the fact that the experimenter hands the mug to the subject may *signal* to the subject that the mug is valuable; the subject upgrades her assessment of the mug’s value based on an inference that the mug is valuable, given that the experimenter made a deliberate decision to give her the mug (rather than something else).⁵⁹ Thus, a subject who is given a mug and asked to sell it will give it a higher dollar value than a subject not given a mug. This pattern would be predicted by standard neoclassical theory, based on an individual’s rational updating of beliefs about a product’s value based on actions taken by others.

Another closely related possibility is that attitudes about *gifts and other-regarding preferences* may make subjects less willing to sell the mugs given to them.⁶⁰ After all, many people would consider it rude or ungrateful to sell a gift immediately after receiving it—and to do so in front of the gift-giver! Yet many experiments testing for an endowment effect involve the experimenter handing a mug to a subject with the words such as “I am giving this mug to you,” which implies a gift. Then, inquiries about willingness to part with the mug are made in the presence of the *same* experimenter. Thus, the reluctance of mug-owners to part with their mugs may be a function

56. See *supra* notes 33-39 and accompanying text.

57. See Plott & Zeiler, *supra* note 55, at 531.

58. See *id.* at 531-32; Plott & Zeiler, *supra* note 47, at 1450.

59. See Plott & Zeiler, *supra* note 47, at 1455.

60. *Id.* at 1454.

of social pressures rather than a change in the subject's valuation of the mug due to being endowed with it.

Unlike the signaling story, however, this story about other-regarding preferences is inconsistent with the narrow conception of self-interested preferences traditionally employed in neoclassical models. Thus, if other-regarding preferences explains the results of the endowment effect studies, this is still a "behavioral" result—but one based on a *different* behavioral phenomenon.

In a series of meticulously constructed experiments, Charles Plott and Kathryn Zeiler replicated the iconic mug studies but refined their experimental design to rule out the effects of signaling, other-regarding preferences, and other possible confounds.⁶¹ To rule out signaling, they added a statement in the instructions to subjects that the experimenter chose to give a mug (rather than something else) based on a coin flip.⁶² To rule out the effect of the mug being perceived as a gift, they removed any references to "giving" or "gift" when distributing the mugs, instead saying to the group of subjects, "These mugs are yours."⁶³ In a series of experiments in which the effects of signaling and other-regarding preferences were eliminated, evidence of an "endowment effect" disappeared.⁶⁴

More generally, Plott and Zeiler show that tweaking instructions to subjects is enough to make the experimental results for the endowment effect go away.⁶⁵ And realistic conditions, such as opportunities for learning and instruction or experience with a type of transaction, also eliminate the experimentally observed endowment effect.⁶⁶ As they put it, "Either no 'endowment effect' of

61. *Id.* at 1450. Plott and Zeiler also account for the possibilities that subjects' decisions are affected by observing other subjects' decisions, that subjects were affected by the physical proximity of the mugs at the time their willingness to trade was elicited, or that trading away their mugs required more effort than retaining them. *See id.* at 1450, 1455, 1460-63. These other potential confounds, however, did not seem to be driving the results. *Id.* at 1458, 1460-61.

62. *Id.* at 1454-55.

63. *Id.* at 1454, 1459.

64. *Id.* at 1458, 1463.

65. *Id.* at 1463.

66. John A. List, *Does Market Experience Eliminate Market Anomalies?*, 118 Q.J. ECON. 41, 70 (2003) [hereinafter *Market Anomalies*]; John A. List, *Neoclassical Theory Versus Prospect Theory: Evidence from the Marketplace*, 72 ECONOMETRICA 615, 624 (2004) [hereinafter *Neoclassical Theory*]; Plott & Zeiler, *supra* note 55, at 543-44.

the sort predicted by prospect theory exists or the effect is sufficiently weak that other phenomena easily swamp it.”⁶⁷

2. *Social Preferences and Observer Effects*

A frequent finding in the behavioral literature is that people have social preferences—in other words, a desire to treat other people fairly in a way that is inconsistent with the assumption of narrow self-interest that is usually made in neoclassical models.⁶⁸ It is, of course, unquestionable that people indeed have such preferences. But to the extent that such preferences are a challenge to neoclassical theory, it is because neoclassical theory predicts that buyers and sellers *in markets* will be driven by private gain, not social preferences, in their dealing. For example, neoclassical theory might predict that sellers in a market will care about their reputations among consumers, but only to the extent that reputation helps them earn profits—not out of any non-instrumental desire to treat consumers with fairness.

Do the findings of behavioral economics refute this prediction of neoclassical economics? The answer is not obvious. Laboratory experiments repeatedly find that subjects are willing to incur a cost to treat others fairly, but does this translate to the market? Or is this an artifact of the fact that the subjects (usually college students) know they are being closely observed by the experimenter (usually the students’ own professors)?

John List set out to test these questions with a series of ingenious experiments.⁶⁹ His study used as subjects not college students but professional memorabilia dealers—people who make a living buying and selling collectibles such as baseball cards—and conducted laboratory experiments where they would be offered a payment (say \$20) by a buyer and asked for a baseball card of commensurate value.⁷⁰ What he found in the laboratory setting was

67. Plott & Zeiler, *supra* note 47, at 1463.

68. John A. List, *The Behavioralist Meets the Market: Measuring Social Preferences and Reputation Effects in Actual Transactions*, 114 J. POL. ECON. 1, 2 (2006).

69. *Id.* at 3.

70. *Id.* Although secondary to his experimental objective, it is worth noting that by constructing a laboratory experiment where subjects undertook activities with which they were very familiar, List eliminated one of the major concerns with experimental work, which is that the subjects are confused by an unfamiliar set of demands placed upon them.

that baseball card dealers would select baseball cards of equal value to the amount of money offered them by a buyer in the experiment, *even when the dealer could have gotten away with selling a baseball card of lesser value.*⁷¹ (This was possible because many lower-value baseball cards are indistinguishable to the untrained eye from a baseball card in better condition.) This result confirmed the frequent finding in the experimental literature that people's preference for fairness trumps the prediction of neoclassical models that self-interest will lead the dealer to substitute the similar-but-lower-value card in order to make a greater profit.

List then repeated the experiment not in the laboratory but in the field. He went to a real-world baseball card convention, and he had confederates posing as baseball card collectors approach dealers and offer them money for baseball cards. (Thus, the dealers did not know they were subjects in an experiment.) These confederates then returned and had their cards examined by experts in order to see whether the dealers had given them cards of equal value to the money offered, or if the dealers had substituted cards of lesser value that would be indistinguishable to untrained eyes.⁷² The effect of social preferences that was detected in the laboratory was only sometimes present in the real-world setting: Consistent with a neoclassical model in which only reputation (rather than reciprocity or fairness) constrains sellers, local sellers (i.e., sellers who were more likely to see the same buyer again) would offer a higher-quality card in response to a higher dollar offer—but nonlocal dealers (who would never see the buyer again and therefore had no repeat-play incentives) did *not*.⁷³

3. Altruism and Stakes

Another concern with many results from laboratory experiments, including experiments on the endowment effect and social preferences, is that the stakes of the experiments are too low to induce subjects to behave in the way they would in real-world settings. In a recent article by Tess Wilkinson-Ryan, she examines experimental subjects' willingness to breach a contract in order to make more money.⁷⁴ The experiment tests the neoclassical prediction

71. *Id.* at 4.

72. *Id.*

73. *Id.* at 4, 22-24.

74. Tess Wilkinson-Ryan, *Incentives for Breach*, 17 AM. L. & ECON. REV. 290, 291 (2015).

of “efficient breach,” in which a party deliberately breaches a contract because it is more profitable to break one’s promise than to comply with one’s contractual obligations. And it entertains the competing hypothesis that moral considerations lead people to keep their promises even when neoclassical theory says it is inefficient to keep a promise.⁷⁵

Most of the subjects in the experiment did not breach their contracts even when it was in their financial self-interest to do so, at least when stakes were low. But for a profit of a mere \$12, the majority of subjects would breach the contract, and when the payoff from breaking one’s promise reached \$24, over 72% of subjects broke their promises.⁷⁶ Most revealing was one of the reasons given by a subject for not breaching the contract: “Betrayal, for the most part, was not worth 4–15 extra dollars.”⁷⁷

In other words, while it is surely true that moral considerations lead people to keep promises that they would otherwise benefit from breaking, what we find is a result that looks less like social or moral preferences, and more like *homo economicus* and the Law of Demand: People respond in predictable ways to changes in prices, even the price of a broken promise. For the experimental subjects, it might not be worth four dollars, or even fifteen dollars, but *twenty-four dollars to commit betrayal?* Sure!

B. Two Lessons

In short, the take-away from studies such as those by Plott and Zeiler, List, and Wilkinson-Ryan is that showing that a behavioral phenomenon occurs under (some) laboratory conditions can prove that a phenomenon exists, but it is something else entirely to show that: (1) the phenomenon is sufficiently big that it will not be swamped by other factors outside the pristine setting of the laboratory; and (2) the phenomenon persists in real-world settings, where things like experience, learning, and competition may serve to compensate for or correct behavioral biases.

Does this mean we should disregard results from laboratory experiments? Of course not. Rather, these studies counsel us to be mindful that observer effects are a serious concern in laboratory settings in the social sciences precisely because human subjects are

75. *Id.* at 291-93.

