Short Course on Behavioral Economics and Finance
Part I: An Overview

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Evaluation of Future Cash Flow

- Future cash flow $\tilde{X}$: *Random variable* or *lottery* or *prospect*
  e.g. $\tilde{X} = (110, 60\%; 90, 40\%)$.
- How to compare random variables?
- *Expected value* or *mean* $\mathbb{E}[\tilde{X}]$: $110 \times 60\% + 90 \times 40\% = 102$.

St Petersburg Paradox

A fair coin is tossed repeatedly until the first head appears. You get 2 ducats if the first head appears on the 1st toss, 4 ducats if the first head appears on the 2nd toss, and 2^n ducats if the first head appears on the nth toss.

- How much would you be willing to pay to play? 4, 20, or 50 ducats?
- The wining prospect is $\tilde{X} = (2, \frac{1}{2}; 4, \frac{1}{4}; ...; 2^n, \frac{1}{2^n}...)$.
- The **expected** payoff

$$\mathbb{E}[\tilde{X}] = \frac{1}{2} \times 2 + \frac{1}{4} \times 4 + \frac{1}{8} \times 8 + \cdots + \frac{1}{2^n} \times 2^n + \cdots = +\infty!$$

- "Few of us would pay even 25 ducats to enter such a game" (R. Martin 2004, *The Stanford Encyclopedia of Philosophy*).

Bernoulli's Resolution

Daniel Bernoulli (1738): Satisfaction from a payoff x should not be proportional to x, but should be a proper function U of x.

- Bernoulli proposed $U(x) = \log(x)$ (1 utiles $= \log$(ducats)).
- Value of the St Petersburg game in utiles:

$$\begin{aligned} & \mathbb{E}[U(X)] \\ = \; & \tfrac{1}{2} \times \log(2) + \tfrac{1}{4} \times \log(4) + \tfrac{1}{8} \times \log(8) + \cdots + \tfrac{1}{2^n} \times \log(2^n) + \cdots \\ = \; & \log(4) \end{aligned}$$

  - ... or 4 ducats.

Gossen's First Law: Diminishing Marginal Utility

Herman Gossen (1854) "*Laws of Economic Activity*"

- $U(x) = \log(x)$ is **increasing** in x.
- **Speed** of increase is **decreasing** in x ($U'(x) = \frac{1}{x}$), and negligible when x is sufficiently large - *decreasing and diminishing marginal utility*.
- Key to Bernoulli's resolution of St Petersburg paradox.
- Mathematically, decreasing marginal utility equivalent to a *concave* utility function.

Risk Aversion

A concave utility function, in turn, suggests *risk aversion*.

- Choose between
  - A: Win \$10,000 with 50% chance and \$0 with 50% chance
  - B: Win \$5,000 with 100% chance
  - Most people chose B
- Generally, most people choose B in the following
  - A: Win x with 50% chance and y with 50% chance
  - B: Win $\frac{1}{2}(x + y)$ with 100% chance
- People dislike mean-preserving spread – *"risk averse"*.
- $U(\frac{1}{2}x + \frac{1}{2}y) \geq \frac{1}{2}U(x) + \frac{1}{2}U(y)$ - Concave function!

Expected Utility Theory

- *Expected Utility Theory (EUT)*: To evaluate gambles (random variables, lotteries) and form preference.
- Foundation laid by von Neumann and Morgenstern (1947).
- Axiomatic approach: completeness, transitivity, continuity and independence.
- Behaviour of a **rational** agent necessarily coincides with that of an agent who values uncertain payoffs using expected **concave** utility.

Neoclassical Finance and Rationality

- *Neoclassical finance*, regarded as the first revolution in the history of financial theory, began with the mean–variance portfolio theory, capital asset pricing model (CAPM) and efficient markets theory (EMH) around the 1960s, and with the intertemporal capital asset pricing model (ICAPM) and arbitrage-based option-pricing theory in the 1970s.
- Neoclassical finance seeks to understand financial markets and provide investment guidance using models in which individual agents and firms are assumed to be **rational**.
  - Frame Independent: the problem does not change by different descriptions.
  - Baysian rule works accurately.

