

**Translating Science into Policy
The Role of Decision Science
*An Educational Module***

Prepared by

**Paul Brest
Former Dean and Professor Emeritus (active)
Stanford Law School**

For

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I – Introduction

Public policy is the result of political processes that embody an accommodation of competing social, cultural, economic, and political values and interests. Science can inform but seldom determine policy choices. The basic means for applying science to policy questions are applications of *expected utility* theory, also known as *rational choice* theory.

Axiomatically, a good decision is one that maximizes expected utility. (We spend the first section of this paper discussing just what constitutes “utility.”) In decisions where risk or uncertainty is not an issue, expected utility is essentially the benefits that a policy is expected to produce compared to its cost. We can combine this information in two useful ways:

- A *particular* course of action is worthwhile if *subtracting* the costs from the benefits produces a positive difference. (See, e.g., the Food and Drug Administration’s consideration of graphic warning labels on cigarettes, below.) This is the essence of ***cost-benefit analysis***.
- When comparing *alternative* courses of action, it is often useful to *divide* the benefit by the cost, which allows comparing the ratios—in effect, “bang for the buck”—of the alternatives. This is the essence of ***cost-effectiveness analysis***.

Where the probability of obtaining the benefit is less than 100%, the expected utility is the benefit multiplied by the likelihood of success.

These materials are mainly prescriptive, focusing on how to make good decisions. But they also include examples of the systematic ways that people make poor decisions— usually a consequence of decision makers’ overconfidence in their judgment or in errors in perceiving risks. The prescriptive materials, drawn from statistics and economics, introduce some basic techniques of “decision science.” The analysis of errors comes from social psychology and the psychology of judgment and decision making (JDM).

The text follows this order:

- Part II surveys the meanings of utility.
- Part III examines decision making in conditions where risk is not an issue.
- Part IV examines decision making in conditions where risk *is* an issue because the likelihood of success is not assured.
- Part V examines errors and biases that can affect the decision-making processes.

We hope that your understanding of decision making will result in better decisions for you, your organizations, agencies, constituents, and other stakeholders. In any event, the insights from these disciplines are a useful part of professional students’ repertoire of knowledge.

II – The Concept of Utility

As its name implies, expected utility theory embodies the concept of *utility*. Yet there is little agreement about the precise meaning of utility or how to measure it. This section surveys some major efforts to cabin this elusive term.

UTILITY ≠ “HAPPINESS”

People sometimes use “happiness” as a synonym for utility, but that is somewhat misleading. Many people have a conception of leading a “good” or “whole” or “balanced” life that seems trivialized by reducing it to happiness. Individuals value many things that can’t be simply classified as happiness producing. “Ascetics, saints, and those willing to sacrifice everything for spite all have perfectly coherent utility seeking goals.”¹ Perhaps “well-being” or “satisfaction” comes closer to the concept of utility than “happiness.” But even these terms do not necessarily capture the experience of someone who, say, sacrifices himself out of a sense of duty, loyalty, or other obligation.

In *Because It Is There: The Challenges of Mountaineering . . . for Utility Theory*,² George Loewenstein examines the diaries and memoirs of individuals on serious mountain climbing explorations, “which tend to be one unrelenting misery from beginning to end.” Drawing on Jeremy Bentham’s categories in *The Principles of Morals and Legislation* (1789), Loewenstein discerns a number of different motivations other than the immediate experience of thrills, natural beauty, and the like.

- Mountaineers seek Bentham’s “pleasure of a good name”—the desire to impress others.
- They seek the “pleasure of self-recommendation” or what Loewenstein calls self-signaling—the need for self-esteem or to define oneself as having a particular set of character traits.
- They are motivated by “the almost obsessive human need to fulfill self-set goals,” which may also be an aspect of self-signaling.
- They are motivated by the desire to master their environments, by the need for control.
- And they seek experiences—often near-death experiences—that will give meaning to their lives.

¹ Mark G. Kelman, *Law and Behavioral Science: Conceptual Overviews*, 97 Nw. L. Rev. 31: 1347, 1364 (2003).

² George Loewenstein, *Because It Is There: The Challenges of Mountaineering . . . for Utility Theory*, 52 *Kyklos* 315 (1999).

THE INHERENT SUBJECTIVITY OF ENDS

For all its power as an abstract economic concept, utility ultimately depends on one's own conception of what's valuable. Jim can enjoy classic literature as much as Jane enjoys pop culture magazines. Both can derive the same (or different) utility from reading their preferred works. Jeremy Bentham, perhaps the first utilitarian philosopher, wrote:³

The utility of all these arts and sciences,—I speak of those of amusement and curiosity,—the value which they possess, is exactly in proportion to the pleasure they yield. Every other species of preeminence which may be attempted to be established among them is altogether fanciful. Prejudice apart, the game of push-pin is of equal value with the arts and sciences of music and poetry. If the game of push-pin furnished more pleasure, it is more valuable than either. Everybody can play push-pin: poetry and music are relished only by a few. . . . If poetry and music deserve to be preferred before a game of push-pin, it must be because they are calculated to gratify those individuals who are most difficult to be pleased.

While one can argue—from a moral, religious, or aesthetic point of view—that an individual's values are good or bad, rational choice theory is agnostic about the correctness or morality of utility. Mark Kelman notes that people's "ends are not only private and individual but, perhaps most importantly, individuating. What most clearly makes us differentiable individuals is our unique preference structure. . . ."⁴

PROCESS AS (DIS) UTILITY

Utility is affected not only by the outcome of the decision-making process, but by the decision process itself, which may be pleasurable, exciting, anger-inducing, or frustrating. The perceived fairness or unfairness of the process may not only affect one's experienced utility, but may affect a person's compliance with the outcome.⁵

Americans like, or believe they like, to have many choices. But as Sheena Iyengar indicates in her far-ranging and subtle *Art of Choosing* (2011), being presented with too many choices may lead to "choice overload," an unpleasant experience that may produce suboptimal outcomes, for example, in choosing health plans.⁶ Also, autonomy sometimes comes with a price. For example, when it comes to medical decision making for neonatal units, the United States and France have drastically different policies. In the United States, parents are required to make life and death medical decisions; in France, doctors retain considerable decision-making autonomy. Iyengar and her colleagues compared the mental well-being of French parents who didn't have to give consent for their children to be taken off support to American

³ Jeremy Bentham, from *The Rationale of Reward*, excerpted and reprinted in *The Classical Utilitarians: Bentham and Mill*, (Indianapolis: Hackett, John Troyer, ed., 2003), p. 94. Minor spelling changes.

⁴ Id. at 1358.

⁵ Tom Tyler, *Procedural Justice, Legitimacy, and the Effective Rule of Law*, 30 *Crime and Justice* 283–357 (2003).

⁶ Judith H. Hibbard, Jacquelyn J. Jewett, Mark W. Legnini, and Martin Tusler, *Choosing a Health Plan: Do Large Employers Use the Data?*, *Health Affairs* 172 (Nov.–Dec. 1997).

parents who did. On the whole, the American parents were much more distressed. They (irrationally) blamed themselves, felt guilty, and some were depressed even much later. The French parents were also distressed, but much more accepting of the circumstances and not nearly as depressed.

Consider your own good or bad experiences with a decision process, and what accounted for them.

Problem: The Ultimatum and Dictator Games

In the *Ultimatum Game*, the first player (the proposer) receives a sum of money and proposes how to divide the sum between the proposer and the other player. The second player (the responder) chooses to either accept or reject this proposal. If the second player accepts, the money is split according to the proposal. If the second player rejects, neither player receives any money. The game is typically played only once so that reciprocation is not an issue. People offer “fair” (i.e., 50:50) splits, and offers of less than 30% are often rejected.⁷

In the Dictator Game, the first player, “the dictator,” determines how to split an endowment (such as a cash prize) between himself and the second player. The second player, “the recipient,” simply receives the remainder of the endowment left by the dictator. The recipient’s role is entirely passive and has no input into the outcome of the game (and therefore it really isn’t a “game”). Experimental results have indicated that adults often allocate money to the recipients, reducing the amount of money the dictator himself receives. Children also tend to allocate some of a resource to a recipient and most 5-year-olds share at least half of their goods.⁸

What is the nature of the utility that the typical first player as well as the typical second player in the Ultimatum Game get from each of these games?

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THE LIMITS OF REVEALED PREFERENCES: INDIVIDUALS’ MISpredictions OF THEIR UTILITY

Economists often use “utility” to refer to an individual’s revealed preferences for goods, services, experiences, and so on. They postulate that people make decisions that maximize their utility. However, people are not always good at predicting whether a decision will increase their experienced utility years, months, or even hours in the future. Research in the psychology of decision making has identified many ways in which people systematically mispredict what will bring them satisfaction, suggesting that what economists assume to be revealed preferences may turn out to be “mis-wants”—not in a moral sense but simply in terms of an individual’s own utility.

One major factor contributing to misprediction is what Timothy Wilson and Daniel Gilbert have termed *impact bias*—our tendency to overestimate the intensity and length of

⁷ See https://en.wikipedia.org/wiki/Ultimatum_game.

⁸ See https://en.wikipedia.org/wiki/Dictator_game.

future feelings.⁹ We tend to focus on the immediate emotions flowing from a good or bad event—our favorite team winning or losing a major sports event, becoming seriously ill or disabled, getting or not getting tenure—without putting it in the context of the rest of our lives. We tend not to realize how our “psychological immune system” helps us adapt to emotionally fraught events and bring us back to our normal emotional state.

A related sort of error, termed *projection bias*, refers to the difficulty we have predicting our future preferences, for example:¹⁰

- When we are young, predicting our preferences when we are older.
- When we are healthy, predicting our preferences when we are chronically ill.
- When we are hungry, predicting our preferences when they are sated.
- When we experiment with tobacco or drugs, predicting the likelihood that we will become addicted and how we will experience being addicted.

Problem: Planning for the End of Life¹¹

An advance health care directive, also known as a living will, is a legal document in which a person specifies what actions should be taken for her health if she is no longer able to make decisions for herself because of illness or incapacity.

Advance directives were created in response to the increasing sophistication and prevalence of medical technology. Medical care of the dying is often prolonged, painful, expensive, and emotionally burdensome to both patients and their families.

The advance care directive is used only if the individual has become unable to give informed consent or refusal. It usually provides instructions about the course of treatment to be followed by health care providers and caregivers. It may, for instance, forbid the use of various kinds of burdensome medical treatment. It may also be used to express wishes about providing food and water via tubes or other medical devices.

Many healthy people sign advance care directives to the effect: “If I suffer an incurable, irreversible illness, disease, or condition and my attending physician determines that my condition is terminal, I direct that life-sustaining measures that would serve only to prolong my dying be withheld or discontinued.” Yet many people, when they are actually in prolonged, painful, expensive, and emotionally burdensome conditions toward the end of their lives, nonetheless request that extraordinary measures be taken to prolong their lives.

⁹ D.T. Gilbert, E.C. Piel, T.D. Wilson, S.J. Blumberg, and T.P. Wheatley, *Immune neglect: A source of durability bias in affective forecasting*. *Journal of Personality and Social Psychology* (1998).

¹⁰ See George Loewenstein and Erik Angner, Predicting and Indulging Changing Preferences, in Loewenstein et al. eds., *Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice* (2003). Projection bias may affect our decisions when planning for later stages of life. Researchers at the Stanford University Virtual Human Interaction Lab conducted a set of experiments studying consequences of interaction with an age-progressed avatar of oneself. They demonstrated that participants viewing the age-progressed avatar allocated significantly more money to long-term savings than those viewing current-aged (age-matched) avatars. T. Sims, J. Bailenson, and L.L. Carstensen, Connecting to Your Future Self: Enhancing Financial Planning among Diverse Communities Using Virtual Technology, paper presented at the annual meeting of the Gerontological Society of America, Orlando, FL (2015).

¹¹ Based on https://en.wikipedia.org/wiki/Advance_healthcare_directive.

Of course, the validity of an advance care directive depends on the individual's being competent to make a decision today for a time in the future when he or she may not be competent. Would it be a good practice for lawyers, doctors, or other counselors to go beyond ensuring the individual's competence when providing advice about an advance health care directive? What else should they discuss?