76. *Id.* at 300 fig.1.

77. *Id.* at 307.

cognizant of the experimental setting and influenced by the social context in which they behave.⁷⁸ In the jargon of economics, laboratory experiments often have limited *external validity*, meaning that their results cannot necessarily be extrapolated to contexts different from the experimental setting in which the results were observed.

To be more precise, the Uncertainty Principle offers two lessons for behavioral economics. First, it inverts the critique often levied by behavioral economists that neoclassical economics relies upon “unrealistic” assumptions. The same gimlet eye cast upon neoclassical analysis can be directed toward behavioral analysis; both fields benefit from greater skepticism. Second, it identifies the directions future empirical work in law and economics should take. The “lab” will always be essential for identifying behavioral phenomena, but it is only in the “field” that policy-relevant empirical regularities can be measured.

1. Lesson: *Physician, Heal Thyself!*

The perfect-rationality assumption in many neoclassical models has long been pilloried as unrealistic, which it surely is. The concern is that findings based on *artificially constructed and deliberately simplified* theoretical models may be unreliable guides for policy in the real world. Scholars and policymakers who have long been uneasy with the formality and reductionism of neoclassical theory have enthusiastically embraced this trenchant critique of rational-actor models by behavioral economists.

But laboratory experiments have been the basis for the scholarly claims and policy prescriptions made by most behavioral economists, and the concern *here* is that empirical results based on *artificially constructed and deliberately simplified* empirical models may be unreliable guides for policy in the real world. The fear here is the “train wreck” noted in the introduction—a series of results, each an artifact of peculiar experimental conditions, becoming conventional wisdom.

To be clear, this is not a defense of jumping to policy prescriptions based on simplistic neoclassical models. Instead, I am arguing for an equal dose of caution for scholars in law and

78. See generally, e.g., Steven D. Levitt & John A. List, *What Do Laboratory Experiments Measuring Social Preferences Reveal About the Real World?*, 21 J. ECON. PERSP. 153 (2007).

economics who are tempted to jump to policy prescriptions based on simplistic behavioral experiments. Behavioral law and economics, in other words, would benefit from heeding its own advice.

2. Lesson: Bring Law and Economics Research into the Field

How, then, to make behavioral law and economics (and, for that matter, neoclassical law and economics) sufficiently robust in its findings to justify policy? The answer is to run experiments outside the lab with an eye toward identifying whether behavioral phenomena manifest themselves as empirical regularities in settings that are directly relevant to the legal or policy question at stake and where the artificiality of the lab is reduced.⁷⁹ To be sure, this lesson is not lost on practitioners of behavioral economics. Indeed, the greatest achievements in behavioral economics over the past generation have been replications in the field (under realistic conditions and high stakes) of numerous seminal results from the laboratory.⁸⁰

Experimental work in the laboratory, too, must continue. It has important advantages that make it a necessary part of any serious research agenda on behavior. Lab experiments and field studies simply have different strengths.⁸¹ Field studies, precisely because they involve more realistic conditions, are superior for predicting the direction and magnitudes of potential policy changes.⁸² Thus, a legal intervention intended to correct for a behavioral bias should (ideally) be supported by evidence from field studies indicating that the intervention will have the desired effect.

Lab experiments cannot provide equivalent value for this task. Yet without laboratory experiments, how does one identify whether a bias exists in the first place, given the presence of many confounding

79. See Mitchell, *supra* note 24, at 75 (2002) (noting that for behavioral law and economics to have predictive power, it must accumulate “reliable data regarding . . . the resistance of nonrational behavior to incentives and debiasing mechanisms that may be available through legal and economic systems”).

80. See, e.g., Kahneman, *supra* note 26, at 162 (“The clearest progress has occurred in correcting and elaborating the assumption of selfishness Experiments conducted in low-income countries by investigators armed with dollars confirmed conclusively that quite a few people will forgo a substantial sum for the sole benefit of denying a larger sum to an anonymous stranger who has treated them ungenerously.”).

81. Plott & Zeiler, *supra* note 47, at 1450-51, 1450 n.3.

82. *Id.* at 1450 n.3 (referring to field studies as “parameter estimation”).

factors in real-world settings?⁸³ The laboratory is the only setting where the researcher can control nearly all of the potentially confounding factors. It is no accident, therefore, that the seminal studies supporting prospect theory and identifying behavioral biases have been lab experiments.

The next Part provides examples of how laboratory experiments, field experiments, and observational (i.e., non-experimental) data from the field have yielded refinements to our understanding of the endowment effect and other behavioral phenomena in policy-relevant contexts.

IV. A CORRESPONDENCE PRINCIPLE FOR BEHAVIORAL LAW AND ECONOMICS

In the realm of physics, the Correspondence Principle tells us that Newtonian mechanics is basically wrong, but that it is a pretty good approximation at the scale of human society most, but not all, of the time. The analogous principle in behavioral economics is that neoclassical economics is basically wrong, but that it is a pretty good approximation at the scale of human society most, but not all, of the time.

This presents a crucial question for behavioral law and economics: What happens when you aggregate from the level of individuals up to the level of firms, markets, and other social institutions? Cognitive biases that affect individuals might remain significant at the aggregate level, but they might not. Tom Ulen has made this exact point (albeit without further elaboration):

As a theory of human decision-making, rational choice theory may be analogous to classical Newtonian mechanics: it describes and predicts much of routine human decision-making. For instance, all the consumers in a particular market—e.g., all the consumers of bicycles—when taken together, behave in the fashion that the theory predicts, even if some of them behave irrationally.⁸⁴

Consider the following: In a marketplace, businesses that behave rationally will do better than businesses that do not. Six decades ago, Gary Becker made precisely this argument. If market participants make decisions based on biases, they will not be able to

83. *Id.* (referring to lab experiments as “theory testing”).

84. Ulen, *supra* note 10, 462; *see also* Porter, *supra* note 15, at 1593 (1991) (referring to the principle of “scale,” which is equivalent to what I describe as “correspondence”).

make as much money as market participants who methodically and rationally calculate the profit-maximizing course of action.⁸⁵

Does this mean that markets will eliminate all cognitive biases? No. Another study by John List is helpful here. In this study, List reran a version of the iconic “mug” experiments to test for the endowment effect among individuals at a collectibles convention, thereby studying the endowment effect among a group of subjects with varying experience in both holding onto and trading away collectibles such as baseball cards.⁸⁶ The subjects were a mix of consumers who were merely attending the trade show and professional dealers who tended booths where they bought and sold collectibles.⁸⁷ What List found was striking: Consumers with relatively little trading experience in collectibles exhibited a strong endowment effect, while consumers with “intense” trading experience, as well as professional dealers, had no endowment effect at all—their behavior was perfectly predicted by neoclassical theory.⁸⁸ And that is the rub: The endowment effect *does matter* in real-world, market settings—but only *in some circumstances*. Relying solely on “neoclassical” results will lead academics and policymakers astray; but so will reliance solely on “behavioral” results.

In this Part, I describe three examples of important research that shows the limit of quantum economics when applied at the “Newtonian scale,” i.e., longer time periods and interacting groups of individuals, rather than test subjects acting in isolation. What we find is that sometimes quantum effects disappear at the Newtonian scale—but sometimes they do not. And because law operates at varying scales, regulating individuals, markets, institutions, and so on, sometimes behavioral effects will dominate, and sometimes neoclassical effects will dominate. One doesn’t need quantum mechanics to build a bridge, but one does need quantum mechanics to build a smart phone. Similarly, the challenge for law and economics is determining when behavioral findings remain

85. See GARY S. BECKER, *THE ECONOMICS OF DISCRIMINATION* 16 (2d ed. 1971).

86. See List, *Neoclassical Theory*, *supra* note 66, at 617.

87. *Id.* at 617-18.

88. *Id.* at 621-22; see List, *Market Anomalies*, *supra* note 66, at 70-71 (finding the same pattern in an earlier field experiment in which he endows subjects with different memorabilia, such as baseball cards or collectible pins).

important at policy-relevant scales.⁸⁹ The three examples below lead us to two lessons for addressing this challenge.

A. Three Examples

1. *Quantum Economics at Newtonian Time Scales*

In addition to the shift from isolated individuals to aggregates of individuals in market settings, another sense in which “scale” matters is temporal scale. Imagine workers engaged in collective bargaining with an employer over the structure of their wage contract in a setting where each worker individually produces output (i.e., a “piece rate” contract). An example of this is tea-plucking, where workers on a tea plantation collect tea leaves and are paid a baseline wage plus a piece rate per kilogram of tea leaves collected.⁹⁰

Standard price theory would predict that a wage structure with a lower base wage but a higher piece rate would lead to higher productivity than a wage structure that pays a higher base wage but a lower piece rate. This is because workers receive the baseline wage regardless of effort, but the piece rate only with effort. A relatively high piece rate, therefore, incentivizes high effort.

One can easily anticipate the “behavioral” rejoinder: A higher base wage and lower piece rate signals trust in the worker, reduces stress and anxiety, and triggers norms of reciprocity that could increase productivity, contrary to the neoclassical prediction. Thus, the behavioral prediction based on social and moral preferences for trust and reciprocity would be that a higher base rate and lower piece rate would lead to higher productivity.

