Behavioral Economics, Financial Literacy, and Consumers' Financial Decisions

Gregory Elliehausen
Federal Reserve Board

15 October 2018

Behavioral Economics, Financial Literacy, and Consumers' Financial Decisions

Research in the areas of behavioral economics and financial literacy has raised concerns that consumers lack competence to make complex financial decisions. In behavioral economics, much of the literature argues that consumers rely on heuristics that cause them to make systematic errors in judgement. The literature on financial literacy suggests that many individuals lack an understanding of basic financial principles, which arguably would hamper individuals' ability to manage their finances effectively. This article reviews findings from a broad literature in economics and psychology on individuals' economic decision processes.

The review discusses whether optimality is the appropriate basis for judging behavior as rational, whether use of heuristics invariably results in harmful decisions, whether measures of financial literacy reflect ability to manage finances, and whether individuals having incomplete information and using heuristics inevitably lead to market failure.

Evidence indicates that individuals do not collect comprehensive information. They take shortcuts, use rules of thumb, and do not carefully consider all alternatives available in the marketplace. Financial literacy, whether the ability to answer correctly test questions on financial concepts or participation in financial education programs, appears to have little effect on outcomes of financial decisions. As such, decision processes fall far short of what neoclassical economic models would seem to require.

Decisions are generally purposive, however; and individuals tend to be deliberative and thoughtful when the situation warrants. Outcomes may not be optimal but such decision processes nevertheless may be an economical means for achieving desired goals. While most economists and psychologists agree that cognitive errors and time inconsistent behavior occur, the extent to which these phenomena impair actual decisions in markets is not at all clear. At this time, neither existing behavioral evidence nor conventional economic evidence supports a general conclusion that consumers' financial decisions are not rational or that markets do not work reasonably well.

Psychology and Economic Behavior

Around the mid-twentieth century, researchers were developing information processing models of decision-making (Miller 2003, Fiori 2005). The work of Herbert Simon contributed significantly to this effort. Simon proposed that cognitive and time limitations prevent individuals from obtaining full information and evaluating all possible alternatives to achieve optimal outcomes. Instead, he argued, individuals simplify using heuristics, shortcuts that simplify decision processes. Heuristics enable them to limit the decision process, ending the process as soon as a satisfactory alternative is achieved. Decision processes are rational if they lead consumers to achieve desired goals. He called this process "satisficing" and this concept of rationality "bounded rationality."

Bounded rationality has stimulated research in several areas. In one area, researchers used surveys to question consumers about the extent their decision process when making economic choices. Findings indicate that consumers simplify and take shortcuts in the decision process but tend to be purposive and deliberate. Another area is concerned with biases in behavior arising from use of heuristics.

Researchers rely primarily on experiments to detect deviations from rationality as defined by statistics or logical rules. Frequent deviations are attributed to faulty application of heuristics to solve problems. A third area, also concerned with heuristics, views heuristics as specialized tools guiding decisions in specific environments. Such heuristics are argued to allow fast decisions with limited information in uncertain environments.

Extent of Decision Processes

The decision process that emerged from the literature can be described as a series of steps consisting of recognition of problem, acquisition of pertinent information, development of possible solutions, evaluation of alternatives using relevant criteria, choice of an alternative, and assessment of the decision. Influences that affect the process include consumer resources, motivation and involvement, knowledge, attitudes, personality, values, lifestyle, culture, family, and situation.[1] This model provided a framework for questioning consumers about their decision processes. Much of the survey research on the extent of decision processes for saving, household investment, and borrowing was carried out from the 1950s through the mid-1970s by George Katona and his colleagues at the University of Michigan' Institute for Social Research.[2]

Household Investment and Borrowing

Katona and Mueller's "A Study of Purchase Decisions" (1954) provides an especially comprehensive analysis of processes leading the purchase and financing of household durables. They found that many decisions were not based on an extensive search for information and evaluation of alternatives. Consumers tended to simplify by contacting a few sellers and focusing on only one or a few attributes of the transaction. In some cases, they depended on information from past experience or experiences of friends and relatives. When financing their purchases, they did little credit shopping, often relying on the seller to provide financing. Their research identified factors that tend to lead to more or less deliberation. The extent of deliberation depended on the situational factors. Deliberation tended to be limited when buyers perceived a special opportunity (an especially favorable sale price, for example), felt an urgent need, or experienced satisfaction with a similar item previously used. Greater deliberation was found for purchases that are considered expensive or particularly important, associated with a new or unfamiliar product, or involve unsatisfactory experience with previous purchases.

The Michigan surveys questioned consumers about their knowledge and decision criteria for financial products. Responses suggested widespread lack of financial knowledge and use of heuristics. Most consumers were not well informed about interest rates for consumer credit, for example. Many respondents reported that they did not know the interest rate one has to pay on an auto loan. A

[1] See Blackwell, Mineard, and Engel (2006).

[2] For a summary of three decades of research at the Institute for Social Research, see Katona (1975).

substantial fraction of respondents reported rates that were unreasonably low.[3] Only about 20 to 30 percent of respondents provided a rate that suggested awareness of actual market rates.

Evidence collected in the surveys indicated that many consumers based their borrowing decisions on the dollar amount they could afford to pay after meeting their monthly contractual obligations. This finding suggests a monthly payment heuristic for assessing credit cost. Comparison of the size of monthly payments is a useful measure for credit cost when the number payments is the same for a given amount of credit (Mors 1965). Also, when an alternative credit opportunity with the same term to maturity offers a lower product price but higher finance charge, the monthly payment directly reveals the lower cost alternative (Durkin and Elliehausen 2010). In this situation, the joint purchase of product and credit, a monthly payment heuristic provides a simple and effective decision rule.

Day and Brandt's (1973) survey for the National Commission on Consumer Finance provides further evidence on consumers' decision processes for durable purchase and credit use decisions. Day and Brandt found that by far most consumers planned for large purchases for several weeks or more. The lengthy planning period suggests that few purchases were truly urgent, a condition that was associated with less extensive search in the Michigan surveys. Planning periods for replacement of items that were no longer usable tended to be longer than those for other items. Apparently, consumers in such situations recognized the condition of the present item and took steps to prepare for the eventual breakdown. Well more than half shopped for at least a few days and considered more than one brand or seller. That shopping was not more extensive may be explained at least in part by previous experience with similar items that were already owned.

Day and Brandt found that consumers were less deliberative in their credit decisions than their product decisions. A little more than a quarter of consumers using credit searched for information about credit sources, and only about one in five considered alternative types of credit. Many consumers apparently simplified their decision process by relying on the seller to arrange for credit. Credit choices were rarely considered among the most difficult part of the decision and often were considered as the least important part of the process when purchasing durable goods. Consumers simplified, focusing instead on the product decision. Consumers most often reported that the amount to spend and product characteristics were most frequently mentioned as the most difficult parts of the decision process.

Day and Brandt, whose surveys were conducted 15 months after Truth in Lending mandated disclosure of an effective annual rate of interest (the annual percentage rate), found greater awareness of interest rates for consumer credit than the earlier Michigan surveys. Still, fewer than half of Day and Brandt's respondents were able to report reasonably accurate effective interest rates. Consumers generally were aware of differences in credit costs among types of lenders, however. For instance, they knew that finance company and retail credit were more expensive than bank or credit union credit.

Day and Brandt's survey explored respondents' understanding of instalment mathematics, specifically the relationship between an effective interest rate and the dollar finance charge. Respondents were first asked for an estimate of the total of payments (interest and principal) for a one-year $500

[3] Much of the Michigan survey research took place before Truth in Lending mandated disclosure of an effective annual rate (the Annual Percentage Rate). At that time, three different types of rates were quoted—add-on, discount, and percent per month—depending largely on the institutional type of lender. The add-on and discount methods produce rates that are considerably lower than an effective annual rate. See Mors (1965).

instalment loan and then asked to estimate the interest rate associated with this loan. A large percentage of respondents reported plausible values for interest rates. Finance charges computed from responses to the first question asking for the finance charge, however, were unrealistically high for most respondents. Further examination of responses suggest that many respondents applied an interest rate to the original balance, not recognizing that the outstanding balance declined over the term of the loan.[4]

Over time, required disclosures appear to have increased consumers' awareness of interest rates. Recent survey data on awareness are available for bank cards, which to a great extent have replaced closed-end retail credit for financing durables.[5] A little more than half of bank card holders in Day and Brandt's time reported reasonably accurate rates (Durkin and Elliehausen 1978). In 2012, nearly all bank card holders reported rates that can be deemed as accurate (Canner and Elliehausen 2013). In contrast, understanding of instalment mathematics does not appear to have increased. Similar findings to those of Day and Brandt were found for 1977 (Durkin and Elliehausen 1978) and 1983 (Stango and Zinman 2011). Whether understanding of instalment mathematics is needed for effective decision-making is unclear, as required Truth in Lending disclosures provide both the finance charge and effective interest rate.[6]

Saving Behavior

Survey evidence suggests that saving can be grouped into three categories—contractual, discretionary, residual savings—based on motivation and situation (Katona 1975). Contractual saving results from committing to fixed contractual obligations, such as debt repayments, life insurance premiums, and pension contributions. Consumers typically do not consider all of these obligations as saving. Debt repayments are considered part of purchase decisions. Debt is a prevalent source of funding household investment in durables by consumers, especially in early life cycle stages. Life insurance premiums are commonly viewed as fees paid for protection against adversity, even if the insurance has a savings feature. Consumers also generally do not consider social security taxes or employer contributions to pension plans as savings, but they do consider their own contributions to pension plans as savings. Contractual saving may be a form of pre-commitment, a method to enforce compliance with long-term plans (Strotz 1955-1956).[7] In recent years, availability of tax-deferred retirement, education, and medical savings plans has increased the possibilities for conscious decision making for contractual saving.

Discretionary saving involves a conscious decision to set aside funds for specific purposes. The most common purpose is precautionary, to provide funds for expenses in emergencies. Such funds tend to be held in highly liquid assets such as bank accounts. Other common purposes for discretionary spending

[4] Applying the interest rate to half the initial balance provides an approximation of the finance charge for a one-year loan. Had respondents used this procedure to estimate finance charges, their reported finance charges would have been consistent with estimated interest rates.

