

Perspective

Behavioral economics: Reunifying psychology and economics

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“Behavioral economics” improves the realism of the psychological assumptions underlying economic theory, promising to reunify psychology and economics in the process. Reunification should lead to better predictions about economic behavior and better policy prescriptions.

Because economics is the science of how resources are allocated by individuals and by collective institutions like firms and markets, the psychology of individual behavior should underlie and inform economics, much as physics informs chemistry; archaeology informs anthropology; or neuroscience informs cognitive psychology. However, economists routinely—and proudly—use models that are grossly inconsistent with findings from psychology. A recent approach, “behavioral economics,” seeks to use psychology to inform economics, while maintaining the emphases on mathematical structure and explanation of field data that distinguish economics from other social sciences (1–3).

In fact, behavioral economics represents a reunification of psychology and economics, rather than a brand new synthesis, because early thinking about economics was shot through with psychological insight. For example, in his *Theory of Moral Sentiments*, Adam Smith (4) described all the ways in which people care about the interests of others. In his later book, *The Wealth of Nations*, he suggests that people get dinner “not from the benevolence of the butcher, the brewer, or the baker” but “from the regard [of those agents] to their own interest” (5). The latter passage is one of the most famous in economics, whereas Smith’s earlier book on moral sentiments is ignored (6). Why?

The answer is that two trends led economics and psychology along different paths this century (although both were trying to make their disciplines more scientific). One trend was that theorists like Samuelson, Arrow, and Debreu worked hard at formalizing economics mathematically, with physics as inspiration. Psychologists were also inspired by natural sciences—by experimental traditions rather than mathematical structure. As a result, to an economist, a theory is a body of mathematical tools and theorems. To a psychologist, a theory is a verbal construct or theme that organizes experimental regularity.

This divergence in methods and ways of expressing knowledge pushed economics and psychology apart. A second trend kept the fields apart. In the 1940s, economists took up logical positivism with a special twist (called the “F twist” after its advocate, Milton Friedman): because theories with patently false assumptions can make surprisingly accurate predictions, economic theories that assume that individual agents are highly rational and willful, judge probabilities accurately, and maximize their own wealth might prove useful, even though psychology shows that those assumptions are systematically false. The F twist allowed economists to ignore psychology. Many theorists also thought that relaxing rationality assumptions would inevitably lead to analytical intractability. Recent theoretical leaps have shown cases in which this guess is wrong.

Toward a Reunification

In the 1950s, the brilliant polymath Herbert Simon—later a Nobel laureate in economics—took a run at reunifying psychology and economics. He advocated theories of individuals in economics based on algorithms that embodied cognitive mechanisms and acknowledged the “bounded rationality” of humans. Simon’s suggestion came just as economists were finding interesting ways to study economics more mathematically; these ways were not easily integrated with algorithmic theories.

In the 1970s, however, cognitive psychologists began studying judgment and economic decision making. They took maximization of utilities and logical rules of probability judgment as benchmarks and used conformity or deviation from these benchmarks as a way to theorize about cognitive mechanisms (much as optical illusions are used to understand perception). Important psychology of this sort was done Ward Edwards in the 1950s, and later by Amos Tversky, Daniel Kahneman, Baruch Fischhoff, Paul Slovic, and others. The findings of this research often consisted of psychological principles or constructs that could be expressed in simple formal terms, thus providing a way to model bounded rationality in terms familiar to economists.

Behavioral economics tries to incorporate this kind of psychology into economics. Considerable progress has been made in a couple decades, and increasingly, economists are taking up the challenge of attaching economic theory to psychological foundations.

Four Principles of Economic Behavior

One goal of behavioral economics is to suggest mathematical alternatives with firm psychological foundations to rationality assumptions. Good alternative principles should be parsimonious—as Einstein said, “as simple as possible, but no simpler.” Ideally, they should include the rational principle as a mathematical special case to permit easy statistical measurement of how much the new assumption adds and to allow that possibility that, when stakes are high and learning is easy, general behavior can converge to rationality. Table 1 lists four rational principles used in economics, along with four behavioral principles that are ready to be included in textbook discussions and tried out in modeling applications.

