

RATIONALITY FOR ECONOMISTS?

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ABSTRACT: Rationality is a complex behavioral theory that can be parsed into statements about preferences, perceptions, and process. This paper looks at the evidence on rationality that is provided by behavioral experiments, and argues that most cognitive anomalies operate through errors in *perception* that arise from the way information is stored, retrieved, and processed, or through errors in *process* that lead to formulation of choice problems as cognitive tasks that are inconsistent at least with rationality narrowly defined. The paper discusses how these cognitive anomalies influence economic behavior and measurement, and their implications for economic analysis.

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1. INTRODUCTION

Economics has always been concerned with the motivations and behavior of consumers. Rational behavior, in the broad meaning of sensible, planned, and consistent, is believed to govern most conduct in economic markets, because of self-interest and because of the tendency of markets to punish foolish behavior. However, rationality has been given a much more specific meaning in the classical theory of consumer demand perfected by Hicks and Samuelson that forms the cornerstone of courses in economic theory. In Herb Simon's words, "The rational man of economics is a maximizer, who will settle for nothing less than the best." While this model of consumer behavior dominates contemporary economic analysis, there is a long history among economists of questioning its behavioral validity and seeking alternatives.

What has come to be known as *Behavioral Decision Theory* had its origins in the von Neumann & Morgenstern (1947) treatise on choice under uncertainty and game theory.² This work had two major impacts beyond its direct effect of providing a prescriptive framework for analyzing risky behavior: It made formal, axiomatic analysis fashionable in economics and psychology, and it invited laboratory experimentation to test the descriptive validity of the axioms. Most of this work

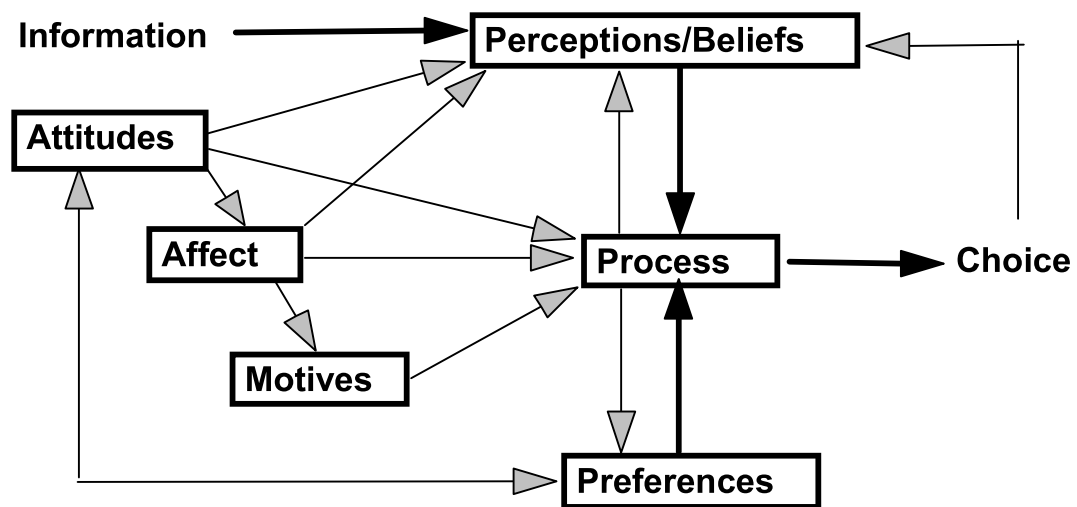
1. This paper is dedicated to the memory of Amos Tversky, whose brilliant life profoundly influenced psychology and economics. In the subject known as Behavioral Decision Theory, Tversky's hand appears everywhere, through his papers, and through his ingenious and definitive experiments that have made clear the importance of heuristics and judgment in human cognition. He will be counted among the great minds of the 20th Century. It was a delight and an education to have been his friend.

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2. There is an early history of economic thought on risk-taking behavior, in the work of Bernoulli (1736), Fisher (1930), Keynes (1921), Menger (1934), Knight (1921), and Ramsey (1931), as well as important developments by Friedman & Savage (1948), Marschak (1950), and Arrow (1951) that parallel the von Neumann-Morganstern contribution.

concentrated on choice among lotteries, but the ideas spread to other decision-making situations. In the following two decades, behavioral science and cognitive psychology came of age, with the participation of notable economists such as Allais (1953), Chipman (1960), Marschak (1950), Papandrea (1960), and Simon (1959).

Figure 1. The Decision Process



The rational consumer model is so deeply entwined in economic analysis, and in broad terms so plausible, that it is hard for many economists to imagine that failures of rationality could infect major economic decisions or survive market forces. Nevertheless, there is accumulating behavioral evidence against the rational model. Choice behavior can be characterized by a *decision process*, which is informed by perceptions and beliefs based on available information, and influenced by affect, attitudes, motives, and preferences. Figure 1 depicts these elements in the decision process and their linkages. A few brief definitions are needed. *Perceptions* are the cognition of sensation. I will use "perceptions" broadly to include *beliefs*, which are mental models of the world, particularly probability judgments. *Affect* refers to the emotional state of the decision-maker, and its impact on cognition of the decision task. *Attitudes* are defined as stable psychological tendencies to evaluate

particular entities (outcomes or activities) with favor or disfavor. Technically, attitudes are often defined as latent factors that explain the variation in a battery of indicators (most commonly semantic differentials). The domain of attitudes may be very broad, including for example comparative judgments, but an attitude itself is a unitary valuation. *Preferences* are comparative judgments between entities. Under certain technical conditions, including completeness and transitivity, preferences can be represented by a numerical scale, or *utility*. *Motives* are drives directed toward perceived goals. The *cognitive process* for decision making is the mental mechanism that defines the cognitive task and the role of perceptions, beliefs, attitudes, preferences, and motives in performing this task to produce a *choice*.

Neoclassical economics and psychology have radically different views of the decision-making process. First, the primary focus of psychologists is to understand the nature of these decision elements, how they are established and modified by experience, and how they determine values. The primary focus of economists is on the mapping from information inputs to choice. Preferences, or values, can be treated for most economic applications as primitives of the analysis, and the decision process as a black box. The aphorism "Economists know the price of everything and the value of nothing" correctly characterizes the discipline's scientific priorities.

Second, psychological views of the decision process are dominated by ideas that behavior is local, adaptive, learned, dependent on context, mutable, and influenced by complex interactions of perceptions, motives, attitudes, and affect. The *standard model* in economics is that consumers behave *as if* information is processed to form perceptions and beliefs using strict Bayesian statistical principles (*perception-rationality*), preferences are primitive, consistent, and immutable (*preference-rationality*), and the cognitive process is simply preference maximization, given market constraints (*process-rationality*). George Ansley (1982) gives a psychologist's view of these differences:

"Since ancient times people have tried to understand the nature of value, this is, how events motivate us. Two kinds of good have been described: what might be called visceral satisfactions, closely associated with the consumption of a concrete object and usually in the service of an obvious biological need; and more subtle satisfactions, such as [acquisition of] knowledge... .. Quantitative description of the value of concrete objects became the science of economics. By restricting its attention to goods that trade in a cash market, this discipline has been able to

describe striking regularities in how we value these goods. For all the usefulness that this may have had, it has tended to create a self-contained body of procedures without reference to the human motivational processes that actually determine value."

Is the lack of attention to the *process* of decision making and formation of values a fundamental failing of economics? If the standard model were always successful in explaining market behavior, and economists confined their attention solely to market data, the answer would be no. Economists might be criticized for lack of scientific curiosity, but their discipline would nevertheless sit securely on its own bottom. However, accumulating behavioral evidence that the standard model fails under some market conditions, and accelerating interest by economists in non-market data obtained from surveys and experiments, makes this lack of attention much more critical. Consumers may be wired differently than economic rationality in the sense of the standard model requires. While the consumer's wiring may produce patterns of market behavior that in many cases can be approximated well by the standard model, when we approach the consumer from a different angle, asking direct and unusual questions about beliefs or values, we find alarming variations from the standard economist's story. All these apparently normal consumers are revealed to be shells filled with books of rules for handling specific cognitive tasks. Throw these people a curve ball, in the form of a question that fails to fit a standard heuristic for market response, and the essential "mindlessness" of the organism is revealed. For most economists, this is the plot line for a really terrifying horror movie, a heresy that cuts to the vitals of our profession. To many psychologists, this is a description of the people who walk into their laboratories each day.