[5] More recent data are not available for closed-end credit.

[6] As mentioned, three types of interest rates were in use before Truth in Lending. Familiarity with instalment mathematics might have been useful for comparing credit costs across institution types at that time. See Mors (1965) for discussion.

[7] See discussion on hyperbolic discounting below for discussion of pre-commitment.

include retirement, education, and purchases of homes or expensive durables. Discretionary savings is most common among middle age consumers with substantial incomes and wealth. These consumers may continue saving into retirement because wealth tends to raise levels of aspiration and because established habits tend to continue. Precautionary motives may help explain why some consumers simultaneously have savings in bank accounts and owe higher rate credit card debt. Because of strong precautionary motives to have available funds for emergencies, such funds provide a high subjective rate of return (Katona 1975).

Finally, residual saving consists of funds that individuals fail to spend. Residual saving is saved by default rather than planning. This type of saving typically would include funds held in bank accounts and used for paying monthly expenses.

Saving decisions are influenced by affordability and circumstances. Greater uncertainty heightens the precautionary savings motive. Individuals may reduce withdrawals from discretionary savings. They may postpone new purchases or replacement of durables or expenditures for travel and vacations. By postponing replacement of durables they may also complete repayment of existing debts, resulting in smaller deductions from income for debt servicing.

A stimulus may have different outcomes depending on circumstances. For example, responses to uncertainty arising from inflation were generally increases in precautionary saving in liquid assets even if inflation tended to reduce value of assets. The perception of special opportunity in an inflationary environment led on occasion to different outcomes. The price freeze in August 1971 was accompanied by a rollback of prices. Individuals perceived prices to be low and expected government efforts to hold down prices would not be successful. Consumers perceived that low prices were temporary and that it was a good time to purchase goods in advance of higher prices.

Rationality of Consumers' Economic Decision-Making

Whether consumers are informed depends on the type of information. Knowledge of specific economic facts and numerical data is not widespread. Survey findings suggest that most consumers are aware of major changes in the economy, increases or decreases in unemployment, prices, stock market prices, and interest rates, for example. They are not generally aware of the precise magnitude of such changes, however, and may overlook small changes.

Katona (1975) summarized his conclusions about rationality of consumers' economic decisions based on over 25 years of research as follows:

> If careful deliberation were defined as comprising all the features of decision making … the conclusion would emerge that almost all people proceed in a careless way in purchasing large household goods. This conclusion is, however, not justified. Deliberation may be strongly focused on one aspect of the purchase to the exclusion of other aspects. Therefore, it may be considered as careful deliberation if some, but by no means all, of the features of problem solving and thinking are present (p. 220).

In reaching this conclusion, Katona focuses on the process rather than the outcome in assessing rationality. For Katona, rational behavior involved choosing appropriate means for achieving improvements in one's well-being.[8]

Heuristics and Biases and Other Systematic Errors

Psychologists Daniel Kahneman and Amos Tversky's research in the 1970s on individual's decision making under risk and uncertainty has strongly influenced a branch of economics known as behavioral economics. Kahneman and Tversky observed that many individuals' choices in problems involving risk or uncertainty violated statistical or logical rules. They attributed errors to use of specific heuristics that biased reasoning or valued gains and losses inconsistently (Tversky and Kahneman 1974 and 1981).

Heuristics and Biases

Focusing on decision making under risk and uncertainty, Kahneman and Tversky identified heuristics that if followed cause individuals to make logical or statistical errors or otherwise obtain suboptimal outcomes (Tversky and Kahneman 1974). They gathered empirical evidence mostly from small-scale experiments in which subjects responded to test problems. Their findings indicated that large percentages of subjects' responses violated logical or statistical rules. They attributed errors to use of specific heuristics that biased reasoning.

For example, in one well-known study (Tversky and Kahneman 1983), presented subjects with the following problem: "Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Which is more probable? (1) Linda is a bank teller, or (2) that Linda is a bank teller and is active in the feminist movement." By far most subjects in this experiment failed to recognize that the probability of any one of two events is greater than or equal to the probability of both events occurring together (a conjunction fallacy). The error was attributed to a representativeness heuristic, which caused subjects to ignore logic and judge the likelihood of an event by its similarity to a known event. The heuristic apparently caused subjects to view Linda as more typical of someone who is active in the feminist movement than someone who is a bank teller.

Other heuristics that have been studied include availability, anchoring, recognition, and take the best. The availability heuristic assesses the likelihood of an event by how easily an example can be brought to mind. For example, an individual may assess the likelihood of price rises for a particular stock based on information recalled from a newspaper article reporting recent changes in stock market indices. The anchoring heuristic relates to an initial value as a reference point in making subsequent judgements about value. For example, the first house shown by a real estate agent may influence a buyer's perceptions whether subsequent houses are inexpensive or expensive. The recognition heuristic holds that if one of two objects is recognized and the other is not, then the recognized object has the higher value with respect to some criterion. Thus, individuals might judge the stock of a recognized company to be less risky than the stock of a company they never heard of. They take the best heuristic estimates

[8] Katona (1975) argued that the predominant alternative to rational behavior is habitual behavior, not irrational behavior. Habitual behavior occurs when consumers are satisfied with previous decisions and do not experience any stimulus to change.

which of two alternatives has a higher value on a criterion by choosing the alternative based on the first attribute that discriminates between the alternatives, where attributes are ordered by attributes' ability to distinguish best among the alternatives.

As mentioned, heuristics are shortcuts that may help simplify decision making and shorten the decision process. Taking shortcuts is not necessarily harmful, but heuristics and biases research and behavioral economics that has been influenced by this research focus on logical or statistical errors that arise from the use of heuristics. Individuals are capable of overriding heuristic biases, but the heuristics and biases literature argues that due to limitations on cognitive ability and motivation often fail to do so (Kahneman and Frederick (2005). Other research discussed in the next section focuses on heuristics that may be effective in certain environments.[9]

Framing

Beyond heuristics and biases, Kahneman and Tversky (1981) pointed to inconsistencies arising from how risky options are framed and proposed prospect theory as a model of choice under risk. Framing is the manner in which an option is presented. They found that framing options as a losses elicits different preferences than framing equivalent prospects as gains. For example, individuals tend to prefer a prospect that saves 90 out of 100 lives to a prospect that loses 10 out of 100 lives, even though the prospects are equivalent. Loss aversion generally causes individuals to avoid risky choices when they evaluate possible gains, since they prefer avoiding losses to making gains. However, in some situations, individuals may prefer a risky option if the riskier option provides the possibility to mitigating a loss.

Prospect Theory and Mental Accounting

Prospect theory describes the process of simplifying complex problems involving losses and gains (Kahneman and Tversky 1979). Underlying prospect theory is an assumption that individuals perceive outcomes relative to a reference point rather than an absolute value. That is, they perceive outcomes as gains or losses. Individuals organize and reformulate options to simplify evaluation and choice.

Kahneman and Tversky suggested several rules for simplifying choices: Probabilities of identical outcomes may be simplified by combining probabilities, sometimes prospects can be segregated into riskless and risky outcomes, common components of different prospects can be ignored, and outcomes or probabilities associated with a prospect may be simplified by rounding.

Individuals evaluate prospects by considering the monetary value of the each simplified outcome of a prospect and the decision weight that reflects the likelihood of an outcome but is not a probability.[10] Low probabilities are overweighted, and moderate and high probabilities are underweighted. The latter effect is more pronounced than the former. The overweighting of low probabilities may contribute to the attractiveness of both insurance and gambling.

[9] For discussion of other common heuristics that have been linked to cognitive biases, see Kahneman (2011). For heuristics that have been found to perform well, see Gigerenzer et al. (1999), Gigerenzer (2008), or Gigerenzer and Brighton (2009).

[10] Probability weights may be influenced by ambiguity or vagueness.

Kahneman and Tyersky's research strongly influenced a branch of economics known as behavioral economics. This branch of economics seeks to provide a more realistic description of individual decisions than standard neoclassical economics. Economist Richard Thaler (1980 and 1985) adapted prospect theory to develop a model of mental accounting, a set of cognitive operations to organize, evaluate, and manage budgets. Building on Kahneman and Tversky's findings on risk aversion and rules for simplification of prospects, Thaler proposed additional rules for further simplifying prospects that involved separating, combining, integrating, or segregating gains and losses to obtain the greatest utility from a set of prospects. Specifically, evaluate gains separately (because utility increases less than proportionately with the amount of gain); combine losses (because the disutility of two smaller losses is greater in absolute value than the sum of two losses), integrate smaller losses with larger gains (to offset disutility arising from loss aversion); and rules for segregate small gains from larger losses (because the utility of a gain may be greater than the utility from a small reduction in the amount of a loss). Prospects that are so organized are then evaluated on the basis of two types of utility, acquisition utility and transaction utility. Acquisition utility arises from consumption of an item. Transaction utility reflects the outlay required to pay for the item.

To simplify further, Thaler argued that prospects are grouped into categories, which he called mental accounts. Purchase decisions take place within mental accounts. Each mental account is subject to a budget constraint, which typically is based on current income flows (perhaps augmented by credit that the income can service). Individuals normally restrict expenditures in each category to the income allocated to the category.

Thaler's mental accounting requires less information and knowledge of financial concepts than neoclassical economic models, which maximize the present value of lifetime wealth. Mental accounting is a heuristic that simplifies decision making and may facilitate self-control. It likely works well in most circumstances but is not optimal. Mental accounting may help explain many consumers' focus on monthly payments in making credit decisions (facilitates budgeting of debts) and their simultaneous holding of substantial liquid assets and owing credit card debt (prevents depletion of funds held for emergencies). In restricting expenditures to income allocated to the category, the mental accounting heuristic prevents shifting of income from one category to another to equalize marginal consumption across categories.