Achievement of Neoclassical Finance

- *Efficient market hypothesis (EMH)*: mispricing cannot exist because it will be arbitraged away once it appears. As a consequence, market prices are always correct.
- *Mean-variance theory* and *capital asset pricing model (CAPM)*

$$\bar{r} - r_f = \beta(\bar{r}_M - r_f)$$

where $\bar{r}$: expected return rate of any given asset, r_f: risk-free rate, $\bar{r}_M$: expected market return rate, β: "beta" of the asset.

- *Consumption-based CAPM*

$$\bar{r} - r_f \approx \alpha \mathbf{Cov}(\tilde{g}, \tilde{r})$$

where $\alpha := -\frac{e_0 u''(e_0)}{u'(e_0)}$: relative risk aversion index, $\tilde{g}$: overall consumption growth rate, $\tilde{r}$: asset return rate.

- *Interest rate theory*

$$1 + r_f \approx \frac{1 + \alpha\bar{g}}{\gamma}$$

where $\bar{g}$: expected consumption growth rate, γ: discount rate.

Puzzles in Asset Pricing

- *Size premium*: Firms of smaller size have higher expected return than firms of larger size. Evidence from Fama and French (1992): in 1963–1990, the average return of the smallest stock decile in the US market is 0.74% per month higher than the average return of the largest stock decile.
- *Volatility puzzle*: The equity volatility is too high (16%) to be explained by the consumption-based CAPM (11%) (Campbell and Cochrane, 1999).
- *Equity premium puzzle*: The historical equity premium in the US—6.18% (in real terms)—is too high to be explained by the consumption-based CAPM (less than 1%) (Mehra and Prescott 1985).
- *Risk-free rate puzzle*: The observed risk-free rate is too low (less than 1%) to be explainable by classical CCAPM (Weil 1989).

Behavioral Finance and Irrationality

- *Behavioral finance* is a recent development in the finance area starting 1980s: Cumulative prospect theory, SP/A theory, regret and self-control, heuristics and biases.
- Behavioral finance discards the rationality assumption and argues that individuals are **irrational**.
- Describes the "reality".
- What is "rationality" and what is "irrationality"?

Decision-Making Under Risk

- The key difference of neoclassical finance and behavioral finance lies in the modelling or description of human behavior of decision-making under risk/uncertainty.
- Decision processes can be divided into three stages: *editing and framing* stage, *probability assessing* stage, and *evaluating* stage.
- The modeling of decision processes in the neoclassical finance is based on "rationality" assumption. Behavioral Finance describes "irrationality" in decision processes.

	Editing and Framing	Probability Assessing	Evaluating
Neoclassical Finance	Framing Doesn't Matter	Bayes' Rule	Expected Utility Theory, Risk Aversion
Behavioral Finance	Mental Accounting Framing Effects	Heuristics	CPT, SP/A Theory, Loss Aversion

Cognitive System — Roots of Biases

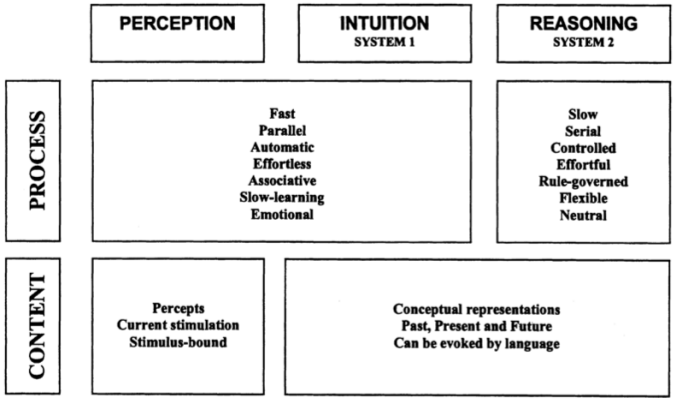


Figure: Cognitive system illustraed in Kahneman (2003).