A recent paper by Jayaraman, Ray, and de Véricourt tested exactly these hypotheses in a real-world setting. Workers on a tea plantation in India experienced a switch from a high piece rate (with a low base wage) to a high base wage (with a low piece rate).⁹¹ What

89. Rachlinski, *supra* note 52, at 1689-90 (“Institutional settings can reduce errors in judgment, and this concern is a more serious criticism [of existing work in psychology upon which behavioral law and economics relies]. Psychologists rarely study institutional settings even though most choices are made within an institutional framework. . . . [But] [d]ecisions by consumers, judges, and juries are not necessarily made with the kind of institutional framework that can improve judgment. The role of incentives and institutions is thus important but only deepens the project of BLE, it does not undermine it.”).

90. See Rajshri Jayaraman, Debraj Ray & Francis de Véricourt, *Anatomy of a Contract Change*, 106 AM. ECON. REV. 316, 316 (2016).

91. See *id.*

they found was that in the first month following the change, there was an enormous surge in productivity—maybe a 40% increase relative to a comparison plantation without the change.⁹² This was clearly inconsistent with neoclassical theory and consistent with a behavioral explanation.

But the increased productivity did not last. Three months later, the productivity of workers had regressed to the level predicted by price theory. Concepts such as trust or reciprocity had no explanatory power.⁹³

So which is right: quantum or Newtonian economics? The answer is, roughly, “both”; but *scale* matters—in this case, the time scale. Price effects cannot explain the observed effects of the change in the first month of the new contract. The emotional or psychological effect of a higher base wage mattered, at least in the short term. But over time, the cold, relentless logic of the Law of Demand sufficed to explain the behavior of the workers.

Does this mean that behavioral economics is irrelevant in longer time scales? Certainly not! Indeed, an important finding of behavioral economics is that people’s perceptions and preferences adapt over time to a new status quo.⁹⁴ More to the point, though, is that the application of behavioral versus neoclassical methods depends on the policy-relevant question: Do we care about the effect of the wage-contract intervention in the short term (about one month) or the long term (four months or more)? If it is the latter, the simplest and most reliable model for predicting the impact of the policy is neoclassical.

Field experiments in the United States have yielded similar results, albeit over much shorter time scales. Uri Gneezy and John List recruited subjects for (real) work doing data entry or door-to-door fundraising for six hours.⁹⁵ Although the jobs were advertised as paying \$12/hour (data entry) or \$10/hour (fundraising), participants in the “gift” treatment group were told they would be paid \$20/hour

92. *Id.* at 323-25.

93. *Id.* at 339-40, 350.

94. For a discussion of literature in this area and an application to law, see generally John Bronsteen, Christopher Buccafusco & Jonathan Masur, *Happiness and Punishment*, 76 U. CHI. L. REV. 1037, 1039-55 (2009).

95. Uri Gneezy & John A. List, *Putting Behavioral Economics to Work: Testing for Gift Exchange in Labor Markets Using Field Experiments*, 74 ECONOMETRICA 1365, 1367 (2006).

(and in fact they were).⁹⁶ Just as in the tea plantation study, if reciprocity is an important determinant of behavior, one might predict that workers receiving the “gift” treatment would be more productive.

And so they were—up to a point. Over the first three hours, the gift-wage group was significantly more productive than the regular-wage group. But by the second half of the working period, the productivity of the gift-wage group was indistinguishable from the productivity of the regular-wage group.⁹⁷ Further, from the employer’s perspective the experiment “backfired”; the increase in productivity was far less than the increase in wages paid. More work would have been completed, at lower total cost, if more people were hired, all at \$10 or \$12 per hour.⁹⁸

In these studies, the reversion from a “behavioral” response to a “neoclassical” response itself might have been predicted based on results from behavioral economics. The authors note different “psychological processes in the short run and in the long run . . . *hot* versus *cold* decision making,” as they label it.⁹⁹ But if you are a business trying to make money in data entry or fundraising, which hypothesis—the behavioral or the neoclassical—will help you make money? This is the Correspondence Principle in action: Quantum economics is “right,” and Newtonian economics is “wrong,” but at larger scales, Newtonian economics will often be the better tool for analysis.

2. *Intermediaries and the Endowment Effect*

Another way that real-world market settings can differ from experiments involving isolated subjects is that in the real world, biased individuals have the benefit of others who might be in a position to improve their decision-making. “Two heads are better than one,” as the old saying goes, and perhaps two heads are more “rational” than one, as well. More precisely, in market settings we often make transactions, especially major transactions such as buying a home or starting a business, with the aid of experienced intermediaries, such as lawyers.

96. *Id.* The treatment and control groups in each experiment were isolated from each other to avoid the subjects knowing the existence of another group being paid a different wage. *Id.* at 1370.

97. *Id.* at 1370.

98. *Id.* at 1378.

99. *Id.* at 1366.

A recent paper by Jennifer Arlen and Stephan Tontrup explores the role of intermediaries on the endowment effect.¹⁰⁰ The study is a laboratory experiment, very much in the spirit of countless other laboratory experiments on the endowment effect. The subjects of this experiment were each given a lottery ticket. The lottery ticket had a payoff that depended on the flip of a coin. Some tickets would win if the coin came up heads, and others won if the coin came up tails. A winning ticket would give the students eight euros, while a losing ticket would pay nothing.¹⁰¹

After each subject was given a ticket and he or she had a chance to see whether the ticket would win with heads or win with tails, each subject had the chance to trade his or her ticket for a ticket of the opposite type. A ticket that won with heads could be exchanged for a ticket that won with tails, and vice versa. If a subject made such a trade, she would get paid a twenty-five euro-cent bonus regardless of whether or not the ticket won.¹⁰²

Given that heads and tails have exactly equal probabilities of winning, conventional neoclassical theory predicts that most or all subjects will trade their tickets. After all, making an exchange is like getting twenty-five cents for free. But the behavioral prediction would be that most subjects would not exchange their tickets because of the endowment effect.

What Arlen and Tontrup found was a dramatic confirmation of the endowment effect. Over 70% of the subjects did not trade. In other words, over 70% of subjects chose to forgo the opportunity for *free money* after being endowed with a lottery ticket.¹⁰³

Then they ran a second experiment. This one had a twist. It used the same set of lottery tickets, and the bonus for trading one's ticket remained the same as well. But this time, the decision whether or not to exchange the ticket would not be made by the subject herself but instead by her agent. Each subject had an agent, designated by the experimenter, who was simply another student participating in the experiment. The agent would not share in any of the payments to the subject but instead would get paid separately. The agent's payment was based on an incentive scheme chosen by the subjects: Each subject would choose whether the agent would

100. See Jennifer Arlen & Stephan Tontrup, *Does the Endowment Effect Justify Legal Intervention? The Debiasing Effect of Institutions*, 44 J. LEGAL STUD. 143, 144-45 (2015).

101. *Id.* at 148. Eight euros was worth about \$11 at the time. *Id.*

102. *Id.*

103. *Id.* at 154.

receive the incentive payment only if the agent traded the ticket, or only if the agent did not trade the ticket.¹⁰⁴

Now, given that in the first experiment over 70% of the subjects refused to exchange their tickets, one would expect that 70% of the subjects would give their agents an incentive *not* to trade. But Arlen and Tontrup found the opposite. Over 75% of the subjects gave their agent an incentive to trade.¹⁰⁵ It is as if the mere act of shifting responsibility for the final decision from the subject to the agent led the subjects in this experiment to behave in ways much more consistent with neoclassical theory than those same subjects would have behaved if they had to make the decisions themselves.

Thus, we see that the endowment effect can be largely eliminated by the introduction of an agent who makes the decision on behalf of the subject. Importantly, this is so even though the agent's instructions for what to do (i.e., the incentive scheme) were given *by the subject herself*. This experiment adds a little realism to the literature on the endowment effect—after all, for many of the major transactions we undertake in our lives we retain agents—and in so doing it reveals the fragility of the behavioral prediction of an endowment effect.¹⁰⁶ Increase the “scale” of the transaction from one person to two and the effect nearly disappears.

3. Judges and the Contrast Effect

So far, I have described examples where behavioral effects disappear in the context of real-world institutions (transaction intermediaries) or long time scales (hours or months). But behavioral effects don't always go away at the scale of real-life institutions over long time periods. A recent paper makes this point in a setting where the stakes could not be higher: real-world criminal sentencing.

Many studies in the laboratory setting have found behavioral biases at work in decision-making intended to mimic judicial decision-making¹⁰⁷ or jury decision-making.¹⁰⁸ If these studies have

104. *Id.* at 152.

105. *Id.* at 155.

106. See also Linda Babcock, George Loewenstein & Samuel Issacharoff, *Creating Convergence: Debiasing Biased Litigants*, 22 L. & SOC. INQUIRY 913, 922 (1997) (noting that lawyers can debias litigants to achieve mutually beneficial bargains).

107. Holger Spamann & Lars Klöhn, *Justice Is Less Blind, and Less Legalistic, than We Thought: Evidence from an Experiment with Real Judges*, 45 J. LEGAL STUD. 255, 276 (2016) (finding in an experimental setting that real-world

external validity, the stakes for real-world judging are enormous. Do we observe behavioral biases in real-world judicial decision-making? Can we demonstrate this in an empirically rigorous way?