Shefrin and Thaler (1988) applied mental accounting to inter-temporal choice. They proposed that consumers allocate their resources to one of three mental accounts: (1) current income, (2) current assets, and (3) future income. They assume that consumers have self-control problems, which causes consumers to use various devices such as participating in pension plans and employing heuristics to curb current spending. Different mental accounts have different vulnerability to temptation. Current assets (savings for emergencies, for example) and future income (saving for retirement) are more vulnerable to self-control problems than current income. Allocation of income to an account depends on how the income is framed (lump-sum bonus or regular income, for example).

Prelic and Loewenstein (1998) adapted the mental accounting framework to analyze individuals' decision to pay by cash or credit. Analogous to acquisition and transaction utility, Prelic and Loewenstein define net utility from consumption (utility of consumption less disutility of associated payments) and net disutility of payments (disutility of consumption less utility of associated

consumption). When these values occur over time, they are discounted, not necessarily at a constant rate.

They further posit that that past events are largely written off (prospective accounting) and that individuals allocate future payments to consumption or allocate consumption over future payments (that is, individuals try to match consumption to payments), but that individuals do not necessarily fully link payments and consumption (which they called "decoupling"). The extent to which payments and income are coupled, they suggested, varies according to the situation, payment method, and individual.

Prelec and Loewenstein argued that prepayment enhances the utility from consumption. The prospect of future consumption diminishes the pain of prepayment, while the prospective accounting assumption would largely write off past payments at the time of consumption. In contrast, debt financing tends to diminish the utility of consumption. Future payments are discounted for current consumption, but past consumption is written off when future payments are made. Thus, consumers would tend to be averse to owing debt. However, an installment purchase of a durable good may be attractive if the durable good provides a series of surpluses of consumption over the periodic payments. Prelec and Loewenstein suggested that debt aversion resulting from mental accounting may help explain why individuals with temporarily low incomes fail to borrow sufficiently against future income to maintain a constant consumption profile over their lifetime. Thoughts of future debt repayments diminish the utility of the additional present consumption while in the future no benefits diminish the disutility of the debt repayments. They also suggested that mental accounting might prevent consumers from paying off credit card debts. The pain of repaying a credit card debt immediately would be relatively large and possibly greater than the discounted disutility of making relatively small minimum payments in the future to repay the debt. Additionally, if expenditures financed by credit cards provide little or no stream of future consumption, any benefits experienced in the past would tend not to be recalled and therefore be available to offset the pain of current full repayment. In some cases, however, they suggested that credit cards may actually enhance consumption paid by credit card if payment is associated with the monthly credit card payment rather than signing the credit card slip. This possibility arises because mental accounting enables the consumer to decouple the consumption from thoughts about paying.

Hyperbolic Discounting

Individuals' tendency to discount proximate utilities more heavily than distant utilities is among the cognitive biases that have raised significant concerns for financial decision making. When discount rates decline over time, the choice between two options items closer in time are discounted more than items more distant in time. Such preference reversals are called time inconsistent behavior.

In economists' expected utility model, individuals maximize the sum of all future utilities. Future utilities are reduced to comparable magnitudes by discounting. For simplicity, individuals are assumed to discount by a single constant discount rate, which is the same across all time periods and also for all types of consumption. Assuming the same rate across all time periods precludes time inconsistent

behavior.[11] Time inconsistent behavior may lead individuals to deviate from prior optimal inter-temporal allocations in future time periods. Assuming the same discount rate across all types of consumption precludes different discount rates for different items, such as gains being discounted more heavily than losses (that is, loss aversion discussed earlier in this section). [12]

A declining rate of time preference is often termed "hyperbolic discounting" because a hyperbolic function provides a better fit to experimental data than a constant, exponential function. Many researchers have observed behavior consistent with hyperbolic or other non-constant rates of time discounting (see Frederick, Loewenstein, and O'Donoghue 2002 for a comprehensive list). Available evidence from many different studies suggests that discount rates decline sharply during the short run and then level off and become practically constant. Frederick, Loewenstein, and O'Donoghue (2002) examined the relationship between estimated discount rates and the time horizon from different studies. They found that the discount rate was inversely related to the length of the time horizon. The highest discount rates were for time horizons of one year or less. Discount rates decreased with the length of the time horizon. After a year, the discount rate was nearly constant, on average about 25 percent. This relationship is quite imprecise, however. Estimates from the individual studies varied quite substantially.

Hyperbolic discounting lead individuals to deviate from prior optimal inter-temporal allocations in future time periods. For example, individuals might postpone or abandon earlier plans for setting aside money in savings. As a consequence, individuals might not save enough for future expenses or retirement. Hyperbolic discounting has also been be linked to behavior that can be or is harmful, such as procrastination and addiction (O'Donoghue and Rabin 1999), for instance.

Whether or not hyperbolic discounting is irrational is not clear. Individuals make numerous intertemporal choices, in most cases apparently without suffering great harm. In some cases, choosing a smaller proximate reward may be sensible, such as when future prospects, preferences, and resources are uncertain or when the proximate reward ensures survival (Becker and Mulligan 2001, Smith 2005).

In addition, individuals may exercise self-control to prevent impatience from jeopardizing long-term plans. Individuals may also enter into contractual arrangements that obligate them to carry out long-term plans (pre-commit). Individuals have cognitive self-control structures that provide them with the ability to direct thought and action to achieve internal goals. Activation of these cognitive control

[11] See Samuelson (1937). Samuelson did not claim that individuals actually discounted using a single constant rate. Instead he maintained that a single constant rate was a hypothesis, subject to refutation by the observable facts.

[12] Besides a constant discount rate, the expected utility model involves several additional assumptions: (1) When evaluating new prospects, individuals consider how new prospects will affect consumption in all future periods. (2) Aside from discounting, the distribution of utility across time does not matter, ruling out preferences for a flat or improving utility profile over a highly uneven utility profile. (3) Utility of consumption in any period is unaffected by consumption in any other period, which does not allow for a preference for variety in consumption. (4) An individual's well-being in any time period is constant regardless of the time at which utility is evaluated, precluding changes in preferences. Empirical evidence indicates that individuals do not behave in accordance with these assumptions either (see Frederick, Loewenstein, and O'Donohue 2002). Departures from these assumptions of the expected utility model generally have not been viewed as problematic.

structures enables individuals to inhibit automatic processes that are susceptible to impulses.[13] Benhabib and Bisin (2005) model such a structure for a consumption/saving decision. The structure trades off impulsive immediate consumption with a saving rule requiring self-control for its implementation. Self-control requires actively maintaining attention to the saving rule. An individual facing temptations might yield to a temptation only if it does not perturb the saving plan too much and does not have large permanent effects on the prescribed wealth accumulation pattern. To be effective, the saving rule requires that the internal inhibitions become stronger the as the awareness of the cost of impulsive consumption increases.

To enforce previous decisions, individuals sometimes pre-commit to future actions, such as having automatic contributions from pay to tax-deferred savings accounts or using instalment credit to purchase relatively expensive household durables (see Strotz 1956 or Laibson 1997, for example). Casual observation and empirical evidence indicates that individuals exercise self-control through pre-commitment. Ariely and Wertenbach (2002) provide experimental evidence that in circumstances where time inconsistent behavior is costly, many individuals self-impose binding constraints to overcome perceived self-control problems. In two experiments, participants were assigned to groups with either self-imposed deadlines or mandatory deadlines. Participants that failed to meet deadlines were penalized. In both experiments, performance of participants with evenly spaced deadlines was similar, regardless of whether mandatory or self-imposed. Performance of participants with end of period deadlines was worse than the performance of participants with evenly spaced deadlines. When given a choice, most participants chose evenly spaced deadlines. This choice suggests that individuals self-imposed deadlines to overcome procrastination and improve performance.

Robustness of Evidence of Cognitive Biases

Evidence on the existence of cognitive biases arising from the use of many common heuristics is mostly from small-scale experimental studies using convenience samples (often students). In these studies, biases are elicited from responses to test-type problems. Biases are deviations from statistical or logical rules. When similar experimental procedures were followed, findings of these studies have been replicated. However, results are sensitive to changes in the format, context, or content of the problem Changing the format of the question or implementing different procedures can make cognitive biases disappear. No generally accepted theory explains why cognitive biases occur or what causes them to disappear, although some psychologists have suggested hypotheses. These hypotheses along with empirical evidence will be discussed in the next subsection.

Economists also noticed inconsistent findings and questioned the robustness of experimental evidence of cognitive biases. In an especially thorough study, Plott and Zeiler (2005) investigated differences in preferences attributed to an endowment effect, which is hypothesized to cause individuals' willingness to pay for an item to differ from their willingness to accept payment to do without the item. The endowment effect is attributed to loss aversion. Individuals' value an item that they own much more than an identical item that they do not own. Hence, they demand much more to do without the item than they would pay to obtain it.

[13] See Miller and Cohen (2001) or Camerer, Loewenstein, and Prelec (2005) for a neurobiological description of cognitive control structures.

Plott and Zeiler examined in detail previous experimental studies of the endowment effect. They noted that the different studies employed various procedures to avoid participant misunderstanding of the nature of the problem. The procedures included ones that (1) explained the nature of the experiment and optimal response, (2) provided with an opportunity to practice and experience the consequences of their decisions, (3) offered incentives to provide true valuations rather than respond strategically, (4) elicited valuations in a market environment with incentives for optimal responses, and (5) measured differences based on actual trades rather than willingness to pay and willingness to accept responses.

Previous studies did not agree on the nature of misunderstanding, and no study included all of procedures to avoid participant misunderstandings that Plott and Zeiler identified. Participant misunderstanding may have influenced the results of any of these experiments. Also notable is that the evidence is not robust, despite beliefs to the contrary.[14] Twelve of 39 experiments examined by Plott and Zeiler reported no significant difference in willingness to pay and willingness to accept. Evidence of an endowment effect is not conclusive.