Expected Utility Theory. Expected utility (EU) theory assumes that people value risky gambles by weighting the utility of an outcome X_i by its probability P_i , denoted $\sum_i P_i u(X_i)$, where u is a function that measures the value of an outcome. EU assumes that people integrate the outcomes into their overall wealth, and if two gambles have a common probability of a

Table 1. Four parsimonious behavioral replacements for rational modeling principles

Rational principle	Behavioral principle	Psychological foundation
Expected utility $\sum_i P_i u(X_i)$	Prospect theory $\sum_i \pi(P_i) u(X_i - r)$	Psychophysics, adaptation: loss-aversion, reflection, mental accounting, nonlinear $\pi(P_i)$
Equilibrium (mutual best response)	Learning, evolution	Generalized reinforcement, replication by fitness
Discounted utility $\sum_t \delta^t u(x_t)$	Hyperbolic discounting $u(X_0) + \sum_{t=1} \beta \delta^t u(X_t)$	Preference for immediacy (temptation)
Own-payoff maximization $u_{X_2}^1(X_1, X_2) = 0$	Social utility $u_{X_2}^1(X_1, X_2) \neq 0$	"Spend" money on other people (reciprocate, dislike inequality)

Variables are defined below.

common outcome, that outcome is cancelled out when deciding among the two gambles. EU is the foundation of theories of asset pricing, purchase of insurance, corporate structure, and personal decisions like investments in education. A behavioral alternative, "prospect theory" (7), incorporates psychophysical features that EU ignores: people adapt to what they have experienced and weight probabilities nonlinearly. Adaptation implies that utilities are determined by gains and losses from some reference point r , rather than by overall wealth. Furthermore, people seem to "mentally account" for money in separate categories, rather than adding it all together (e.g., people will spend more from a tax refund than from an increase in the value of their stocks or their homes, which standard theory does not allow). Many studies suggest behavior toward perceived losses and gains is different in two ways. In "loss-aversion" studies, losses are disliked about twice as much as gains equal in size to the losses are liked; people *seek* risk when gambles involve only losses, such that the best they can do is "break even" (i.e., reach the reference point), whereas they *avoid* risk when gambles all yield gains (the "reflection effect"). Loss-aversion can explain the large gap between hypothetical buying and selling prices for nontraded goods, such as environmental damage. In most surveys, people ask for 2 to 10 times as much money to accept damage to the environment (presumably because they are averse to the loss of environmental purity) as they are willing to pay to clean up the same damage, even though, in standard theory, these selling and buying prices should generally be close together (8).

In EU, people weight a possible outcome by its probability. In prospect theory, in contrast, people are assumed to weight a possible outcome by a "decision weight," a nonlinear transformation of the outcome's probability. Ample evidence suggests that people overweigh low probabilities (7, 9). This overweighting helps explain the widespread desire to gamble on low-probability events (e.g., lottery tickets) and to insure against low-probability catastrophes, which are not easily explained by EU.

Exponential Discounting. Most economic choices yield costs and benefits that are incurred at different points in the future. To make choices, people must weigh the utilities of these future costs and benefits in some way. Rational evaluation of future consequences assumes "exponential discounting"—future utilities $u(x_t)$ are discounted by a weight δ^t , which is an exponentially declining function of t . Exponential discounting makes the strong prediction that the relative evaluation of two payments depends on *only* the amount of delay between the two payments. For example, people tend to prefer getting \$100 now over getting \$110 in a week, but they also prefer \$110 in 11 weeks to \$100 in 10 weeks, even though both choices involve waiting an extra week to get \$10 more (10). Exaggerated preference for immediate reward is particularly evident in nonhuman animals and young children and is thought to explain adult behavior like addiction and procrastination. The impulsive preference for immediate reward can be captured in

(quasi-) "hyperbolic discounting," weighting delayed rewards by $\beta \delta^t$. The parameter β expresses the preference for immediate reward, and δ expresses the preference for reward delayed t periods, relative to a delay of $t + 1$ periods. Exponential discounting also does not allow phenomena like the desire to "savor" good outcomes by delaying them and the fact that people like wage profiles that always increase (10).