Example: Parking Ticket

- Penalty of parking tickets are similar in HK and UK.
- In HK, the penalty charge notice (PCN) read:
  - A penalty HK$400 is now payable and must be paid in 14 days.
  - If you pay after 14 days there is a *surcharge* of an additional HK$400.
- Most paid reluctantly, on the last day.
- The PCN in UK said:
  - A penalty £70 is now payable and must be paid in 28 days.
  - But ... if you pay in 14 days there is a *discount* of 50% to £35.
- Many paid immediately ... *filled with gratitude and joy.*
- Framing does matter!

Example: $1/n$-th Heuristics

- Before 1988, TIAA-CREF, the largest defined-contribution saving plan, offered two investments: TIAA (bonds) and CREF (stocks). In the study of TIAA-CREF (1997), almost half of the participants of the plan chose a precise 50-50 allocation between TIAA and CREF.
- Harry Markowitz, the founder of modern portfolio theory, reported that he also "split my contributions fifty-fifty between bonds and equities".
- This observation is a special case of the "$\frac{1}{n}$ heuristics": many employees simply divide their contributions evenly among the n options offered in their retirement savings plans.

Example: $1/n$-th Heuristics (Cont'd)

- Benartzi and Thaler (2001) did a survey of the employees of the University of California. The employees were asked one short question about how they would allocate their defined contribution retirement funds if they were offered a particular set of investment options. Three different pairs of options are offered to three different groups: Stock Fund and Bond Fund; Stock Fund and Balanced Fund (that invests half in stocks and half in bonds); and Balanced Fund and Bond Fund. As expected, the most common allocation in each group is 50-50. As a result, the final allocation between stocks and bonds are much different in the three groups. The first group effectively has a 50-50 allocation, the second group has 75-25, and the last group has 25-75.

Example: $1/n$-th Heuristics (Cont'd)

- Benartzi and Thaler (2001) also compared the plan offered to TWA pilots with that offered to University of California (UC) employees. The TWA plan offers five core stock funds and one core bond fund (a stable value fund to be precise.) The participants in this plan invest 75 percent of their money in stocks which is well above the national average of 57 percent. The University of California plan, on the other hand, offers one stock fund and four bond funds, and employees in this plan invest only 34 percent in stocks, well below the national average.
- Benartzi and Thaler (2001) ran an additional experiment in which the UC employees were asked to make an asset-allocation decision if they were faced the TWA plan. It turned out that they chose from a mostly stock mix. Therefore, the different stock-bond allocation between the UC employees and TWA pilots are due to the $\frac{1}{n}$ heuristics, rather than due to different risk appetite between them.

Bayes' Rule

Bayes' rule is the standard theory of updating beliefs based on incoming information. It says

$$\mathbb{P}(A|B) = \frac{\mathbb{P}(B|A)\mathbb{P}(A)}{\mathbb{P}(B)},$$

where

- $\mathbb{P}(A)$ is the *prior probability* of the event A whose probability you want to estimate.
- B is the incoming information/event, and $\mathbb{P}(B|A)$ is the *likelihood* of the incoming event happening if event A happens.
- The denominator is a normalizing factor making the posterior belief a probability distribution.

Bayes' Rule: Example

Suppose a drug test will produce 99% true positive results for drug users and 99% true negative results for non-drug users. Suppose that 0.5% of people are users of the drug. If a randomly selected individual tests positive, what is the probability he or she is a user?

$$\begin{aligned}
\mathbb{P}(\text{user}|+) &= \frac{\mathbb{P}(+|\text{user})\mathbb{P}(\text{user})}{\mathbb{P}(+)} \\
&= \frac{\mathbb{P}(+|\text{user})\mathbb{P}(\text{user})}{\mathbb{P}(+|\text{user})\mathbb{P}(\text{user}) + \mathbb{P}(+|\text{non-user})\mathbb{P}(\text{non-user})} \\
&= \frac{0.99 \times 0.005}{0.99 \times 0.005 + 0.01 \times 0.995} \\
&= 33.2\%.
\end{aligned}$$

So s/he is more likely a non-user than a user!

Example: Concurrent Decisions

Imagine that you face the following pair of *concurrent* decisions. First examine both decisions, then indicate the options you prefer.