Economic Rationality and the Standard Model

I will call a consumer *Chicago man* if he conforms to the standard economic model of perception, preference, and process rationality, since the postulated behavior includes the ubiquity of maximizing behavior associated with Becker (1993) and the structure of beliefs associated with Lucas (1987). Chicago man is associated with one-way flows from perceptions and tastes to the

cognitive task of preference maximization, corresponding to the heavy arrows in Figure 1. I have four observations on the Chicago-man model:

- *It is convenient.* With additional assumptions, it leads to straightforward and handy procedures for empirical demand analysis and benefit-cost analysis. It has been an important tool for economic analysis and policy.
- *It is successful.* In applications ranging from assessing the opportunities for arbitrage in financial markets to the design of incentive schemes in contracts, it characterizes the most salient aspects of behavior in markets.
- *It is unnecessarily strong.* Many of the core objectives of economic analysis are attainable with weaker forms of rationality that relax perception-rationality, and permit some important deviations from preference rationality (e.g., mutable preferences) and process-rationality (e.g., bounded rationality). Both users and critics of the model sometimes interpret it in unnecessarily restrictive ways. For example, immutability of preferences does not imply that consumers are unaffected by history or incapable of learning, but only that preferences develop consistently following a "rational" template.
- *It is false.* Almost all human behavior has a substantial rational component, at least in the broad sense of rationality. However, there is overwhelming behavioral evidence against a literal interpretation of Chicago-man as a universal model of choice behavior.

So what is it with economists and Chicago man? Why is it that when economists are confronted with behavioral evidence against this model, they shuffle their feet, mumble excuses, and go on doing what they have been doing? I believe the answer is more complicated than saying Chicago man is the street lamp under which economists search for the truth, or even that it is the "anvil on which intellectual positions are hammered out." If one looks at the history of the concept of rationality, one sees two distinct ideas. The first, which might be termed 19th Century choice theory, is summed up in a quote from a principles textbook by Frank Taussig (1912):

"An object can have no value unless it has utility. No one will give anything for an article unless it yield him satisfaction. Doubtless people are sometimes foolish, and buy things, as children do, to please a moment's fancy; but at least they think at the moment that there is a wish to be gratified."

In this view, preference maximization is a synonym for choice. Preferences may be volatile and context dependent; what is missing from this theory is an explanation for the process that generates

this volatility. This view of rationality is virtually irrefutable until one starts to restrict and codify the manner in which preferences shift with experience in subsequent choice occasions. What is useful to note is that almost all of the elements of economic demand analysis, and of benefit-cost analysis, can be obtained by assuming little more than this. Suppose mild stationarity assumptions, so that the distribution of preferences in the population remains unchanged even though the preferences of each individual are volatile; call this *stochastic rationality*. A theory of social choice that looks only at the distribution of outcomes, and not the names of recipients, handles individual preference volatility in the same way that it handles heterogeneity in preferences across individuals; see McFadden (1981, 1997). Thus, rationality in an early, broad sense is sufficient to accomplish major objectives of economics, while avoiding some of the invariance properties in later restrictions and codifications of the Chicago- man model that are so easily refuted experimentally. Unfortunately, stochastic rationality is no panacea: it cannot explain cognitive anomalies that correspond to shifts in the distribution of preferences, nor is it immune to experimental refutation. For example, it implies the potentially refutable *regularity property* that a choice probability cannot rise when the choice set is expanded.

The second historical idea is the picture of the consumer codified in the 20th century and elegantly summarized (with italics added) in Debreu (1959):

" .A commodity is a good or a service completely specified physically, temporally, and spatially. For any economic agent a complete plan of action (*made now for the whole future*) is a specification for each commodity of the quantity that he will make available or that will be made available to him."

Debreu's consumer is postulated to choose his complete plan to maximize primitive rational preferences. The Debreu view of the consumer is rather Calvinistic: behavior is preordained by the consumer's genetically determined preferences over alternative life courses. This is not a perspective that most behaviorists will find appealing. However, note what it accomplishes. It allows very complex patterns of experience and learning, although in light of the consumers' postulated omniscience, perhaps we should call it verification or expression rather than learning. Because commodities can be contingent on future events, the theory provides a complete theory of behavior

under uncertainty. The whims of 19th Century utility theory are ruled out; apparently volatile and context-dependent current preferences are simply projections of immutable strategic preferences. Because we can never measure all the aspects of the complex life-course objects the consumer is choosing among, we are never sure whether what appears to be irrational behavior in some limited time window is not part of an overarching rationality, a grand strategic design. Deaton & Muellbauer (1980) draw out a different implication on the nature of commodities:

"The [preference] axioms are defined over some field of choice. In the usual presentation individual purchases of commodities are objects of choice. In principle, choice could be exercised over a much wider field, for example, over different life-styles, each embodying a preference system of its own. As it is, we shall interpret "commodities" rather widely, leaving the way open for application to leisure choice, intertemporal choice, social choice, and so on. Even so, a clear definition can be important in practice since two apparently similar choices may in fact be very different if there are unrecognized components."

Thus, commodities can be complex objects that have broad ethical and social aspects as well as more conventional physical ones. With this interpretation, propositions such as "If I go bankrupt, I will learn to enjoy the simple life" can be interpreted as aspects of objects in the field of choice. We may fail to measure all aspects of commodities, and apparent failures of rationality may arise from unrecognized but salient differences in the objects of choice.

There are very few irregularities or volatilities in observed behavior that could not be explained away by a combination of a rational template for preferences and unrecognized aspects of commodities. However, the Debreu-Deaton-Muellbauer view of rationality does impose invariance properties on preferences that in combination with other assumptions become a powerful restriction. Its most serious limitation for a behaviorist is that its panoramic view of the consumer provides an unsuitable platform for understanding the *process* of learning and adaptation.

The Chicago-man model in its most commonly used form is a specialization of the Debreu-Deaton-Muellbauer view of rationality in which commodities are restricted to market goods without social or ethical aspects, and the temporal structure of preferences is tightly restricted. Stripping away the robust features of the abstract version makes Chicago man a powerful but brittle model that is vulnerable to behavioral attack. Economic opinion spans the spectrum from those who

believe Chicago man is the literal truth to those who believe that failures of rationality appear systematically and predictably in economic decisions. However, I believe that most economists think rationality in one of its more fundamental and robust forms is valid, and think of Chicago man as an abstraction or approximation to this form of rationality. They do not really expect the approximation to work perfectly, and they do not interpret evidence against the approximation as necessarily evidence against the fundamentals. Perhaps this is a sensible way to approach economic analysis, but it may blind economists to behavioral evidence that challenges rationality at a more fundamental level. One implication of these comments is that economic rationality has many lives, and will not be felled by the silver bullet of a single experiment.

The Psychology of Decision-Making

Psychology has developed a variety of theories and techniques for studying the *process* of decision-making, including decision delay times, and subject reports before, during, and after decisions are made, and has accumulated a large body of experimental evidence on the decision-making process. The leading research paradigm has been the focus of Amos Tversky and Danny Kahneman on experimental study of *cognitive anomalies*: circumstances in which individuals exhibit surprising departures from rationality. This work has both fascinated and dismayed economists; it has been like watching master carpenters construct the scaffold for your hanging. The studies show that individuals faced with decision-making tasks in carefully constructed experimental settings often exhibit behavior that is inconsistent with the Chicago-man model: decision makers have trouble handling information and forming perceptions consistently, use decision-making heuristics that can fail to maximize preferences, and are too sensitive to context and process to satisfy rationality postulates formulated in terms of outcomes. Cognitive anomalies are most apparent for choice among formal lotteries where probability judgments are critical, but also appear in "risk-free" choice problems.³ Here is Tversky's (1977) own commentary on these results:

3. Some degree of uncertainty surrounds any decision, due to uncertainty about the attributes of alternatives, conditions under which delivery will occur, and indirect social and strategic implications of the choice.