In *Relative Judgments*, Adi Leibovitch notes a puzzle about the criminal sentencing of juvenile offenders. In study after study, researchers have found that minors who are sentenced in the juvenile justice system receive harsher sentences than minors who are sentenced in the regular criminal courts for the identical crime.¹⁰⁹ How could it be that an alternate system especially created to provide greater leniency towards minors would have the opposite effect? Leibovitch hypothesizes that behavioral economics has the answer: This strange result is due to the “contrast effect.”¹¹⁰

In the context of criminal sentencing, the contrast effect will lead a judge to exaggerate the lenity or severity of a sentence in a given case based on comparisons with other cases. A judge who has heard many petty cases will perceive a moderately severe case as relatively grave and impose a high sentence. A judge who has heard many cases involving heinous crimes will perceive a moderately severe case as relatively mild and impose a low sentence. Because judges in the juvenile system tend to deal with a baseline of less-serious cases, cases right on the borderline between going to juvenile court and regular criminal court seem very serious. And because judges in the regular criminal system have a baseline of more-serious crimes, those same cases, in contrast to the rest of their docket, seem mild.¹¹¹

This is a clever hypothesis, but how do you test it? Without the ability to “experiment” on real cases, this is an immensely hard question to answer empirically. If you try to compare juvenile courts and regular courts, there are all sorts of differences that could potentially explain a difference in outcomes: maybe different kinds of people become juvenile court judges versus regular criminal

judges will interpret identical legal rules in opposite ways based on legally irrelevant personal characteristics of litigants).

108. Edward J. McCaffery, Daniel J. Kahneman and Matthew L. Spitzer, *Framing the Jury: Cognitive Perspective on Pain and Suffering Awards*, 81 VA. L. REV. 1341, 1403 (1995) (finding strong framing effects of jury instructions on non-pecuniary damage awards).

109. Adi Leibovitch, *Relative Judgments*, 45 J. LEGAL STUD. 281, 319 (2016).

110. *Id.* at 288-89.

111. *See id.*

judges; maybe the juvenile system has different procedural rules than the regular system; and so on.¹¹²

What Leibovitch did is take advantage of what economists refer to as a “natural experiment”—a situation where real-world circumstances have led to randomization roughly equivalent to the randomization into treatment and control groups that would occur in a laboratory experiment. She collected data from the Pennsylvania state courts and focused on a set of judges who were all elected in the same election and who all served in the same courthouses and applied the same law, in the same context, in the same communities, to the same pool of defendants. But—and this is a very important “but”—during their first few months on the bench, *just by random chance*, some judges happened to get a mix of criminal cases with more serious crimes, while other judges (just by random chance) happened to get a mix of criminal cases with less serious crimes. It was as if an experimenter was randomly assigning some judges to see a baseline set of serious cases and other judges a baseline set of mild cases.¹¹³

Of course, over time as more cases come through the door, the caseloads of every judge will all average out to the same level. Once the caseloads evened out, Leibovitch asked: Did their exposure during the first few months affect the sentences these judges gave? Do judges with a baseline of serious cases give the same sentence as judges with a baseline of mild cases when these judges are sentencing defendants for the exact same crime?

No. A judge that was exposed to a higher baseline will give a sentence 25% shorter for the same crime than the judge exposed to a lower baseline.¹¹⁴ This is the contrast effect in action: not just in the laboratory, and not just at a collectibles convention, but in decisions affecting the incarceration of our fellow citizens.

B. Two Lessons

Do the behavioral biases that behavioral economics has identified dominate the patterns of behavior that we see? Or do the predictions of rational agent models used in neoclassical economics adequately describe human behavior? The resounding, if unsatisfying, answer the examples above give to both these questions

112. *See id.* at 284-85.

113. *Id.* at 291-93, 295-99.

114. *Id.* at 306.

is “sometimes.” Simply because we detect a behavioral bias at the individual level does not mean that we will see the same bias play out on a larger scale when we aggregate the behavior of hundreds or thousands or millions of people into a market, a society, or a political community. How individuals behave, acting alone in an experimental environment, may not correspond to how economically and legally significant entities like firms or government agencies behave. But it may. Just as an understanding of quantum tunneling is irrelevant to the game of basketball but indispensable to mobile telecommunications, Newtonian economics gets the job done some, but not all, of the time.

This fact offers two lessons: one for neoclassical economists, and one for behavioral economists. The first lesson is that, because behavioral phenomena can be significant at policy-relevant scales, any serious economic analysis must be sensitive to the potential role of behavioral factors. Sometimes, maybe most times, the Correspondence Principle will apply, and the predictions of a behaviorally influenced approach will be no different from a more parsimonious, neoclassical approach.

Further, over the past few decades, much of the literature in neoclassical economics incorporated behavioral advances into more traditional models.¹¹⁵ Conversely, behavioral economists, acknowledging the success that neoclassical models have had in many areas, recognize that overlap between behavioral results and neoclassical predictions is a feature, not a bug, of good economic theory.¹¹⁶

This brings us to the second lesson: Behavioral economics needs theory. If the myriad empirical findings of behavioral economics can begin to coalesce into a coherent *theory* of behavior, scholars and policymakers will be able to make more confident predictions about *when* and *how* behavioral phenomena such as the endowment effect or the contrast effect will matter at the scale of markets or courts and when they will not.

115. See Kahneman, *supra* note 26, at 166 (noting the limits of this approach to synthesis).

116. Jessica L. Cohen & William T. Dickens, *A Foundation for Behavioral Economics*, 92 AM. ECON. REV. 335, 337 (2002) (“This view of behavior is profoundly different from the standard view in economics but often will not lead to different predictions. . . . This is a desirable characteristic of a behavioral framework since that model often predicts well.”).

1. Lesson: We Are All Behavioral Economists Now¹¹⁷

An important lesson from our examination of quantum and Newtonian economics is that all economics is behavioral economics.¹¹⁸ Indeed, behavioral research brings economics back to its roots—all the way back to the likes of Adam Smith, who grounded his economic reasoning in thoughtful observation of not only the rational, but the moral and emotional motivations for real-life human action. The popular association of Adam Smith’s “invisible hand” with the notion of *homo economicus* is perhaps the most profound misapprehension in economics.¹¹⁹ Smith himself considered his first monograph, *The Theory of Moral Sentiments*, to be his greatest work. It begins with these words: “How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortunes of others, and render their happiness necessary to him, though he derives nothing from it, except the pleasure of seeing it.”¹²⁰

Smith’s far more famous reference to “not . . . the benevolence of the butcher, the brewer, or the baker, . . . but . . . their regard to their own interest,”¹²¹ has to be understood in this light.¹²² To be sure, Smith saw self-interest as a primary motive force behind the prosperity created by markets. But the notion that humans are *purely*

117. Cf. Joseph William Singer, *Legal Realism Now*, 76 CALIF. L. REV. 465, 467 (1988) (“To some extent, we are all realists now.”); Elena Kagan & John Manning, *The Scalia Lecture: A Dialogue with Justice Elena Kagan on the Reading of Statutes*, YOUTUBE 8:28 (Nov. 25, 2015), <https://www.youtube.com/watch?v=dpEtszFT0Tg> [<https://perma.cc/H9UP-HWWD>] (“[W]e are all textualists now.”).

118. See Korobkin, *supra* note 31, at 1655 (“The behavioral economic analysis of law—which is ecumenical enough to adopt basic insights of traditional analysis such as that law acts as a price system, that there tends to be an inverse relationship between the price of a good and the quantity demanded, and that in some situations individuals might, in fact, act optimally—has become the economic analysis of law.”).

119. ADAM SMITH, *THE THEORY OF MORAL SENTIMENTS* 165 (Dover 2006) (1790).

120. *Id.* at 4.

121. ADAM SMITH, *AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS* 16 (Hartford 11th ed. 1818) (1776).

122. Unfortunately, some of the most prominent champions of behavioral law and economics have not always done so. See Korobkin & Ulen, *supra* note 30, at 1064 (concluding that the “implication [of Smith’s famous statement] is that if we can figure out what course of action will most profit the decision maker, we will be able to predict his course of action”).

self-interested would have been no less ridiculous to him than it is to us today.

Hence, “behavioral economics” is, quite literally, *neoclassical* economics. It is making new the economics of Adam Smith and his contemporaries. But in the latter half of the twentieth century, the discipline of economics became increasingly obsessed with sophisticated mathematical modeling and formal proofs derived from mathematical axioms that reflected strict assumptions about the nature of human behavior. One could have forgiven the outside observer for mistaking economics for a branch of applied mathematics.¹²³ By exposing the absurdities of an excessive reliance on mathematical sophistication at the expense of descriptive realism, behavioral economics has done all of economics immeasurable good.