Social Utilities. Most applications of economic theory assume individuals care only about their own wealth and won't sacrifice to help or hurt others. Of course, such sacrifices are common in the form of altruism and vengeance. Laboratory experiments help uncover these "social utilities." For example, in "ultimatum games," one player offers a portion of \$10 to another player and keeps the rest for herself. The responding player can either accept the offer or reject it and leave them both with nothing. Wealth-maximizing players will accept anything; thus, the first player should offer very little. Surprisingly to economists, in many studies in several countries, some with very high stakes, players routinely offer about \$4 of \$10, and low offers of less than \$2 are rejected half the time (11). Mathematical theories of social utility explain these patterns by assuming that people dislike allocations in which they earn different amounts than others (12) or that people like to reciprocate (13). These theories are parsimonious, can explain a surprisingly wide range of different experiments (such as frequent cooperation in one-shot prisoners' dilemma games), and predict some new patterns as well.

Equilibrium. Economists typically study systems "in equilibrium." In a market, equilibrium means that supply meets demand; in a strategic game, equilibrium means all agents are choosing optimal strategies (given that others are too). As economics developed mathematically, little attention was paid to the process of *equilibration*—how an equilibrium comes about. However, recent theory on population evolution (14), learning from others (15), and rules of individual learning derived from experimental observation (D. Stahl, unpublished work), suggest parsimonious principles of equilibration. In the most general and predictively accurate theory, people learn by "reinforcing" strategies that performed well or would have performed well had they been chosen (16). This "experience-weighted attraction" rule shows that two classes of learning rules—reinforcement, mostly studied in psychology, and belief learning, studied by game theorists—which were thought to be fundamentally different, are closely related. Empirical learning rules like experience-weighted attraction and population dynamics might someday supply a firm justification for the long-standing focus on equilibrium and make fresh predictions about when and how quickly equilibria will arise.

Table 1 also describes the psychological foundations of the behavioral alternatives. Curiously, the rationality principles economists have chosen as theoretical workhorses are sensible prescriptions for ideal behavior: people would be better off if they added their monetary funds together to make important economic decisions, weighted outcome utilities by their prob-

abilities, resisted the lure of immediate satisfaction, and turned the other cheek rather than spending money to harm enemies. In contrast, the alternative assumptions are all justified by psychological evidence on how people think, rather than by normative prescription. Moving from rational principles to behavioral alternatives means moving from theorizing about how people *should* behave to theorizing about how they *do* behave and forces thoughtful economists to look to psychology.

Other rational principles have provoked behavioral critique, but formal replacements have not yet been created. For example, utility maximization is the assumption that people rank objects—e.g., monetary gambles, shopping baskets of products, and jobs—consistently enough to permit assignment of a unique utility number $u(X)$ to object X . Contrary to this presumption, there is a long list of ways in which utilities depend on how objects are described or on the way in which choices are made; these changes suggest that preferences are “constructed” (17). Evidence of constructed preference is widespread but has not yet led to a simple alternative to utility maximization, comparable to the alternatives listed in Table 1.

Another rationality principle that has resisted replacement so far is Bayesian probability judgment. Bayes’ rule prescribes a precise way in which judged probabilities should be altered in light of new information—namely, $P(A|D) = P(D|A)P(A)/P(D)$, where A is an hypothesis, D is new evidence, and $P(A|D)$ denotes the “posterior” probability of A conditional on observing the evidence D . Although normatively appealing, Bayes’ rule is cognitively unnatural, because (i) it insists that the order in which information arrives should not affect judgment (contrary to experimental evidence that quite old and quite new information weigh more heavily); and (ii) it insists that belief in A , measured by $P(A)$, and evaluation of the data, measured by $P(D|A)$, be independent. This independence is violated when beliefs about what is likely influence encoding of evidence, which is called “top-down” processing in perception and is manifested by “confirmation bias” in psychology (i.e., people see new evidence as more consistent with their beliefs than it really is; ref. 18).

One alternative to Bayes rule is a set of “heuristics” (19), such as availability (easily retrievable information is overweighted) and representativeness (hypotheses that are well represented by evidence are thought to be likely), but these have not been codified mathematically. Another alternative, used recently to model price swings in the stock market (20), is that people use Bayes’ rule based on the evidence they perceive but incorrectly specify the initial set of hypotheses about how events occur.

What’s Next?

The only active resistance to behavioral economics is based on the pessimistic fear that the psychological evidence is too fragmented to suggest coherent formal alternatives to rationality. Table 1 shows that this pessimism has been proven wrong four times. Utility maximization and Bayesian updating have admittedly proved harder to replace, but there are many ideas in the air, and progress is likely.