" .Daniel Kahneman and I have studied the cognitive processes underlying the formation of preference and belief. Our research has shown that subjective judgments generally do not obey the basic normative principles of decision theory. Instead, human judgments appear to follow certain principles that sometimes lead to reasonable answers and sometimes to severe and systematic errors. Moreover, our research shows (Tversky & Kahneman, 1974; Kahneman & Tversky, 1979a) that the axioms of rational choice are often violated consistently by sophisticated as well as naive respondents, and that the violations are often large and highly persistent. In fact, some of the observed biases, such as the gambler's fallacy and the regression fallacy, are reminiscent of perceptual illusions. In both cases, one's original erroneous response does not lose its appeal even after one has learned the correct answer.

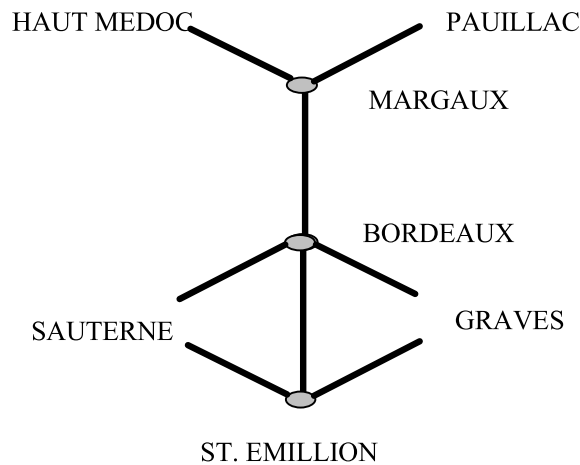
To gain a perspective on this research, it is useful to draw some parallels between decision-making and vision. Figure 2 is a simplified map of the wine-producing region around Bordeaux. Bordeaux appears to be closer to St. Emillion than to Margaux. However, the reader will immediately recognize that this is the classical Muller-Lyer optical illusion in which the distances are actually the same. Even after you are told this, St. Emillion looks closer. Could this illusion affect behavior? In fact, St. Emillion is more crowded than Margaux, perhaps due to other wine-lovers' illusions, but I doubt that anyone would claim that this is due to mass misreading of maps. We learn to be suspicious of our perceptions. We may see things cock-eyed, but we adopt conservative behavioral strategies, such as making it a rule to always measure distances on the map, that prevent us from deviating too far from our self-interest.⁴ Does this mean that there is, after all, a saving remnant of rationality? In the broad sense of rationality, perhaps so.

One can learn a great deal about how visual information is processed by studying the breakdown regions where optical illusions occur, and draw from this lessons for how "normal" vision operates. Clearly a crude "what you see is what a camera sees" model of vision is false. Nevertheless, if your are trying to predict how people react when driving, the crude model may be a better platform for forecasting than the library of optical illusions. I once asked Tversky if he thought choice behavior was similar to vision, in that one could induce cognitive illusions under specific circumstances, but for most human activity cognition is acceptably rational. He replied that

4. Recognizing and compensating for one's limits are called *meta-cognition* and *calibration*.

his experiments on cognition *were* like experiments in vision, concentrating on the breakdown region that reveals how we are put together. He said that these experiments were not designed to be representative of all behavior, and should not *in themselves* be interpreted as broadly predictive. He went on to say, however, that he saw little evidence from the research on cognition that would suggest that human thought is ever sufficiently divorced from context and process to produce the global invariances required by economic rationality.

Figure 2. Roads in the Wine-Producing Region near Bordeaux



The experimental results from psychology have not been codified into a "standard model" for behavioral decision theory; and many psychologists would argue it is not possible or useful to construct such a model. Nevertheless, it is possible to identify some of the major features of a psychological view of decision-making. Referring to Figure 1, the central element is the *process* by which the cognitive task is defined and elements such as perceptions and attitudes enter. Attitudes and affect are major factors in determining motivation and the structuring of the cognitive task. Attitudes and affect also influence perceptions. Finally, there may be feedbacks, depicted by light arrows in Figure 1, from process and choice to attitudes and perceptions, as the decision-maker

reconciles and rationalizes trial choices. Preferences may play a role in the psychological view, as may maximization, but they compete with other heuristics for defining and solving the cognitive task.

Psychologists make a sharp distinction between attitudes and preferences. In this view, attitudes are multi-dimensional, with no requirement of consistency across attitudes. Preferences are viewed as constructed from more stable attitudes by a context-dependent process that determines the prominence given to various attitudes and the tradeoffs between them; see Kahneman, Ritov, & Schkade (1998) and Payne, Bettman, & Johnson (1992). Technically, a utility index can be interpreted as an attitude scale, and may be defined over a broad field of objects, not just concrete outcomes. The hypothesis that a utility index is less stable than other attitude scales has some plausibility in light of experimental evidence that cognitive anomalies arise in forming trade-offs, but it is difficult to formulate and test this hypothesis satisfactorily because there is no consensus on what the stable attitudes are, and because attitude scales that have been proposed seem themselves to be sensitive to context. At bottom, the differences between psychologists and economics on the attitude/preference dimension are almost theological: the psychologists' decision-maker is driven by many demons, the economists' decision-maker by the one "devil that made me do it".

Choice tasks are distinguished by their complexity and familiarity, from quick and largely automatic or impulsive decisions on one hand to complex, planned decisions on the other; see Azjen (1987), Garling (1992,1998). An example of an "automatic" decision is choosing to change lanes when driving. An example of a "planned" decision, which may also contain "impulsive" elements, is choice of occupation, where the alternatives have to be elicited or created, and the task requires problem-solving to clarify attributes and goals. Psychologists emphasize the importance of affect on decisions, with emotion not only inducing "hot" or "impulsive" decisions, but also coloring perceptions; see Lowenstein (1996).

There may be feedbacks from the decision process to perceptions, particularly through affect and attitudes, with perceptions becoming an instrument to facilitate the cognitive decision process. Svenson (1979,1996) describes a decision process in which simple heuristics are used to produce a preliminary choice, using *markers* and *editing* to simplify and group information; see Kahneman &

Tversky (1979) and Coupey (1994). Then, the decision-maker engages in a process of differentiating the test choice from the alternatives, through an internal dialogue in which ambiguity about tastes is resolved so that features where the test choice has an advantage are emphasized, through sharpening of perceptions of the favorable attributes of the test choice and unfavorable attributes of alternatives, and through restructuring of the choice situation by adding or resurrecting alternatives. There may also be consolidation of perceptions following choice, to reduce dissonance and promote development of rules and principles for future decisions.

Outside a relatively narrow domain where choices are driven by the goal of satisfying visceral needs, psychologists argue that decisions are often the result of application of attitudes and moral principles. In this view, humans often approach decisions as problem-solving tasks, seeking *exemplars* that suggest simple choice rules and reduce cognitive effort; see Payne, Bettman, & Johnson (1992). Even in the emotional realm, where "out of control" behavior appears anything but rational, affect may operate, internally and externally, as a device to promote self-interest; see Frank (1990). The proverb "Learn to complain without suffering" illustrates use of a meta-rational rule for manipulation of affect.

Psychologists use the terms *problem-solving*, *reason-based*, or *rule-driven* to refer to behavioral processes that override cost-benefit calculations, relying instead on principles or analogies to guide choice. Drazen Prelec (1991) distinguishes this view of decision-making from utility-maximization models by the cognitive processes involved: "Decision analysis, which codifies the rational model, views choice as a fundamentally technical problem of choosing the course of action that maximizes a unidimensional criterion, utility. The primary mental activity is the reduction of multiple attributes or dimensions to a single one, through specification of value trade-offs. For rule-governed action, the fundamental decision problem is the quasi-legal one of constructing a satisfying interpretation of the choice situation. The primary mental activity involved in this process is the exploration of analogies and distinctions between the current situation and other canonical choice situations in which a single rule or principle unambiguously applies." Prelec goes on to conclude: "The purpose of rules must be derived from some weakness of our natural cost-benefit

accounting system, and one might expect to find rules proliferating in exactly those choice domains where a natural utilitarianism does not produce satisfactory results."