To be sure, neoclassical economics was never entirely blind to the nuances of human cognition and emotion. Gary Becker, arguably the greatest economist of the past century, used neoclassical models, but always with the express purpose of untangling the complexities and foibles of real-world human behavior. In the view of Becker and his countless protégés (I will count myself as one of them), *homo economicus* is altruistic, makes mistakes, yields to peer pressure, feels loss aversion, and even succumbs to addiction.¹²⁴

Ironically, the icon of neoclassical law and economics (but whipping boy of behavioral law and economics), Ronald Coase, would have been the *first* to say that the messy reality of human interactions would lead real-world behavior to deviate from the predictions of simplistic mathematical models. In fact, he *was* the first to say this. This is the thesis of *The Nature of the Firm*,¹²⁵ and he won a Nobel Prize for it.¹²⁶

Unfortunately, this fact has been lost on a generation of students of behavioral law and economics due to an out-of-context

123. See, e.g., *id.* at 1054 (“Mathematical elegance often becomes the primary goal, with usefulness in the realm of law, that combines logic with human experience, a mere afterthought.”).

124. See, e.g., GARY S. BECKER, ACCOUNTING FOR TASTES 139 (1996).

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

126. Strictly speaking, Coase won the 1991 Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel “for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy.” *The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1991*, NOBEL MEDIA (Oct. 8, 2017), http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1991/ [<https://perma.cc/7RS4-DQUU>].

focus on the so-called Coase Theorem, which is often stated along these lines: “In a world of zero transaction costs, the initial allocation of legal entitlements does not matter from an efficiency perspective.”¹²⁷ Behavioral law and economics scholars, even those as eminent as Cass Sunstein, have claimed that Coase won a Nobel Prize for the Coase Theorem and that “behavioral law and economics shows that the Coase Theorem is often wrong.”¹²⁸

This is inaccurate, as Coase won his Nobel Prize for his work on property rights and the theory of the firm. In fact, Coase did not even come up with the Coase Theorem. The author of the Coase Theorem was George Stigler, a point Coase himself was keen to emphasize.¹²⁹ But more importantly, this claim that behavioral economics refutes the Coase Theorem misunderstands Coase’s contribution. Coase had no interest in a world of zero transaction costs any more than he had interest in understanding a world populated by unicorns and leprechauns. Those worlds do not exist.¹³⁰

The thrust of Coase’s insights in *The Nature of the Firm*¹³¹ and *The Problem of Social Cost*¹³² was that we can understand deviations

127. See, e.g., Bingyuan Hsiung, *Sailing Towards the Brave New World of Zero Transaction Costs*, 8 EUR. J.L. & ECON. 153, 153 (1999) (“In a world of zero transaction costs, regardless of how the property rights are assigned initially, resources will be utilized efficiently in the sense that the value of production will be maximized.”). An influential, early formulation to this effect appears in Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 349 (1967) (“[I]n a world of zero transaction costs[,] [t]he output mix that results when the exchange of property rights is allowed is efficient and the mix is independent of who is assigned ownership . . .”).

128. Cass R. Sunstein, *Introduction*, in BEHAVIORAL LAW AND ECONOMICS 2 (Cass R. Sunstein ed., 2000).

129. See Ronald H. Coase, *Centennial Coase Lecture*, U. CHI. NEWS 37:56 (2003), <https://news.uchicago.edu/multimedia/ronald-coase-centennial-coase-lecture> [<https://perma.cc/T3EH-62AR>] (“[*The Problem of Social Cost*] was a great success. It helped to create the modern subject of Law and Economics; it has been cited more than any other article in the modern economics literature. However, much of this attention does not relate to what I said in that article, but to something called the Coase Theorem. This was invented by George Stigler.”). As an aside, this misattribution is an example of Stigler’s Law, which is that “[n]o scientific discovery is named after its original discoverer.” Stephen M. Stigler, *Stigler’s Law of Eponymy*, 39 TRANSACTIONS N.Y. ACAD. SCI. 147, 147 (1980). As Stephen Stigler explains, Stigler’s Law was discovered by Robert Merton. *Id.*

130. See Coase, *supra* note 129, at 39:44 (“Of course, in making one’s argument, it’s quite all right to simplify, but this has to be done sensibly. . . . [Yet] people didn’t say, ‘Oh, we’re neglecting the effect of transaction costs in this particular transaction.’ They said, ‘In a world of zero transaction costs,’ which is . . . a world that couldn’t exist.”).

131. See generally Coase, *supra* note 125.

from market structures and efficient private ordering if we understand transaction costs, and we sometimes improve markets and social welfare by reducing transaction costs.

But what are transaction costs? What are the costs that prevent the reallocation by contract of initial endowments to their most valuable uses? Well, there are obvious ones, such as the time and money required to find a buyer or seller, but cognitive phenomena such as the endowment effect also create frictions that inhibit value-increasing exchanges. In this way, behavioral insights naturally integrate themselves into familiar, neoclassical frameworks.

Even more broadly, one can apply the central tenet of neoclassical economics, the Law of Demand, to generate hypotheses about when behavioral biases are more likely to manifest themselves. To quote Coase: “When the price of being irrational is very high, people don’t do much of it.”¹³³ This brings us to the second lesson: Behavioral law and economics, no less than neoclassical law and economics, needs theory.

2. Lesson: Build Theories for Quantum Law and Economics

Behavioral economics has thoroughly succeeded in undermining our confidence in economic analysis based on the unreflective assumption that *homo economicus* is an adequate model for human behavior. But to date, the achievements of behavioral economics have been largely negative—showing what is *not* the case, rather than providing a superior set of alternatives to guide our analysis.¹³⁴ This is a striking *dis*-analogy between behavioral economics and quantum physics. Quantum physics has a (nearly) comprehensive *theory* of the behavior of the physical world at the nanoscale.

132. See generally Ronald H. Coase, *The Problem of Social Cost*, 56 J.L. & ECON. 837 (1960).

133. Coase, *supra* note 129, at 53:35; see also Gary S. Becker, *Irrational Behavior and Economic Theory*, 70 J. POL. ECON. 1, 12-13 (1962).

134. See Cohen & Dickens, *supra* note 116, at 335 (“[Behavioral economics] has been most successful in documenting failures of the rational-actor model (e.g., failures of expected-utility theory, irrational cooperation, and time-inconsistent preferences). However, attempts to incorporate these observations into theory have been ad hoc[.]”); Mitchell, *supra* note 24, at 77 (noting that behavioral law and economics “usefully directs attention to the behavioral assumptions underlying the law, it presently offers little helpful guidance about how to amend prevailing assumptions”).

This lack of theory threatens to render behavioral economics incoherent or even self-defeating. The voluminous and rich literature detailing behavioral heuristics and biases leads to a wide range of predictions—sometimes conflicting predictions—about human behavior. Unlike neoclassical economics, which has rational behavior as its unifying concept and the Law of Demand as its unifying prediction, behavioral economics does not have a unifying theoretical framework—and indeed, given its varied and complex empirical findings, it would be foolhardy to assume that a *single* unifying principle is out there, waiting to be found. But a natural and important next step would be to build up a set of theories, maybe even many theories, that apply to specific contexts and to specific categories of biases. Such theories will aid policymakers in *predicting* which of the many cognitive biases will matter the most in a given real-world setting.

Without this, what we have at this point is a dizzying array of heuristics, biases, and other cognitive quirks that have been identified through myriad experiments. For example, the Wikipedia page called “List of Cognitive Biases” names 183 different biases.¹³⁵ Not surprisingly, some of these biases cut in opposite directions. I’ve already noted the “contrast effect,” which leads people to move their quantitative judgments *away* from a given baseline. But what about the “anchoring effect,” which leads people to move their quantitative judgments *toward* a previously observed baseline? How then are we supposed to use behavioral economics to predict future behavior?

This is not a fanciful concern. Seminal experimental work on judge and jury decision-making has emphasized that the anchoring effect draws judicial sentences and jury verdicts closer to irrelevant anchors.¹³⁶ Based on these findings on the anchoring effect, we might think that the irrelevant baseline set by low sentences in earlier cases will lead real-world judges to set sentences relatively *low*. Yet Leibovitch finds exactly the opposite. The contrast effect leads real-world judges who observe a baseline of low sentences to set sentences relatively *high*.¹³⁷ More generally, with 183 biases to choose from and precious little data on behavior in real-world settings, what is a policymaker to do? The danger is that scholars and

135. *List of Cognitive Biases*, WIKIPEDIA, https://en.wikipedia.org/wiki/List_of_cognitive_biases [<https://perma.cc/C8LF-KL9Z>] (last visited Oct. 1, 2017).

136. See Birte Englich & Thomas Mussweiler, *Sentencing Under Uncertainty: Anchoring Effects in the Courtroom*, 31 J. APPLIED SOC. PSYCHOL. 1535, 1546 (2001); McCaffery, Kahneman & Spitzer, *supra* note 108, at 1385.