- **Decision (i):** Choose between:
  - A. a sure gain of \$240
  - B. 25% chance to gain \$1000 and 75% chance to gain nothing
- **Decision (ii):** Choose between:
  - C. a sure loss of \$750
  - D. 75% chance to lose \$1000 and 25% chance to lose nothing

Which pair would you like to choose?
It turned out that among the 150 subjects, 84% chose A, 16% chose B, 13% chose C, and 87% chose D.

Example: Concurrent Decisions (Cont'd)

- Thus, more than half of the subjects chose the pair A&D over the pair B&C
- Actually, the combined payoff of each of these pairs is

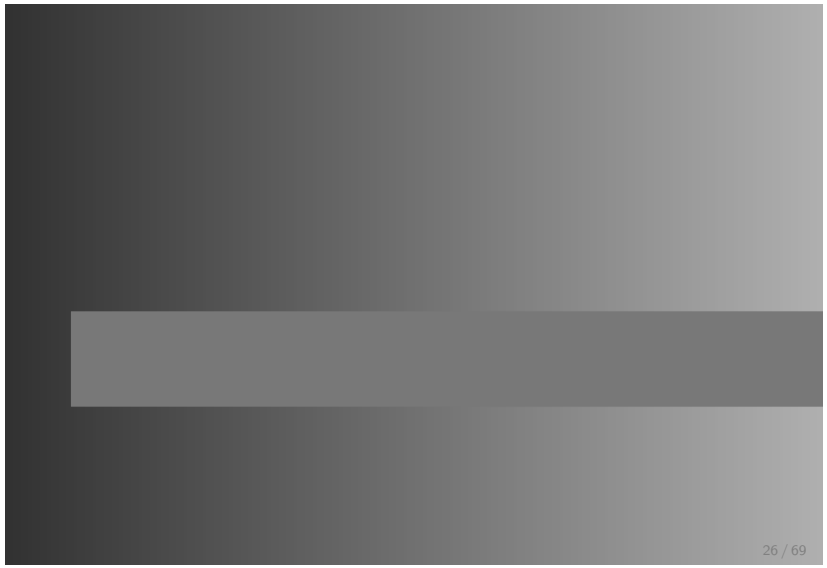
A&D: 25% chance to win \$240 and 75% chance to lose \$760.
B&C: 25% chance to win \$250 and 75% chance to lose \$750.

- More than half of the subjects chose the dominated pair!
- Framing matters! Although the subjects were told these two decisions were concurrent, the framing of the problem induces the subjects to treat Decisions (i) and (ii) separately!

Cause of Framing Effect: Effect of Context

- The same problem, such as assessing some quantity or identifying some object, can be framed in different ways; e.g., when the quantity and object are placed in different contexts.
- Individuals then act differently because of the different framing (different context).

Example: Brightness Gradient



Example: Effect of Context

Example: Effect of Context

Mental Accounting

- On the other hand, individuals may frame decision problems in their own minds in particular ways, a phenomenon known as *mental accounting*.
- Thaler (1999) suggested that mental accounting has three components
  - The first component captures how outcomes are perceived and experienced, and how decisions are made and subsequently evaluated. Example: the same 5% return on a stock might be a good return for some investors but a bad return for others.
  - The second component of mental accounting involves the assignment of activities to specific accounts. Example: you may assign your entertainment activity and investment activity into different accounts.
  - The third component of mental accounting concerns the frequency with which accounts are evaluated. Example: How frequently do you evaluate your investment in a stock?

Example: Jacket and Calculator

- Imagine that you are about to purchase a jacket for \$125 and a calculator for \$15. The salesman informs you that the calculator you wish to buy is on sale for \$10 at the other branch of the store, located 20 minutes drive away. Would you make the trip to the other store?
- Imagine that you are about to purchase a jacket for \$15 and a calculator for \$125. The salesman informs you that the calculator you wish to buy is on sale for \$120 at the other branch of the store, located 20 minutes drive away. Would you make the trip to the other store?

This example was taken from Tversky and Kahneman (1981). 68% of the subjects chose to make the trip in the first question and 29% of the subjects chose to make the trip in the second question. This example shows that the subjects had separate mental accounts for the purchase of the jacket and the calculator. In addition, the subjects compared the \$5 saving with the original prices.