Prelec identifies situations where cost-benefit calculations get into difficulty as ones where there is a mismatch between cost and benefits in terms of time, saliency, or scale. Consider the question of whether to fasten one's seat belt when driving. A Chicago-man at the start of a trip will compare the time-cost of buckling up with the probabilities of avoiding injury, given driving conditions. The difficulty with the utilitarian calculation is that one is trading off a small immediate time cost against an improbable large future loss that is difficult to anticipate and evaluate; see Fredrickson & Kahneman (1993), Kahneman, Fredrickson, Schreiber, & Redelmeier (1993), Lowenstein (1988), and Lowenstein & Schkade (1998). This creates a saliency mismatch where errors in handling uncertainty or evaluating the tradeoff between minor inconvenience now and injury in the future may lead to tactical choices that clearly contradict strategic self-interest. A "sensible self" might decide that this calculus is too tedious, or too prone to misjudgment, and adopt the rule "always fasten your seat belt". Going further, seat belt laws can be interpreted as social recognition that rules are needed to override deficient individual cost-benefit calculations.

There is nothing in rule-driven behavior *per se* that is inconsistent with the Debreu-Deaton-Muellbauer view of the economically rational consumer; rules may simply facilitate the consumer's life-course strategic preference maximization. This could be true even if rule-driven behavior is apparently inconsistent with the Chicago-man model. For example, suppose you look whether consumers buckle up on trips of various descriptions. You might be led to conclude that consumers are irrational, either overestimating small probabilities because they always buckle up, or underestimating them because they rarely buckle up. However, strategically optimal behavior will appear tactically non-optimal precisely when the purpose of strategy is to avoid tactical decisions that have dangerous *long-run* implications.

The psychological view of rule-driven procedures is that they come not from overarching strategic rationality, but rather are learned via the process in which children acquire self-control, learning to delay gratification, until in normal adults some degree of abstinence and control becomes

an end in itself. Processes of precommitment, particularly adoption of rules or principles, become an important part of behavior. Conduct in an abstract choice situation is likely to be determined by deciding which principles apply. In this view, there is no reason for choices in different situations to be mutually consistent.

To test for the presence of rule-driven behavior, an experiment you can try at home is to ask a friend for the payment they would require today to give up their right to vote (WTA) in the next election, and alternately the maximum poll tax they would pay today to have the right to vote (WTP) in this election. For most people, WTA is much larger than WTP. A utilitarian rationalization, requiring that each individual's indifference curve be kinked at one vote no matter what his circumstances, is implausible. A more plausible explanation is that consumers are guided by two principles, "voting is a fundamental entitlement; you should not have to pay for it", and "it is immoral to sell a fundamental entitlement".

Since many of the features of the psychological views of decision making just described are rooted in the work of Kahneman and Tversky, I will call this view the *K-T man*. Beyond the obvious scientific question of where the truth lies between Chicago man and K-T man, there is a natural question for economists to ask: How deeply do cognitive anomalies infect economic market behavior and economic data, and how much of the edifice of economic analysis, particularly demand forecasting and project evaluation, can be preserved? The answer will depend critically on how rationality fails. It is possible that the standard model of rationality works well in some circumstances, where repetition and the experience of market rewards train consumers to adopt behavior rules that are consistent with rationality. It is also possible that consumers conform to the rational model at some points in the decision process, but not in others. For example, it may be the case that perceptions are particularly susceptible to cognitive illusions, but the evolution of preferences follows a rational template. In this case, behavior may be inconsistent with the Chicago-man model, even in some market situations, but fundamentals exist that form a basis for economic analysis.

Table 1. Cognitive Anomalies

Effect	Description
CONTEXT:	
Anchoring	Judgments are influenced by quantitative cues contained in the statement of the decision task
Context	History and presentation of the decision task influence perception and motivation
Framing	Equivalent lotteries, presented differently, are evaluated differently
Prominence	The format in which a decision task is stated influences the weight given to different aspects
Saliency	Subjects are inconsistent in selecting and weighting the information judged salient to a decision task
REFERENCE POINT:	
Asymmetry	Subjects show risk aversion for gains, risk preference for losses, and weigh losses more heavily
Reference point	Choices are evaluated in terms of changes from an endowment or status quo point
Status Quo/Endowment	Current status and history are favored relative to alternatives not experienced
AVAILABILITY:	
Availability	Responses rely too heavily on readily retrieved information, and too little on background information
Certainty	Sure outcomes are given more weight than uncertain outcomes
Focal	Quantitative information is retrieved or reported categorically
Isolation	The elements of a multiple-part or multi-stage lottery are evaluated separately
Primacy and Recency	Initial and recently experienced events are the most easily recalled
Regression	Idiosyncratic causes are attached to past fluctuations, and regression to the mean is underestimated
Representativeness	High conditional probabilities induce overestimates of unconditional probabilities
Segregation	Lotteries are decomposed into a sure outcome and a gamble relative to this sure outcome
SUPERSTITIION:	
Credulity	Evidence that supports patterns and causal explanations for coincidences is accepted too readily
Disjunctive	Consumers fail to reason through or accept the logical consequences of actions
Superstition	Causal structures are attached to coincidences, and "quasi-magical" powers may be attributed to opponents
Suspicion	Consumers mistrust offers and question the motives of opponents, particularly in unfamiliar situations
PROCESS	
Rule-Driven	Behavior is guided by principles, analogies, and exemplars rather than utilitarian calculus
Process	Evaluation of outcomes is sensitive to process and change
Temporal	Time discounting is temporally inconsistent, with short delays discounted too sharply relative to long delays
PROJECTION:	
Misrepresentation	Subjects may misrepresent judgments for real or perceived strategic advantage
Projection	Judgments are altered to reinforce internally or project to others a self-image

2. EXPERIMENTAL EVIDENCE ON RATIONALITY

I will summarize some of the evidence for the conclusion that the Chicago man model is false, and offer my own assessment of the sources, scope, and significance of this failure. There are excellent surveys of behavioral decision theory by Camerer (1998), Machina (1989), Rabin (1997), and Thaler (1991); to reduce overlap, I abbreviate my discussion of the areas of choice under uncertainty and behavior in games which are emphasized in these surveys. Table 1 lists major cognitive anomalies, and gives a capsule description of each. Calling these phenomena "anomalies" does not necessarily mean that they are uncommon, or that they are inconsistent with rationality at some level of abstraction.

The text expands some of the descriptions in Table 1 that are incomplete and overly general. The list is divided somewhat arbitrarily into four major areas dealing with information processing and formation of perceptions (Context, Reference Point, Availability, and Superstition) and two major areas dealing with the process of structuring the cognitive task (Process and Projection). The list is incomplete, and has considerable overlap. For example, prominence, availability, and status quo effects may all be manifestations of a phenomenon that less accessible information is discounted or ignored; temporal and rule-driven anomalies are two faces of the ways humans deal with time perception and delayed gratification.

CONTEXT EFFECTS

The anomalies in this group arise because the presentation of information influences how it is processed. *Framing* refers to the format in which alternatives, particularly lotteries, are presented. In a Kahneman & Tversky (1984) experiment, subjects are told that a new disease is expected to kill 600 people, and then given the choice between alternatives A and B in the table below, or in a second experiment, between alternatives C and D:

Experiment 1 (N = 152)	Choice	Experiment 2 (N = 155)	Choice
A: 200 people saved	72%	C: 400 people die	22%
B: 600 saved with probability 1/3 0 saved with probability 2/3	28%	D: 0 die with probability 1/3 600 die with probability 2/3	78%

The alternatives A and C have identical outcomes, as do the alternatives B and D. Nevertheless, changing the frame from lives saved to lives lost significantly alters choice. The conclusion of

Kahneman and Tversky is that humans think differently about gains and losses from the status quo, and if one frames a decision task in a way that alters the perceived status quo, then one can alter choice behavior; see also Tversky & Kahneman (1981) and Sonnemans, Schram, & Offerman (1994).

