

# *Psychology of Decision Making*

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# “Social science matters”

- Economic analysis and analysis of institutional constraints are important element of risk management plans, but
  - economics, political science, geography not the only useful social sciences
  - risk communication needs to reach human decision makers and risk management needs to be embraced and implemented by human decision makers
    - What is special about *human* risk perception and decision making under (climate) risk and uncertainty?
  - *psychology, behavioral economics, and behavioral game theory* add important insights and risk management process design tools

# Outline 1

- Uncertainty as barrier to predictability
- Models of how people (actually) deal with uncertainty
  - I: Predicting uncertain events
  - II: Choosing among actions with uncertain outcomes
- Multiple processes
  - Multiple modes of decision making
    - Calculation-based, rule-based, and affect-based decisions
    - Analytic vs. experiential processing of information
      - Use of personal experience vs. statistical summary information to assess and manage risks
  - Multiple goals and incentives

# Outline 2

- Human judgment and decision making as the result of
  - Cognitive constraints: Bounded rationality (Simon, 1957)
    - Due to memory and attentional limitations, people are selective in what they process and often simplify how they process it
  - Motivational constraints: Conflicting goals and strategic distortions
    - Information is evaluated as strategic communication
      - Role of trust
      - Source of risk communication matters
    - Selectivity of attention and interpretation of uncertainty are often strategically in one's favor (self-serving biases)

# Outline 3

- Multiple sources of uncertainty
  - Outcomes are known only probabilistically
    - Different sources of uncertainty
    - Need for probabilistic thinking and modeling
  - Outcomes are also delayed in time
    - Need for model-based projections
- Implications for design of communication of climate (change) uncertainty and risks
- Implications for design of (climate) risk management systems

# Predictability

- Powerful human need and human skill
  - result of evolutionary selection (or intelligent design)
- Provides control
  - avoid threats to physical and material well-being
- Allows to plan and budget for the future
  - Homo sapiens arguably the most successful species on earth

# Need for Control

- So strong, it can lead to wishful thinking
  - “illusion of control” in situations that are obviously determined by chance
    - superstitious behaviors
    - control, even when illusory, has important health benefits
- Perceived lack of control raises anxiety, individually and socially
  - Inverse u-shaped function for beneficial effect of anxiety
  - Moderate levels motivate behaviors to regain control
    - information search, theory building
    - science and technology development
      - Forecast developments for weather, climate, earthquakes, economy, etc.

# Modeling Uncertainty I:

## Predicting uncertain events

- Normative models
  - Probability calculus
  - Bayesian updating and belief revision
- Descriptive reality
  - Phenomena
    - Deterministic/causal/experiential thinking more prevalent than statistical/probabilistic thinking
    - Overconfidence in accuracy of prediction

# Experiential processing to predict uncertain events

- Use of heuristics that utilize stored personal experience
  - ***Representativeness heuristic***: Similarity to category prototype as indicator of likelihood
    - “What is the probability of getting a hot and dry summer?”
    - Answer is based on similarity of current conditions to prototype; base rates get ignored
  - ***Availability heuristic***: Ease of recall as indicator of likelihood
    - “How likely will New York City experience a terrorist attack before the November federal election?”
    - More likely events generally easier to recall; heuristic gives rise to biases due to media distortions or other sources of nonrepresentativeness
    - Rare events only get into memory storage after a long time; not sufficiently considered most of the time
    - Rare events that happen to occur get overweighted
      - recency effects
      - catastrophic rather than chronic risks are overreported and thus overweighted