In the absence of a theory of how perceptions might influence experimental results, Plott and Zeiler developed an experimental design to avoid all possible sources of misunderstanding identified in previous studies. They initially choose the experimental design reported in Kahneman, Knetsch, and Thaler (1990) and replicated Kahneman, Knetsch, and Thaler's results, finding that median willingness to accept was significantly greater than median willingness to pay. Plott and Zeiler then modified the survey procedures to avoid possible participant misunderstandings identified in the literature. To elicit valuations, they used a market mechanism that provides incentives for participants to provide "true" valuations. They explained to participants how providing true valuations maximizes earnings and provided practice rounds for both selling (willingness to accept) and buying (willingness to pay) valuations. Participants kept any earnings from the practice rounds. Participants were told that strategic behavior was not optimal, and practice rounds allowed participants to learn that such behavior reduced earnings. Plott and Zeiler also ensured that decisions and payments were anonymous so that participants would not be tempted to consider how others (experimenters or other participants) would view their valuations.

Results of the modified experiment indicated that participants' willingness to accept was not significantly different from willingness to pay. Based on their findings, Plott and Zeiler concluded that the observed differences in willingness to accept and willingness to pay do not reflect a fundamental feature of preferences and do not support the endowment effect hypothesis:

> The fact that the gap [between willingness to pay and willingness to accept] can be turned on and off demonstrates that interpreting gaps as support for endowment effect theory is problematic. The mere observation of the phenomenon does not support loss aversion—a very special form of preferences in which gains are valued less than losses. That the phenomenon can be turned on and off while holding the good constant supports a strong rejection of the claim that WTP-WTA [willingness to pay-willingness to accept] gaps support a particular theory of preferences posited by prospect theory (p. 542).

[14] For example, "After more than a decade of research on this topic we have become convinced that the endowment effect, status quo bias, and the aversion to losses are both robust and important (Kahneman, Knetsch, and Thaler 1991, p. 205)."

Plott and Zeiler did not advance a theory explaining participants' perceptions but did speculate about possible explanations for their findings. One explanation is that the valuations reflect motivations to announce a value other than the true value. Experimental procedures sought to eliminate motivations based on strategic considerations or concern about how others might judge their valuations, but other motivations might still exist. Explanations that the procedures removed any attitudes in which ownership plays a role or suggested that a value other than participants' valuations was desired are possible, but Plott and Zeiler's experimental data suggest that these explanations are unlikely. Other explanations included that participants perceived they were expected to remove any special value of ownership from their valuation and that the willingness to pay-willingness to accept gap reflects a learning process. Plott and Zeiler's experimental results provided no evidence regarding these latter explanations.[15]

Fast and Frugal Heuristics

Researchers in the field of evolutionary psychology have proposed hypotheses to explain why cognitive biases are observed in some situations and not in others. Evolutionary psychologists approach the problem on the basis of a theory that humans have many specialized cognitive processes that underlie their reasoning and that responses to stimuli are adaptations to the humans' natural environment.[16] For example, they argue that human cognition of statistical processes occurs naturally through observation of a series of events. As a consequence, human cognitive processes have adapted to process frequency information rather than probabilities. Experimental studies that frame problems in terms of probabilities therefore may not adequately replicate the situations in which individuals make decisions under uncertainty.

Based on this theory, some researchers have hypothesized that presenting statistical problems in terms of frequencies would produce fewer errors than problems presented in terms of probabilities. In one study, Fiedler (1988) replicated Kahneman and Tversky's experiment using the original formulation of the Linda problem. He found that 91 percent of participants responded that the feminist bank teller option was more probable than the bank teller option. He conducted a second experiment in which he asked which option is more frequent rather than which is more probable.[17] In this experiment, only 22 percent of participants responded that the feminist bank teller option was more probable than the bank teller option. Similarly, Hertwig and Gigerenzer (1993), reported in Gigerenzer (1994), found that 88 percent of participants made cognitive errors for the probability format, but only 20 percent made errors for the frequency format.

The frequency format reduced cognitive errors in other experimental problems as well. Gigerenzer and

[15] See Plott (1996) and Loomes, Starmet, and Sugden (2003) for further discussion and evidence of learning in repeated markets.

[16] For a brief description of the theory, see Samuels, Stich, and Falcher (2004).[17] Recall that participants were asked whether it was more probable that (1) Linda is a bank teller or that (2) Linda is a bank teller and active in the feminist movement. The frequency format is "There are 100 people who fit the description above. How many of them are (1) … bank tellers? (2) … bank tellers and active in the feminist movement?

[17] Recall that participants were asked whether it was more probable that (1) Linda is a bank teller or that (2) Linda is a bank teller and active in the feminist movement. The frequency format is "There are 100 people who fit the description above. How many of them are (1) … bank tellers? (2) … bank tellers and active in the feminist movement?

Hoffrage (1995) and Cosmides and Tooby (1996) conducted experiments comparing responses to probability and frequency formats in medical diagnosis problems. In both studies, participants were considerably more likely to provide correct responses to frequency formats than probability formats. Such results support the hypothesis that frequency formats facilitate statistical inference under some circumstances. They do not indicate that cognitive biases do not exist, but they do refute the notion that all statistical reasoning is biased.

The context of the problem may also influence how individuals respond. Hertwig and Gigerenzer (1999) investigated this possibility, again using Kahneman and Tversky's Linda problem. Hertwig and Gigerenzer pointed out that the opening statements in the problem (that Linda is 31 years old, single, outspoken, and very bright; that she majored in philosophy; and that as a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations) are not needed to answer the statistical problem. They hypothesized that these statements can be interpreted as asking for a typicality judgement. In that case, a representativeness heuristic might well be an efficient process for producing an appropriate judgement.

Hertwig and Gigerenzer's empirical analyses supported this hypothesis. In a small-scale experiment, they found that by far most participants chose (2) as the correct answer. When asked about their understanding of the word "probable," most provided responses suggesting a nonstatistical understanding. In a second experiment, Hertwig and Gigerenzer presented the problem in the original format to half of the participants and a modified format asking for both typical and statistical judgments. Participants responding to the modified, two-part, format provided correct answers to the statistical problem much more frequently than participants responding to the original format.

Hertwig and Gigerenzer conducted a similar analysis of participants' understanding of the question in a frequency format. When participants were asked about their understanding of "frequently", only one of 55 responses were nonstatistical. Thus, it seems that findings of considerably lower cognitive error rates for the frequency format than the probability format are not surprising, regardless of the validity of evolutionary psychologists' theories about frequency data.

Krynski and Tenenbaum (2003) proposed another potential cause of observed cognitive errors in experimental studies. They argued that human reasoning under uncertainty naturally operates over causal mental models, rather than purely statistical representations. Typically, individuals make correct statistical inferences only when the data can be incorporated into a causal model consistent with individuals' theories of the environment

The problem focused on predicting the incidence of cancer given a false positive test result. The possible cognitive error for this problem arises from failure to consider the overall base rate of cancer in the population. They hypothesized that lacking an explanation for a false positive test result, individuals will tend to believe the test and focus only on the information from the test.

Krynski and Tenenbaum conducted two experiments. In the first experiment, they tested whether describing false positive test results as uncertain would lead participants to believe the false positive rate and incorporate that information in their estimates. In the second test, they compared responses to a statistical question with those to a question that attributed false positive results to benign cysts. In both experiments, they found that providing a way for participants to make sense of false positive results improved estimates. The number of participants who failed to consider the low base rate (high false positive rate) was lower, and the number of correct or near-correct estimates was higher for the

causal format. They interpreted these findings as evidence that human probabilistic reasoning operates over causal mental models. These findings suggest that failing to consider or misunderstanding causal structure may be an important source of error in experimental studies of problem solving involving uncertainty. In order to construct such causal models, theories of cognitive processes for specific environments are needed.

Even without accepting the theories of evolutionary psychologists, the sensitivity of experimental results to the format, context, and content of the problem suggests that some scepticism about the extent and impact of cognitive biases is warranted. Beyond questioning the robustness of the heuristics and biases program's findings, the fast and frugal heuristics program argues that heuristics may provide be an effective way to make choices situations where information is limited and consequences of actions are uncertain (Gigerenzer et al. 1999, Gigerenzer 2008, or Gigerenzer and Brighton 2009).[18]

For example, DeMiguel, Garlappi, and Uppal (2009) compared a heuristic portfolio diversification rule with 14 mean-variance optimization rules. The heuristic rule (called the 1/N rule) divides assets equally across assets available for investment at each rebalancing date. They found that none of the mean-variance optimal portfolios' out-of-sample performance consistently exceeded that of the 1/N heuristic.[19, 20] This finding does not indicate that the 1/N heuristic generally better than mean-variance rules. Three environmental conditions tend to favor use of a 1/N heuristic: (1) high uncertainty, (2) a large number of assets, and (3) a short estimation period (Gigerenzer 2008). The influence of environmental conditions on performance is consistent with environmental psychologists' hypotheses that heuristics are specialized to certain environments.

Monti et al. (2012) found evidence of heuristic use in their investigation of decision processes for investment products. They recruited 15 non-expert investors at an Italian bank and 56 university students who had no investment experience but had taken courses in economics or finance. The experimental setup was designed to reflect the information environments investors commonly encounter when making investment decisions. Information on features of seven investment products (bank accounts, bonds issued by the bank, bonds issued by the government, insurance products, a corporate bond mutual fund, a large- company stock mutual fund, and a balanced mutual fund of stocks and bonds) was provided. The investment features were risk, time horizon, cost, liquidity, cost before redemption, and coupon.

Participants generally considered a small subset of the information provided despite search costs that were minimal. Participants neither looked at all available data nor fully compare the available choices, which would be expected from a rational choice model. Observing the predominant behavior of participants, modeled investment choices with a lexicographic decision tree that ordered risk first among the various investment features. That is, risk was most important and non-compensatory. If risk was unacceptable, the investment product was discarded. The decision tree model then used a tallying

[18] For discussion of differences between Kahneman/heuristics and biases program and Gigerenzer/fast and frugal heuristics program, see Forbes et al. (2015).
[19] Performance was measured by the ratio of mean excess portfolio return to the portfolio standard deviation, the certainty equivalent return for an expected utility mean-variance investor, and trading volume for each portfolio.
[20] Earlier studies by Bloomfield, Leftwich, and Long (1977) Jorion (1991) also found that mean-variance portfolios did not outperform 1/N portfolios.

rule for the remaining investment features. Positive features were assigned a weight of one. For each product, the number of 1s is counted, and the product with the highest number of 1's is chosen.[21]

Some of the same qualifications apply to evidence from the fast and frugal heuristics programs as those that apply to the heuristics and biases program. Much of the evidence is from experimental studies that do not involve actual market choices. Samples are often convenience samples, and sample sizes are small. Again, results are imprecise and cannot confidently be generalized.