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Several other phenomena tend to cause people to adversely affect their future utility.

First, people may "mischoose," preferring to grab something today when deferring immediate gratification would increase their utility in the long run. Walter Mischel's famous experiment, in which children were given a marshmallow and offered a second one if they could postpone eating it for a few minutes, nicely demonstrates the problem.¹² For adults as well as children, this phenomenon of "present bias" manifests itself, for instance, in the tendency to procrastinate and in an unwillingness to pay more for durable items that will save dollars in energy consumption over the long run. Put in economic terminology, people's choices between present and deferred gratification often manifest a ridiculously high implied discount rate.

Second, we often succumb to the "planning fallacy," in which our predictions of how long it will take to complete a task are unrealistically optimistic.¹³ We tend not to think of the myriad details of implementation and to focus on the most hopeful scenario, rather than using our full experience of how much time similar tasks generally require or, indeed, how long they have taken us in the past. (Perhaps readers have experienced this phenomenon themselves when writing papers.) The problem may be exacerbated by many people's tendency to believe that they are above average—what one might term the Lake Wobegon Effect.

Finally, and a consequence of our tendency to adapt to good as well as unfortunate circumstances: As we become wealthier, our expectations and desires rise, with no long-lasting gain in happiness. This has been described as a "hedonic" or "aspiration" "treadmill."¹⁴

The preceding discussion only touches on some of the complexities of predicting our utility. As Daniel Keys and Barry Schwartz write: a complete theory of rational decision making "must consider the very broadly construed consequences of a decision. That is, it must consider short- and long-term consequences, consequences to the self and to others, consequences that are central to the decision at hand, and consequences that may be more peripheral. It must also consider consequences of decisions for the character of the decision maker, as the effects on character may have a significant impact on a host of future decisions."¹⁵

¹² Walter Mischel, *The Marshmallow Test: Mastering Self Control* (2014).

¹³ Roger Buehler, Dale Griffin, and Michael Ross, Inside the planning fallacy: The causes and consequences of optimistic time predictions, in *Heuristics and Biases: The Psychology of Intuitive Judgment* 250–270 (Cambridge, UK: Cambridge University Press, Thomas Gilovich, Dale Griffin, and Daniel Kahneman, eds., 2002).

¹⁴ See https://en.wikipedia.org/wiki/Hedonic_treadmill.

¹⁵ Daniel J. Keys and Barry Schwartz, "Leaky" Rationality: How Research on Behavioral Decision Making Challenges Normative Standards of Rationality, 2 *Perspectives on Psychological Science* 162–180 (2007).

THE DUBIOUS RELATIONSHIP BETWEEN DAILY EXPERIENCES AND GENERAL SENSE OF WELL-BEING

Though, as mentioned above, no single concept can capture the many nuances of individuals' utility, "well-being" comes reasonably close. Yet well-being has two quite different components: the experience of life moment by moment and the experience of satisfaction with one's life.

Daniel Kahneman and colleagues examined the relationship between people's (positive and negative) affective experiences during the day and their overall, or "global," assessment of their well-being. The relationship often is quite weak. For example, parents whose daily interactions with their children are fraught with negativity are, on the whole, quite satisfied with being parents. Kahneman and colleagues comment: "The contrasting results reflect the difference between belief-based generic judgments ('I enjoy my kids') and specific episodic reports ('But they were a pain last night')." ¹⁶ Christopher Hsee, Reid Hastie, and Jingqiu Chen comment:

In our view, overall retrospective evaluation is also a momentary experience; it is one's experience when recalling past experiences and making a summary judgment. However, we do not think a temporal integral of momentary experience assigning equal weight to different moments should be the standard for happiness maximization. Instead, we should give different weights to different moments; for example, momentary experience when reflecting on one's life should be given more weight than momentary experience when having a bowel movement (unless the person is doing the two things simultaneously). The challenge is how to assign weights.

Life Satisfaction

Life Satisfaction is assessed when an individual reflects on the entirety of his or her life. Efforts to measure subjective well-being usually have relied on surveys that ask participants to assess their own life satisfaction. Methods of gauging how individuals feel about their lives vary from poll to poll. For example, Cantril's *self-anchoring striving scale* asks participants to rank their lives in terms of steps of a ladder, framing the top rung as the "best possible life" and the bottom, the "worst." Another survey asks respondents if they are generally "very happy, pretty happy, or not too happy" these days, without providing the best/worst extremes to anchor responses. The aggregate data from these life self-assessments tend to correlate with each other as well as with other validating metrics. ¹⁷ For example, those who report themselves as satisfied tend to recover more quickly from illness, have completed more years of education,

¹⁶ Daniel Kahneman, Alan B. Krueger, David Schkade, Norbert Schwarz, and Arthur A. Stone, *A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method (DRM)*, 306 *Science* 1776–1780 (2004).

¹⁷ Such framing differences do make a difference when examining the correlation between income and satisfaction. We will discuss this at length in 1.4 of this section.

have higher incomes, smile more, are less prone to commit suicide, and are rated happier by those who know them.¹⁸

Taken individually, however, answers are highly unreliable. Daniel Kahneman writes:¹⁹

[P]eople do not know how happy or satisfied they are with their life in the way they know their height or telephone number. The answers to global life satisfaction questions are constructed only when asked, and are, therefore, susceptible to the focusing of attention on different aspects of life.

Most individuals do not know what to consider about themselves when asked how satisfied they are, so they turn to what they can objectively gauge and compare. As a result, quantifiable or identifiable life circumstances, such as income, employment, and marriage status, are much more correlated with responses to satisfaction survey than experienced moment-to-moment happiness. In other words, life assessments “[re]mind the rich that they are rich and the divorced that they are divorced,”²⁰ so this forms the basis of their responses, even if it has little overall impact on their everyday experience of well-being.

Responses to life-satisfaction surveys may also be affected by respondents’ normative theories of whether they should be happy. Alan Krueger comments:²¹

The mental exercise that well-off respondents go through is probably something like, “I’m a fortunate person. I have a high-paying job. I live in a big house and I have an expensive car. I should report myself as satisfied with my life. If I don’t, I’m not a very responsible person [even if these things don’t actually make me happy].”

Conversely, minor events unrelated to life satisfaction can have an outsized influence on individuals’ life evaluations. Norbert Schwarz and Gerald Clore were able to significantly change the participants’ responses to life satisfaction surveys by having them “serendipitously” find a dime on their way to the experiment room, or take the survey while it was raining, or write about happy or sad events in their lives before giving a response.²²

Besides these mood effects, there can be large differences in how people experience events and how they remember them. Because global evaluations ask respondents to evaluate the entirety of their lives at a single point in time, one would expect these differences to affect

¹⁸ Daniel Kahneman and Alan Krueger, *Developments in the Measurement of Subjective Wellbeing*, 20 *Journal of Economic Perspectives* 3–24 (2006).

¹⁹ Daniel Kahneman et al., *Would You Be Happier if You Were Richer? A Focusing Illusion*, 312 *Science* 1908–1910 (2006).

²⁰ Daniel Kahneman, Alan Krueger, David Schkade, Norbert Schwarz, and Arthur Stone, *A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method*, 306 *Science* 1776–1780 (2004).

²¹ Alan Krueger, commenting, Betsey Stevenson and Justin Wolfers, *Economic Growth and Subjective Wellbeing: Reassessing the Easterlin Paradox*, Institute for the Study of Labor Discussion Paper No. 3654 95–102 (August 2008).

²² Norbert Schwarz and Gerald Clore, *Mood, Misattribution, and Judgments of Wellbeing: Informative and Directive Functions of Affective States*, 45 *Journal of Personality and Social Psychology* 513–523 (1983); Norbert Schwarz, Fritz Strack, Detlev Kommer, and Dirk Wagner, *Soccer, Rooms, and the Quality of Your Life: Mood Effects on Judgments of Satisfaction with Life in General and with Specific Domains*, 17 *European Journal of Social Psychology* 69–79 (1987).

life assessments. One example of the difference between experienced and recollected events, is the “peak-end” phenomenon, in which people’s recollection of pain is the average of how they felt at its most intense and how they felt when it ended, with little attention to how long the pain lasted. In a classic experiment, people recalled a colonoscopy that lasted longer with gradually diminishing discomfort at the end of the procedure as less painful than a shorter procedure with the discomfort ending suddenly.²³

Comparing responses among individuals, particularly across countries and cultures, presents its own challenges. Not only do words like “happy” and “satisfied” have different meanings in different languages and cultures, but they are labile among individuals speaking the same language: “If Jim says that he is ‘very satisfied’ and Tim says that he is only ‘satisfied,’ is Jim really more satisfied than Tim? Maybe. But perhaps Tim is the type of person who rarely uses superlatives to describe himself, either when he is jubilant or depressed, while Jim tends to extremes in his self-descriptions.”²⁴

Even if survey questions were linguistically equivalent, do equivalent levels of reported satisfaction amount to equivalent states of well-being? Amartya Sen writes that²⁵

hopelessly deprived people may lack the courage to desire any radical change and often tend to adjust their desires and expectations to what they see as feasible. They train themselves to take pleasure in small mercies. The practical merit of such adjustments for people in chronically adverse positions is easy to understand: this is one way of making deprived lives bearable. But the adjustments also have the incidental effect of distorting the scale of utilities.

To this, Sabina Alkire adds that it should make a difference whether “people’s values and ensuing behaviors are deliberated and informed, or based on inaccurate information, propaganda, social norms, or manipulation.”²⁶

None of this means that reports of life satisfaction are inconsequential in determining a person’s subjective well-being. Moments of assessing life satisfaction, regardless of their “accuracy,” are important, especially if they influence our daily mood, sense of contentment, and major life decisions. But, when well-being is gauged by the valence and intensity of our affect from moment to moment, most objective circumstances (such as income and career) that correlate with life satisfaction are not significant. This raises an important epistemological question for policymakers: should we be more concerned with how people perceive themselves to be or how they “actually” are?

²³ Barbara L. Fredrickson and Daniel Kahneman, *Duration neglect in retrospective evaluations of affective episodes*, 65 *Journal of Personality and Social Psychology* 1 (1993): 45–55; Donald A. Redelmeier and Daniel Kahneman, *Patients’ memories of painful medical treatments: real-time and retrospective evaluations of two minimally invasive procedures*, 66 *Pain* 1: 3–8 (1996).

²⁴ Commission on the Measurement of Economic Performance and Social Progress, *Survey of Existing Approaches to Measuring Socio-Economic Progress*, working paper (2008).

²⁵ Amartya Sen, *The Economics of Happiness and Capability*, in *Capabilities and Happiness* 18–27 (New York: Oxford University Press U.S., Luigino Bruni, Flavio Comim, and Maurizio Pugno, eds., 2008).

²⁶ Sabina Alkire, *The Capability Approach to the Quality of Life*, working paper (2008).

Experienced Affect

Experienced Affect captures individual's assessment of life at a given moment. Early conceptions of well-being were more concerned with moment to moment happiness than retrospective life evaluations, and certainly more concerned with subjective utility than with measures such as gross domestic product (GDP). In 1881, Francis Edgeworth conceptualized a "hedonometer" that could record an individual's instantaneous utility, and asserted that an individual's overall utility would be the sum of the instantaneous measures over a period of time.²⁷ Daniel Kahneman and colleagues note that²⁸

global subjective evaluations of one's life [e.g., life satisfaction surveys] are unlikely to provide an accurate representation of the concept of utility that Edgeworth proposed. Discrepancies will arise because the durations of experiences are not adequately weighted in global assessments, and because the assessments are unduly influenced by the immediate context and by irrelevant standards of comparison. To overcome these biases we need measures of well-being that have the following characteristics: (i) they should represent actual hedonic and emotional experiences as directly as possible; (ii) they should assign appropriate weight to the duration of different segments of life (e.g., work, leisure, etc.); and (iii) they should be minimally influenced by context and by standards of comparison.

Psychologists have used two approaches to create a hedonometer that satisfies these specifications: experience sampling and daily reconstruction.