# Overconfidence

**“Sensible and responsible women do not want to vote.”**

Grover-Cleveland, President of U.S., 1905

**“There is no likelihood man can ever tap the power of the atom.”**

Robert Milikan, Nobel Prize in Physics, 1923

**“Heavier than air flying machines are impossible.”**

Lord Kelvin, President of Royal Science Society, 1895

# *Overconfidence in judgments or decisions*

- Confidence ratings
  - Poor calibration found in most cases
    - Proportion of time a prediction of answer is correct ought to equal the confidence assigned to that estimate
    - Only weather forecasters, bookies, and expert bridge players are well calibrated
      - Due to availability of quick and frequent corrective feedback
- Confidence intervals (CIs) tend to be too narrow
  - 95% CIs are closer to 50% CIs
    - E.g., in series of general knowledge questions
      - Length of Nile river?
  - engineering discount/safety factors are social acknowledgment of systemic overconfidence



# Reasons for Overconfidence

- **Attentional**

- Selective information and memory search
  - Difficult to know what we don't know
  - Confirmation bias
  - Implications for veridicality of personal recollections of climate information

- **Motivational**

- Need to appear competent and confident to others and oneself
- Confidence and optimism help to get the job done

# *Theory*: Multiple Processing Systems

- Analytic system
  - new evolutionary accomplishment; only available to homo sapiens in full form
  - effortful, slow, requires conscious awareness, and knowledge of rules
    - e.g., probability calculus, Bayesian updating, formal logic
  - Conscious calculation-based decisions
    - May become habits/rules by virtue of repeated execution
- Experiential system
  - evolutionarily older, hard-wired, fast, automatic
    - Trial and error learning: Association between behavior and consequences
    - Emphasis on outcomes of decisions (probabilities not explicitly represented)
    - Emotions as a powerful class of associations
      - risk represented as a “feeling” that serves as an “early warning system”
  - Affect-based decisions (fear or worry as motivator for action)
  - Rule-based decisions that get triggered (automatically) by cues in the environment
    - Emergency room procedures, trading floor decisions

# Analytic and Experiential System

- Interact to some extent
  - Emotional reactions can be input into analytic processing
- Operate in parallel
  - “Is a whale a fish?”
  - Affective/experiential system is fast, delivers output earlier
  - when output of two systems in conflict, behavior typically determined by experiential processing system
- Discrepancy in output of two systems often accounts for controversies and debates about magnitude and acceptability of risks
  - e.g., nuclear power, genetic engineering
    - Technical experts and academics rely more heavily on analytic processing
    - Politicians, policy makers, end-user stakeholders, and general public rely more heavily on experiential/affective processing

# How do we know about the possible outcomes of different actions?

- In Decisions from Description
  - Outcome distribution fully described
    - possible outcomes and their probabilities provided numerically or graphically
      - seasonal climate forecast for next growing season
      - hurricane warning issued by local TV station
  - Extensive use of analytic processing system
    - rare events are overweighted (Prospect Theory)
- In Decisions from Experience
  - Outcome distribution initially unknown
    - knowledge of possible outcomes and their likelihood acquired by personal exposure in repeated choices
      - intuitive forecast of climate in next growing season based on years of experience
      - intuitive assessment of likelihood of being affected by hurricane based on past experience with warnings and events
  - Extensive use of experiential processing system
    - recent events get disproportionate weight
    - rare events are underweighted, unless they recently occurred

# Adaptive Value of Recency Bias in Experiential Processing

- Good idea in nonstationary environments
  - When contingencies between behavior and outcomes change over time (e.g., trends, cyclical changes), putting more weight on recent observations makes sense
- Underweighting of low-probability events until they occur and overreaction to them once they occur is the price we pay for a generally adaptive behavior

# Modeling Uncertainty II: Choosing among actions with uncertain outcomes

- Outcomes of actions modeled as random variables
- Using moments to describe characteristics of distributions of possible outcomes
  - EV, variance, skew, .....
- Normative models
  - Risk-return models
  - Expected utility theory
    - Shape of utility function as measure of risk aversion/seeking