Context refers more generally to the current and historical setting in which a choice is offered. For example, Simonson & Tversky (1992) report an experiment involving microwave brands A and B, and a more expensive model A' of brand A. They found that the proportion of consumers choosing A was higher from the choice set {A,A',B} than from the choice set {A,B}, a violation of the regularity property of stochastic preference maximization. Apparently, the presence of the expensive model A' in the choice set made A appear to be a bargain, and thus more attractive; see also Huber, Payne, & Puto (1982). Unlike the canonical setting for rational choice, the consumers in these experiments are presented with alternatives that in themselves involve uncertainty about their true attributes. Consumers are faced with the statistical exercise of drawing inferences about these attributes. Context effects might appear as the result of such inference, even if information processing is "rational". For example, in choice among appliances, consumers are aware that price is usually correlated with quality, but that brands of a given quality may also vary in price. Observed price alone is not sufficient to identify the quality of a product, and whether it is a bargain at this price. Additional information, such as the information that the manufacturer of A sells another model A' with more features at a considerably higher price, might lead the consumer to infer that A is in fact a bargain. Simonson and Tversky anticipated this problem, and circumvented it by giving consumers a catalogue to read at the start of the experiment that contained information on all the appliance brands. Thus the information available to the consumer remains the same, even when the choice set is altered. Then, the experiments indicate that the inconsistencies that consumers show arise because the context alters the *saliency* of available information.

In a related finding, Tversky, Sattath, & Slovic (1988) show that the decision format can change the *prominence* given to different attributes of alternatives. In choice among products, price is given more weight in a direct choice task than it is when consumers are asked to specify an attribute level (such as price) that makes two alternatives indifferent. The *preference reversal* phenomenon in choice among lotteries may arise from the effect of format on prominence; see Delquie (1993), Grether & Plott (1979), Machina (1989), and Tversky, Slovic, & Kahneman (1990). Obviously, marketers can frame their presentations to take advantage of such systematic biases.

Anchoring describes a family of effects observed in many psychological studies of beliefs about uncertain quantities, such as the length of the Amazon or the height of the tallest redwood; see

Tversky & Kahneman (1974). Subjects in these studies are asked to judge whether a particular value (the anchor) is higher or lower than the uncertain quantity, before stating their own estimate. A robust result is that subjects start from the anchor, and fail to adjust fully to their base beliefs, so that their estimates are pulled toward the anchor. Even an explicitly uninformative prompt, such as the output of a random device, can operate as an anchor. The usual explanation for the phenomenon of anchoring is that the anchor value creates, at least temporarily, the possibility that the quantity to be estimated could be near this value. It is possible to construct models of *rational* anchoring in which subjects behave as Bayesian statisticians who treat the anchor as a datum that with some probability is valid and can be used to update a prior distribution of possible values. However, the fact that anchoring occurs even when the anchor value is explicitly random indicates that much of the effect comes from how humans handle uncertainty, rather than from rational statistical processing of information.

In an experimental study analyzed by Green, Jacowitz, Kahneman, & McFadden (1996), anchoring effects were investigated for both estimation tasks and public project valuation tasks. An initial sample of subjects were asked unprompted open-ended questions. Then a second sample was recruited, and asked referendum (yes/no) questions as to whether their estimates exceed specified anchors; the anchors were picked by experimental design from specified quantiles of the first sample responses. The finding was that, compared to the first sample, the anchoring provided by the referendum cue value increased minority "Yes/No" responses (e.g., an anchor corresponding to the 90 percent quantile of the open-ended responses would yield 20 percent rather than 10 percent "Yes" referendum responses). Consequently, anchors located in the upper tail of a skewed distribution of unprompted open-ended responses produce a dramatic upward shift in the apparent distribution of responses when it is deduced from referendum data alone.

A large panel study, the Asset and Health Dynamics of the Oldest Old (AHEAD) survey, is tracking the economic and health status of elderly households. To reduce serious non-response problems, consumers who respond "Don't Know" to economic questions are asked to give "Yes/No" responses to an unfolding series of values that bracket the individual's economic value. This elicitation procedure, called the *unfolding bracket* method, is very successful in increasing response rates, but responses may be influenced by anchoring effects. Hurd *et al* (1997) analyzed an experimental module in this survey that varied the levels and sequence of prompts, and found that there is indeed economically significant anchoring, with estimated mean household consumption varying by as much as a factor of two depending on the sequence of prompts. Hurd (1998) finds

significant anchoring in a similar experiment conducted in a panel of consumers approaching retirement. These studies conclude that except for idiosyncrasies in tasks caused by responses at focal points, anchoring effects are systematic and largely predictable across a spectrum of tasks, economic and non- economic. The studies recommend varying anchors by experimental design so that their impact can be identified and compensated for.

In addition to economic household surveys where one would expect to see anchoring effects very similar to those found in psychological experiments, anchoring may affect market transactions involving complex commodities. For example, houses and automobiles are typically sold by bargaining, starting from initial price quotes. It would be surprising if perceptions were not colored by the initial quote. An implication for economic analysis is that one should be cautious in taking market data at face value in project evaluation.

REFERENCE POINT EFFECTS

A *reference point* is a base position or alternative from which changes are assessed. In particular, in consumer behavior under uncertainty, the reference point is the consumer's position before entering the market for lotteries. For a classically rational economic consumer, only final allocations matter, and the reference point is irrelevant. However, Kahneman & Tversky (1979, 1984) find that in choice among lotteries, the pain of marginal losses apparently exceeds the benefit of comparable gains. Consequently, consumers display *loss aversion*, leading them to reject some actuarially favorable lotteries even at small scale, contrary to the implications of expected utility maximization. Another interpretation is that the consumer gives the status quo a privileged position, and may refuse to trade away from it. This effect also appears when there is no uncertainty, in the form of a gap between willingness-to-accept (WTA) less of a commodity and willingness-to-pay (WTP) for more of this commodity, starting from the consumer's initial position. Thaler (1980) calls this the *endowment effect*; see also Kahneman, Knetsch, & Thaler (1991) and Samuelson & Zeckhauser (1988).

Experiments by Thaler & Johnson (1990) and Kahneman, Knetsch, & Thaler (1990) establish that endowment effects are not only pervasive and substantial, but also almost instantaneous, so that they are not coming from sentimental attachment to long-term possessions. There are economic factors that will induce some differences between WTA and WTP, arising from diminishing marginal rates of substitution or from income effects. However, the magnitude of the endowment effect and features built into the experiments eliminate these as plausible explanations.

One of the implications of the endowment effect is that consumers will refuse to trade away from an endowment point for a range of relative prices. As a consequence, fewer market transactions will occur than the usual calculus of marginal utilities would suggest. There are some conventional economic arguments for a paucity of transactions: the transactions cost of monitoring and completing small trades, and asymmetric information, or fear of asymmetric information, between traders. If market trades are viewed as having uncertain outcomes, above and beyond lottery risk, due to the potential perfidy of trading partners, then there are "rational" reasons to avoid trades that promise only modest gains. The reference point effect for lotteries, the endowment effect for "risk-free" objects, and mistrust of trades may all be facets of the same process of learning to be suspicious of market offers.

AVAILABILITY EFFECTS

The anomalies in this group arise from the way humans process information to form beliefs. Tversky & Kahneman (1971) and Kahneman & Tversky (1973,1982) have documented several persistent errors that are made in handling probabilities: a *representativeness* effect in which subjects fail to use Bayes' law, and instead overestimate the unconditional probability of an event A when the conditional probability of A given B is high, even though the probability of B is low; an *availability* effect in which consumers place too much weight on easily accessible or salient information, and too little on base rates, and fail to account properly for sampling variation; and a *regression effect* in which subjects interpret observed changes as idiosyncratic shifts in the underlying structure rather than random fluctuations, and fail to anticipate regression to the mean. These biases appear to carry over to choice situations where consumers infer properties of the alternatives from their presentation; see Kahneman, Slovic, & Tversky (1982).

Several other cognitive illusions are related to the effort required to retrieve various pieces of information; these might all be referred to as *availability* effects. Examples are *primacy* and *recency* effects, in which initial or most recent experiences are more readily recalled than ones in between, *saliency* effects in which the information that seems most relevant at the moment is overemphasized relative to other information, and *status quo* effects in which historical experience is more easily retrieved than hypothetical alternatives. *Framing* and *anchoring* phenomena may be related to availability as well, with the question itself providing immediately accessible information. The possible impacts on economic survey responses are obvious: information on social security income is more accessible than asset income, so the former may provide an internal anchor for the

latter; beliefs about mortality may be unduly influenced by the ages attained by relatives and friends, to the exclusion of baseline information from life tables; recent changes in health status may be weighed too heavily in predicting future health status, with insufficient allowance for regression to the mean.