137. Leibovitch, *supra* note 109, at 288-89.

policymakers will simply pick and choose among biases, basing policy recommendations on arbitrary subsamples of potentially relevant behavioral phenomena.¹³⁸

This is why broader theories of behavior are necessary. And there is nothing inherent in the behavioral approach that forecloses a more unified, theory-driven approach. Indeed, Kahneman and Tversky's 1979 *Econometrica* piece, which is perhaps the seminal work in behavioral economics, did not merely present empirical evidence of loss aversion, but developed and presented an explicit, formal theory ("prospect theory") that could be used to generate predictions about how loss aversion would affect behavior across many contexts.¹³⁹ Prospect theory was not a rejection of formal theory, but a call for *better* theory, theory in which individuals optimize their utility based on *biased* and *loss-averse* preferences.¹⁴⁰

In sum, the findings of behavioral economics are numerous and varied, but this rich array of results is both a blessing and a curse. People are overly optimistic, which causes them to behave in risk-seeking ways; but people have loss aversion, which causes them to behave in risk-averse ways. There is an anchoring effect, which causes estimates to be biased toward initial baselines; but there is a contrast effect, which causes estimates to be biased away from initial baselines. Without some theory to connect these ideas, how do we

138. See Rachlinski, *supra* note 52, at 1687 (recognizing that "absent an organizing framework, [behavioral law and economics] scholars can cherry-pick from a range of cognitive phenomena to support whatever policy preference is consistent with their political views"); see also Cohen & Dickens, *supra* note 116, at 335 ("The lack of theoretical foundations causes a number of problems for BE [behavioral economics]. First, empirical analysis can show the inadequacy of mainstream theory, but it does little to help develop alternatives. Second, without a coherent theory it is difficult to develop new applications. Third, the policy influence of [behavioral economics] is limited by its inability to predict circumstances in which anomalous behavior will arise (other than those sorts of circumstances in which it has been observed before) or how it will respond to policy changes. Finally, it is hard to judge the welfare implications of policy if we do not understand the origins of such behavior.").

139. Kahneman & Tversky, *supra* note 35, at 274-77.

140. See also Jolls, Sunstein & Thaler, *supra* note 29, at 1475 ("Behavioral economics does not suggest that behavior is random or impossible to predict; rather it suggests, with economics, that behavior is systematic and can be modeled. We attempt to sketch several such models here."); Matthew Rabin, *Incorporating Fairness into Game Theory and Economics*, 83 AM. ECON. REV. 1281, 1282-83 (1993) (discussing a formal model of "fairness" and using the model to explain a series of results from behavioral experiments).

know which of these opposite forces will predominate in response to a new law?

This brings us to the third concept from quantum physics, the Quantum Principle. It offers the basis for a conjecture that the concept of *quanta* may offer a fruitful direction for a theory that will help unify a few of the disparate empirical results in behavioral economics.

V. A QUANTUM CONJECTURE FOR BEHAVIORAL LAW AND ECONOMICS

To say a theory would help is not to provide a theory. Further, human decision-making and behavior is far too complex to be reduced to a single, comprehensive theory. But behavioral economists, going back to the earliest work in the field, have attempted to make progress toward a firmer theoretical grounding for the field.¹⁴¹ In that spirit, I offer here a (very tentative) conjecture that may contribute to one future theory in behavioral economics.

We perceive our own cognition, effort, and attention in a Newtonian way: smoothly and continuously adjustable, such that I can think a little bit harder or work a little bit less on any particular task. Newtonian mechanics—and Newtonian economics—assumes that this is exactly how the world works. It is perhaps no coincidence that the primary mathematical tool for both Isaac Newton's laws of motion and Gary Becker's price theory is calculus, a technique that generates elegant solutions to complex problems by conceptually breaking every curve or shape down into infinitely small bits.

As noted above, this isn't quite true in physics. Quantum mechanics concerns itself with *quanta*: small, but discrete and indivisible quantities. What if quantum economics did, too? I suggest what I will call the Quantum Conjecture: Human cognition occurs in discrete quanta. People have a finite set of packets of attention or energy that cannot be subdivided as the occasion warrants.¹⁴²

141. See Cohen & Dickens, *supra* note 116, at 337 (“This view of behavior is profoundly different from the standard view in economics but often will not lead to different predictions. . . . [T]his is a desirable characteristic of a behavioral framework since that model often predicts well.”); Jolls, Sunstein & Thaler, *supra* note 29, at 1475.

142. To be clear, this conjecture is a *positive* claim about behavior, not a *descriptive* claim. I do not assert that human attention or energy *actually* takes the form of packets, but rather that human behavior might be better understood with a model that assumes we behave *as if* our cognition could only be parceled into

Consider the notion of the “tyranny of choice.” Having too many options may be paralyzing rather than liberating. The conventional wisdom in neoclassical economics is that giving people an additional option always makes them better off—or at least no worse off. After all, if they don’t like the new option, they can simply do what they were doing before; and if they do like the new option, then they are strictly better off. Yet personal experience, if not behavioral research, tells us that often things are not so simple.¹⁴³

As options multiply, we cannot simply divide and further subdivide our attention and cognitive effort among an ever-growing list of priorities. It seems as though there is a minimum, indivisible quantum of attention that we can deploy. As a consequence, some tasks or options receive a packet of our attention, while other options are ignored, even if, in a Newtonian world, we could spread our attention evenly and ever more thinly across all of these options.

I would argue that one manifestation of this is the “certainty effect,” which was identified long ago by Amos Tversky and Daniel Kahneman.¹⁴⁴ People would rather eliminate a small risk (thereby reducing total risk by a small amount) than to drastically limit, but not eliminate, a large risk (thereby reducing total risk by a large amount). This is a terrible policy preference, but there is logic to it. Reducing the big risk leaves one with just as many risks to worry about as before. Eliminating a small risk reduces the number of discrete topics one need to think about. Life has become simpler; the cognitive burden of attending to risk has been relieved, and mental faculties have been freed up for other tasks. More generally, the cognitive load imposed by decision-making and multitasking is

indivisible packets. In this sense, the Quantum Conjecture hews to the neoclassical approach to modeling. *See* Friedman, *supra* note 26, at 3.

143. The “choice overload hypothesis”—that increasing the number of choices will reduce willingness to choose or satisfaction with a choice made—has been the subject of many studies seeming to confirm the phenomenon. *See* Benjamin Scheibehenne, Rainer Greifeneder & Peter M. Todd, *Can There Ever Be Too Many Options? A Meta-Analytic Review of Choice-Overload*, 37 J. CONSUMER RES. 409, 409 (2010). But it has not been consistently confirmed as an empirical matter. *Id.* at 421 (finding that the effect of increasing the number of options, estimated in fifty separate experiments, was on average almost exactly zero, but noting substantial variation in results across studies).

144. Kahneman & Tversky, *supra* note 35, at 274. *See also* John W. Pratt & Richard J. Zeckhauser, *Willingness to Pay and the Distribution of Risk and Wealth*, 104 J. POL. ECON. 747, 748 (1996).

deceptively high.¹⁴⁵ It is a kind of internal transaction cost that introduces a huge amount of friction into human decision-making.

The idea that consideration of options or information is costly to people is in fact a familiar one in neoclassical economics, too. Although traditional rational choice models would often ignore such cognitive costs, a considerable modern literature incorporates such costs into the study of decision-making. A nice example of this is Benjamin Lester, Nicola Persico, and Ludo Visschers's *Information Acquisition and the Exclusion of Evidence in Trials*,¹⁴⁶ which uses the fact that processing information imposes a cognitive cost to explain the contours of Federal Rule of Evidence 403, which gives the judge discretion to exclude evidence if its probative value is outweighed by "unfair prejudice."¹⁴⁷ Their model assumes that jurors are "fully rational" but are "cognitive misers" because processing information is burdensome.¹⁴⁸ In this way, they deploy a set of theoretical tools familiar to "Newtonian" economists, but in a way that recognizes the "quantum" reality of human behavior.

In the remainder of this Part, I present three examples of disparate phenomena—involving consumer protection, public health, and environmental regulation—which I argue might be explained by a single, simple analytical framework: a quantum approach to behavioral law and economics. I then draw two lessons from this excursion into a "quantum" theory for behavioral law and economics. First, it reveals the symbiotic, complementary relationship between neoclassical and behavioral economics. The notion that these are competing paradigms for analysis is not only mistaken but deeply misguided. For many important policy problems, it is simply not possible to undertake sensible analysis without utilizing both behavioral insights and price theory in tandem. Second, recognizing the interrelationships between behavioral and neoclassical economics also explodes one of the most stubborn myths in law and economics: that neoclassical economics is a reflection of conservative or anti-regulatory ideologies, and that behavioral economics caters to progressive or pro-regulatory

145. See, e.g., Susan Weinschenk, *The True Cost of Multi-Tasking*, PSYCHOL. TODAY (Sept. 18, 2012), <https://www.psychologytoday.com/blog/brain-wise/201209/the-true-cost-multi-tasking> [<https://perma.cc/5X4L-ASZY>] ("Recent estimates are that you can lose up to 40% of your productivity [] if you multi-task.").

146. 28 J.L. ECON. & ORG. 163 (2009).

147. *Id.* at 163, 163 n.1.

148. *Id.* at 164. They provide some useful citations to the cognitive psychology literature on the "cognitive miser" phenomenon. *Id.* at 164 n.5.

ideologies. Not only is this wrong as a conceptual matter—economics is methodology, not ideology—it is wrong as a predictive matter. Neoclassical economics can point toward more regulation, and behavioral economics can counsel for less.

A. Three (Possible) Examples

Here, I offer three examples of the wide array of phenomena that might be amenable to analysis in a unified theoretical framework built around the idea of quanta of attention. The examples below are straightforward and familiar, and surely one could invoke many others.¹⁴⁹ The value of these examples is not that a “quantum theory” would predict these outcomes—such a result is both obvious and superfluous. Rather, the point of the exercise is to show that a *single* set of theoretical assumptions can explain a *wide range* of otherwise disconnected phenomena. It is precisely this effort—to unify disparate findings in a common framework that allows us to make predictions about outcomes *not* yet observed—that behavioral law and economics requires more of.