# *Theory:*

## Risk—Return Models of Risky Choice

- Finance literature
  - Risk—Return models: e.g., Capital Asset Pricing Model
    - $WTP(X) = V(X) - bR(X)$
    - Willingness to Pay for Option X involves a tradeoff between Return (EV) and Risk, or between “greed and fear”
- Animal literature (behavioral ecology)
  - risk-sensitivity theory
    - energy-budget model describes a very similar tradeoff for the risky foraging decisions made by birds and insects
- Common feature of models
  - Response is a function of variability of outcomes of risky option
    - *Variance* of outcomes

# *Stylized Fact:*

## *Perception of risk is subjective*

- Variance of outcomes does not describe how people perceive the risk of risky options
  - Upside and downside variability do not enter symmetrically
    - Downside gets greater weight
  - Variability and risk often perceived in a relative fashion
    - neural basis
    - found in very basic psychophysical judgments like perceived loudness or brightness (Weber's law, 1834)
    - *coefficient of variation* (CV) a measure of relative risk: risk per unit of return
      - defined as standard deviation / expected value
      - used in many applied areas
        - » engineering, medicine, agricultural economics, etc.

# *Theory: Fixing Descriptive Fit of EU with **Prospect Theory***

- Psychological extension of expected utility theory
  - by Kahneman and Tversky (1979)
- Prospects are evaluated by
  - Value function
  - Decision Weight Function
- Value Function:
  - Defined over gains and losses on deviations from some reference point
  - Concave for gains (risk-averse), convex for losses (risk-seeking)
  - Steeper for losses than for gains (“losses loom larger”)

# (Q1)

If you were faced with the following choice, which alternative would you choose?

Option A: A sure gain of \$240.

Option B: A 25% chance to gain \$1,000 and a 75% chance of getting \$0.

## (Q2)

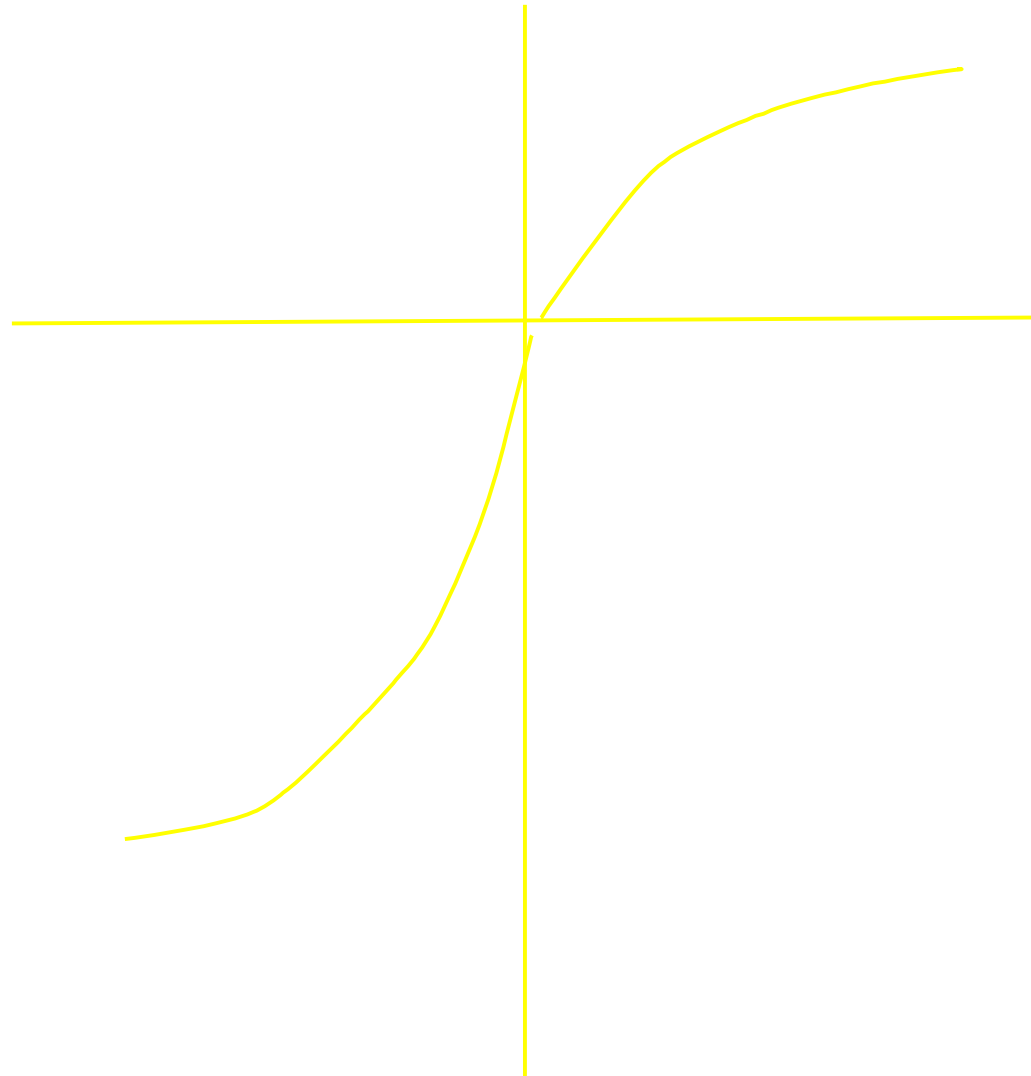
If you were faced with the following choice, which alternative would you choose?