Rationality of Credit Card Use

Credit card use is often suggested to be vulnerable to cognitive biases. Prelic and Loewenstein's (1998) mental accounting model is just one of a number of studies that raise behavioral issues regarding credit card use. Many other studies have hypothesized that consumers' are prone to making errors when using credit cards.[22] Much of the evidence supporting these studies hypotheses is based on experimental studies using responses to hypothetical choices. This section reviews findings of using data on actual behavior of consumers using credit cards.

Gross and Souleles (2002) analyzed monthly panel data of several thousand individual bank card accounts from several different lenders in 1995. They found that increases in credit limits produce immediate increases in debt. The response was strongest for accounts starting near their limit, but increases were also observed for accounts starting well below their credit limit. Increases in debt for accounts starting near their limit can be explained by binding liquidity constraints (credit rationing). The increases in debt for accounts starting well below their limit cannot, however.
Looking at utilization rates (the ratio of debt to the credit limit), Gross and Souleles found a plausible explanation for increases in debt After an initial drop in utilization following an increase in the credit limit, consumers quickly increased borrowing, returning to their original utilization within a relatively short period of time. That this behavior was true for accounts starting near their limit as well as accounts starting well below their limits suggests that consumers may have target utilization rates, which may arise from behavioral rules of thumb about appropriate amounts of borrowing or from precautionary motives for maintaining a reserve of available credit. Evidence exists showing that outcomes are largely consistent with predictions of economic theory.

Results of regressions for changes in interest rates indicate that borrowing was sensitive to interest rates. Increases in the interest rate produce nearly proportionate declines in borrowing within a short period of time and eventually greater than proportionate declines in borrowing. Furthermore, they find that consumers shift balances to other accounts when the interest rate on an account rises, but the rise in balances on other accounts is less than half the decline in the balance on the account whose interest rate has risen. Thus, while some balances are shifted to other accounts, an increase in the interest rate still causes a large decrease in debt overall.

[21] For further discussion of fast and frugal heuristics in financial decision making, see Forbes et al. (2015).
[22] For example, Shefrin and Thaler (1988), Thaler (2005), Ausubel (1991, 1999), Shui and Ausubel (2005), Soman (2003), Soman and Gourville (1998), DellaVigna and Malmendier (2004), Gabaix and Laibson (2006). See Durkin et al. (2014, chapters 5 and 7) for further discussion.

Gross and Souleles also examined responses to temporary teaser rates for new accounts and for balance transfer offers, which have become a ubiquitous part of competition in the bank card market since the 1990s. They found that large decreases in interest rates, such as those typically occurring when a teaser rate is taken, have stronger effects than small decreases. They also found that large decreases in rates had greater effects than the large increases, which follow upon the expiry of teaser rates. Thus, temporary teaser rates would produce a rise in debt, a result that helps explain card issuers' widespread use of teaser rates.

In an experimental study using bank card solicitation data, Ausubel (1999) found that that more consumers responded to lower price bank card offers than higher price offers which is consistent with downward sloping demand curves and rational behavior. Consumers do not always act in a fully optimal manner, however. Ausubel's (1999) found that consumers may be more responsive to teaser rates than equivalent reductions in post-introductory rates or the duration of the introductory rate. These results certainly suggest that consumers do not calculate precisely and may respond differently when price changes are framed in different ways.

Results of a large-scale experiment undertaken by a bank produce further evidence that consumers are sensitive to credit card interest rates in choosing credit card offers (Agarwal, Chomsisengphet, Liu, and Souleles 2005). A large bank credit card issuer t offered consumers a choice between credit card contracts, one with a fee but a low fixed interest rate and another with no fee but a higher fixed rate. The offer included an option to switch contracts after the initial choice. These authors found that the majority of consumers chose the lower cost choice based on their subsequent card use behavior, suggesting that most consumers understood the likelihood of their future use of the card to add debt. Consumers who chose to pay an annual fee in order to obtain a lower interest rate (perhaps because planned to use the card for debt purposes) more frequently revolved balances and borrowed greater amounts than consumers who chose a higher interest rate and no fee.

Sixty percent of the consumers who remained with their initial choice made an optimal choice.[23] The likelihood of making an optimal choice was much greater for consumers who did not pay a fee (79.0 percent) than for consumers who pay a fee (44.5 percent). That the frequency of errors was much higher for those who paid an annual fee can be explained by the magnitude of the potential cost of the mistake. The potential cost is limited to the amount of the fee, which was a small dollar amount (on average about $20) for consumers who paid the fee.[24] In contrast, the potential cost for borrowers who did not pay a fee depends on the amount of borrowing. Thus, the cost of making an error could become quite large with frequent or large amounts of debt. These findings suggest that many borrowers who could not or did not want to estimate future borrowing very precisely may have chosen contracts that limited the cost of mistakes to a small dollar amount. Those who chose contracts with potentially large costs, being much more likely than not to have chosen the right contract, apparently were aware of their (limited) future borrowing.

Consumers who initially chose not to pay an annual fee were more likely to switch as the net savings from paying the fee increased, and consumers who initially chose to pay the fee were less likely to switch as net savings increased. Of the small percentage (3.4 percent) of consumers who eventually

[23] A choice that turns out to be a mistake ex post may not be a mistake ex ante. Consumers may experience unexpected expenses or shortfalls in income that cause them to borrow when they initially had not intended to borrow.

[24] The annual fees on cards ranged from $10 to $24.

switched accounts, nearly all made a suboptimal choice initially and had corrected their mistake by switching.

Agarwal, Chomsisengphet, Liu, and Souleles concluded that most consumers made cost minimizing choices of credit card contracts. Further, they reported that the probability of making the wrong choice declines with the size of the potential error, and "those who made larger error in their initial contract choice were more likely subsequently to switch to the optimal contract" (Agarwal, et al. 2005, p. 5). It is hard to reconcile these results with the hypothesis of consumer insensitivity toward rates. These authors do note, however, that a "small minority of consumers persists in holding substantially suboptimal contracts without switching" (Agarwal, et al. 2005, p. 5).

In another study Agarwal, Driscoll, Gabaix, and Laibson (2008) provide evidence that credit card holders' behavior is sensitive to late, over limit, and cash advance fees. In their data, which were obtained from a large bank, they observed that when consumers incurred these fees, they incurred the fees most commonly soon after opening an account. Subsequently, the incidence of these fees declined, falling by 75 percent during the first four years of account life. To explain this behavior, Agarwal, Driscoll, Gabaix, and Laibson suggested that consumers often learn about fees by incurring them or having incurred a fee, consumers are more careful in managing their accounts. Consumers learn from their mistakes and take steps in the future to avoid making a mistake again. In the case of late payments, for example, they found that incurring a late payment fee reduced the probability of a late payment in the next month by 44 percent. They also found that a recent fee payment had a larger effect than more distant fee payments.

The findings of Agarwal, Driscoll, Gabaix, and Laibson suggest that consumers may not consider all available information in opening accounts or always manage their accounts carefully. That alone does not indicate that consumers' behavior is not rational. That consumers learn from experience and correct their behavior after mistakes in consistent with rationality, where rationality is viewed as taking actions to achieve objectives.

In sum, evidence from analyses of actual credit card behavior indicates that consumers are sensitive to price, consistent with the predictions of economic theory. When a credit card company increases the interest rates on an account, consumers reduce new charges, reduce existing balances, and shift charges to other credit card accounts; and over the course of a year, they reduce total credit card balances from the level before the price increase. Based on subsequent account use, consumers generally make cost minimizing choices trading off interest rates and annual fees when choosing new credit card accounts. When they make mistakes, the mistakes are usually relatively small. If mistakes are large, consumers generally correct the mistakes. Although some consumers do not correct large mistakes, persistent large mistakes are not the rule. Analyses of credit card behavior based on survey data also suggest that consumers are sensitive to cost and do not incur costly mistakes. Survey data indicate that by far most consumers believe that credit cards provide a useful service (Canner and Elliehausen 2013). Consumers whose choices are inconsistent with their interests are unlikely to evaluate a product positively. Analyses of actual behavior in the credit card market does not support a hypothesis that credit market failures arising from behavioral biases are large and persistent.

Financial Literacy

Researchers have written numerous papers examining individuals, knowledge of financial concepts and the effects of such knowledge on financial decisions.[25] These studies can broadly be classified in one of two groups, measured financial literacy studies or financial education intervention studies (Fernandes, Lynch, and Netemeyer 2014). Measured financial literacy is defined as percentage of correct answers on test questions on financial knowledge.[26] These studies correlate financial literacy with different indicators of financial management of behavior. Financial education intervention studies compare outcomes of individuals who participated in various financial education programs. Financial education intervention studies are generally experimental or quasi-experimental assessments of the effects of financial education on subsequent financial outcomes. Outcomes consist of behavior that is generally considered good financial practice, such as accumulating savings, planning for retirement, budgeting expenses, investing in stocks, having a diversified asset portfolio, avoiding late fees, improving credit bureau scores, paying credit card statement balances in full, avoiding high-rate credit products.

Research on financial literacy often starts with a formal economic life-cycle model of intertemporal consumption (see Lusardi and Mitchell 2014). The details differ, but the basic structure of the various models is similar. Individuals receive an income stream and seek to achieve an optimal time pattern or consumption over their lifetimes. They may borrow when young, when returns on household investment in durables are high, pay down debts and save during high earning years, and rely on social security and savings to support consumption in retirement. Decisions may be influenced by borrowing constraints, mortality risk, demographic factors, stock market returns, tax considerations, and earnings and health shocks. In some models, individuals may incur costs for acquiring financial information and knowledge to improve the financial outcomes, which allow them to obtain higher valued distribution intertemporal consumption. An important implication of allowing individuals to choose the amount of financial information and knowledge is that they will choose different types and amounts depending on their circumstances. For example, Lusardi and Mitchell hypothesize that individuals with limited education might rationally choose not to incur the costs to increase financial knowledge because having few assets or discretionary income to invest and anticipating receipt of substantial social security income in old age would obtain little benefit from such knowledge.