Focal effects occur when categorical approximations are used to minimize recall and reporting effort; see Poulton (1989, 1994). Mentally, we may retrieve quantitative memory via a series of referendum queries, or even organize quantitative information in a hierarchical, categorical format, so that focal responses are more available than non-focal ones. Open-ended responses on many economic variables exhibit the focal phenomenon, with responses piled up at rounded off numbers. For example, travel times are usually reported in five minute intervals, willingness to pay for a public good in multiples of \$5, etc. Hurd *et al* (1997) found in AHEAD data that focal responses are more common among the cognitively impaired, and that the probabilities of giving focal responses are correlated across questions.⁵ The focal response phenomenon can have significant impacts on analysis of economic data. Since focal responses concentrate at rounded-off dollar amounts, growth or inflation are captured mostly through switches between focal points, rather than marginal adjustments. "No change" may be a focal point in expectations questions. Focal effects interact with context, as changing reporting periods or units changes the natural focal points.

Let $(x_1, p_1; x_2, p_2; \dots; x_k, p_k)$ denote a lottery that has payoff x_k with probability p_k . By convention, omit x_k, p_k if $x_k = 0$, and omit p_k if $p_k = 1$. Then the lottery that pays \$100 with probability 0.4 and zero otherwise is denoted $(100, 0.4)$, and a sure payoff of \$100 is denoted (100) . There are a number of cognitive anomalies specific to evaluation of lotteries. The classic anomaly is the Allais paradox, illustrated by the following experiment of Kahneman & Tversky (1979a).

Experiment 1 (N = 95)	Choice	Experiment 2 (N = 95)	Choice
A: Lottery (4000, 0.8)	20%	C: Lottery (4000, 0.2)	65%
B: Sure (3000)	80%	D: Lottery (3000, 0.25)	35%

A statistically significant number of subjects choose B over A and C over D. Expected utility maximization using the objective probabilities and a utility of outcomes $v(x)$ scaled with $v(0) = 0$

6. Cognitive impairment is measured using a battery of questions to test several domains of cognition: immediate and delayed word recall, counting backwards, and naming of public figures, dates, and objects; see Herzog & Wallace (1997). No attempt is made to distinguish physical and psychological sources of impaired cognitive performance.

implies from the first experiment that $v(3000)/v(4000) > 0.8$ for a majority of subjects. The second experiment implies the opposite inequality for a majority of subjects, a contradiction of the substitution axiom in von Neumann-Morgenstern utility theory.

A stylized summary of choice behavior among lotteries, deduced from this experiment and others, is that consumers display (i) a *reference point* effect, evaluating lotteries as *changes* from a reference point that may be sensitive to framing, (ii) an *asymmetry effect* in which the consumer is more sensitive to losses than to gains, displaying risk aversion for gains and risk seeking for losses, (iii) a *certainty effect* in which sure outcomes are overvalued relative to lotteries, (iv) an *isolation or cancellation effect* in which common aspects of alternative lotteries are ignored when they are compared, and (v) a *segregation effect* in which a riskless component of a lottery is evaluated separately from the risky component.

Kahneman & Tversky (1979a) and Tversky & Kahneman (1992) have formulated a partial theory of risky choice that accommodates these experimental findings; they call this *prospect theory*. This theory postulates that choice is achieved by maximization of a *weighted* value function of *gains* and *losses*: The shape of the value function conforms to the asymmetry effect. The weighting function overweights improbable events and underweights probable events. An important psychological part of the theory is that consumers first engage in an *editing* process that determines the reference point and the perception of lottery outcomes as gains or losses. Segregation and isolation effects lead to different evaluations of lotteries that mix positive and negative outcomes from those that have only non-negative (or non- positive) outcomes. Prospect theory is partial in that it does not spell out except via anecdotes the operation of the editing process to determine the critical reference point and the perception of lotteries, particularly complex or multi-stage lotteries.

Let $v(x)$ denote the value function and $\pi(p)$ the weight function from prospect theory, with $v(0) = 0$. The operation of the theory can be illustrated by application to an experiment reported by Tversky & Fox (1995). The table below gives the median net willingness-to-pay $w(X,P)$ for a lottery that pays X with probability P , and zero otherwise; X can be either positive or negative. The experimental results show the asymmetry effect, with risk aversion for gains and risk seeking for losses, reversed for small probabilities due to overweighting.

<u>Probability</u>	<u>Gain</u>	<u>Loss</u>
<i>Low</i> (<i>E Payoff</i> = ±5)	$w(100,0.05) = 14$ (<i>risk seeking</i>)	$w(-100,0.05) = -8$ (<i>risk aversion</i>)
<i>High</i> (<i>E Payoff</i> = ±95)	$w(100,0.95) = 78$ (<i>risk aversion</i>)	$w(-100,0.95) = -84$ (<i>risk seeking</i>)

Kahneman and Tversky argue that when asked to pay a *net* amount W for a lottery (x,p) , consumers segregate the certain payment W and the lottery, evaluating each in isolation, *without* adjusting their reference point for the payment W . Thus, an offer of the lottery ticket (x,p) at price W is *not* evaluated the same way as a free lottery ticket $(x-W,p;-W,1-p)$. In the experiment above, the median response $w(100,0.05) = 14$ implies $\pi(0.05) \cdot v(100) + v(-14) = 0$. The experimental outcomes are easily represented by the prospect theory model, say by postulating $\pi(0.05) = 0.2$, $\pi(0.95) = 0.9$, and a piecewise linear $v(x)$ function through the points given below:

x	-100	-78	-14	0	8	84	100
v	-200	-180	-40	0	20	90	100

On the other hand, Mark Machina has pointed out that if the payment W and the lottery ticket (x,p) *were* evaluated the same as the simple lottery $(x-W,p;-W,1-p)$, as expected utility theory would require, than the experimental results are inconsistent with a monotone increasing value function, even if one allows for the possibility of biased weighting of probabilities.

A possible explanation for the certainty effect is that consumers suspect that unforeseen events may occur to prevent completion of a lottery. Thus, they may seek to postpone booking sure losses in the hope that an unforeseen event might reverse them, and seek to immediately book sure gains for the same reason. Certainty and asymmetry effects are sharpened if consumers mistrust their trading partners, and suspect that unforeseen events in which they lose are more likely than those in which they gain. For example, a consumer whose decisions are consistent with the prospect theory model just described is vulnerable to a mugs' game in which he would purchase the lottery ticket $(100,0.05)$ at the apparently favorable price of \$13, and once this is in his pocket and part of his reference point, would sell this lottery ticket at the apparently favorable price of \$7. The consumer then ends up where he started, but \$6 poorer. A strategic defense is to mistrust one's perceptions and make a rule to avoid gambles; a psychological defense is to reduce dissonance by attributing losses to cheating by opponents.

SUPERSTITION EFFECTS

One of the implications of almost any model of rational economic choice under uncertainty is that two consumers who have different beliefs about the probability that an event will occur should find it mutually advantageous to wager on this event. Hildreth (1974) noted that this mutual advantage does not seem to translate into ubiquitous betting:

"Ordinary conversations suggest that different opinions on future events are common and it is not hard to think of people who must surely have widely different relative needs in particular events. With the multitude of possible people-event combinations in any large community, it would seem at first glance that there must be many potential mutually favorable bets. Why is more betting by the general public (as opposed to habitual gamblers) not observed?"

In a response, McFadden (1974) suggests some cognitive factors that are consistent with the Kahneman and Tversky findings, and provide one possible interpretation for some of the observed behavior:

"Professor Hildreth has suggested that when individuals consider wagers against the background of the 'grand lottery of life', they may not view as independent the events determining the outcomes of the 'grand' lottery and the wager. We first ask whether it is likely that personal probabilities would tend to display this non-independence; in particular, more likely than 'objective' probabilities determined by relative frequencies. An examination of human psychology suggests an affirmative answer. Chance jolts the harmony of conscious belief; relief from this dissonance is gained by imposing an order over chaos, weaving a fabric of cause and effect, out of the jumbled coincidences of random events. The mind accepts and emphasizes those coincidences which reaffirm the perceived order of the universe, ignores and forgets inconsistent data."