Option A: A 100% chance of losing \$50.

Option B: A 25% chance of losing \$200 and a 75% chance of losing nothing.

# Prospect Theory Value Function

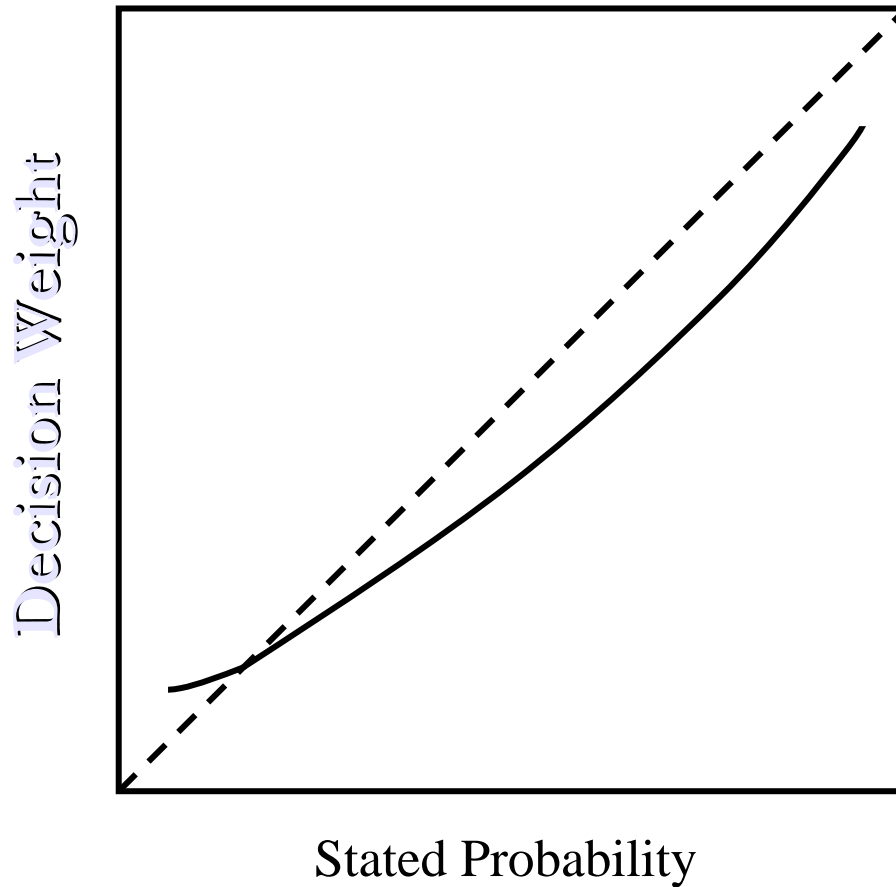
- **Relative Evaluation:**  
Value is judged relative to a reference point
- **Diminishing sensitivity**
  - Risk averse for gains
  - Risk seeking for losses
- **Loss Aversion:**  
Losses loom larger than gains