Evaluation Period

- In an experiment conducted by Thaler, Tversky, Kahneman, and Schwartz (1997), the subjects were not informed of the true distributions of the bond fund and the stock and they had to learn the distributions in the experiment.
- In each period, the subjects decided the allocation to the bond and the stock.
- After each period, the subjects saw a bar graph that displayed the aggregated returns of each fund and of their portfolio for the previous periods.
- Initially, the subjects tended to allocated half to bond and half to stock whatever the evaluation period is. Then, they adjusted the allocation differently according to different evaluation periods.
- For shorter evaluation periods, e.g., 1 month, they increased the allocation to bond gradually as they learned the true distributions gradually, while for longer evaluation period, e.g., 1 year or 5 year, they lowered the allocation.

Mental Accounting and Evaluation Period (Cont'd)

- This experiment shows that an agent's evaluation period, which is a result of framing effect or his mental accounting, has significant effect on his investment decisions.
- Applying this idea and other aspects in behavioral finance, Benartzi and Thaler (1995) proposed the so-called *myopic loss aversion* theory to explain the equity premium puzzle.
- It is common that many investors' evaluation period is different from their planning horizon.
- For instance, the planning horizon for an employee who decides the allocation between bonds and equities is the retirement date. However, his evaluation period might be much shorter than the planning horizon due to mental accounting.

Disposition Effect

- *Disposition effect*: individual investors are more likely to sell "winner" stocks than "loser" stocks although the former have higher average return than the latter afterwards.
- Odean (1998) examined the individual investors trading data in a brokerage house in the US from 1987 to 1993.
- On each day that a sale took place in a portfolio of two or more stocks, the author compared the selling price for each stock sold to its average purchase price to determine whether that stock is sold for a gain or a loss. Each stock that is in that portfolio at the beginning of that day, but is not sold, is considered to be a paper (unrealized) gain or loss (or neither).

Disposition Effect (Cont'd)

- Two ratios were calculated:

$$\text{PGR} := \frac{\text{Realized Gains}}{\text{Realized Gains} + \text{Paper Gains}},$$

$$\text{PLR} := \frac{\text{Realized Losses}}{\text{Realized Losses} + \text{Paper Losses}}$$

- The PLR in the sample is 0.098, statistically lower than the PGR in the sample, 0.148.
- These investors were more likely to sell prior "winners"!
- Is it because the investors knew that these prior winners would perform worse in the future than the prior losers?
- No! The average excess returns (relative to market index) on winning stocks sold in next 84, 252, and 504 trading days are 0.47%, 2.35%, and 6.45%, respectively, while those on paper losses are -0.56%, -1.06%, and 2.87%, respectively.

Disposition Effect: Realization Utility

- It turned out that people were reluctant to sell prior "losers" and willing to sell prior "winners" because they treated paper losses and realized losses differently and treated paper gains and realized gains differently as well.
- Using this idea, Barberis and Xiong (2012) proposed the notion of *realization utility* to model investors' behavior and applied this model to explain the disposition effect.

Categories of Heuristics

- Due to limited cognitive resource, individuals frequently employed various *heuristics* (*rules of thumb*) to assess probabilities.
- These heuristics work well in most circumstances, but fail in some situations.
- In the following, we discuss these heuristics in two categories:
  - Representativeness
  - Anchoring
- There are more categories of heuristics summarized, e.g., self deception and biases from social interaction.

Representativeness

- The *representativeness* heuristic involves assessing the probability of a state of the world based on the degree to which the evidence is perceived as similar to or typical of the state of the world.
- Many of the probabilistic questions with which people are concerned belong to one of the following types: What is the probability that object A belongs to class B? What is the probability that event A originates from process B? What is the probability that process B will generate event A?
- In answering such questions, people typically rely on the representativeness heuristic, in which probabilities are evaluated by the degree to which A is representative of B, that is, by the degree to which A resembles B.
- This approach to the judgement of probability leads to serious errors.

Example: Linda

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 of the following Linda is more likely?