This comment goes on to cite evidence from Festinger (1957) and Davidson & Suppes (1957) that personal probabilities will fail to reflect the independence properties of 'objective' probabilities, instead exhibiting correlations between events which are in fact independent. Tune (1964) and Kahneman & Tversky (1972) document experimentally that individuals intuitively reject randomness when they see recognizable patterns or streaks, systematically underestimating the probability that these can occur by chance. These biases reinforce the influence of random coincidences on beliefs and behavior. Selective memory in which coincidences of favorable or unfavorable events are remembered more readily than non-coincidences may be a cognitive mechanism that induces subjective correlation between objectively independent events, and induces belief in 'streaks' of good or bad luck. Individuals may also seek "emotional and spiritual sustenance" by searching selectively for confirmation of current beliefs; see Sterman (1994). Paraphrasing Umberto Eco, if two things don't fit, a *credible* individual may nevertheless believe both, thinking that somewhere, hidden, must be a third thing that connects them. Both selective memory and selective search cause individuals to

be *superstitious*, perceiving correlation between their own actions and outcomes of random events even when such correlation is implausible. Superstition appears irrational, but may in fact be consistent with an complex non-ergodic world view in which a Bayesian never accumulates sufficient objective data to rule out a mental model in which Nature is conspiratorial and personal.

Shafir & Tversky (1992) have examined experimentally the tendency of consumers to behave as if they believe that opponents in games have an edge in information. They ask subjects to play the one-shot prisoner's dilemma game below:

		OPPONENT	
		Cooperate	Compete
SUBJECT	Cooperate	S: 75, O: 75	S: 25, O: 85
	Compete	S: 85, O: 25	S: 30, O: 30

When subjects are told in advance that their opponent has chosen to compete, virtually all subjects (97%) choose to compete. When they are told in advance that their opponent has chosen to cooperate, the rational response is to compete. In fact, 84% choose to compete; the remaining 16% apparently make an ethical judgment that cooperation should be met with cooperation. When the opponent's choice is *not* announced in advance, one would expect a division intermediate between these cases, since there is less ethical imperative to cooperate when the opponent's action is unknown than when it is known to be cooperative. However, in this case 37% of the subjects choose to cooperate. Thus, uncertainty changes behavior even if there is a single optimal action when uncertainty is removed. Shafir and Tversky call this a *disjunctive effect*, in which subjects do not reason through the consequences of the removal of the uncertainty, a violation of the sure-thing principle; see Tversky & Shafir (1992). These authors find that this effect is enhanced when subjects are told that the opponent has been very accurate in predicting what people are going to do and in matching their action; subjects often play cooperatively, even if the opponent's move is explicitly made and sealed in advance, so that this is never rational. Thus, subjects behave *as if* their opponents know more than themselves about their own behavior, or *as if* they can by setting an example influence the behavior of their opponent. Shafir and Tversky term this "quasi-magical" thinking, since subjects may consciously reject the idea that the opponent has supernatural powers or that current actions could influence earlier moves of the opponent, and yet superstitiously avoid actions that could give a bad outcome if there were such powers or linkages.

Superstition, in the form of mental models containing causal structures that are not supported by objective frequentist evidence, or in the form of suspicion that opponents have "quasi-magical" inside information, is a phenomenon that may explain a variety of anomalies such as reference point or status quo effects and the certainty effect. There are two, subtly different, sources for superstition. One is a true bound on rationality arising from limited, selective memory, or from a confirmation bias that selectively seeks evidence to support beliefs. This leads to biased subjective probabilities that highlight coincidence and support occult causal theories even in the face of logical inconsistency. The second is *suspicion*, beliefs learned from being burned by sharp traders that opponents may have inside information or hidden control even when it appears causally impossible. Suspicion may be a rational rule that provides a defensive against tactically attractive but unsafe actions. Both superstition and suspicion may be psychologically stable states, in that information acquisition, experience, and memory may provide continual reinforcement. Further, the market is ineffective in inducing fully rational behavior, as opposed to defensive behavior induced by superstition and suspicion.

PROCESS EFFECTS

The anomalies in this group arise from the ways consumers approach choice problems. Limits on human computational and information processing ability may lead to the adoption of boundedly rational heuristics. Consumers may adopt problem-solving modes and heuristics that at least on the surface are quite different than the process of forming tradeoffs and maximizing utility; see Tversky & Kahneman (1974), Kahneman & Tversky (1979), and Schkade & Payne (1994). *Process effects* arise because consumers establish aspiration levels or reference points and set goals relative to these benchmarks; derive benefits and losses from the decision-making process itself; and respond to perceived interactions between the process and other activities and rules of conduct (including ethical and superstitious beliefs). Thus, an element in the attractiveness of a lottery ticket is the "action" in the random event; other elements are the personal interaction required to pay off or collect on the lottery, and ethical attitudes and superstitious beliefs toward gambles. These benefits and losses need not lie outside the conventional theory of utility maximization. However, behavior inconsistent with rationality can result if process looms too large relative to outcomes in the consumer's consciousness.

Rule-driven choice may lead to behavior that is inconsistent with maximization of current preferences, perhaps because the "sensible self" adopts principles that establish precommitments to prevent the "indulgent self" from excesses that have undesirable consequences later. However, most

behaviorists will argue that ethical systems are assembled by accretion and differentiation, rather than being developed from a rational template. There is evidence that consumers develop commitments to their rules, and view them as more than just devices to regulate tactical behavior; see Baron (1994). Further, there are large individual differences in the rules that consumers state that they follow, and consumers with limited rule systems often fare better than those with complex and rigid rule systems; see Larrick (1993). Money is a prime example of an abstract good for which individuals develop what appear to be elaborate and not necessarily consistent rules or heuristics for how it is accounted for, acceptable and unacceptable uses, and the process as well as the outcome of exchanges of money; see Thaler (1985, 1990), Prelec & Lowenstein (1997). The homily "Neither a borrower nor a lender be" is a principle for conduct, not an instruction for rational behavior.

Temporal anomalies arise because consumers are inconsistent in time discounting, failing to discount events in the distant future consistently with short-term discounting. The explanation is that short-term gratification delays have a strong affect, while long-term benefits and costs are difficult to perceive now on the same basis as immediate benefits and costs. The argument is that immediate visceral satisfactions are easy to experience (or difficult to not experience), but that humans have difficulty previewing the experience of future gains and losses, particularly if they are uncertain; see Frank (1992), Hoch (1991), Lowenstein (1988). Temporal anomalies may also arise because of the psychophysical perception of time; see Herrnstein & Prelec (1991).

PROJECTION EFFECTS

When an experimenter presents a choice task within a limited context, the subject may interpret the problem within a broader, strategic context. Then, responses that are consistent or rational in the broader context may appear irrational when viewed narrowly. The "anomalies" in this group have this form, and in contrast to the previous groups arise from the experimentalist's failure to correctly assess the context adopted by the subject rather than the cognitive function of the subject.

Economic theory suggests that when subjects anticipate a possible connection between their response and some psychological or economic outcome in which they have an interest, they may have strategic incentives to *misrepresent* information. To illustrate, subjects asked about their interest in nursing home insurance may *overstate* their willingness-to-pay (WTP) if they believe a large response will increase the probability they will have this service as an option without committing them to this cost. On the other hand, they may *understate* WTP if they believe that their actual cost would be tied to their response. In practice, most standard economic surveys have *no* linkage from response to

subsequent economic events that would create incentives for misrepresentation. Further, there is at least fragmentary evidence that subjects are usually truthful when there are no positive incentives for misrepresentation, and even in some circumstances where there are such incentives; see Bohm (1972), Smith (1979).

There are some areas where there may be strong *non-pecuniary incentives* for *projection* of a misleading image. For example, subjects asked questions like "How often do you go to church?", or "How much did you contribute to charity last year?", may give biased responses in order to project a more favorable image to the interviewer and to themselves; see Quattrone & Tversky (1986). In public good valuation surveys, this phenomenon is sometimes called the "warm glow" motivation for overstating WTP for public goods. There are some elementary precautions in economic survey design that decouple responses from economic consequences, and eliminate obvious sources of *economic* incentives for misrepresentation. One way to control misrepresentation arising from *non-pecuniary* incentives is to present subjects with tasks that are "ethically neutral". For example, subjects may have no incentive to misrepresent trade-offs between different public goods, even when "warm glow" distorts their stated trade-off between public goods and personal private goods.