# Endowment Effect and Status Quo Bias as a result of Loss Aversion

- Endowment effect
  - more painful to *give up* an asset than it is pleasurable to *acquire* it
    - *selling* prices are higher than *buying* prices, contrary to economic theory
    - violates Coase's theorem of economics that initial ownership of assets does not matter
  - results in status quo bias
    - disadvantages of leaving the current state seem larger than advantages
    - provides powerful advantages for decision defaults

# Prospect Theory Decision Weight Function



- Certainty Effect
  - Overweight low  $p$
  - Underweight high  $p$

## (Q3)

If you were given a choice which of the the following gambles would you prefer?

Option A: \$1,000,000 for sure.

Option B: A 10% chance of getting \$2,500,000  
and a 89% chance of getting \$1,000,000  
and a 1% chance of getting \$0.

## (Q4)

If you were given a choice, which of the following gambles would you prefer?

Option A: An 11% chance of getting \$1,000,000 and an 89% chance of getting \$0.

Option B: A 10% chance of getting \$2,500,000 and a 90% chance of getting \$0.

# Modeling Uncertainty II:

## Choosing among actions with delayed outcomes

- Same basic framework as for decisions under risk
  - Integrate/aggregate over all possible outcomes of a choice option, but also discount outcomes based on their time delay
- Normative models
  - Discounted utility theory
    - Utility of outcome  $x$  ( $u(x)$ ) is discounted as a function of its time delay
    - Interest rate on money deposits a reasonable discount rate

# Intertemporal Choice Stylized Facts

- People are impatient
  - Discount “too much”
  - Implicit discount rate far greater than interest rate
- Discount rates are inconsistent over time
  - People especially dislike delays that prevent immediate consumption
  - Delays on existing delays less consequential
    - Captured by hyperbolic discounting, where initially very high discount rate levels off with time delay

# (Hyperbolic) discounting of delayed costs and benefits

- Delay of gratification is aversive
  - Lack of self-control
    - Initially observed in children (Mischel et al., 1969), also in adults and other animals
  - Modeled by hyperbolic discounting
    - Discounting strongest for immediate consumption deferral from now to  $\text{now} + t$
    - Recent psychological explanations in terms of preference construction from memory

# Multiple Goals and Incentives

- Multiattribute utility theory is normative model
  - allows decision makers to make tradeoffs between multiple outcome dimensions in ways that can satisfy multiple goals
- Deviations from normative model
  - People dislike tradeoffs (we “want it all”) and use choice processes that are noncompensatory
    - Decision rules used that avoid the realization of goal conflict
    - Editing out of perceptions or decisions that remind us of goal conflicts
  - Goal space broader than assumed by traditional economic view of human nature
    - Includes social goals not just selfish goals of homo economicus
    - Communication and trust play a major role
      - Most interactions seen as repeated games
      - Communication is seen as binding and not just “cheap talk”

# Economic and Other Incentives

- Common-pool resource dilemmas (“tragedy of the commons”) are serious, but situation not as hopeless as envisioned by Hardin
  - Cooperation can be facilitated by appealing to social identity of people
    - Social affiliation and social approval are powerful human needs
    - Priming of social goals by the way situations are described or “framed” often more effective, “cheaper,” and more feasible than the modification of economic incentives