Experience Sampling. The Experience Sampling Method (ESM) is among the most accurate real-time measures of well-being.²⁹ Participants carry around a mobile electronic device that, at random points in the day, prompts them to record where they are, what they are doing, feelings they have, and how intensely they feel them. While this is about as close to Edgeworth's hedonometer as one could get, it suffers from a number of drawbacks, including its inability to measure infrequent or brief activities and the expense and annoyance of measurement.

Daily Reconstruction. In efforts to remedy issues with ESM, Daniel Kahneman, Alan Krueger, David Schkade, Norbert Schwarz, and Arthur Stone developed the Daily Reconstruction Method (DRM). Instead of responding in real time, participants reconstruct their previous day's memories as "a sequence of episodes," describing each in terms of situation, activity, and feeling. DRM metrics correlate strongly with ESM results, thus remedying the shortcomings of ESM while minimizing the memory biases of recalling past hedonic states. DRM captures both infrequent and brief activities while also providing information about how people budget their time, allowing researchers to

²⁷ Daniel Kahneman, Alan Krueger, David Schkade, Norbert Schwarz, and Arthur Stone, *Toward National Wellbeing Accounts*, 94 *The American Economic Review* 429–434 (2004).

²⁸ *Id.*

²⁹ Mihaly Csikszentmihalyi and Reed Larson, *Validity and Reliability of the Experience Sampling Method*, in *The Experience of Psychopathology: Investigating Mental Disorders in their Natural Settings* 43–57 (Cambridge: Cambridge University Press, Marten De Vries, ed., 1992).

better approximate the value of nonmarket activities, such as leisure and household work.

Yet both methods may fail to capture more meaningful pursuits whose positive contribution to well-being either is not consciously considered or takes place over a long period of time—pursuits that are more likely to be considered during life satisfaction surveys. Kahneman and colleagues note that “life circumstances have relatively small effects on [daily] affective experience, unless they [are frequently salient], as in the case of time pressure at work.”³⁰ Rather, many life circumstances, such as job security, are affectively important only when one thinks about them, which does not happen often for the most part. For example, as noted above, raising a child may contribute positively to life satisfaction when taken as a whole but, on a moment-to-moment basis, may be consistently dominated by the negative affect of stress, exhaustion, frustration, and so on. Yet few parents would claim that having children was a mistake, even though experienced affect measures may classify child-rearing as a detractor from well-being.

Experienced affect fails to consider circumstances that only “become salient when people are questioned about their well-being and implicitly encouraged to evaluate how (un)fortunate they are.”³¹ It follows that experienced affect and life satisfaction should be viewed as *complementary*, as they capture collectively what neither can alone.

Problem: Mountaineering Revisited

Reconsider Loewenstein’s description of the experience of mountaineers in terms of the distinction between experienced affect and life satisfaction.

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THE DIMINISHING MARGINAL UTILITY OF WEALTH AND OTHER THINGS

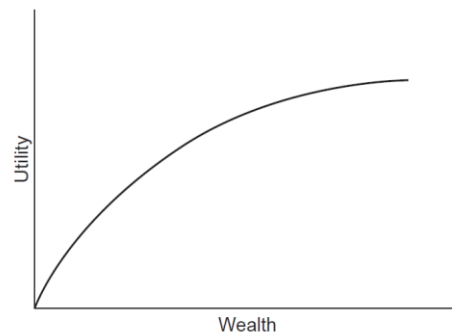
Greater consumption of goods, services, experiences often leads to greater utility. The additional satisfaction an individual gains from an extra unit of consumption is called *marginal utility*. Marginal utility is usually *diminishing*—that is, as more of a good is consumed, the additional amount of utility gained decreases. To illustrate, suppose you order a pizza. The utility you gain from eating the first several slices is great, since you are very hungry. But each subsequent slice you eat is less satisfying as you become fuller and your pizza cravings have been satisfied. (And to return to the difficulty of predicting experienced utility, you may eat the sixth slice at a time when you still feel hungry because your metabolism has not yet adjusted to the fifth, thus leading you to erroneously believe that the sixth slice (downed with another glass of beer) will satiate your hunger, when in fact it will leave you feeling bloated.)

Daniel Bernoulli, an 18th century scientist, observed that diminishing marginal utility applies to money. For example, the subjective value of an increase in salary from \$100 to \$200

³⁰ Daniel Kahneman, Alan Krueger, David Schkade, Norbert Schwarz, and Arthur Stone, *A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method*, 306 *Science* 1776–1780 (2004).

³¹ *Id.*

is greater than the subjective value of increasing salary from \$1,000,100 to \$1,000,200. This idea generates Bernoulli's curve for wealth and utility, pictured below:



As wealth increases, the additional utility gained by more wealth decreases.

GLOBAL COMPARISONS OF WELL-BEING

There is considerable controversy about the relationship between money and happiness when comparing different countries. The issue was framed in 1974 by the economist Richard Easterlin, who argued that countries do not become happier with increasing income. The so-called Easterlin paradox has been hotly debated during the ensuing four decades.³²

Daniel Kahneman and Angus Deaton argue that income is positively correlated with subjective well-being, that it is more strongly correlated with life satisfaction than with experienced affect, but that the slope diminishes along the lines of Bernoulli's curve. Responding to the claim that "money doesn't buy happiness," they write: "Average national life evaluation is linear when appropriately plotted against *log GDP*; a doubling of income provides similar increments of improved life evaluation for countries rich and poor."³³

Kahneman and Deaton write that money does not bring improvements in *experienced affect* beyond a certain satiation income, which they suggest occurs at about \$75,000 annually (1985 dollars) in the United States. As income falls below this level, experienced affect worsens: "[T]he pain from many life's misfortunes, including asthma, divorce, and being alone, is significantly exacerbated by poverty; even the benefits of the weekend are less for the poor. In *Scarcity: The New Science of Having Less and How It Defines Our Lives*, Sendhil Mullainathan and Eldar Shafir document the disastrous psychological effects of living in poverty and suggest that contrary to folk wisdom, failure is a consequence of poverty, not its cause.

The authors' explanation is anchored in people's "bandwidth," including their ability to pay attention, to make good decisions, to stick with plans, and to resist temptations. Because the very poor are often preoccupied with financial problems and are busy making ends meet, very little bandwidth remains for making good decisions about other life goals. "[The poor] are juggling rent, loans, late bills, and counting days till the next paycheck. Their bandwidth is used up in managing scarcity." The consequences include lower productivity at work, lower

³² See https://en.wikipedia.org/wiki/Easterlin_paradox.

³³ Daniel Kahneman and Angus Deaton, *High Income Improves Evaluation of Life but Not Emotional Wellbeing*, 107 Proceedings of the National Academy of Sciences 16489–16493 (2010).

medication adherence rates, lower ability to restrict one's diet, worse parenting performance and even less sleep. All these goals require "freedom of mind [which] is one luxury the poor do not have."³⁴

Above a satiation point, however, people tend to buy goods to which they hedonically adapt³⁵ or, alternatively, their greater wealth creates new stressors: The "activities that higher-income individuals spend relatively more of their time engaged in [such as work and shopping] are associated with no greater happiness, on average, but with slightly higher tension and stress"³⁶ and come at the expense of time spent on more leisurely activities.

The relationship between income and *life satisfaction* may be even more complicated and more difficult to discern. Carol Graham, Soumya Chattopadhyay, and Mario Picon write:³⁷

While in general rich countries are happier than poor ones, there is a great deal of variance among the countries within the rich and poor clusters, as well as in the slope of the relationship. The results are quite sensitive to the method selected, the choice of micro- or macro-data, and the way the happiness questions are framed, thus supporting divergent conclusions about the importance of the paradox.

We find, for example, that question-framing makes a major difference to the relationship, both in terms of direction and slope. Analysis based on questions that are framed in economic or status terms, for example, seems much more likely to yield a positive and linear relationship between income and happiness, across and within countries, than are open-ended happiness or affect questions.

What countries are in the sample also matters. Respondents in poor countries, who are still struggling to meet basic needs, display a stronger income–well-being link than do those in wealthy countries, where that relationship is mediated by factors such as relative differences and rising aspirations. . . .

[Research] suggests that the rate of change matters as much to happiness as do per capita income levels, and that rapid growth with the accompanying dislocation may undermine the positive effects of higher income levels, at least in the short term. . . .

These complexities, coupled with different conceptualizations of happiness, which are captured differently by the various questions that are used to measure happiness, as well as important differences in the sampling of countries that are studied, are alone sufficient to explain divergent conclusions about the Easterlin paradox.

³⁴ The authors write that the limited bandwidth of the poor "is not of the standard physiological variety, having to do with a lack of nutrition or stress from early childhood hindering brain development. Nor is bandwidth permanently compromised by poverty. It is the present-day cognitive load of making ends meet: when income rises, so, too, does cognitive capacity. The bandwidth of the farmers was restored as soon as crop payments were received. Poverty at its core taxes bandwidth and diminishes capacity." Sendhil Mullainathan and Eldar Shafir, *Scarcity: Why Having Too Little Means so Much* (Henry Holt and Company, LLC, 2013).

³⁵ Thomas Gilovich and Amit Kumar suggest that "experiential purchases (such as vacations, concerts, and meals out) tend to bring more lasting happiness than material purchases" because experiences are less prone than possessions to hedonic adaptation." Thomas Gilovich and Amit Kumar, *Chapter Four-We'll Always Have Paris: The Hedonic Payoff from Experiential and Material Investment*, 51 *Advances in Experimental Social Psychology* 147–187 (2015).

³⁶ Daniel Kahneman et al., *Would You Be Happier if You Were Richer? A Focusing Illusion*, 312 *Science* 1908–1910 (2006).

³⁷ Carol Graham, Soumya Chattopadhyay, and Mario Picon, The Easterlin and Other Paradoxes: Why Both Sides of the Debate May Be Correct, in *International Differences in Wellbeing* 276–277, 247–288 (Oxford: Oxford University Press, Ed Diener, John Helliwell, and Daniel Kahneman, eds., 2010).

At any given time, income and happiness tend to be positively correlated *within* individual countries. This has been explained by the relative income hypothesis—the idea that (at least above some level) one’s income relative to peers matters more to life satisfaction than the absolute amount. Easterlin remarks: “In judging their happiness, people tend to compare their actual situation with a reference standard or norm, derived from their prior and ongoing social experience. While norms vary among individuals within a given society, they also contain similar features because of the common experience people share as members of the same society and culture. . . .”³⁸

Although the strength of the correlation appears to have weakened in recent decades, Ed Diener suggests that “it may be that the standard for material well-being is now largely worldwide rather than defined within nations.”³⁹ In other words, people haven’t stopped comparing themselves to others; they are now just watching more television and movies and browsing the Internet.

Most writers on this subject assume that causality flows from income to well-being. But perhaps happier people are more productive and therefore earn more income. And perhaps both variables influence each other. “Variables such as GDP per capita, unemployment, and inflation are not exogenous. These variables are influenced by politicians’ choices; their choices are shaped by reelection probabilities; those probabilities in turn can depend on the feeling of contentment among a country’s citizens.”⁴⁰

Research by Arie Kapteyn and colleagues found that of the four domains contributing to life satisfaction, “social contacts and family have the highest impact...followed by job and daily activities and health. Income has the lowest impact.” Ronald Inglehart writes that “economic development is conducive to subjective well-being, but it is only one of many causal factors. ...[E]conomic development by itself does not necessarily bring rising subjective well-being.”⁴¹

NATIONAL MEASURES OF UTILITY

The above-mentioned efforts of Daniel Kahneman, Alan Krueger, and their colleagues may eventually lead to reliable and practicable measures to assess the subjective well-being of a nation or community. At present, however, the most common measures are objective.

³⁸ Richard A. Easterlin, *Does economic growth improve the human lot? Some empirical evidence*, 89 *Nations and Households in Economic Growth* 89–125 (1974).

³⁹ Ed Diener, Weiting Ng, James Harter, and Raksha Arora, *Wealth and Happiness Across the World: Material Prosperity Predicts Life Evaluation, Whereas Psychological Prosperity Predicts Positive Feeling*, 99 *Journal of Personality and Social Psychology* 52–61 (2010).

⁴⁰ Rafael Di Tella, Robert MacCulloch, and Andrew Oswald, *The Macroeconomics of Happiness*, 85 *The Review of Economics and Statistics* 809–827 (2003).