Lusardi and Mitchell (2014) argue that knowledge of several concepts are fundamental to making saving and investment decisions in a life-cycle framework. Key concepts include effects of interest compounding, inflation, and risk diversification. They developed three test questions for these concepts to measure individuals' understanding of the concepts, with correct answers being interpreted as being financially literate. They developed an expanded set of test questions on financial knowledge for savings and investment decisions (Lusardi and Mitchell 2010) to assess knowledge relevant for borrowing decisions (Lusardi and Tufano 2009).

[25] Fernandes, Lynch, and Netemeyer (2014) identified 10,650 studies published between 1987 and 2013 that were empirical tests of the effect of financial literacy on financial behavior.

[26] Some questions test knowledge of basic financial concepts such as compound interest: For example, "Suppose you had $100 in a savings account and the interest rate was 20 percent per year. After 5 years how much do you think would you have on this account in total? [More, exactly or less than 200]." Other questions require knowledge of basic concepts and institutional features: For example, "Buying a company stock usually provides a safer return than a stock mutual fund. [True or false?]" Correctly answering this question requires understanding of risk diversification and knowing the definition of a stock mutual fund. See Lusardi and Mitchell 2010 for a list of the full set of financial literacy questions.

Lusardi and Mitchell's three test questions were included in the 2004 Health and Retirement Study, which surveyed a representative sample of individuals in the US aged 50 years or older. Large percentages of respondents provided incorrect answers or said that they did not know the correct answer to each of the test questions (33, 25, and 48 percent for interest compounding, inflation, and risk diversification, respectively).[27] Responses to these questions by other population groups produced similar large percentages of individuals who were unable to provide correct answers (Lusardi, Mitchell, and Curto 2014 and Lusardi and Mitchell 2010, for example). These findings led Lusardi and Mitchell to conclude that the level of financial literacy is quite low.

Evidence on the Effects of Financial Literacy on Behavior

Simply knowing facts, such as knowing correct answers to test questions, however, does not ensure that an individual is capable of making sound financial decisions. Individuals must be able use their knowledge effectively. A large number of papers have examined whether financially literate individuals achieve better financial outcomes than financially illiterate individuals. In a meta-analysis, Fernandes, Lynch, and Netemeyer (2014) reviewed the findings of 168 such papers containing 201 nonredundent studies, which were systematically selected to produce a representative sample.[28] They also conducted original analyses.

Fernandes, Lynch, and Netemeyer examined two types of studies assessing the effects of financial knowledge on outcomes of financial decisions. One type assessed outcomes of financial literacy of individuals defined by the percentage of correct answers on test questions on financial knowledge, such as the test questions of Lusardi and Mitchell. These studies Fernandes, Lynch, and Netemeyer called measured financial literacy studies. The other type of study compared outcomes of individuals who participated in various financial education programs, which they called financial education intervention studies. Financial education intervention studies are experimental or quasi-experimental assessments of the effects of financial education on subsequent financial decisions.

Their review indicated that financial education intervention studies have statistically significant but inconsiderable effects on behavior. Measured financial literacy studies have larger, significant effects than financial education intervention studies, but the effects of measured financial literacy are still very small. Results varied by the studies' research design, with stronger designs estimating smaller effects than weaker designs. Experimental studies of financial education interventions produced smaller effects than quasi-experimental studies, and studies of measured financial literacy using instrumental variables produced smaller effects than studies using ordinary least squares.[29]

[27] Sixty-six percent gave incorrect answers or said that they did not know the correct answer for two or more questions. Ten percent gave incorrect answers or said that they did not know the correct answer for all three questions.

[28] If two papers analyzed the same data, they included the paper with the most inclusive sample. Pretest/posttest studies were included only if the posttest was at least two weeks later than the pretest. They excluded studies that did not provide sufficient information to calculate effect size.

[29] This finding is in sharp contrast to Lusardi and Mitchell (2014), who point to selected studies that report larger effects for instrumental variable regressions than OLS regressions. As mentioned, Fernandes, Lynch, and Netemeyer's results are based on a systematically selected set of all studies, which includes more studies, and

Studies of measured financial literacy have used instrumental variables in efforts to account for possible bias from omitted variables, which may occur if an omitted variable is correlated with both financial literacy and financial behavior. For example, personal characteristics (such as confidence in information search, propensity to plan, willingness to take financial risks, and numeracy) might be correlated with financial literacy but also with positive financial behavior (such as saving for emergencies, planning for retirement, and avoiding overdraft or late fees). In their original analyses, Fernandes, Lynch, and Netemeyer found that measured financial literacy was significantly related to positive financial behavior after accounting for individuals' demographic characteristics. However, when they added personal characteristics to the model, measured financial literacy was statistically insignificant. These personal characteristics quite plausibly are related to acquisition of financial knowledge and positive financial behavior, a conclusion that is consistent with these findings.

Fernandes, Lynch, and Netemeyer found that effects of manipulated financial literacy decay with delay but at a decreasing rate. The decay over time is greater for larger interventions (measured by hours of instruction) than for smaller interventions. After 24 months, the effect of the intervention is about the same regardless of the size of the intervention.

Implications of Behavioral Studies for Financial Literacy

Fernendes, Lynch, and Netemeyer offered possible explanations for weak effects of financial education. They noted that financial education competes for consumers' attention with other information available in the market. Without a ready expected use, consumers' motivation to acquire knowledge may be weak. This argument favors just-in-time financial education tied to a particular decision over youth financial education interventions intended to affect behavior in the distant future.

Their finding that knowledge decays over time suggests that imminent use of acquired information aids retention. Time-sensitive content knowledge is especially likely to be forgotten. Over time, consumers are likely to forget information that is not used.

The content of a given financial education interventions may be useful in some situations but not in other situations. For example, teaching budgeting skills might be useful to consumers with limited resources. In contrast, consumers with significant surpluses in their budgets may not need to budget their expenses very carefully and therefore may obtain little benefit from such education (Xiao and O'Neill 2018). Uncertainty also may affect the usefulness of financial education interventions. Stating normative behavior is difficult when neither instructors nor consumers can anticipate future circumstances.

Multiple-skill, multiple-behavior programs may be less effective than single-behavior programs. Consumers may perceive less relevance and give less attention to broad-based programs that address some future, as yet unanticipated decisions than single-behavior programs addressing a specific known and imminent decision. Some studies suggest that attitudes and personal traits such as propensity to plan, confidence to be proactive, and willingness to take financial risks may be more effective than

likely is more representative of such studies than Lusardi and Mitchell. Also, Fernandes, Lynch, and Netemeyer report standardized effects (partial correlation coefficients) to facilitate comparisons of effects across models.

content knowledge about financial mathematics or financial markets and instruments for achieving utility increasing outcomes (Hadar et al. (2013).

Further study of decision processes and outcomes are needed to resolve differences in implications of behavioral analyses for financial literacy and education. The heuristics and biases literature does not find much of a role for financial education to improve financial decisions. According to this literature systematic errors are hard wired in the brain. Consumers use heuristics that are error-prone and often do not realize their mistakes. Education can have little effect on behavior under this circumstance. In contrast, the fast and frugal literature views heuristics as experience-based decision making shortcuts for specific environments. Actual choice environments are characterized by asymmetric, incomplete, and even false information. Financial education interventions informed by understanding decision processes can improve outcomes by facilitating information acquisition and improving choice environments.

Public policy implications of the heuristics and biases program differ from those of the fast and frugal heuristics program. Heuristics and biases suggests that experts know desirable financial outcomes better than consumers. Regulation of products and nudges into decisions that are deemed in the best interest of consumers are the preferred policies. Fast and frugal heuristics generally respects differences in individuals' circumstances and preferences. The fast and frugal approach favors disclosure and financial education interventions that improve decision making environments and facilitate achievement of better financial outcomes.[30]

Limited Information and Heuristic Decision Making in Market Environments

Limited theoretical evidence indicates that a satisficing heuristic produces long-run optimal outcomes in some circumstances. Empirical evidence from experimental economics supports this theoretical conclusion.[31] The studies consistently indicate that individual decisions based on limited information in experimental markets produce prices and allocations that converge quickly to the neighborhood of optimal equilibrium values.[32] The results occur even though participants do not engage in extensive weighing of alternatives. The behavior of participants using various heuristics with limited information produces efficient market outcomes.

Experimental studies have also found that market environments reduce the incidence of preference reversals for risky prospects and losses from failure to recognize sunk costs and opportunity costs. Smith (1991) argued that the findings of these studies suggest that markets reinforce or even induce individual rationality, although the manner in which markets promote rationality is not well understood. In a later paper Smith (2005) speculated on how markets promote rationality. Market prices provide stimuli that cause individuals to take actions that better their situations. These actions move prices and

[30] See Altman (2012) for further discussion.
[31] Experimental economics is a field of economics that applies experimental methods to study how markets and other exchange systems work.
[32] See Smith (1991) for references and a summary of the findings various studies.

allocations to competitive equilibrium.[33] Focusing on whether or not individual decisions are optimal misses the point (p. 146).

Consistent with the findings in experimental markets, evidence of the existence of behavioral biases in equity markets does not lead to the conclusion that market outcomes are not efficient. Shiller (1999) in a review of behavioral finance describes various anomalies and departures from rationality in financial markets. He concludes

> Because of its focus on anomalies and departures about conventional notions of rationality, I worry that the reader of this paper can get a mistaken impression about the place of behavioral finance and the importance of conventional theory. … The lesson from the literature surveyed here, is not that "anything can happen" in financial markets. … I could have, had that been the goal of this paper, found very many papers that suggest that markets are impressively efficient in certain respects (p. 1333).