# III. Policy Implications

- How to get stakeholders (public officials, members of the general public) to pay attention to climate change and variability?
- Analytic appeals not effective
  - Contrary to personal experience of climate change in many regions of the world
  - Mitigative and adaptive actions often require immediate costs/sacrifices/losses to achieve time-delayed benefits/gains
    - Both hyperbolic discounting and loss aversion argue against taking such actions
- Is there wisdom in designing more emotional appeals, i.e., in inducing people to worry more about climate change and variability?
  - Could be done by
    - visualization or graphic description of catastrophic climate change
    - emotional appeals
    - concretizing future changes in simulations of conditions in local environments

# Caveats

- Finite Pool of Worry
  - Jeff Sachs: overload of crises in the world make leaders less responsive
  - Increases in worry about one hazard may result in decrease in worry about other hazards
    - Found in Argentine farmers with climate risks and political risks (Hansen, Marx, Weber, 2004)
- Single Action Bias
  - Tendency to engage in only a single corrective action to remove perceived threat of a hazard (single action removes “hazard flag”), even when portfolio of responses is clearly advantageous
    - Radiologist: detect single abnormality, miss others
    - US Midwestern farmers: engaged in single adaptation to climate change (*either* production practice, pricing practice, or endorsement of government intervention) (Weber, 1997)
    - Argentina Pampas farmers: less likely to use irrigation or use crop insurance if they had capacity to store grain on their farms (Hansen, Marx, Weber, 2004)
  - Reactions on multiple fronts may require more analytic response to situation

# Risk Communication and Management Challenges and Implications

- How to use people's experiential and affective processing and their aversion to uncertainty constructively?
  - Help people plan for uncertainties
    - Scenario analysis provides good match to nonprobabilistic information processing of experiential system
      - Worst case, best case, most likely case scenarios
    - Contingency plans, especially for worrisome worst and bad case scenarios
      - Real benefits
        - » Increased response speed; better responses
      - Psychological benefits
        - » Perceived preparedness reduces anxiety

# Conclusions

- Probabilistic nature of climate (change) forecasts
  - Liability
    - In the absence of clear action implications (that allow a feeling of control), awareness of climate risk may arouse too much anxiety
      - Gets edited out, i.e., treated as being effectively zero, resulting in procrastination and decision avoidance
    - Strategic use of uncertainty to justify decisions that are desired for other reasons (hidden agendas)
  - Opportunity
    - Steve Zebiak: “Uncertainty is not the enemy”
    - Development of forecast formats that take into consideration human information processing modes and constraints can minimize liabilities and maximize opportunities

# Conclusions – cont'd

- Consider the combination of analytic and experiential/emotional processes
  - to facilitate correct interpretation of climate forecasts
  - to motivate forecast usage and adaptive risk management actions
- Tailor forecast formats and risk management process to different classes of users
  - Amount and sophistication of analytic processing a key variable, but time horizon and incentives/goals also differ
  - For most users, it will pay to
    - Elicit optimal level of worry/concern
      - Development of envisioning tools to concretize the (temporally and spatially distant) impacts of climate change
    - Concretize statistical uncertainty measures
      - Localize forecasts
      - Provide analogies to previously experienced situations
      - Discretize the distribution of different futures
        - » Best case, most likely case, worst case, likelihood of extreme events
    - Provide of accurate degree of confidence in forecasts

# Conclusions – cont'd

- Actions and choices can be influenced by
  - Strategic use of “framing”
    - Description of situation in ways that prime cross-group commonalities, social goals, and cooperation vs. differences, selfish goals, and competition
    - Choice of reference points that depict alternatives as involving gains or losses, depending on desired response
      - Risk seeking in the domain of losses, risk aversion for gains
      - Hurricane Katrina and Climate Change Mitigation as either involving costs and losses or benefits and opportunities
        - » Both perceptions are true, but attentional focus that is highlighted by problem description often determines responses

# “Social science matters”

- In addition to economic and institutional constraints, constraints on human cognition and motivation need to be considered to design of effective risk communication and risk management processes
- Knowledge about human capabilities and constraints can provide useful tools
- Ignoring such knowledge leaves proverbial “money on the table” and leaves many problems seemingly more intractable than they have to be