Summarizing the Behavioral Evidence

When one looks at the whole body of experimental studies of cognition and choice over the past twenty-five years, what stands out is that humans fail to retrieve and process information consistently, and this generates a variety of cognitive anomalies, including behavior that makes consumers vulnerable to exploitation in markets. Available, salient information looms too large, and beliefs are distorted because attention to new information is selective. These failures may be fundamental, the result of the way human memory is wired. I conclude that perception-rationality fails, and that the failures are systematic, persistent, pervasive, and large in magnitude.

There is also substantial experimental evidence that process-rationality fails, with humans adopting a variety of problem-solving modes, rules, and heuristics rather than monolithic utility maximization. Many psychologists take the view that preferences are temporary, changing each time the choice problem is reframed. and would argue that even if humans have a rational template for preferences at some deep level, it is so far removed from the problem-solving tools actually used that it is not useful for explaining behavior. An alternative view accepts the proposition that individuals are miserable statisticians who systematically mishandle information and misjudge probabilities, but attributes process anomalies to decision heuristics that preference-rational consumers learn as defense

against sharp traders. Which of these views is right matters to economics, since in the second case there may be stable preferences that can be uncovered and used for economic policy analysis. If Tversky's (1977) assessment of human psychology is right, economists will eventually lose this point. Nevertheless, my view of the experimental record is that this coffin has not yet been nailed shut. It is difficult to exclude failures of perception rationality as sources of many observed anomalies. In particular, the evidence against preference rationality is primarily circumstantial, based on the adaptability and malleability of human cognition in general, and on failures of preference axioms for Chicago man in experimental situations that, arguably, do not control for all the unrecognized aspects of objects that can matter to an abstractly preference-rational consumer.

3. IMPLICATIONS FOR ECONOMIC SURVEY DATA

Confronted with the accumulated experimental evidence, economists must recognize that the Chicago-man model does not apply universally, or even regularly, to choices made in non-market contexts. Economic surveys and laboratory experiments present decision tasks that closely resemble those in psychological experiments, and are likely to produce similar cognitive anomalies. This has important implications for non-market data, such as reported assets in household interviews.

Nowhere has this been more evident than in economist's attempts to value non-use public goods, such as endangered species or wilderness areas. A large literature documents the attempts by economists, in the end largely unsuccessful, to treat responses to such questions at face value, without psychometric correction; see Baron (1997), Bishop & Heberlein (1979), Boyle (1989), Boyle et al (1985), Boyle et al (1993), Carson et al (1994), Cameron & Huppert (1991), Desvousges et al (1994), Diamond & Hausman (1994), Harrison (1992), Holmes & Kramer (1995), Hutchinson et al (1995), Kahneman & Knetsch (1992), McFadden (1994), Siep & Strand (1992). Silberman & Klock (1989), Whittington et al (1992). A question on the value of a public good may invoke a rule-driven response rather than a utilitarian one. Examples might be rules that say "be agreeable when it does not threaten self-interest", or "no matter how desirable the cause, it is not my responsibility". When consumers are unclear about the public good, or unsure about the benefits of the proposed action, contextual features that suggest analogies to familiar exemplars may receive particularly high weight. Further, valuation questions may be posed in ways that make them vulnerable to rule-driven responses. Asking for a trade-off between public goods and money may invoke principles regarding the desirability of protecting the environment, and principles regarding the treatment of money and its appropriate use. Valuation tasks may be affected by the particular rules that consumers use when

they put values in dollars, and different patterns might emerge if trade-offs were requested in goods that are more alike in terms of scale and saliency. Good survey design can identify and reduce these effects; it is less clear that it can eliminate them.

4. IMPLICATIONS FOR ECONOMIC MARKET BEHAVIOR

One objection that economists have raised to the applicability of the Tversky and Kahneman results to economic decisions is that systematic departures from rationality, say in the form of intransitivity induced by sensitivity of preferences to context or reference point, will be punished through the actions of arbitragers. In this view, traders will devise mugs' games to exploit irrationalities, and as a result the market will teach consumers to avoid the obvious manifestations of irrationality; see Russell & Thaler (1988). This argument is not without merit, but it has two limitations. First, arbitragers are pervasive only in a limited number of highly organized markets, such as financial markets. It is by no means clear that the consumer is sufficiently engaged in many markets, or that the potential arbitragers in these markets are active and aggressive enough, to provide the discipline required to eradicate irrational behavior: "There is a fool reborn every minute". Second, not all departures from rationality will open opportunities for arbitrage. Specifically, reluctance to trade, whether induced by reference point or endowment effects, or otherwise, will tend to protect the consumer from arbitragers, and may in addition shelter other irrationalities that by themselves would be vulnerable to arbitrage. The casual observation that consumers participate in only a limited number of the available markets, and are suspicious of attractive but unfamiliar opportunities, may be a large-scale manifestation of strategic defensive behavior. Reluctance to gamble may be the specific result of the ease with which arbitragers can exploit irrationalities in these markets; see McFadden (1974) and Camerer (1987).

What are the economic implications of cognitive illusions that survive market forces? First, the way consumers process price information is part of the folklore of marketing, and plays a role in determining the products the consumer sees in the marketplace. For example, restaurateurs know that consumers use price as a guide to quality of wines, and that the second lowest priced wine is usually the best seller on the wine list. This effect is enhanced if a clearly lower quality wine is offered at a price only slightly below the targeted seller, making the targeted wine appear to be a good buy. Similarly, supermarkets will typically carry a low-quality generic brand priced slightly below the house brand, making the latter seem like a better deal. Second, marketers are aware of the importance of establishing and consolidating habits, and design product launches to achieve and sustain feasible

levels of market penetration. By reframing product descriptions, product perceptions can be changed; see Gourville (1996). Thus, these biases in consumer behavior are recognized, and alter the consumer's market environment. Economics needs to catch up to marketing to understand the extent to which the mix and presentation of products reflects anomalies in consumer behavior.

5. CONCLUSIONS

Chicago man is an endangered species. Behavioral decision theory has accumulated experimental evidence that severely restricts his maximum range, and he is not safe even in markets for concrete goods where he was once thought secure. His limits are determined primarily by failures of perception and process rationality. The experimental evidence provides no support for preference rationality, although the evidence contradicting preference rationality is mostly circumstantial. More seriously, failures of perception and process rationality may render behavior so erratic that even if they exist, preferences are largely irrelevant to the explanation of observed behavior.

Faced with this evidence, what should economists do? The challenge is to evolve Chicago man in the direction of K-T man, adopting those features needed to correct Chicago-man's most glaring deficiencies as a behavioral model, and modifying economic analysis so that it applies to this hybrid. This is a challenging task, but not an impossible one: many economic propositions hold under much weaker rationality assumptions than the Chicago-man model, and K-T man obliges us by using rules and heuristics that in many cases do not drift too far from Chicago-man behavior. Both theoretical and empirical study of economic behavior would benefit from closer attention to how perceptions are formed and how they influence decision-making. If the cognitive anomalies that do appear in economic behavior arise mostly from perception errors, then much of the conventional apparatus of economic analysis survives, albeit in a form in which history and experience are far more important than is traditionally allowed. Even social choice theory will work, in an interpretation that makes welfare comparisons relative and produces social optima that are dependent on history and path. In economic measurement, particularly in non-market forms but also in market data, economists should be sensitive to the impact of cognitive anomalies on observed responses, and seek methods to minimize these response errors.

How far will economics have to travel to reach solid behavioral ground? Some psychologists suspect that in seeking to measure deeply held, stable preferences, there is no "there" there; that preferences are illusory, the temporary product of rule-driven processes and problem-solving constructions. If so, more elaborate surveys will simply generate more complex, but no more

fundamental, stated preferences and choices. On the other hand, evolution and learning may condition consumers to adopt broad strategic principles that are not so "irrational" as to endanger survival, and which in some rough-and-ready sense promote "happiness". Behavior in markets, surveys, and experiments may generally conform to these principles, with "superficial" errors caused by perceptual biases and mistakes in formulating the cognitive tasks. Then, careful attention to the processes that consumers use to define tasks (see Fischhoff & Welch, 1998) and construct preferences (see Payne, Bettman, & Schkade, 1998) may allow one to look behind the superficial errors to uncover stable principles, attitudes, and preferences upon which a new economic analysis might be built.

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