Reviewing studies of stock return anomalies attributed to behavioral biases, Malkiel (2003) noted that although statistically significant, the anomalies are generally quite small and that the anomalies sometimes persist for short periods but usually disappear quickly. Malkiel argued that while market participants clearly do make mistakes and the actions of some market participants are demonstrably less than rational, the preponderance of evidence suggests that the market is remarkably efficient. Whatever evidence of anomalies in pricing of equities have been found, he concluded, do not persist and provide few opportunities for investors to obtain extraordinary returns. Fama (1998) and Schwert (2003) provide a similar assessments of the evidence on behavioral anomalies in stock market returns.

Conclusions

Behavioral research indicates that consumers do not always make the cognitive efforts required for an extensive decision process. Individuals often take shortcuts, simplify, and use heuristics. Cognitive effort tends to be reserved for situations where commitments in money and duration are great, past experience and information are insufficient or obsolete, and outcomes of previous decisions are regarded as unsatisfactory. In situations where consumers have previous experience and are satisfied with past decisions, consumers often make choices with little further deliberation.
That cognitive biases and time inconsistent discounting exist is well established in the behavioral literature. Some research suggests that these psychological considerations influence consumers' credit behavior. The extent to which cognitive biases and time inconsistent discounting affect actual credit decisions is not known at this time.

The experimental evidence supporting cognitive biases and time inconsistent discounting is sensitive to the format, content, and context of the problems presented to study participants. When problems are framed differently the results sometimes contradict previous findings. Experimental problems often appear more similar to test questions than choices that consumers actually face in the markets. Hypothetical situations are likely perceived as such by study participants. And it seems unlikely that participants in experimental studies view the consequences of their choices as very important even when they are paid or their course grade may be affected. Individuals may be predisposed to impulsive behavior but they also have the capacity to exert self-control to implement forward looking plans.

[33] In a theoretical study, Bendor, Kuymar, and Siegel (2009) found that a satisficing heuristic (choose an action again if it previously satisfied aspirations; search otherwise) often produces optimal long-run outcomes and improved but not optimal outcomes in others).

Self-control requires actively maintaining attention to the plan. An individual facing an impulse might yield to the impulse if it does not perturb the plan too much. To be effective, self-control requires that the internal inhibitions become stronger as awareness of the cost of impulsive behavior increases. It is not clear that participants exert the same cognitive efforts in experimental situations that they exert in actual situations where commitments in money and duration are great, past experience and information are insufficient or obsolete, and outcomes of previous decisions are regarded as unsatisfactory. Empirical evidence indicates that consumers generally use credit to finance purchases of relatively expensive consumer durable goods, not to smooth consumption. In doing so, behavioral concepts such as pre-commitment and mental accounts may be used to manage behavior. Such concepts may not be optimal in the sense of global utility maximization, but they may be sensible when future prospects, preferences, and resources are uncertain.

Evidence indicates that many consumers have little knowledge of basic financial principles or financial institutions and markets. Greater knowledge or participation in financial education interventions is generally associated with positive financial outcomes, but the effects are small. Behavioral studies suggest different implications for this finding. The heuristics and biases literature suggests that education has little effect because systematic cognitive errors are frequent and hard wired in the brain. The fast and frugal heuristics literature suggests that consumers use experience-based decision making heuristics appropriate for specific environments. As these heuristics may not require extensive collection of information and evaluation of alternatives, consumers may not need the same knowledge of financial principles or financial institutions and markets that underlie tests for financial literacy and financial education interventions. Further study of decision processes and outcomes are needed to resolve differences in implications of behavioral analyses for financial literacy and education.

Analyses of actual credit card behavior indicate that consumers are sensitive to price, consistent with the predictions of economic theory. When a credit card company increases the interest rates on an account, consumers reduce new charges, reduce existing balances, and shift charges to other credit card accounts; and over the course of a year, they reduce total credit card balances from the level before the price increase. Based on subsequent account use, consumers generally make cost minimizing choices trading off interest rates and annual fees when choosing new credit card accounts.
When they make mistakes, the mistakes are usually relatively small. If mistakes are large, consumers generally correct the mistakes. Although some consumers do not correct large mistakes, persistent large mistakes are not the rule. Analyses of credit card behavior based on survey data also suggest that consumers are sensitive to costs and do not incur costly mistakes. And by far most consumers believe that credit cards provide a useful service and are satisfied with their dealings with credit card companies. Thus, neither behavioral nor conventional evidence provides much support for the conclusion that market failure is pervasive.

References

Agarwal, Sumit, Souphala Chomsisengphet, Chunlin Liu, and Nicholas S. Souleles. “Do Consumers Choose the Right Credit Contracts?” Working Paper, Federal Reserve Bank of Chicago, December 18, 2005.

Altman, Morris. "Implications of Behavioural Economics for Financial Literacy and Public Policy." *Journal of Socio-Economics*, 41 (2012): 677-90.

Agarwal, Sumit, John C. Driscoll, Xavier Gabaix, and David Laibson. "Learning in the Credit Card Market." Working Paper 13822. Cambridge: National Bureau of Economic Research, February 2008.

Ariely, Dan and Klaus Wertenbach. Procrastination, Deadlines, and Performance: Self-Control by Precommitment. *Psychological Science*, 13 (May 2002): 219-24.

Ausubel, Lawrence W. "The Failure of Competition in the Credit Card Market." *American Economic Review*, 81 (March 1991): 50-81.

Ausubel, Lawrence M. "Adverse Selection in the Credit Card Market." Working Paper, University of Maryland (June 17, 1999).

Becker, Gary S. and Casey B. Mulligan. "The Endogenous Determination of Time Preference." *Quarterly Journal of Economics*, 116 (August 1997): 729-58.

Bendor, Jomathan Brodie, Sunil Kumar, and David A. Siegel. "Satisficing: A 'Pretty Good' Heuristic." *The B.E. Journal of Theoretical Economics*, 9 (2009): 1-36. www.bepress.com/bejte/vol9/iss1/art9.

Benhabib, Jess and Alberto Bisin. 2005. Modeling Internal Commitment Mechanisms and Self-Control: A Neuroeconomic Approach to Consumption-Saving Decisions. *Games and Economic Behavior*, 52 (2005): 460-92.

Blackwell, Roger D., Paul W. Mineard, and James F. Engel. *Consumer Behavior*, 10th edition. Stamford, CT: Thompson South Western, 2006.

Bloomfield, Ted, Richard Leftwich, and John B. Long Jr. "Portfolio Strategies and Performance." *Journal of Financial Economics*, 5 (November 1977): 201-18.

Camerer, Colin, George Loewenstein, and Drazen Prelec. "Neuroeconomics: How Neuroscience Can Inform Economics." *Journal of Economic Literature*, 43 (March 2005): 9-64.

Cosmides, Leda and J. Tooby. "Are Humans Good Intuitive Statisticians After All? Rethinking Some Conclusions from the Literature on Judgment under Uncertainty." *Cognition*, 58, 1 (1996), 1-73.

Canner, Glenn B. and Gregory Elliehausen. "Consumer Experiences with Credit Cards." *Federal Reserve Bulletin*, 99 (December 2013): 1-36.

Day, George S. and William K. Brandt. "A Study of Consumer Credit Decisions: Implications for Present and Prospective Legislation." In *National Commission on Consumer Finance: Technical Studies*, vol. 1. Washington, DC: US Government Printing Office, 1973.

DellaVigna, Stefano and Ulrike Malmendier. "Contract Design and Self-Control: Theory and Evidence." *Quarterly Journal of Economics*, 119 (May 2004): 353-401.

DeMiguel, Victor, Lorenzo Garlappi, and Raman Uppal. "Optimal versus Naïve Diversification: How Inefficient Is the 1/N Portfolio Strategy?" *Review of Financial Studies*, 22 (May 2009): 1915-53.

Durkin, Thomas A. and Gregory Elliehausen. *1977 Consumer Credit Survey.* Washington: Board of Governors of the Federal Reserve System, 1978.

Durkin, Thomas A. and Gregory Elliehausen. *Truth in Lending: Theory, History, and a Way Forward*. New York: Oxford University Press (2010).

Durkin, Thomas A., Gregory Elliehausen, Michael E. Staten, and Todd Zywicki. *Consumer Credit and the American Economy*. New York: Oxford University Press, 2014.

Fama, Eugene F. "Market Efficiency, Long-Term Returns, and Behavioral Finance." *Journal of Financial Economics*, 49 (1998): 283-306.

Fernendes, Daniel, John G. Lynch, and Richard Netemeyer. "A Meta-Analytic and Psychometric Investigation of the Effect of Financial Literacy on Downstream Financial Behaviors." *Management Science*, 60 (August 2014): 1861-83.

Forbes, William, Robert Hudson, Len Skerratt, and Mona Soufian. "Which Heuristics Can Aid Financial-Decision-Making? *International Review of Financial Analysis*, 42 (2015): 199-210.

Fiori, Stefano. Simon's Bounded Rationality: Origins and Use in Economic Theory. Working Paper No.09/2006. Torino: Università di Torino, Department of Economics, 2005.

Fiedler, Klaus. The Dependence of the Conjunction Fallacy on Subtle Linguistic Factors. *Psychological Research*, 50, (1988): 123-29.

Frederick, Shane, George Loewenstein, and Ted O'Donoghue. "Time Discounting and Time Preference: A Critical Review." *Journal of Economic Literature*." 40 (June2002): 351-401.

Gabaix, Xavier and David Laibson. Shrouded Attributes, Consumer Myopia, and Information Suppression in Competitive Markets. *Quarterly Journal of Economics*, (May 2006): 505-40.

Gigerenzer, Gerd. "Why the Distinction between Single-Event Probabilities and Frequencies Is Important for Psychology (and Vice Versa)." In *Subjective Probability*, G. Wright and P. Ayton, editors. New York: John Wiley, 1994.

Gigerenzer, Gerd. Why Heuristics Work. *Perspectives on Psychological Science*, 3 (January 2008): 20-9.

Gigerenzer, Gerd and Henry Brighton. "Homo Heuristicus: Why Biased Minds Make Better Inferences." *Topics in Cognitive Science*, 1 (2009): 107-43.