⁴¹ Robert Inglehart, Faith and Freedom: Traditional and Modern Ways to Happiness, in *International Differences in Wellbeing* 351–397 (Oxford: Oxford University Press, Ed Diener, John Helliwell, and Daniel Kahneman, eds., 2010), p. 384.

Gross Domestic Product

Gross domestic product is the final monetary value of all goods and services produced by a particular country, or the total income that production creates. GDP is a useful tool for policy makers to gauge a country's general economic health, as the concept is well defined and comprehensive. Its benefits are nicely summarized by economists Paul Samuelson and William Nordhaus:⁴²

Much like a satellite in space can survey the weather across an entire continent, so can the GDP give an overall picture of the state of the economy. It enables the President, Congress, and the Federal Reserve to judge whether the economy is contracting or expanding, whether the economy needs a boost or should be reined in a bit, and whether a severe recession or inflation threatens.

Without measures of economic aggregates like GDP, policymakers would be adrift in a sea of unorganized data. The GDP and related data are like beacons that help policymakers steer the economy toward the key economic objectives.

For all of its benefits, GDP has serious limitations.⁴³ One concern, of particular interest here, is the correlation between a society's GDP and its inhabitants' subjective well-being.⁴⁴ Robert F. Kennedy⁴⁵ famously said:

Gross National Product counts air pollution and cigarette advertising, and ambulances to clear our highways of carnage. It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder in chaotic sprawl. It counts napalm and counts nuclear warheads and armored cars for the police to fight the riots in our cities. It counts. . .television programs which glorify violence in order to sell toys to our children. Yet the gross national product does not allow for the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to our country, it measures everything in short, except that which makes life worthwhile. And it can tell us everything about America except why we are proud that we are Americans.

⁴² Paul Samuelson and William Nordhaus, *Economics*, 15th ed. (New York: McGraw Hill, 1995).

⁴³ In addition to conceptual problems, GDP also suffers from measurement and data collection problems that are exacerbated by weak capacity of institutions in some (typically developing) countries.

⁴⁴ The following discussion relies heavily on the exhaustive *Report by the Commission of the Measurement of Economic Performance and Social Progress* by Joseph Stiglitz, Amartya Sen, and Jean-Paul Fitoussi.

⁴⁵ See <http://www.jfklibrary.org/Research/Ready-Reference/RFK-Speeches/Remarks-of-Robert-F-Kennedy-at-the-University-of-Kansas-March-18-1968.aspx>.

Alternatives to GDP: Human Development Index and Other Composites

Amartya Sen notes that whether or not economic development increases happiness, human development and dignity requires according people basic rights to self-determination, free expression, property rights, education, health, and personal security.⁴⁶

Unlike GDP, which measures only one dimension, another approach to the measurement of well-being weights and aggregates several metrics to create a standardized composite score. For example, the human development index (HDI), evaluates social progress in three dimensions: life expectancy, education, and purchasing power.⁴⁷

HDI is only one among many composite scores, which differ both in which basket of metrics they consider and how those metrics are weighted. One recently proposed composite statistic, for example, is based on consumption, leisure, life expectancy, and inequality.⁴⁸ In general, the rankings of countries determined by these composites statistics correlate with GDP and with each other. Where deviations occur, however, they may indicate significant issues, such as high childhood mortality or illiteracy, that GDP overlooks.

Despite their benefits, these nonmonetary composite measures suffer from at least two limitations: first, both the choice of dimensions and the weights assigned to them are subjective; second, because a drastically low score in one dimension might be offset by high scores in another, even if the low score in one dimension is deemed morally or socially unacceptable.

Problem: Measures of Utility

The newly elected mayor of a small city ran for office on the platform of increasing its residents' well-being. His initiatives include:

- A program to reduce childhood obesity.
- A program to reduce homelessness.
- A program to provide transportation and home care for the elderly.
- A congestion pricing program for cars entering the business district.
- Banning cigarette smoking on the street and in multiunit dwellings, such as apartment houses.
- Any other program of your choice—to illustrate aspects of utility not elicited by the preceding programs.

⁴⁶ Commission on the Measurement of Economic Performance and Social Progress, Joseph E. Stiglitz, Amartya Sen, and Jean-Paul Fitoussi, *Report by the Commission on the Measurement of Economic Performance and Social Progress* (2009).

⁴⁷ In 2010, the United Nations Development Program began calculating inequality-adjusted HDI, adding one more factor to those comprising the composite score. *Human Development Report 2010* (New York: UN Development Program, 2010).

⁴⁸ Charles Jones and Peter Klenow, *Beyond GDP? Welfare Across Countries and Time* (Cambridge, Massachusetts: National Bureau of Economic Research, 2010).

The mayor recalls the question that Ronald Reagan asked the electorate in 1980 when running against the incumbent Jimmy Carter: “are you better off now than you were four years ago?” Wanting to be able to answer this question with respect to his initiatives when he runs for reelection in 4 years, the mayor asks you to develop an appropriate standard for assessing whether the initiatives have made his constituents better off. In answering this question, refer to the various concepts and measures of utility discussed in the previous pages. Consider only what measures you deem to be most appropriate from a public policy perspective, and *not* what measures will help the mayor get reelected.

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https://en.wikipedia.org/w/index.php?title=There_you_go_again&oldid=699095238.

THE ROLE OF GOVERNMENT IN A LIBERAL STATE⁴⁹

Much of the earlier discussion focused on individual decision making. Individuals’ pursuits of their own interests sometimes interfere with others. Consider Joe, who wishes to smoke wherever and whenever he can, and Alice, who does not want to be subjected to secondhand smoke. Section III will examine some techniques to assist policy makers in reconciling the many competing interests of their constituents and other individuals and entities.

In the absence of competing interests, what is government’s role in preempting or influencing an individual’s decisions for his or her own good? Continuing the discussion quoted above, Mark Kelman notes that “the existence of . . . differentiable tastes and ends is foundational for all political theories that would describe themselves as essentially liberal. . . . [Liberal theories] affirm that there are a multitude of good lives and that each individual is in a unique position to ascertain which of the many reasonable conceptions of the ‘good’ best fit her circumstances and express her individuated soul.”⁵⁰

A liberal government therefore will have a strong presumption against prohibiting its citizens’ choices of particular ends unless the prohibition compromises the well-being of other citizens. In what they term “libertarian paternalism,”⁵¹ however, Richard Thaler and Cass Sunstein propose behavioral “nudges” to protect citizens against choices that would compromise their own experienced utility—decisions affected by some of the errors mentioned earlier in this section. Skeptics of libertarian paternalism, beyond the obvious critique that this justifies a “nanny state,” suggest that these interventions may covertly incorporate the regulators’ own views of the “good life.”⁵² The 2009 publication of Thaler and Sunstein’s *Nudge*⁵³ signaled the growth of research seeking to apply the insights of psychology and

⁴⁹ “Liberal” in this context does not refer to the contemporary political distinction between liberals and conservatives, but to the modern understanding of the source of authority and role of the state, most famously described by the 17th century philosopher, John Locke. See, e.g., <https://en.wikipedia.org/wiki/Liberalism>.

⁵⁰ Kelman, *supra*, at 1358.

⁵¹ Richard Thaler and Cass Sunstein, *Libertarian Paternalism*, 93 *The American Economic Review* 175–179 (2003).

⁵² Kelman, *Behavioral Economics as Part of a Rhetorical Duet: A Response to Jolls, Sunstein, and Thaler*.

⁵³ Richard Thaler and Cass Sunstein, *Nudge* (2009).

behavioral economics to real-world problems faced by individuals, governments, and organizations.⁵⁴

Problem: Easy cases for the liberal state?

In *The Hidden Wealth of Nations*,⁵⁵ the British public policy expert David Halpern argues that certain government policies would increase residents' well-being without giving rise to the concerns mentioned above. That is, they would generally make everyone better off and increase both momentary and reflective, life satisfaction measures of well-being. We summarize some of his recommendations below. What do you think? Can you add too or subtract from his examples?

- *Expand services for people suffering from mental illness*, who Halpern terms the “well-being poor.”
- *Teach children resilience skills* – how to better weather the challenges of life, including the ability to forestall depression.
- *Ban advertising to children*. Halpern writes: “One of the key objectives of advertising is to make us want things we don’t have.” Whatever its proper role might be with respect to adults, government could protect children by continuing to subsidize children’s programming so that it can be presented ad-free (as the Public Broadcasting System does in the United States).
- *Reduce commute times*. People should be better informed about how their housing and commute choices affect well-being—for example, a smaller house closer to work enhances well-being more than a larger house farther away. Improved housing and transportation policies, such as increasing neighborhood density and public transit access, would likely enhance subjective well-being in most cities.
- *Strengthen social capital*. Social capital—the size and strength of our social networks— has an outsized impact on well-being. Halpern suggests:

Social capital can be built at the individual, community, and at the national level. At the individual level, it can be built through mentoring; volunteering programs; and through strengthening the skills of parents, such as through parenting classes. At the community level, it can be built through physical environments that make it easy for people to interact with each other but that do not force them together; using [technology] to lower barriers to interaction and informing others of mutual interests; and creating situations that encourage mixing between people from different social and ethnic groups. At the national level, it can be built through service learning programs in schools; through national community service schemes; and through vibrant democratic and media spheres that enable people to negotiate and develop shared social norms and habits.

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⁵⁴ See, e.g., www.ideas42.org; David Halpern, *Inside the Nudge Unit* (2015).

⁵⁵ David Halpern, *The Hidden Wealth of Nations* (Cambridge: Polity Press, 2009), 31–44.

III – Decision Making Where Risk or Uncertainty Is Not a Major Factor

Having surveyed some essential concepts of utility, we now turn to tools to help make decisions that maximize utility for individuals or the common good. Section III considers two basic tools where the results of the decision can be predicted with reasonable certainty. Section IV expands the tool set to situations where the results are of a probabilistic nature.

This section considers two basic decision tools: (1) the subjective linear model, which provides a helpful way to model choices among several options, and (2) cost-benefit analysis, which helps determine the tradeoffs between the costs of a regulation and its desired benefits.

THE SUBJECTIVE LINEAR MODEL

Decisions generally involve trade-offs among multiple objectives, with the decision maker attempting to optimize a number of values. In a subjective linear model, the decision maker:

- Sets out the attributes by which the decision will be judged a success.
- Generates a list of alternative options.
- Qualitatively assesses and then quantitatively scores each alternative decision with respect to each attribute.
- Assigns weights to the attribute and computes aggregate scores for each alternative.

This approach is “subjective” because the values depend on the decision maker’s preferences. It is “linear” because all increases in the value of an attribute are treated identically (rather than, say, having declining utility as in Bernoulli’s curve for wealth). For the application of a subjective linear model to a public policy issue, consider this problem.

In response to skyrocketing increases in the health and social costs of drug addiction in a small city, a mayor’s task force is recommending that the city establish a drug rehabilitation center where addicts can receive health and psychological interventions through a mixture of residential and outpatient care. The task force is now considering where to locate the center, taking into account the importance of accessibility, cost, and impact on residents and businesses. Needless to say, the task force must consider the interests of multiple stakeholders.

Here are the steps that the task force might take in using a subjective linear model to structure the decision.

Step 1. Identify the major attributes affecting the decision:

- *Economic impact* – minimize property value loss to surrounding homes and businesses.
- *Safety impact* – minimize dangers of drug-related crimes to nearby residents and others.

- *Accessibility for clients* – location that allows for easy access by the clientele by probable modes of transportation (public transportation or by foot).
- *Accessibility for professionals* – location to which therapists, physicians, psychologists, and support staff can travel safely and conveniently.
- *Property costs* – low costs of acquiring the property.
- *Space* – adequate space and facilities to serve the clients' needs.