A. Linda is a bank teller
B. Linda is a bank teller and is active in the feminist movement

Insensitivity to Prior Probability of outcomes

- The above famous example was from Tversky and Kahneman (1983). It turns out that most people choose B.
- However, A is more likely because A strictly contains B.
- Individuals choose B because the description is representative of a feminist.
- While Bayes' rule says that

$$\mathbb{P}(\text{statement B}|\text{description}) = \frac{\mathbb{P}(\text{description}|\text{statement B})\mathbb{P}(\text{statement B})}{\mathbb{P}(\text{description})},$$

individuals apply the law incorrectly, putting too much weight on $\mathbb{P}(\text{description}|\text{statement B})$, which captures representativeness, and too little weight on the base rate, $\mathbb{P}(\text{statement B})$.

Example: Hospital

A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50 percent, sometimes lower. For a period of 1 year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?

A The larger hospital

B The smaller hospital

C About the same (that is, within 5 percent of each other)

Insensitivity to Sample Size

- This experiment was ran by (Tversky and Kahneman, 1974).
- It turned out that 21 subjects chose A, 21 subjects chose B, and 53 subjects chose C.
- However, with basic probability knowledge (such as law of large number and central limit theorem), we know that sample size *matters* in the sense that the larger the sample size is, the less likely that the sample average deviates from the mean of the random quantity. Thus, the correct answer should be B.
- This experiment shows that individuals are insensitive to sample size, mistakenly believe that samples with small size contain same information as samples with large size.
- This wrong belief can be regarded as a result of representativeness. After all, samples with small size could be as represenative of an event as samples with large size.

"Hot Hand" Fallacy

- The insensitivity to sample size leads to the phenomenon called "hot hand" fallacy: sports fans become convinced that a basketball player who has made three shots in a row is on a hot streak and will score again.
- However, there is no evidence of a hot hand in the data (Gilovich, Vallone, and Tversky, 1985).
- "Hot hand" fallacy commonly exists in the financial market: investors come to believe that a financial analyst with four good stock picks is talented because four successes are not representative of a bad or mediocre analyst.

Anchoring and Adjustment

- In many situations, people make estimates by starting from an initial value that is adjusted to yield the final answer.
- The initial value, or starting point, may be suggested by the formulation of the problem, or it may be the result of a partial computation.
- In either case, adjustments are typically insufficient. As a result, different starting points yield different estimates, which are biased toward the initial values.
- We call this phenomenon *anchoring*.

Example: Evaluation of Conjunctive and Disjunctive events

Consider three types of events. Which one do you prefer to bet on?

(i) Simple events: drawing a red marble from a bag containing 50 percent red marbles and 50 percent white marbles

(ii) Conjunctive events: drawing a red marble seven times in succession, with replacement, from a bag containing 90 percent red marbles and 10 percent white marbles;

(iii) Disjunctive events: drawing a red marble at least once in seven successive tries, with replacement, from a bag containing 10 percent red marbles and 90 percent white marbles.

Evaluation of Conjunctive/Disjunctive Events

- This experiment was conducted by Tversky and Kahneman (1974).
- A significant majority of subjects preferred to bet on the conjunctive event (the probability of which is .48) rather than on the simple event (the probability of which is .50).
- Subjects also preferred to bet on the simple event rather than on the disjunctive event, which has a probability of .52.
- Thus, most subjects bet on the less likely event in both comparisons.

Evaluation of Conjunctive/Disjunctive Events (Cont'd)

- When evaluating conjunctive and disjunctive events, individuals start from the probability of elementary event—anchoring—and then adjust towards the final answer.
- Because the adjustment is insufficient, individuals tend to overestimate the probability of conjunctive events and underestimate the probability of disjunctive events.
- The successful completion of an undertaking, such as the development of a new product, typically has a conjunctive character. The general tendency to overestimate the probability of conjunctive events leads to unwarranted optimism in the evaluation of the likelihood that a plan will succeed or that a project will be completed on time.
- Conversely, disjunctive structures are typically encountered in the evaluation of risks. Because of anchoring, people will tend to underestimate the probabilities of failure in complex systems.