Behavioral economics has also been used to explain and predict field phenomena. Prospect theory has been used to explain stock market pricing anomalies (N. Barberis, M. Huang, and T. Santos, unpublished work), to explain asymmetric responses of consumers to price increases and de-

creases, and to predict downward-sloping labor supply among cab drivers (i.e., driving more hours when wages were lower, paradoxically; ref. 21). Hyperbolic discounting has been used to explain addiction and procrastination (22), as well as patterns in savings and consumption (23).

Behavioral economics can also provide a more realistic and thoughtful basis for making economic policy. Because rational people make few mistakes, policies aren’t necessary to help them. Relaxing rationality assumptions therefore permits reasoned argument about how people can be helped. For example, if people weight the future hyperbolically rather than exponentially, they will impulsively buy goods they will soon regret having bought. A good policy to help those who weight the future hyperbolically is a mandatory “cooling off” period that permits “hot” consumers to renege on purchase decisions for a short period of time, such as 3 days. (Many states have such policies.) Cooling-off policies exemplify “conservative paternalism”—they will do much good for people who act impulsively and cause very little harm (an unnecessary 3-day wait) for those who do not act impulsively; thus, even conservatives who resist state intervention should find them appealing.

Behavioral economists hope to look back soon and regard rational assumptions like exponential discounting, self-interest, or even equilibrium as special examples of much more general theories, much as simple functional forms [e.g., $u(x) = \log(x)$] are used in lieu of more general forms just for simplicity. Then behavioral economics will cease to be a distinctive label for an approach as it becomes part of mainstream economic thinking, evincing a healthy reunification of psychology and economics.

1. Thaler, R. H. (1992) *The Winner’s Curse*. (Free, New York).
2. Camerer, C. F. (1995) in *Handbook of Experimental Economics*, eds. Kagel, J. & Roth, A. (Princeton Univ. Press, Princeton), pp. 587–703.
3. Rabin, M. (1998) *J. Econ. Lit.* **36**, 11–46.
4. Smith, A. (1976) *Theory of Moral Sentiments* (Oxford Univ. Press, Cambridge, U.K.).
5. Smith, A. (1976) *The Wealth of Nations* (Oxford Univ. Press, Cambridge, U.K.).
6. Smith, V. L. (1998) *South. Econ. J.* **65**, 1–19.
7. Tversky, A. & Kahneman, D. (1992) *J. Risk Uncertainty* **5**, 297–323.
8. Kahneman, D., Ritov, I. & Schkade, D. (1999) *J. Risk Uncertainty*, in press.
9. Gonzalez, R. & Wu, G. (1999) *Cognit. Psychol.* **38**, 129–166.
10. Loewenstein, G. & Prelec, D. (1992) *Q. J. Econ.* **107**, 573–597.
11. Camerer, C. F. & Thaler, R. (1995) *J. Econ. Perspect.* **9**, 209–219.
12. Fehr, E. & Schmidt, K. (1999) *Q. J. Econ.*, in press.
13. Rabin, M. (1993) *Am. Econ. Rev.* **83**, 1281–1302.
14. Weibull, J. (1995) *Evolutionary Game Theory* (MIT Press, Cambridge, MA).
15. Bikhchandani, S., Hirshleifer, D. & Welch, I. (1998) *J. Econ. Perspect.* **12**, 151–170.
16. Camerer, C. F. & Ho, T. (1999) *Econometrica* **67**, 827–874.
17. Slovic, P. (1995) *Am. Psychol.* **50**, 364–371.
18. Rabin, M. & Schrag, J. L. (1999) *Q. J. Econ.* **114**, 37–82.
19. Kahneman, D., Slovic, A. & Tversky, A. (1982) *Judgment Under Uncertainty: Heuristics and Biases* (Cambridge Univ. Press, Cambridge, U.K.).
20. Barberis, N., Shleifer, A. & Vishny, R. (1998) *J. Financ. Econ.* **49**, 307–343.
21. Camerer, C. F. (1999) in *Choices, Values, and Frames*, eds. Kahneman, D. & Tversky, A. (Cambridge Univ. Press, Cambridge, U.K.), in press.
22. O’Donoghue, T. & Rabin, M. (1999) *Am. Econ. Rev.* **89**, 103–124.
23. Laibson, D. (1997) *Q. J. Econ.* **112**, 443–475.