Step 2. Identify candidate sites:

The task force has identified four possible sites:

1. *Within an existing hospital.* The hospital is located adjacent to a business district and is accessible by subway. The neighborhood is mainly industrial with few restaurants or consumer-oriented businesses. Space in the hospital is limited and expensive, and the drug rehabilitation center would compete with a plan to increase the size of the maternity ward. The rehabilitation floor will only be able to hold up to 15 inpatients.
2. *In a peri-urban area.* The rehabilitation center would be located in a former commercial building about 10 miles from the city center, where property costs are low. It is accessible by public transportation, but it takes about 45 minutes and requires subway-bus transfers from the inner city, where the majority of the intended clientele reside. The center would have plenty of space for out-patient treatment and could provide beds for up to 50 patients at one time.
3. *Former department store near the city center.* The city has an option to purchase a former department store for a low price. Like the peri-urban location, it would have plenty of space for outpatient treatment and could provide beds for up to 50 patients at one time. The site would be easily accessible by clients and professionals alike. However, restaurants and retail businesses as well residents of apartment houses in the neighborhood are concerned about safety and economic effects on the neighborhood.
4. *Slum neighborhood.* The center would be placed in a very low-income neighborhood, known to be home to many drug addicts to whom the center would be readily accessible. Though it can be reached by many forms of public transportation, its high crime rate and unsafe sidewalks would make many health professionals uncomfortable. The cost of the property is low, and the facility could hold up to 30 in-patients.

Step 3. Describe the attributes of each location qualitatively:

Location	Economic Impact	Safety Impact	Accessibility for clients	Accessibility for professionals	Property costs	Space
Hospital	Good	Good	Good	Ideal	Very poor	Poor
Peri-urban area	Poor	Poor	Very poor	Poor	Very good	Very good
City center	Very poor	Very poor	Very good	Very good	Good	Very good
Slum Neighborhood	Good	Good	Ideal	Very poor	Very good	Good

Step 4. Translate the qualitative values into quantitative ones and calculate and compare the total scores for each site:

Using a 100-point scale assign quantitative scores to the qualitative attributes and sum them to calculate a total score for each site.

Location	Economic Impact	Safety Impact	Accessibility for clients	Accessibility for professionals	Property costs	Space	Average
Hospital	60	70	60	100	10	50	58
Peri-urban area	30	40	10	50	90	90	52
City center	20	30	80	80	70	90	62
Slum neighborhood	60	60	100	20	80	70	65

At this point, it seems that the slum neighborhood is the most preferable location due to its low property costs and easy accessibility for clients.

Alternative Steps 4A and B. Assign weights to the attributes and calculate scores based on those weights.

So far, however, we have assumed that each objective is equally important. But this is not necessarily the case. For example, safety impact and accessibility for professionals may be more important than the economic impact on property prices. Thus, one might take the further step of ranking the attributes in order of importance:

Economic Impact	10%
Safety	20%
Accessibility for Clients	10%
Accessibility for Professionals	30%
Property Cost	10%
Space	20%

A recalculation based on the rankings weights above would lead to somewhat different results:

Location	Economic Impact (10%)	Safety Impact (20%)	Accessibility for clients (10%)	Accessibility for professionals (30%)	Property Cost (10%)	Space (20%)	Total
Hospital	6	14	6	30	1	10	67
Peri-urban area	3	8	1	15	9	18	54
City center	2	6	8	24	7	18	65
Slum	6	12	10	6	8	14	56

Using the weighted method, the hospital becomes the most preferable location because of the weight accorded accessibility to professionals and safety.

Step 5. Do a reality check:

Whether or not you weighted the attributes, take a fresh look at characteristics of each location and its pros and cons. If the calculated results contradict your initial intuitions, this may be because the more granular analysis has focused on attributes that really matter, excluding extraneous considerations. But perhaps, on second thought, you omitted some important attributes. The subjective linear model is only a *decision aid*. Nothing can substitute for your judgment in making the ultimate decision.

Note on Compensatory vs. Non-Compensatory and on Reason-Based vs. Value-Based Decision Making

The subjective linear model embodies a compensatory approach to decision making: A strong score for one attribute can compensate for a weak score in another. But there are many instances of noncompensatory decision making as well. For a vegetarian ordering from a menu in a restaurant, it does not matter that the steak is extraordinarily good and inexpensive. Many moral and constitutional “rights” are treated as non-compensatory, trumping any countervailing interests—though in some cases, courts treat them as being defeasible in the face of very strong countervailing interests.

The subjective linear model also embodies a values-based, as distinguished from a reason-based, approach to decision making—though reasons play a role in designing the model. Most of the time when we decide among difficult individual choices or argue with others about philosophy, politics, or who should take out the garbage, we consider and offer reasons supporting or opposing particular choices or positions. An appellate court decision is a paradigmatic embodiment of reason-based decision making. The subjective linear model is characterized as value-based because, as in the example above, one assigns qualitative or quantitative values to the attributes as they apply to a particular option and then reaches a decision by summing them up. Note, however, that the decision of which attributes to choose is reason-based as is the decision of what weights to place on different attributes. In the end, you can't escape reasons playing a role in the decision making process—and why should you try?

Problem: the Concept of Dominance

One candidate choice (A) dominates another (B) if A is preferable to B in at least one respect and is at least as desirable as B in all other respects. When using the subjective linear model or any other decision tool, if you are able to identify a candidate that is dominated by any other, you can eliminate it. Are any of the candidate sites in our problem dominated?

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Subjective Linear Model Problem

Use a subjective linear model to structure a professional or personal decision (e.g., choosing what class to take, what summer job to take, what apartment to rent, where to take a vacation). It would be ideal, but not necessary, if you used a decision you are actually facing. But if an actual decision does not come to mind, or if you don't feel comfortable describing an actual problem, feel free to use a hypothetical case. The decision ought to involve three or more alternatives and three or more attributes.

Go through the process, step by step, to arrive at a decision. (Actually work through the decision process rather than just describe how you might do it.)

Does the outcome of the process comport with your prior intuitions and, if not, why?

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THE AXIOMS OF EXPECTED UTILITY

The decision-making process that you have just engaged in and, indeed, all other rational decision making processes, are undergirded by certain premises that may seem so obvious as not to need articulation. But there are circumstances where people in fact deviate from some of them. These premises were formalized as the axioms of expected utility theory by John von Neumann and Oskar Morgenstern in their path-breaking 1947 book, *Theory of Games and Economic Behavior*. Von Neumann and Morgenstern asserted that a rational decision making process must satisfy four axioms, and that violation of any of the axioms would lead to

suboptimal decisions.⁵⁶ We describe three of the axioms here, leaving the fourth, *Continuity*, to the discussion of choice under risk, below:

Completeness requires that the individual either prefers A to B, or prefers B to A or is indifferent between A and B. Faced with a choice between a Prius and a Ferrari, you must either prefer the Prius to the Ferrari, or the Ferrari to the Prius, or be indifferent between the two.

Transitivity requires that, as an individual decides according to the completeness axiom, he also decides consistently. If you prefer A to B and prefer B to C, then you must prefer A to C. If you prefer the red Prius to the blue Prius and the blue Prius to the green Prius, then you must prefer the red Prius to the green Prius. There is considerable debate in the psychological literature whether people violate this axiom in any real-world cases.⁵⁷

Independence from irrelevant alternatives. If A is preferred to B out of the choice set A and B, expanding the choice set to A, B, and C, cannot not make B preferable to A—unless option C provides new information about the choice. If you are choosing between two Priuses and prefer the red one to the blue one, seeing the Ferrari cannot make you prefer the blue to the red Prius.

People often violate this axiom. In a classic experiment demonstrating what they termed *trade-off contrast*, Amos Tversky and Itamar Simonson offered one randomly selected group a choice between \$6 and an elegant Cross pen. The pen was selected by 36% of the subjects, with the remaining 64% choosing the cash. A second group was given a choice among three options: \$6 in cash, the same Cross pen, and a second less attractive pen. Only 2% of the subjects chose the less attractive pen, but its presence increased the percentage of subjects who chose the Cross pen from 36% to 46%.⁵⁸ While adding the less attractive pen did not provide any additional information about the prior two choices, Tversky and Itamar Simonson analogize the increased preference for the Cross pen increased to the perceptual phenomenon whereby the same circle appears large when surrounded by small circles and small when surrounded by large ones. Similarly, they note, “the same product may appear attractive on the background of less attractive alternatives and unattractive on the background of more attractive alternatives.”

In another experiment, demonstrating one phenomenon of *extremeness aversion*, Tversky and Simonson asked participants to choose among 35 mm cameras varying in quality and price. One group was given a choice between a Minolta X-370 priced at \$170 and a Minolta 3000i priced at \$240. A second group was given an additional option, the Minolta 7000i priced at \$470. Participants in the first group were split evenly between the two options. Fifty-seven percent of the subjects in the second group chose the middle option (Minolta 3000i), however, with the remaining subjects divided about equally between the two extreme options. While adding a third camera did not change the characteristics of the prior two options or provide more information about them, the selection results were different because the participants in the second group avoided extreme choices.

⁵⁶ See, generally, https://en.wikipedia.org/wiki/Von_Neumann%E2%80%93Morgenstern_utility_theorem.

⁵⁷ See Regenwetter, Dana, and Davis-Stober, *Transitivity of Preferences*, 118 *Psychological Review* 1: 42–56 (2011).

⁵⁸ Amos Tversky and Itamar Simonson, *Context-Dependent Preferences*, 39 *Management Science* 10: 1179–1189 (2011).

These and similar violations of independence have been replicated in many other contexts.⁵⁹

One can think of *invariance* as a corollary of independence. Invariance requires that the order in which choices are presented not affect one’s choice. If the car dealer first shows you a red Prius and then a blue Prius, your choice between the two should be the same as if he first showed you the blue and then the red car.

Can you imagine intelligent people violating this axiom? Eldar Shafir and his colleagues gave this problem to two randomly chosen participants:⁶⁰

Imagine that you serve on the jury of an only-child sole-custody case following a relatively messy divorce. The facts of the case are complicated by ambiguous economic, social, and emotional considerations, and you decide to base your decision entirely on the following few observations. One group of respondents was asked: “To which parent would you *award* sole custody of the child?” The other group was asked: “To which parent would you *deny* sole custody of the child?” Here are the results:

		Award	Deny
Parent A	<ul style="list-style-type: none"> • Average income • Average health • Average working hours • Reasonable rapport with child • Relatively stable social life 	36%	45%
Parent B	<ul style="list-style-type: none"> • Above-average income • Very close relationship with child • Extremely active social life • Lots of work-related travel • Minor health problems 	64%	55%

As a matter of logic, someone who chooses to award custody must reject the alternative of denying custody. But people tend to emphasize positive features of each option when choosing and negative features when rejecting. As a result, the option with more prominent positive and negative features (Parent B) can be both chosen and rejected when compared to the less interesting alternative (Parent A). Shafir and colleagues explain: “Parent A, the impoverished option, is quite plain—with no striking positive or negative features. There are no particularly compelling reasons to award or deny this parent custody of the child. Parent B, the enriched option, on the other hand, has good reasons to be awarded custody (a very close relationship with the child and a good income), but also good reasons to be denied sole custody (health problems and extensive absences due to travel).”⁶¹

⁵⁹ Mark Kelman, Yuval Rottenstreich, and Amos Tversky, *Context-Dependence in Legal Decision Making*, 25 *Journal of Legal Studies* 287-318 (1996)

⁶⁰ Eldar Shafir, Itamar Simonson, and Amos Tversky, *Reason-based choice*, 49 *Cognition* 11–36 (1993).

⁶¹ The phenomenon is somewhat akin to the availability heuristic, discussed below.

COST-BENEFIT ANALYSIS

Cost-Benefit Analysis (CBA) is a technique used by policy makers to compare the dollar value of all the costs associated with a policy or program with the benefits it produces. The idea behind cost-benefit analysis is simple. Under CBA, an activity is justified, if, and only if, its benefits outweigh its costs:

$$\text{Net Benefit} = \text{Total Benefit} - \text{Total Cost}$$

Although the following example focuses on CBA, it is worth noting the related procedure of Cost-Effectiveness Analysis (CEA), which is useful in deciding which program to pursue among several that have the same intended outcome. CEA is a ratio, obtained by dividing the projected cost of each program by the relevant unit of effectiveness.

$$\text{Cost-Effectiveness Ratio} = \text{Total Costs} / \text{Unit of Effectiveness}$$

Units of effectiveness are a measure of any quantifiable outcome central to the program's objectives. For example, a high school dropout prevention program would likely treat the number of dropouts prevented as the most important outcome. For a policy mandating airbags in cars, the number of lives saved would be an obvious unit of effectiveness. Using the formula above, and dividing costs by the number of lives saved, you could calculate a cost-effectiveness ratio in terms of "dollars per life saved." You could then compare this CE ratio to the CE ratios of other proposed auto safety policies to determine which policy costs less per unit of outcome (in this case, lives saved).⁶² However, it is important to note that just because policy A is more cost effective than policy B does not entail that the A dominates B. A might save lives very cheaply but only be able to save a small number of lives, whereas B might cost somewhat more per life but save lots more lives.