Gigerenzer, Gerd and Ulrich Hoffrage. "How to Improve Baysian Reasoning without Instruction: Frequency Formats." *Psychological Review*, 102 (1995): 684-704.

Gigerenzer, Gerd. Peter M. Todd, and the ABC Group. *Simple Heuristics that Make Us Smart.* New York: Oxford University Press, 1999.

Green, Leonard and Joel Myerson. "Exponential versus Hyperbolic Discounting of Delayed Outcomes:

Risk and Waiting Time." *American Zoologist*, 36 (September 1996): 496-505.

Gross, David B. and Nicholas S. Souleles. "Do Liquidity Constraints and Interest Rates Matter for Consumer Behavior? Evidence from Credit Card Data." *Quarterly Journal of Economics*, 117 (February 2002): 149-85.

Jorion, Philippe. "Bayesian and CAPM Estimators of the Means: Implications for Portfolio Selection." *Journal of Banking and Finance* 15 (1991): 717-27.

Hadar, Liat, Sanjay Sood, and Craig R. Fox. "Subjective Knowledge in Consumer Financial Decisions." *Journal of Marketing Research*, 50 (June 2013): 303-16.

Hertwig, Ralph and Gerd Gigerenzer. "Frequency and Single-Event Judgments." Unpublished manuscript, 1993.

Hertwig, Ralph and Gerd Gigerenzer. "The 'Conjunction Fallacy' Revisited: How Intelligent Inferences Look Like Reasoning Errors." *Journal of Behavioral Decision Making*, 12 (1999): 275-305.

Kahneman, Daniel. *Thinking Fast and Slow*. New York: Farrar, Straus and Giroux, 2011.

Kahneman, Daniel and Shane Frederick. "A Model of Heuristic Judgment." In *The Cambridge Handbook of Thinking and Reasoning*, K.J. Holyoak and R.G. Morrison, editors. New York: Cambridge University Press, 2005.

Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler. "Experimental Tests of the Endowment Effect and the Coase Theorem." *Journal of Political Economy*, 98 (1990): 1325-48.

Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler. "Anomolies: The Endowment Effect, Loss Aversion, and Status Quo Bias." *Journal of Economic Perspectives*, 5 (Winter 1991): 193-206.

Kahneman, Amos and Daniel Tversky. "Prospect Theory: An Analysis of Decision under Uncertainty." *Econometrica*, 47 (March 1979): 263-92.

Katona, George. *Psychological Economics*. New York: Elsevier Scientific Publishing, 1975.

Katona, George and Eva Mueller. "A Study of Purchase Decisions." In *Consumer Behavior: The Dynamics of Consumer Reaction*, L. H. Clark, ed. New York: New York University Press, 1954.

Krynski, Tevye R. and Joshua B. Tenenbaum The Role of Causal Models in Reasoning under Uncertainty In *Proceedings of the 25th Annual Conference of the Cognitive Science Society* (2003).

Laibson, David. "Golden Eggs and Hyperbolic Discounting." *Quarterly Journal of Economics*, 112 (May 1997): 443-77.

Loomes, Grahm, Chris Starmer, and Robert Sugden. "Do Anomalies Disappear in Repeated Markets." *Economic Journal*, 113 (March 2003): C153-66.

Lusardi, Annamaria and Olivia S Mitchell. How Ordinary Consumers Make Complex Economic Decisions: Financial Literacy and Retirement Readiness. CFS Working Paper No. 2010/11. Frankfurt: Goethe University, Center for Financial Studies, 2010.

Lusardi, Annamaria and Olivia S Mitchell. The Economic Importance of Financial Literacy: Theory and Evidence. *Journal of Economic* Literature, 52 (March 2014): 5-44.

Lusardi, Annamaria and Olivia S Mitchell, and Vilsa Curto. Financial Literacy and Financial Sophistication in the Older Population. *Journal of Pension Economics and* Finance, 13 (October 2014): 347-66.

Lusardi, Annamaria and Peter Tufano. Debt Literacy. Financial Experiences, and Overindebtedness. CFS Working Paper No. 2009/08. Frankfurt: Goethe University, Center for Financial Studies, 2009.

Malkiel, Burton G. "The Efficient Market Hypothesis and Its Critics." *Journal of Economic Perspectives*, 17 (Winter 2003): 59-82.

Miller, Earl K. and Jonathan D. Cohen. "An Integrative Theory of Prefrontal Cortex Function." *Annual Review of Neuroscience*, 24 (2001): 167-202.

Miller, George A. The Cognitive Revolution: A Historical Perspective, *Trends in Cognitive* Sciences, 7 (March 2003): 141-4.

Monti, Marco, Riccardo Boero, Nathan Berg, Gerd Gigerenzer, and Laura Martignon. How Do Common Investors Behave? Information Search and Portfolio Choice among Bank Customers and University Students. *Mind Science*, 11 (2012): 203-33.

Mors, Wallace P. *Consumer Credit Finance Charges: Rate Information and Quotation*. New York: National Bureau of Economic Research, 1965.

Oaksford, Mike, and Nick Chater. "Rational Explanation of the Selection Task. *Psychological Review*, 103 (1996): 381-91.

O'Donoghue, Ted and Matthew Rabin. "Doing It Now or Doing It Later." *American Economic Review*, 89 (March 1999): 103-24.

Plott, Charles R. "Rational Individual Behavior in Markets and Social Choice Processes: The Discovered Preference Hypothesis." In *Rational Foundations of Economic Behavior*, K. A. Arrow, E. Colombatto, M. Perlman, and C. Schmidt, eds. New York: St. Martins Press, 1996.

Plott, Charles R. and Kathryn Zeiler. "The Willingness to Pay-Willingness to Accept Gap, the 'Endowment Effect,' Subject Misconceptions, and Experimental Procedures for Eliciting Validations." *American Economic Review*, 95 (June 2005): 530-45.

Prelec, Drazen and George Loewenstein. "The Red and the Black: Mental Accounting of Savings and Debt." *Marketing Science*, 17 (1998): 4-28.

Real, Leslie and Thomas Caraco. "Risk and Foraging in Stochastic Environments." *Annual Review of Ecology and Systematics*, 17 (1986): 371-90.

Samuels, Richard, Stephen Stich, and Luc Faucher. “Reason and Rationality.” In *Handbook of Epistemology*, I. Niiniluoto, M. Sintonen, and J. Wolenski, eds. Dordrecht: Kluwer, 2004.

Samuelson, Paul A. “A Note on Measurement of Utility.” *Review of Economic Studies*, 4, (February 1937): 155-61.

Schoemaker, Paul J.H. "The Expected Utility Model: Its Variants, Purposes, Evidence and Limitations." *Journal of Economic Literature*, 20 (June 1982): 529-63.

Shefrin, Hersh M. and Richard H Thaler. “The Behavioral Life-Cycle Hypothesis”. *Economic Inquiry*, 26 (October 1988): 609-43.

Shiller, Robert J. Human Behavior and the Efficiency of the Financial System. In *Handbook of Macroeconomics*, edited by John B. Taylor and Michael Woodford, volume 1, part C, (1999): 1305-40.

Shui, Haiyan and Lawrence M. Ausubel. “Time Inconsistency in the Credit Card Market.” Working Paper, University of Maryland (January 30, 2005).

Schwert, G. William. “Anomalies and Market Efficiency.” In *Handbook of the Economics of Finance*, G.M. Constantinides, M. Harris, and R.M. Stulz, editors. New York: Elsevier, 2003.

Smith, Vernon L. “Rational Choice: The Contrast between Economics and Psychology.” *Journal of Political Economy*, 99 (August 1991): 877-97.

Smith, Vernon L. “Behavioral Economics Research and the Foundations of Economics.” *Journal of Socio-Economics*, 34 (2005): 135-50.

Soman, Dilip. “Effects of Payment Mechanism on Spending Behavior: The Role of Rehearsal and Immediacy of Payments.” *Journal of Consumer Research*, 27 (March 2001): 460-74.

Soman, Dilip. “The Effect of Payment Transparency on Consumption: Quasi-Experiments from the Field.” *Marketing Letters*, 14 (October 2003): 173-83.

Stango, Victor and Jonathan Zinman. “Fuzzy Math, Disclosure Regulation, and Market Outcomes: Evidence from Truth-in-Lending Reform.” *Review of Financial Studies*, 24 (2011): 507-34.

Soman, Dilip and John T. Gourville. “Transaction Decoupling: How Price Bundling Affects the Decision to Consume.” *Journal of Marketing Research*, 38 (February 1998): 30 – 44.

Strotz, R.H. “Myopia and Inconsistency in Dynamic Utility Maximization.” *Review of Economic Studies*, 23 (1955-1956): 165-80.

Thaler, Richard H. “Toward a Positive Theory of Consumer Choice.” *Journal of Economic Behavior and Organization*, 1 (1980): 39-60.

Thaler, Richard H. “Some Empirical Evidence on Dynamic Inconsistency.” *Economics Letters*, 8 (1981): 201-7.

Thaler, Richard H. “Mental Accounting and Consumer Choice.” *Marketing Science*, 4 (Summer 1985): 199-214.

Thaler, Richard H. and Shlomo Benartzi. “Save More Tomorrow: Using Behavioral Economics to Increase Employee Saving.” *Journal of Political Economy*, 112 (2004): S164-S187.

Thaler, Richard H. and Eric J. Johnson. “Gambling with House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice.” *Management Science*, 36 (June 1990): 643-60.

Tversky, Amos and Daniel Kahneman. “Judgment Under Uncertainty: Heuristics and Biases.” *Science*, 185 (1974): 1124-31.

Tversky, Amos and Daniel Kahneman. “The Framing of Decisions and the Psychology of Choice.” *Science*, 211 (1981): 453-8.

Tversky, Amos and Daniel Kahneman. “Extensional versus Intuitive Reasoning: The Conjugation Fallacy in Probability Judgment.” *Psychological Review*, 90 (1983): 293-315.

Xiao, Jing Jian and Barbara O’Neill. “Mental Accounting and Behavioral Hierarchy: Understanding Consumer Budgeting Behaviour.” *International Journal of Consumer Studies*, 42 (April 2018: 448-59.