Estimation of Confidence Interval

- Suppose you are asked to estimate the 80% confidence interval $[X_{10}, X_{90}]$ of the Shanghai Stock Market Index in next year, i.e., the 10% quantile X_{10} and 90% quantile X_{90}.
- Many people start from the mean of the random quantity, a number easier to estimate than the quantiles, and then adjust from it to obtain the confidence interval.
- Because of insufficient adjustment, the resulting confidence interval is narrower than it should be.

Drawing Balls from Urns

There are two urns

Urn A contains 3 blue balls and 7 red ones;

Urn B contains 7 blue balls and 3 red ones.

A random draw of 12 balls, with replacement, from one of the urns yields 8 reds and 4 blues. What is the probability the draw was made from Urn A?

Conservatism

- While the correct answer is 97%, most people estimate a number around 70%, apparently overweighing (i.e. inclining towards) the base rate of 50%.
- *Conservatism*: under appropriate circumstances individuals do not change their beliefs as much as would a rational Bayesian in the face of new evidence.
- Conservatism can be regarded as a consequence of anchoring upon an initial probability estimate.

Conservatism and Representativeness

- Conservatism leads to overweighing prior probability, while representativeness leads to underweighing prior probability (base rate). They seem to conflict. Which bias takes effect?
- Conservatism is more likely to happen in a stable environment where people seem to have a good idea of the underlying data-generating process. Representativeness is more likely to happen in a volatile environment where the underlying data-generating process is not clear.
- Whether conservatism or representativeness is more likely to happen also depends on the data or information people receive. If the data sample or information is representative of certain model, representativeness might be in effect. If the data is not representative of any salient model, people might underweigh these data and rely too much on priors.

Over-reaction and Under-reaction

- Conservatism and representativeness have direct implications in financial markets. For example, conservatism leads to *underreaction* of stock prices to news such as earnings announcements, and representativeness leads to *overreaction* of stock prices to a series of good or bad news.
- Barberis, Shleifer, and Vishny (1998) showed that the combination of underreaction and overreaction might be able to explain some facts such as *medium-term momentum* and *long-term reversal*.

Reference Point: Tough Jobs

Alan Greenspan "The Age of Turbulence" (2007): Choose between the following two job offers:

- A: Earn \$105,000/year while all your colleagues earn at *least* \$210,000/year
- B: Earn \$100,000/year while all your colleagues earn at *most* \$50,000/year
- B was more popular.
- *Reference point*: what matters is **deviation** of wealth from certain benchmark, not wealth itself.
- *customary wealth* (Markowitz 1952).

Risk Aversion vs. Risk Seeking

- Choose between
  - A: **Win** \$10,000 with 50% chance and \$0 with 50% chance
  - B: **Win** \$5,000 with 100% chance
  - B was more popular.
- Choose between
  - A: **Lose** \$10,000 with 50% chance and \$0 with 50% chance
  - B: **Lose** \$5,000 with 100% chance
  - This time: A was more popular.
- Risk averse on gains, risk seeking on losses.

Loss Aversion: Losses Matter More

Paul Samuelson (1963): Choose between

- A: **Win** \$100,000 with 50% chance and **lose** \$50,000 with 50% chance
- B: Don't take this bet
- B was more popular.
- *Loss aversion*: pain from a loss is more than joy from a gain of the same magnitude.

Probability Distortion (Weighting): Lottery Ticket and Insurance

- Choose between
  - A: Win \$50,000 with 0.1% chance
  - B: Win \$50 with 100% chance
  - A was more popular
- Choose between
  - A: Lose \$50,000 with 0.1% chance
  - B: Lose \$50 with 100% chance
  - This time: B was more popular
- Exaggeration of extremely small probabilities of both winning big and losing big.