Foundations sometimes use CEA to compare alternative strategies for achieving an outcome in a particular program area, for example, providing family planning services to poor people in developing countries.⁶³ The Robin Hood Foundation uses CEA to compare grantee organizations that provide workforce development, early childhood education, and K-12 education in terms of the common metric of increases in the beneficiaries' earnings over their lifetimes.⁶⁴

The Steps of Cost-Benefit Analysis

Because CBA shows the net welfare effects on society, it is widely used for assessing government policies. Indeed, federal agencies are required by statute and regulation to select regulatory approaches that maximize net benefits, including potential economic,

⁶² See <http://home.gwu.edu/~scellini/CelliniKee21.pdf>.

⁶³ See, e.g., <http://www.redstonestrategy.com/wp-content/uploads/2013/01/2013-01-04-Doing-Good-Today-Report.pdf>.

⁶⁴ See Michael Weinstein and Ralph Bradburd, *The Robin Hood Rules for Smart Giving* (Columbia 2013).

environmental, public health, and safety.⁶⁵ We will illustrate the CBA process using the example of the 2011 Food and Drug Administration (FDA) regulation mandating that cigarette packages include textual warning statements and color graphics depicting the negative health consequences of smoking.



SOURCE: US Food and Drug Administration. Photo in the public domain.

The following analysis is adapted from a multi-stage process suggested by Stephanie Cellini and James Edwin Kee in their excellent article, *Cost Effectiveness and Cost-Benefit Analysis*.⁶⁶

1. Identify the state of the world without the policy or program.
2. Determine the geographic scope of the relevant costs and benefits.
3. Identify those costs and benefits.
4. Predict the changes in behavior caused by the program.
5. Monetize the costs and benefits.
6. Project costs and benefits over the life of the program.
7. Discount the costs and benefits and compute their net present value.
8. Make a recommendation.

Step 1. Identify the State of the World without the Policy or Program

One typically evaluates the effectiveness of a proposed public policy program by comparing its costs and benefits with the state of the world in the absence of the program. For a new program, this would be the status quo ante, but one can also use CBA to assess whether an existing program should be continued.

The only benefits and costs that CBA should take into account are those that would occur over and above those that would have occurred without any action. In the case of the FDA regulation, the status quo represents warnings that were already required for cigarette packages and advertisement before the new regulation would be implemented.

⁶⁵ Food and Drug Administration, *Required Warnings for Cigarette Packages and Advertisements, Final Rule* (2011), Federal Register 76(120): 36628–36777.

⁶⁶ In Joseph Wholey, Harry Hatry, and Kathryn Newcomer, eds., *Handbook of Practical Program Evaluation* 493–530 (3d ed., 2010).

Step 2. Determine the Geographic Scope of the Relevant Costs and Benefits

Most policy and public initiatives provide benefits for and impose costs on a number of different stakeholders. These are the people whose costs and benefits an agency should presumptively measure. The general approach to this is to consider the jurisdiction (geographical area) whose residents will bear the burden of the costs and receive the benefits. While this is a good approximation, a policy adopted in one jurisdiction may have effects in another; policies concerning air and water pollution are obvious examples. We won't address the political and moral questions involving these externalities here other than to note that there is nothing in the process of CBA that precludes considering effects outside of one's jurisdiction. This is what happens when governments use a global measure for the social cost of carbon in evaluating policies that reduce greenhouse gas emissions.

In the federal regulations to display health warning on cigarette packages, the FDA took into account the costs and benefits throughout the United States. Since there are consumers all over the country who smoke, the targeted benefits affect smokers throughout the nation. On the other hand, the majority of the costs are likely to be concentrated on tobacco companies which will have to bear the costs associated with putting pictures on cigarette packages. These are multinational corporations, many of whose shareholders live outside of the United States. In short, the geographic scope of relevant costs doesn't need to correspond to the geographic scope of the benefits.

Step 3. Identify the Relevant Costs and Benefits

Having identified the relevant stakeholders, the next step is to identify the benefits and costs of the program or policy. In addition to the costs entailed by the policy itself, one must consider the costs of implementing it. The FDA identified these benefits and costs:

Benefits
Smokers' Life-Years Saved
Health Status Improvements
Medical Expenditure Reduction
Other Financial Effects
Fire Loss Averted

Costs	Sector
Label Change	Private
Market Testing	Private
Point-of-Sale Advertising	Private
Continuing Admin & Recordkeeping	Private
FDA	Government

Various Kinds of Costs and Benefits

Cash Outlays and Costs Imposed on other Actors

The costs in CBA include both cash outlays entailed by a program (e.g., salaries and benefits paid to employees to implement a government regulatory program) and costs imposed on others (e.g., those imposed on cigarette manufacturers in changing their packaging).

Direct and Ancillary Costs and Benefits

Direct benefits and costs are those that are closely related to the primary objective of the project. Direct costs include costs for such things as personnel, facilities, equipment and material, and administration. Indirect or secondary benefits and costs are byproducts, multipliers, spillovers, or investment effects of the project or program. An often-cited (but seldom quantified) example of indirect benefits from space exploration is the numerous spin-off technologies benefiting other industries. Indirect costs are unintended costs that occur as a result of an action.

Quantifying ancillary costs and benefits is inherently more difficult. James Campen notes that “because proper identification of indirect effects is subject to disagreement, advocates of particular projects have often sought to include more secondary benefits, and to omit more secondary costs, than is appropriate, while opponents of particular projects have often sought to do the reverse.”⁶⁷ An unbiased CBA process will identify foreseeable ancillary costs and benefits, and include them in the final calculation if they are substantial and sufficiently measurable.

Real Costs and Benefits vs. Transfers

Real benefits and costs represent *net* gains or losses to society—so-called gains from trade. While most government programs involve various cash payments, those payments themselves do not represent either costs or benefits. They merely alter the distribution of resources within the society. Real benefits include dollars saved and dollars earned, lives saved and enriched, increased and decreased costs for the taxpayers, as well as time saved and increased quality of life.

In contrast, a loss for some stakeholders, offset by gains for others, are transfers that should not be counted in the CBA equation. For example, a local tax abatement program for the elderly will provide a tax-saving benefit to some residents but impose a cost (of an equal amount) to others (in terms of higher taxes or lower services). Assuming that there are no other benefits, such as increased health or life expectancy for the elderly, CBA has no light to shed on

⁶⁷ James T. Campen, *Benefit, Cost, and Beyond: The Political Economy of Benefit-cost Analysis* (Cambridge, Mass.: Ballinger Pub. Co., 1986).

transfers that redistribute welfare within society but do not increase total welfare.⁶⁸ Hence, the FDA was not careless in omitting the loss of sales from the list of costs above. Rather, this omission was intentional. As the agency wrote:⁶⁹

This final rule will lead to losses to some segments of U.S. society that will most likely be offset by equal gains to some other segments of society; as such, these effects do not constitute net social costs or benefits. . . . In general, sectors affiliated with tobacco and tobacco products will lose sales revenues as a result of this final rule. Simultaneously, non-tobacco-related industries will gain sales, because dollars not spent on tobacco products will be spent on other commodities.

All other things being equal, if people who stopped smoking ate more, the transfer from the tobacco industry to the food industry would not be a cost. But if as a result of eating more, they became obese, with detrimental consequences to their own health, taxpayers, and insureds, that would be a cost and (coincidentally) one within the FDA's jurisdiction.

Consumer Surplus

CBA readily handles costs and benefits that manifest themselves in market transactions. But as Part II of this text suggests, people obtain utility from activities and experiences that aren't obviously reflected in markets. We consider subjective and difficult-to-quantify costs and benefits in this and the next sections.

The FDA wrote:⁷⁰

The concept of consumer surplus is a basic tool of welfare economics. . . . If consumers respond to price, information, or other market changes, there will be a change in consumer surplus. Some economists describe consumer surplus as a measure of the pleasure, satisfaction, or usefulness that a product provides to consumers [in excess of the costs of obtaining those benefits] . . .

Virtually all studies of the economics of smoking and addiction assume that smoking is pleasurable to smokers. . . . Economists Warner and Mendez state: "Many members of the tobacco control community dismiss the notion that smoking can be pleasurable. . . . [But] smokers derive much more from their cigarettes, including everything from 'mouth feel' to the nicotine drug rush, from relaxation to self-image (think Marlboro Man), and from enhanced ability to concentrate to companionship."

Based on these studies, the FDA adjusted the benefit of its regulations down by 50% to account for the reduction in consumer surplus entailed by the reduction in smoking. Various

⁶⁸ If the benefits flow disproportionately to poorer people, the transfer might result in a net welfare increase because of the declining marginal utility of wealth (see the discussion above), but the same people may suffer a disproportionate loss of consumer surplus.

⁶⁹ Food and Drug Administration, *Required Warnings for Cigarette Packages and Advertisements, Final Rule* (2011), Federal Register 76(120): 36628–36777.

⁷⁰ Food and Drug Administration, *Required Warnings for Cigarette Packages and Advertisements, Final Rule* (2011), Federal Register 76(120): 36628–36777.

comments on the proposed regulations argued that this was an excessive reduction because the analysis assumes perfect rationality on the part of smokers and does not account for their time-inconsistent preferences. The FDA responded that, “on average, smokers are informed of, and able to internalize, some but not all health and life expectancy effects of their smoking.”

In a critique of the FDA’s analysis, a distinguished group of economists explained the meaning of consumer surplus and explained why they believe that the FDA’s accounting for consumer surplus was flawed. Their analysis was based on individuals’ time-inconsistent preferences, such as present bias, mentioned earlier in this paper:⁷¹

For fully-informed, rational consumers, consumer surplus reflects the difference between their willingness to pay for a product and the actual price they pay in the marketplace; graphically, this is the area under the demand curve but above market price. Regulatory actions that reduce the demand for a product or that raise its market price will lead to reductions in consumer surplus, reflecting the lost satisfaction that results from reduced consumption. In FDA’s economic impact analysis of its Graphic Warning Label (GWL) rule, it applied this standard tool of welfare economics to cigarette smoking and reduced the benefits resulting from reductions in smoking caused by the labels by roughly half in order to account for the lost consumer surplus.

In one extreme model in which consumers are making fully informed, perfectly rational, and forward-looking choices, consumers induced to quit by GWLs would indeed lose consumer surplus. Without knowing the exact demand function, this surplus could be much smaller or much greater than half of the health benefits. However—and this is a key point—in this model, there would be no reason for the smoker to quit in response to the GWL. This is a crucial point—the very fact that the GWL has a strong impact on quitting, as documented by the evidence cited above, contradicts the very use of this extreme model.

At the other extreme, in a model in which all consumers are making irrational decisions either when taking up smoking or while deciding whether and when to quit, the concept of consumer surplus loses its normative appeal. If, for example, all smokers are addicted and suffer the disutility of wanting but being unable to quit, their persistent smoking has no implications for the amount of pleasure they receive from continued smoking. Once again, however, in such a model GWL would not cause quitting among these addicted smokers.

While neither of these extreme models is completely correct when applied to smoking, the available evidence suggests that the latter is likely to be closer to reality than the former. As the FDA’s analysis observes, smoking prevalence is well above the level that would result from forward looking, time consistent decisions made by individuals who are fully informed about the health consequences of smoking, including addiction, and who appropriately internalize this information. Instead, most smoking initiation takes place during adolescence or young adulthood among individuals who are often less than fully aware of the health and economic consequences of smoking, have little to no conception of their own mortality, heavily discount future consequences, and, perhaps most importantly, do not fully understand addiction. . . . [F]ew youth who are smoking as high school seniors expect to be smoking five years later, but most continue to do so. Data from the Monitoring the Future Surveys, for example, show that while only three percent of those smoking daily as high school seniors thought that they would

⁷¹ Frank J. Chaloupka et al., An Evaluation of FDA’s Analysis of the Costs and Benefits of the Graphic Warning Label Regulation in <http://tobacconomics.org/research/evaluation-fda-graphic-warning-label-regulation-benefit-cost-analysis/>. Citations omitted. Licensed under a CC BY-NC 4.0 license.

definitely be smoking in five years, almost two thirds were still smoking seven to nine years later.