I will briefly note, too, that if a theory based on the quantum concept is valid, it should explain findings from the neoclassical economic literature as well. Implicit in the conjecture, therefore, is the claim that not only does the Quantum Conjecture gel with many behavioral experimental findings, it harmonizes them with many empirical findings in the more traditional economics literature. I’ll note two examples here. First, econometric estimates of the returns to higher education are so high that the fact that anyone *doesn’t* go to college can only be rationalized by assuming that the psychological costs of attending college are very high.¹⁵⁰ Second, neoclassical theories explaining the extraordinary rates of CEO pay can only be rationalized if one assumes that juggling a large number of cognitive

149. I also note potential connections of the quantum concept here to Lee Fennell’s work on lumpiness in law. See Lee Anne Fennell, *Lumpy Property*, 160 U. PA. L. REV. 1955, 1956 (2012); Lee Anne Fennell, *Slicing Spontaneity*, 100 IOWA L. REV. 2365, 2368 (2015). The object of study in Fennell’s work is not lumpiness in cognition or attention, but lumpiness in activities or legal entitlements. Some activity levels are lumpy—you either go to the state fair or you don’t—while other activities can vary along a continuum—you can buy as many or few tickets as you want for rides once you get to the state fair.

150. See David Card, *Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems*, 69 ECONOMETRICA 1127, 1145-55 (2001).

tasks is extraordinarily difficult.¹⁵¹ These outcomes are easily explained by a model of cognition built around scarce quanta of attention.

1. *The Futility of Increasing Disclosures*

A simple and plausible application of the Quantum Conjecture would be to mandatory disclosures. Much of the policy-oriented work in behavioral law and economics is directed toward improving consumer choice through mandated disclosures of relevant information to consumers.¹⁵² But one of the more sobering findings in the literature on disclosure is that most mandated disclosures are at best ineffective and at worst counterproductive.¹⁵³ As scholars in this area have recognized, consumers lack either the inclination or the cognitive capacity (or both) to process the numerous disclosures attached to a product or service. A neoclassical model of disclosures might predict that the effectiveness of disclosures would decline smoothly, as an individual's attention is gradually spread more and more thin across disclosures. A "quantum" model of disclosures might predict that the first few disclosures will have some level of effectiveness, but any additional disclosures will have no effect; the notion is that once the consumer's quanta of attention are entirely divided up amongst the various disclosures and other product attributes, the consumer is simply unable to allocate attention to additional disclosures.

2. *GMOs, Health, and the Environment*

Many people avoid foods containing GMOs (genetically modified organisms) out of fear of the effects of GMOs on their health or on the environment. Widespread calls to mandate labeling of GMO food have led to legislation directing the FDA issue

151. See, e.g., JOAN WOODWARD, *INDUSTRIAL ORGANIZATION: THEORY AND PRACTICE* 17-34 (1965); Oriana Bandiera et al., *Span of Control and Span of Attention* (Harvard Bus. Sch., Working Paper No. 12-053, 2014), http://www.hbs.edu/faculty/Publication%20Files/12-053_5de59810-1c7a-4101-a58b-309376366347.pdf [<https://perma.cc/BT6Y-MQNR>].

152. See, e.g., OREN BAR-GILL, *SEDUCTION BY CONTRACT: LAW, ECONOMICS, AND PSYCHOLOGY IN CONSUMER MARKETS* 32 (2012); Bubb & Pildes, *supra* note 48, at 1594.

153. See, e.g., OMRI BEN-SHAHAR & CARL E. SCHNEIDER, *MORE THAN YOU WANTED TO KNOW: THE FAILURE OF MANDATED DISCLOSURE* 3 (2014).

regulations on GMO labeling.¹⁵⁴ However, one of the leading figures in behavioral law and economics, Cass Sunstein, describes a scientific consensus that GMOs pose no threat to human health and a near-consensus that they pose little or no risk to the environment.¹⁵⁵ This suggests that aversion to GMOs foods may be “irrational,” in the sense of reflecting heuristics or behavioral biases in perception of risk. One way to explain this alarmist reaction to these new food products is by reference to the certainty effect: Because of their novelty, any risks of GMOs are unquantified, and people seek the certainty of zero risk from GMOs.

The “behavioral” regulatory response to this would be to deny such calls for mandated labeling. Interestingly, although the rationale is paternalistic, this is an example of a paternalistic response to a behavioral bias leading to a deregulatory, rather than pro-regulatory, policy recommendation.

Conversely, a “neoclassical” analysis of consumers’ response to GMO foods would focus on price effects and the Law of Demand. This could lead to a different, aggressively regulatory recommendation. Here is the logic: Producing healthy food without GMOs raises the price of that food, reducing its consumption; therefore, consumer aversion to GMOs actually makes healthy food *less affordable*. And avoiding crops genetically modified to be drought- and pest-resistant means reliance on crops that require increased consumption of scarce water resources and greater use of pesticides—both of which harm the environment. These *negative externalities* that opponents of GMOs impose on public health and the environment externalities could justify government intervention *in favor of* GMOs, rather than government inaction.

3. Regulatory Overkill

Nor is government immune to overreactions to risks. Kip Viscusi’s body of work on the cost-effectiveness of regulation has shown again and again how regulatory programs to eliminate risks that are already vanishingly small lead to regulatory costs of billions or even trillions of dollars on a per-life-saved basis.¹⁵⁶ Such costs

154. See Cass R. Sunstein, *On Mandatory Labeling, with Special Reference to Genetically Modified Foods*, 165 U. PA. L. REV. 1043, 1043 (2017).

155. See *id.* at 1044.

156. See, e.g., W. KIP VISCUSI, *RATIONAL RISK POLICY* (1998); W. KIP VISCUSI & JAMES HAMILTON, *Are Risk Regulators Rational? Evidence from Hazardous Waste Cleanup Decisions*, 89 AM. ECON. REV. 1010, 1022-23 (1999).

would be better spent—thereby saving thousands of lives—regulating in areas where the risks to human life are far greater but cannot be reduced to zero. Government, it seems, suffers from the certainty effect, or at least many of its regulatory policies seem to cater to a public bias in favor of certainty.¹⁵⁷

A notable example of this appears in *United States v. Ottati & Goss, Inc.*,¹⁵⁸ where the Environmental Protection Agency appealed a district court order *in its favor* ordering the defendant corporation to clean up a “Superfund” site contaminated by various pollutants including, as relevant here, a carcinogen called PCB.¹⁵⁹ Although the district court required that the defendant ensure that the site meet a standard of no more than fifty parts per million (ppm) of PCB in the soil, EPA’s appeal sought a stricter standard of no more than twenty ppm, steps that EPA’s own studies estimated would cost nearly \$10 million.¹⁶⁰ The rationale for such strict measures rested on the assumptions that “a) developers will build residential housing on the site, b) small children, playing in the backyard, will eat dirt containing PCBs, and c) the children will eat a little bit of dirt each day for 245 days per year for three and a half years.”¹⁶¹ As Justice Breyer, who wrote the opinion as a Circuit Judge, would later express puzzlement at,¹⁶² the weakness of this argument was that the site to be cleaned up was an uninhabited marsh.¹⁶³ The only way to rationalize such a policy by the EPA was desire to reduce this one risk to *zero*, no matter how vanishingly small it would be otherwise, and no matter the cost.

157. W. Kip Viscusi & Ted Gayer, *Behavioral Public Choice: The Behavioral Paradox of Government Policy* 19 (Vanderbilt Univ. Law Sch. Law & Econ., Working Paper No. 15-2, 2015), <http://ssrn.com/abstract=2559408> [<https://perma.cc/3HM8-C9R9>].

158. 900 F.2d 429 (1st Cir. 1990).

159. *Id.* at 441. See Viscusi & Gayer, *supra* note 157, at 23-25, for a more extended discussion.

160. *Ottati & Goss*, 900 F.2d at 441.

161. *Id.*

162. STEPHEN BREYER, *BREAKING THE VICIOUS CIRCLE: TOWARD EFFECTIVE RISK REGULATION* 11–12 (1993).

163. *Ottati & Goss*, 900 F.2d at 442.

B. Two Lessons

1. *Lesson: Behavioral and Neoclassical Economics Are Complements, Not Substitutes*

As the GMO example above illustrates, behavioral and neoclassical forces are always operating together. Behavioral biases drive consumer behavior, thereby influencing supply and demand in any given market. Thus, behavioral economics and neoclassical economics are best understood as complements rather than substitutes; they are partners, not rivals.¹⁶⁴ Seminal work in behavioral law and economics has made this point emphatically, but it bears repeating.¹⁶⁵

In a recent article, Ryan Bubb and Patrick Warren provide a high-stakes, real-world example of how combining behavioral insights with neoclassical theory can improve regulatory efforts.¹⁶⁶ They study employer-sponsored retirement savings plans, a subject of much discussion in the literature on “nudges” due to the widespread recognition that employees seem to systematically underinvest in retirement savings.¹⁶⁷ One of the best-known policy recommendations in behavioral economics—one that has actually been heeded by Congress—is for employers to “paternalistically harness the stickiness of default rules . . . to counteract myopic workers’ temptation to save too little.”¹⁶⁸ Legislation has encouraged employers to create automatic enrollment plans that set default contribution rates for their employees, so long as the employer sets a

164. For more examples of the importance of understanding how simple applications of neoclassical analysis can identify unintended consequences of behavioral regulation, including a discussion of perhaps the most famous example of this, the “Peltzman effect,” see Viscusi & Gayer, *supra* note 157, at 32, 32 n.84 (citing Sam Peltzman, *The Effects of Automobile Safety Regulation*, 83 J. POL. ECON. 677 (1995)).