Kahneman and Tversky's Cumulative Prospect Theory

- Cumulative Prospect Theory (CPT): Kahneman and Tversky (1979), Tversky and Kahneman (1992), Nobel wining 2002.
- Key ingredients
  - Reference point
  - S-shaped value (utility) function (risk-averse on gains, risk-seeking on losses), steeper on losses than on gains (loss aversion)
  - Probability weighting

Applications of Behavioral Finance

Saving More Tomorrow

- Numerous studies have found that US households save too less.
- One possible reason is the lack of self-control.
- Although many people realize that their saving is insufficient, they are reluctant to give up the consumption today. Usually, they may plan to start saving more tomorrow.
- However, due to the lack of self-control, they fail to save more when tomorrow arrives.
- Another reason might be loss aversion.
- If someone wants to save more today, he will see his paycheck go down immediately. The decrease in the paycheck is conceived as a loss because he will naturally use previous paychecks as the reference point. Due to loss aversion, he is reluctant to save now.

Saving More Tomorrow (Cont'd)

- *Saving More Tomorrow* (SMT): a project launched by Shlomo Benartzi and Richard Thaler in 1998, enrolling employees in workplace pensions.
- SMT smartly surpasses these obstacles caused by psychological biases.
- Once opted in the program, employees start saving at a very low rate, e.g., 3 percent of the current paycheck. Then, the saving rate will up by 3 percent points every time they get a pay raise. (A typical pay raise is about 3.25 to 3.50 percent.)
- The saving rate will continue rising until it reaches a maximum allowed rate such as 15 percent or until employees choose to stop the rate raise.
- More than 60% of US companies offering defined contribution pensions use the SMT programme.

Saving More Tomorrow (Cont'd)

- Employees are willing to opt in the Saving More Tomorrow program because they realize that they need save more.
- The self-control problem does not occur in the program because the rising of saving rates occurs in the future.
- In addition, because the pay raise is higher than the rate raise and people think in nominal dollars (an observation known as *money illusion*), the employees do not feel losses in their future paychecks.
- Finally, because of *inertia*, another psychological bias, the employees are unlikely to stop the rate raise.
- Indeed, in the first implementation of the program, most of the employees who enrolled in the program stuck with it for the full four raises, whereupon the increases were halted because the maximum saving rate allowed had been reached.

Hedge Funds in the U.S.

- Traditionally the managers of hedge funds take about 20% of the fund profits as a performance fee.
- The manager's payoff is asymmetric. The investors take all losses.
- Many fund managers also invest their own capital in the funds and are responsible for the gains and losses induced by their own capital.
- Example: 10% managerial ownership and 20% performance fee.
  - If the fund wins \$100, the manager takes $100 \times 10\% + 100 \times 90\% \times 20\% = \$28$
  - If the fund loses \$100, the manager covers $100 \times 10\% = \$10$

A New Scheme: First-Loss

- A new scheme, called *first-loss* scheme, is emerging in the U.S.
- In this scheme, the managers typically put about 10% of the fund investment from their own money as the first-loss capital that will cover the losses first.
- Example: suppose the fund size is \$1000, among which \$100 is the first-loss capital
  - If the fund loses \$50, the manager loses \$50 and the investor loses nothing
  - If the fund loses \$150, the manager loses \$100 and the investor loses \$50
- In the first-loss scheme, the managers take about 40% of the fund profits. Example: suppose the fund gains \$100, then the manager takes $100 \times 10\% + 100 \times 90\% \times 40\% = \$46$.
- Such improvement is possible because of investors' loss aversion: investors are willing to pay more than 1 dollars to managers in return for managers covering losses first.

Model

- How to compare these two schemes? How to better design them?
- He and Kou (2013) modeled hedge fund management in these two schemes by applying behavioral finance and solve the optimization problems explicitly.
- He and Kou (2013) compared the two schemes from the perspectives of regulators, managers, and investors: regulators are concerned about the risk of hedge funds, managers and investors are concerned about their wealth.
- The preference of the manager and investor are modeled through *cumulative prospect theory* so as to model mental accounting, framing effect, and loss aversion.

A New Hedge Fund Compensation Scheme

- He and Kou (2013) found that when compared to the 10%-20% traditional scheme, the 10%-40% first-loss scheme makes the regulators happy by reducing hedge fund risk and improves the well-being of the manager. However, the investor feels worse.
- When compared to the 10%-20% traditional scheme, the 10%-30% first-loss scheme improves the satisfaction of regulators, managers, and investors at the same time.
- Thus, there are incentives for all of these three parties to implement this new hedge fund compensation scheme.

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