Once smokers begin smoking, extensive behavioral economic and psychological research shows that their decision to continue to smoke are time inconsistent, satisfying their short-run desire for immediate gratification rather than their long-run desire for good health, then later regretting these decisions. Data from the 2002 wave of the ITC-US Survey show that more than nine out of ten smokers agreed or strongly agreed with the statement “If you had to do it over again, you would not have started smoking.” Similarly, CDC reports that in 2010, nearly seven out of every ten smokers reported that they wanted to quit smoking completely and more than half of all smokers stopped smoking for at least one day because they were trying to quit smoking. Yet only 2.7 percent of smokers quit each year.

These data strongly suggest that many, and likely the vast majority of smokers do not find smoking ‘pleasurable’ and derive little ‘consumer surplus’ from smoking. Instead, most continuing smokers are avoiding the withdrawal symptoms they would experience if they were able to stop smoking and break the addiction that most regret having ever started. Indeed, the self-reported happiness of potential smokers rises when cigarette taxes are increased. This is consistent with quitting causing an increase, rather than a reduction, in consumer surplus. Note that smoking literally rewires the brain, a phenomenon not familiar to many economists but indicative of a biological barrier to smokers’ exerting the self-control that is essential in the model of rational consumer behavior. . . .

Given these issues, we conclude that nearly all of the ‘lost pleasure’ from tobacco use, as represented by conventionally measured consumer surplus, should not be included as a cost in FDA analyses of the economic impact of its tobacco regulations. The principle of insufficient reason suggests that the vast majority of any consumer surplus loss should be ignored given that most tobacco users become addicted regular users before reaching the legal purchase age. For those who do begin as adults, their imperfect information and self-control problems (and the associated psychological costs), increased consumer surplus from alternative consumption, and the importance of peer effects reflected in strong anti-tobacco norms suggest that regulations that reduce their tobacco use are more likely to be welfare enhancing than not. Indeed, the data strongly suggest that many smokers do not find smoking pleasurable and that they derive little consumer surplus from smoking. Instead, most are struggling with or avoiding the withdrawal they would experience if they were able to stop smoking and break an addiction they regret having ever started, facing psychological costs from being addicted and lacking the self-control to quit.

Quantifiable and Unquantifiable Costs and Benefits

Quantifiable benefits and costs are those that you can readily describe in unit terms for CEA and can convert to dollars for CBA. In contrast, unquantifiable benefits and costs include things that cannot simply be put into units of measurement such as an increased sense of community. Although these are real costs and benefits—indeed, sometimes the most important ones surrounding a policy, they can be very difficult to monetize. For the reasons implicit in the discussion of prospect theory (discussed at page 65 below), one traditional measure, based on people’s willingness to pay for intangible benefits, is fraught with problems. In the process of *contingent valuation*, people are surveyed to determine how much they would be willing to pay (WTP) to gain an environmental good or how much they would be willing to accept (WTA) to suffer the loss of that good. Contingent valuation is premised on the

assumption that an individual's WTP and WTA for a good are identical. But it turns out that WTP and WTA often differ by large amounts. Russell Korobkin reports:

In one notable study, 2000 duck hunters were surveyed about the value they would place on protecting a wetland from development. Hunters were willing to pay \$247 per person per season, on average, for the right to prevent development to make hunting viable, while they would demand, on average, \$1044 dollars each to give up an entitlement to hunt there [Another] survey found that a sample of residents of a region of the southwest would pay \$4.75 per month, on average, to maintain 75 miles of air visibility in the face of potential pollution that would reduce visibility to 50 miles. In contrast, however, people drawn from the same pool and told that they collectively enjoyed the right to prohibit the pollution, reported that they would demand \$24.47 per month before being willing to permit the pollution.⁷²

To return to our smoking example, while the health costs of secondhand smoke may be difficult to measure, they are objectively quantifiable in principle because one can track spending related to the health care costs they impose. In contrast, people's pleasure from smoking and displeasure from smelling smoke may be very difficult to quantify because these costs reflect subjective experiences (and also may be subject to the problem of contingent valuation just mentioned.)

Difficult to Measure Costs and Benefits

A CBA analyst may recognize certain costs and benefits as important, but too difficult to quantify within reasonable margins of error to justify incorporating into the equation.

For this reason, among others, the FDA did not include—but the group of economists mentioned above criticized it for not including:

- Benefits to nonsmokers through reduction in the health consequences of secondhand smoke exposure.
- Benefits associated with reduced maternal smoking during pregnancy.
- Immediate benefits from reduced risks of heart attack and stroke.
- Reductions in smoking by smokers who do not quit.
- Unhappiness by those who continue smoking who are reminded that it's unhealthy.
- Pain of unsuccessful attempts to stop.
- Excess of pleasure of smoking over cost of cigarettes (consumer surplus).
- Psychic benefits of longer, healthier lives.

⁷² Russell Korobkin, *The Endowment Effect and Legal Analysis*, 97 *Northwestern University Law Review* 1227 (2003).

Step 4. Predict the Changes in Behavior Caused by the Program

Based on the reduction in smoking following Canada's requirement of graphic warning labels the FDA estimated that the implementation of GWLs in the United States would reduce smoking prevalence by 0.4 percent, resulting in 213,000 fewer smokers in 2013 and growing to about 246,000 by 2031, given increases in the population over time. Its approach accounted for the underlying trends in cigarette smoking in the two countries prior to the implementation of GWLs in Canada in mid-2001, as well as the effects of inflation adjusted cigarette taxes in the two countries.

The group of economists quoted above noted:

Recent research, not available to FDA at the time of its analysis, indicates that the 0.4 percent reduction estimated by FDA significantly understates the impact of GWLs on adult cigarette smoking prevalence. For example, using nationally representative data on smoking among persons 15 years and older from the Canadian National Population Health Surveys conducted from 1998 through 2008, Azagba and Sharaf (2013) estimate that smoking prevalence in Canada fell by 12.5 percent as a result of that country's GWLs, nearly thirty times as large a reduction as that estimated by FDA. Importantly, Azagba and Sharaf controlled for other key tobacco control policies, including cigarette prices and smoke-free policies, as well as a variety of individual characteristics. In addition to their findings for smoking prevalence, Azagba and Sharaf also find that the GWLs reduced the prevalence of daily smoking, while significantly increasing quit attempts among smokers.

Predicting the changes in behavior in response to a suggested policy is an important step because it estimates the magnitude of the impact of the discussed policy.

Step 5. Monetize Costs and Benefits

Having determined and identified the types of costs and benefits that the program will produce, we now place a dollar value on them. How does CBA measure benefits that are improvements in health and life expectancy?

Some of the most divisive debates surrounding CBA concern the valuation of human life and health—an issue that often arises in regulatory efforts to reduce workplace, toxic, and other risks. Suppose that 2.5 million people are exposed to an environmental pollutant that causes cancer in one of 10,000 people exposed, and thus is expected to cause 250 cases of cancer. Regulations designed to reduce or obviate the risk are likely to impose tangible and easily measured costs on governments, businesses, consumers, and even their intended beneficiaries. But, how can we accurately quantify the value of each life saved as a result of the program?

Currently, there exist three main methods for the assessment of human life: Value of a Statistical Life (VSL), Value of Statistical Life Years (VSLY), and Quality-Adjusted Life Years (QALY). The last method is typically used to compare health procedures in CEA, which compares benefits and costs that occur within the same domain without necessarily assigning monetary valuations. We will focus on the first two.

Value of a Statistical Life (VSL)

VSL assigns a fixed monetary value to every human life in a certain population. It does not seek to estimate the intrinsic value of an individual human life, but is based on people's willingness to pay (WTP) to avoid life-threatening risks. The VSL is based on the value that individuals place on the value of reducing risks to their lives. VSL can be determined through WTP by using:

1. People's stated preferences for how much they would pay to eliminate risks, or
2. People's revealed preferences, analyzing decisions that people have already made about risk trade-offs for, say, workplace risk reductions.

Utilizing both these techniques, the Environmental Protection Agency considered 26 peer-reviewed value-of-life studies from academic literature to arrive at a single VSL of \$9 million for the United States (in 2015 dollars). Note that VSL values can vary by social and economic status, race, population, and country. For example, residents of a developing country, such as India, have a lower WTP and therefore a lower VSL than citizens in highly developed countries, such as the United States. In fact, VSL evaluations conducted around the world range from \$70,000 to \$16.3 million.⁷³ It is important, therefore, to determine the VSL for the given country to help determine the health benefits and/or costs of a particular program.

Value of Statistical Life Years (VSLY)

VSL treats the lives of the very young and very old as equally valuable. Under the VSLY approach, benefits to individuals are assessed based on their estimated remaining years of life. VSLY values are derived from VSLs drawn from age-specific population.⁷⁴ Proponents of this approach note that "in the case of fatalities, a young person loses a much greater amount of lifetime utility than does an older person," and thus assert that it doesn't make sense to use the same value for an elderly person with a remaining five-year life expectancy as for a 25-year-old.⁷⁵ The VSLY approach assumes a decreasing relationship between willingness to pay and age that is proportional to remaining life expectancy. Critics of VSLY term it the "senior death discount."⁷⁶

The FDA calculated the costs and benefits of GWLs as shown in this table.⁷⁷

Benefits	Annualized \$ million
Smokers' Life-Years Saved	465.1
Health Status Improvements	97.8

⁷³ *Retaking Rationality* 45.

⁷⁴ Joseph E. Aldy and W. Kip Viscusi, *Adjusting the Value of Statistical Life of Age and Cohort Effects*, April 2006, RFF DP 06-19.

⁷⁵ Michael J. Moore and W. Kip Viscusi, *The Quantity-Adjusted Value of Life*, 26 *Econ. Inquiry* 269 (1988).

⁷⁶ Cindy Skrzycki, Under Fire, EPA Drops the "Senior Death Discount," *Washington Post* 13 (2003).

⁷⁷ The table reflects a 3% discount rate. See Step 6, below.

Medical Expenditure Reduction	27.7
Other Financial Effects	27.5
Fire Loss Averted	12.4
TOTAL	630.5
Costs	Annualized \$ million
Label Change	19.3
Market Testing	0.1
Point-of-Sale Advertising	3.0
Continuing Admin & Recordkeeping	0.6
FDA	29.2
TOTAL	52.2

Benefits of Reduced Premature Mortality

The FDA explained:⁷⁸

OMB Circular A–4 (Ref. 103) advises that the best means of valuing benefits of reduced fatalities is to measure the affected group’s willingness-to-pay to avoid fatal risks. Three life-year values (also known as values of a statistical life-year, or VSLY) used frequently in the literature and in previous analyses are \$100,000, \$200,000, and \$300,000, which we update to \$106,308, \$212,615, and \$318,923 in 2009 prices. These values constitute our estimates of willingness-to-pay for a year of life preserved in the present. The economic assessment of a future life-year requires discounting its value to make it commensurate with the value of present events. As required by OMB Circular A–4, we use 3-percent and 7-percent discount rates [see below] to calculate the present value of the life-years we predict will be saved.

For each dissuaded smoker, we multiply a VSLY by the relevant age-and gender-specific life extension and then discount appropriately to arrive at a per-person value of reduced mortality. For 24-year-olds, this value ranges from \$9,280 (for a female applying a VSLY of \$106,308 and a 7-percent discount rate to her 2.4 life-years gained due to smoking avoidance) to \$363,333 (for a male applying a VSLY of \$318,923 and a 3-percent discount rate to his 4.4 life-years gained due to smoking avoidance). Multiplying the per-person values by the predicted number of dissuaded smokers and discounting the results back to year 2011 yields estimates of rule-induced mortality benefits that range from \$1.45 to \$22.56 billion.