165. See Jolls, Sunstein & Thaler, *supra* note 29, at 1475 (“Behavioral economics is a form of economics, and our goal is to strengthen the predictive and analytic power of law and economics, not to undermine it.”); see also *id.* at 1481 (“The first fundamental principle for the conventional approach is downward-sloping demand: Total demand for a good falls when its price rises. This prediction is, of course, valid.”).

166. See Ryan Bubb & Patrick L. Warren, *An Equilibrium Theory of Retirement Plan Design* (N.Y. Univ. Ctr. Law, Econ. & Org., Working Paper No. 16-28, 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2823605 [<https://perma.cc/Z4W5-7F4J>].

167. See *id.* at 1.

168. *Id.*

sufficiently high default. Yet despite the widespread adoption of automatic enrollment plans, Bubb and Warren report that overall retirement savings rates have not risen (and in fact may have fallen) as a result of the reforms.¹⁶⁹

This outcome should be alarming to anyone optimistic about the role behavioral economics can play in improving regulation. The poster child for “libertarian paternalism”—the use of sticky defaults to improve individual saving decisions—seems to have utterly failed. Why?

Behavioral insights describing *individual* behavior need to be placed in the context of *market* behavior. In the retirement savings plan context, Bubb and Warren explain how this plays out.¹⁷⁰ Simplified somewhat, their argument goes like this: Given employers who attempt to maximize their profits and a workforce that contains both forward-looking and myopic workers, employers will structure their retirement plans to attract both types of workers at the lowest cost. Workers are attracted to employers who offer to match all employee contributions; all workers predict that they will contribute to the retirement savings plan at the maximum rate and thus reap the generous employer matching contributions. In the case of myopic employees, however, their forecast is wrong. Once employed, they will only contribute at the default rate. Thus, profit-maximizing employers will offer generous matching contributions (to attract both types of workers) but set relatively low default contribution rates (to save money on myopic workers, because they only have to match the default amount).¹⁷¹

Put simply, the policy intervention got the behavioral economics right but the neoclassical economics wrong. The result was a policy that appears to be worse than if the government had done nothing at all.

169. *Id.* at 3 (citing Bubb & Pildes, *supra* note 48, at 1637).

170. Their analysis is buttressed by a formal, neoclassical model of employer behavior. *See id.* at 4-8. The model is not necessary for the intuition I offer in the text above, but the model generates crisp empirical predictions, which one can test with data, and therefore assess the predictive validity of the model. Bubb and Ryan are, in fact, able to confirm the predictions of their model. *Id.* at 18-19. This model is an elegant example of how behavioral and neoclassical analysis can be synthesized into better theory.

171. *Id.* at 2-4.

2. Lesson: *Economics Is Methodology, Not Ideology*

The GMO example also reminds us not to confuse methodology with ideology. In that example, we see a reversal of the usual trope about behavioral economics overturning the neoclassical skepticism toward government regulation. More generally, neither neoclassical nor behavioral economics incorporates any specific beliefs about the proper role of government or the scope of paternalism.¹⁷² They are simply tools for understanding how people behave. Sometimes we will learn something from them that leads us toward more regulation, sometimes less.

Interacting behavioral and neoclassical economic analyses will sometimes lead one in the direction of more assertive regulation. In a prominent recent article, Ryan Bubb and Richard Pildes give examples of how popular policy prescriptions, such as the sticky default rules in the context of retirement savings plans described above, can be ineffective or even backfire:

[C]hoice-preserving regulatory tools are particularly weak medicine, we argue, when firms have incentives to undermine consumer choice. Instead, the interaction of optimizing firms with nonoptimizing consumers might better suggest traditional regulatory tools, such as product regulation, as well as measures designed to lower the incentives of firms to exploit consumer mistakes.¹⁷³

In other words, adding consideration of market incentives and price theory to the mix leads Bubb and Pildes to favor heavier-handed regulation.

The interaction of behavioral and neoclassical economics can cut the other way, too. While consumers are prone to cognitive biases, “policymakers are also human” and thus also prone to cognitive biases when making policy.¹⁷⁴ Taking into account the incentives of consumers in the market versus the incentives of voters or officials might lead us to worry less about “market failures” and more about “government failures.”¹⁷⁵ In market settings, market discipline makes biases costly; to the extent that consumers succumb to biases in market transactions, they pay the price (either literally or

172. Jolls, Sunstein, and Thaler described behavioral economics’ orientation as “anti-antipaternalism”—a rejection of a presumption in favor of free markets, but skepticism about the rationality of government, as well. Jolls, Sunstein & Thaler, *supra* note 29, at 1541.

173. Bubb & Pildes, *supra* note 48, at 1600.

174. Viscusi & Gayer, *supra* note 157, at 5.

175. *Id.* at 7.

figuratively).¹⁷⁶ While market settings don't transform individuals into *homo economicus*, we saw above that market experience¹⁷⁷ and the assistance of intermediaries in transactions¹⁷⁸ dramatically reduce behavioral phenomena such as the endowment effect. But when consumers vote, what incentive does an individual have to de-bias himself? The winner of the election will not depend on his vote.¹⁷⁹

Further, government actors are not subject to market discipline—and in the case of judges, they may not even be subject to electoral discipline. Think back to the study of contrast effects in criminal sentencing. Judges exercise a monopoly on criminal sentencing, of course, and thus there are no market forces that make it costly for judges to behave in biased ways. While there will be many cases in which we must call upon government officials to ameliorate the effects of behavioral biases, the behavioral biases most likely to go unchecked may be those manifested by government officials themselves.

In short, economics isn't ideology. Neoclassical economics, with its focus on externalities and market failures, often provides grounds for ambitious regulatory agendas.¹⁸⁰ Behavioral economics, which catalogs the fallibility of human judgment in contexts where biases and heuristics are undisciplined by market forces, raises concerns about displacing private ordering with government regulation.¹⁸¹

CONCLUSION

In this Article, I have drawn a set of three analogies between physics and economics, with the objective of illuminating the relationship between behavioral and neoclassical law and economics.

Behavioral law and economics has its own Uncertainty Principle: In laboratory experiments, the act of observation changes the behavior of the observed subject. This is not a fatal weakness, but rather a principle that offers two lessons. First, the limits of neoclassical theory to authentically describe reality must be weighed

176. Edward L. Glaeser, *Paternalism and Psychology*, 73 U. CHI. L. REV. 133, 138-39 (2006).

177. See *supra* notes 86-88 and accompanying text.

178. See Arlen & Tontrup, *supra* note 100, at 144-54.

179. Glaeser, *supra* note 176, at 140, 146-48.

180. Cf. Jonathan S. Masur & Eric A. Posner, *Toward a Pigouvian State*, 164 U. PA. L. REV. 93, 100-04 (2015).

181. Glaeser, *supra* note 176, at 143-47.

against the limits of behavioral experiments to do the same thing. Second, the future of behavioral law and economics lies in an increasing emphasis on field experiments, or at least laboratory experiments designed to capture realistic features of the institutional contexts provided by the legal system.

The Correspondence Principle tells us that neoclassical economics is wrong, but it nonetheless remains a good approximation for human behavior at the scale of human society—at least most of the time. It, too, offers two lessons. First, all economics is behavioral economics; the rational-actor assumptions of neoclassical economics are best understood not as a rejection of a more complete understanding of human cognition, but as a set of simplifying assumptions that are often desirable when studying behavior in settings such as markets. But to advance, neoclassical economics must continue to incorporate insights from behavioral economics. Second, for behavioral economics to be more relevant to policy, it needs theoretical frameworks that help explain when and how behavioral findings apply outside of laboratory settings and at scales relevant to policy.

The Quantum Conjecture is an effort to draw an additional metaphor from quantum physics, one that may provide a conceptual nucleus for a tractable theory in behavioral economics. This third metaphor offers a third pair of lessons. First, behavioral and neoclassical approaches are complements, not substitutes, and should be employed in tandem. Second, the simplistic view that neoclassical economics is anti-regulatory and behavioral economics is pro-regulatory ignores the longstanding grounds for regulatory intervention identified by neoclassical economics, but also (and less obviously) the potentially profound critique of government intervention that behavioral economics suggests.

Finally, I note that as remote as this examination of behavioral law and economics may seem from everyday lawyering, the findings I have discussed above go to the heart of legal practice. Consider Arlen and Tontrup's demonstration of the importance of intermediaries in de-biasing individual decision-makers. That study shows that even unsophisticated intermediaries performing trivial tasks have a dramatic effect on removing what would otherwise appear to be irrational behavior from transactions. Of course, in real life transactions are vastly more complicated, but then again, agents in real life are vastly more sophisticated. And these real-life agents are, of course, lawyers. The practice of law itself is perhaps the most ambitious application of behavioral economics yet underway.