These totals may understate the full value of rule-induced reductions in mortality because they do not account for increasing trends in life expectancy. Sloan et al.’s results, from which our mortality estimates are derived, are based on data from the late 1990s. Arias (Ref. 136) reports that between 1999 to 2001 and 2006 (the most recent year for which life tables have been developed), life expectancy at age 25 increased from 50.54 to 51.5 years, or 1.90 percent, for males and from 55.41 to 56.1 years, or 1.25 percent, for females. If these percentage changes are approximately correct for the typical smoker and nonsmoking smoker populations, then our estimates of smoking-related life expectancy effects would need to be

⁷⁸ Food and Drug Administration, *Required Warnings for Cigarette Packages and Advertisements, Final Rule* (2011), Federal Register 76(120): 36628–36777.

adjusted upward accordingly (or perhaps by different percentages because life expectancy has continued to change since 2006) to smokers and discounting the results back to year 2011 yields estimates of rule-induced mortality benefits that range from \$1.45 to \$22.56 billion.

Step 6 . Project Costs and Benefits over the Life of the Program

A public policy or program is likely to have an impact on society for some time in the future, and it is important to understand how costs and benefits of the program will change over its lifetime. Not infrequently, a program incurs immediate costs, with benefits coming later after it has been implemented. It is important to choose a period of time that is long enough to capture the majority of costs and benefits associated with the program. The FDA wrote:

Because the main benefits associated with the FDA’s regulation to change cigarette package labels are health related, the majority of the benefits will not come until later in the life of the program. As a result, in the FDA’s CBA, the time period covered was extended to 2031. On the cost side of the equation, the FDA’s regulation will likely increase fixed costs in the short for manufacturers as they adjust to the new regulation.

Step 7. Discount the Costs and Benefits and Compute Their Net Present Value

CBA discounts future costs and benefits to obtain their present value, based on the premise that a dollar received today is worth more to you than a dollar that you will receive a year or 10 years from now.

This, in turn, is based on the premise that since money can earn interest, it is worth more the sooner it is received. The present value of money is the current worth of the sum of money plus the stream of cash flow given a specified rate of return. For example, \$1,000 received today would be worth more than \$1,000 received a year from now, since you can invest it for a year and end up with \$1,000 plus interest. The present value depends entirely on how much interest you could earn, that is, the *discount rate*. Discount rate, rates between 3% and 7%, are common in federal cost-benefit analysis.

The FDA calculated the annual costs and benefits of the regulation under two discount rates:

	3% discount rate	7% discount rate
Costs	\$29.1 million	\$37 million
Benefits	\$630.5 million	\$221.5 million

Having discounted future costs and benefits to represent their present value, the next step is to calculate the net present value to determine whether a program’s benefits outweigh its costs. To do this, we simply sum up the present value of all the benefits that the program is expected to yield and subtract the sum of the present value of all the costs associated with the program. This can be done using the equation below.

$$\text{Net Present Value} = \sum[(\text{Benefits} - \text{Costs}) / (1+r)^t]$$

Net present value (NPV) essentially provides the answer to whether the regulation benefits outweighs its costs, and whether it improves social welfare.

The FDA noted:⁷⁹

The total benefits and costs of the final rule can also be expressed as present values. The midpoint of the estimates for the present value of benefits over 20 years is approximately \$9.4 billion at a 3-percent discount rate and \$2.3 billion at a 7-percent discount rate. The midpoint of the estimates for the present value of costs over 20 years is approximately \$434 million at a 3-percent discount rate and \$392 million at a 7-percent discount rate.

Step 8. Make a Recommendation

Finally, the analyst comes to a decision over the policy recommendation. If the program has a positive NPV, then the policy should be implemented. Conversely, if the program yields a negative NPV, then the program should be revised or rejected. Perhaps even if program has a positive NPV there are political considerations that would militate against implementing it, but that's a question beyond the CBA analysis.

The FDA noted:⁸⁰

The FDA concluded that “with both discount rates, our midpoint estimates indicate that the benefits of the rule greatly exceed the costs. Executive Order 13563, section 1(b), requires that, to the extent permitted by law, agencies proceed with a regulation ‘only upon a reasoned determination that its benefits justify its costs.’ The regulation is consistent with this requirement.”⁸¹

Epilogue

The FDA's warning requirements were later struck down on the ground that they violated the Free Speech Clause of the Constitution by compelling speech from tobacco companies whose advertisements and packaging must carry the warnings.⁸²

⁷⁹ Food and Drug Administration, *Required Warnings for Cigarette Packages and Advertisements, Final Rule* (2011), Federal Register 76(120): 36628–36777.

⁸⁰ *Ibid.*

⁸¹ Cellini and James Edwin Kee also wisely suggest taking the further step of performing a sensitivity analysis to see how results and outcomes would change under different assumptions.

⁸² *R.J. Reynolds Tobacco Co. v. Food and Drug Administration*, 845 F. Supp. 2d 266 (D.D.C. 2012); “R.J. Reynolds,” affirmed by *R.J. Reynolds Tobacco Co. v. Food and Drug Administration*, 696 F.3d 1205 (D.C. Cir. 2012).

The Value and Limits of Cost-Benefit Analysis

Societal policies often impose costs in returns for benefits. If one appreciates the inaccuracies, biases, and limitations of the process then, as Sunstein notes, CBA can provide a “concrete sense of what actually is at stake.”⁸³ But CBA has, at most, a limited role in policy decisions where moral and constitutional principles predominate. Indeed, the court’s decision to strike down the FDA’s label requirement is based on the view that the First Amendment’s freedom of speech trumps whatever benefits the requirements may have bestowed on smokers and the public at large.

Cost-Benefit Analysis with a Tone-deaf Ear

The Benefits of Smoking in the Czech Republic

In 2001, the consulting firm Arthur D. Little released the results of a study commissioned by the cigarette manufacturer, Philip Morris, on the effects of smoking on the Czech economy. Taking into account both the costs and benefits of smoking, the report concluded that by virtue of revenues from taxes on cigarettes and the reduced costs of health care, pensions, and housing subsidies resulting from early mortality, smoking produced a net gain of about \$148 million to the Czech government.⁸⁴

What was wrong with Arthur D. Little’s cost-benefit analysis?

Cost-Benefit Analysis Problem

A high-crime city is concerned about the high rate of recidivism among young men released from prison: historically, about 30% are reincarcerated for violation of parole or for conviction of a new crime within 2 years of release.

The city’s commissioner of corrections is considering funding a new program, run by a nonprofit organization, that provides counseling and job training and placement to these young men upon their release from prison. The commissioner seeks your advice about whether and at what cost per client it should support the organization, and provides you with the following information.

- The city measures the marginal cost of a prisoner in terms of the number of “bed days” that he is in prison.
- It costs the city approximately \$150 per bed day.
- The program counsels new-released prisoners for 1 year. We have data on two cohorts for the several years that the program has been in operation: their average

⁸³ Cass R. Sunstein, *Laws of Fear: Beyond the Precautionary Principle* 174 (2005).

⁸⁴ Gordon Fairclough, "Smoking Can Help Czech Economy, Philip Morris-Little Report Says" Wall Street Journal (16 July 2001) online: <http://www.wsj.com/articles/SB995230746855683470>;

https://en.wikipedia.org/wiki/Public_Finance_Balance_of_Smoking_in_the_Czech_Republic

Gordon Fairclough, *Smoking Can Help Czech Economy, Philip Morris-Little Report Says*. Wall Street Journal, July 16, 2001.

rate of reincarceration 2 years after release has been 15%, or half of the historic average.

What further information about (1) the effectiveness of the program and (2) the program's costs and benefits for various stakeholders do you need to properly advise the commissioner?

With respect to (1) focus questions involving evaluating the program's effectiveness. With respect to (2) begin by identifying all relevant costs and benefits.

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IV – Decision Making Under Risk and Uncertainty

Our new Constitution is now established, and has an appearance that promises permanency; but in this world nothing can be said to be certain, except death and taxes.

—Benjamin Franklin, *letter to Jean-Baptiste Leroy, 1789*

It's tough to make predictions, especially about the future.

—Attributed to Yogi Berra

Referring to Benjamin Franklin's quip, even death has its uncertainties . . . The timing and manner of any individual's death is anything but certain and this fact—especially when combined with uncertainties about taxes—provides a good source of income for insurance companies and estate planners.

Not just estate planners, but anyone trying to make plans based on predictions of future events, must deal with the inevitability that their predictions have some probability—sometimes a very high probability—of being wrong. An understanding of the frameworks for addressing this reality is essential for virtually any endeavor in science and policy making, and useful in making personal and business decisions as well.

LOOKING FORWARD AND BACKWARD

This section examines how people perceive, predict, and deal with probabilities, risks, and uncertainties about *future* events. Though we won't focus on the *past*, it is important to note that uncertainties about past events are key features of the natural and social sciences and that they play a major role in the uncertainty of predictions.

The central issue in looking backward is establishing that one activity or event causes or does not cause a particular outcome. Does smoking cause cancer? Does a vaccination produce immunity against certain diseases and does it cause bad side effects? Does emitting greenhouse gas cause global warming? Scientists acknowledge that there is (almost) always a possibility of being wrong about such conclusions. In many domains, they have established conventions for how small the likelihood of being wrong must be before they assert a causal relationship. In much of the natural science and social science literature, the convention is that one can only conclude that a causal relationship exists if the likelihood of being wrong is 5% or lower.

These backward-looking uncertainties are the subjects of statistics and evaluation—not our topic here. But of course they affect predicting the future (a redundant but sometimes evocative phrase) as well. A prediction that relies on a past finding that may be wrong 5% of the time starts with a handicap, which can be greatly exacerbated by the contingencies of generalizing the past circumstances to future ones.

PROBABILITY, RISK, AND UNCERTAINTY—ISSUES OF TERMINOLOGY

The only unequivocally clear term that we shall be using is *probability*: the likelihood that an event will occur, quantified by some number between 0 and 1, where 0 indicates impossibility and 1 indicates certainty.⁸⁵

Economists use the term *risk* to refer to a specified probability that an event will occur, whether the outcome is a good one (improvement in health) or bad (death by cancer). Economists distinguish risk from *uncertainty* (sometimes called “Knightian uncertainty,” named after the economist Frank Knight), which is the concept of an outcome whose probability cannot be determined. In the psychological literature, uncertainty is called *ambiguity*.

Except for one section of this essay where we discuss people’s aversion to ambiguity (as distinguished from their aversion to risk), we will often use the term “uncertainty,” as it is used in common parlance, to refer to an event with a probability of less than 1, whether or not the probability can be determined.

DETERMINING PROBABILITIES

Frequentist Statistics

There are two fundamental methods for determining probabilities. The first, based on conventional *frequentist* statistics, is to observe how frequently a particular event occurs when a process is repeated many times. For example, to learn how often a die toss produces a 2, roll the die a large number of times. This is the basic way that actuarial statistics are derived—for example, the likelihood of dying in a car accident—and underlies most of the common statistical tests used in the natural and social sciences and medicine. In the belief that you’re familiar with the basic concepts, either from having taken statistics courses (even if they are hazy) or from the popular press, we won’t dwell on them.

Subjectivist and Bayesian Statistics

The probability of a unique event has no meaning under frequentist statistics. Yet individuals in their personal lives, policy makers, and adjudicators must often decide on the likelihood of unique events. For example, a jury must decide whether the particular defendant sitting in the courtroom committed the crime he is accused of beyond a reasonable doubt—a very high degree of probability. Such judgments fall into the realm of *subjectivist* statistics, where the term refers to the decision maker’s *belief* in the likelihood of an event’s occurrence. “Subjective” does not mean that the belief is not well founded. An examination of the die together with your knowledge of physics may lead you to believe that the chances of the die falling on a 2 are 1 in 6; our jurors heard and considered evidence on both sides, which allows

⁸⁵ See <https://en.wikipedia.org/wiki/Probability>.

them to form a reasoned belief about likelihood of the defendant’s committing the crime. (And, to anticipate the following section, jurors are instructed to disregard whatever prior beliefs they brought into the courtroom about the defendant’s guilt or innocence.)

Although it is not possible to systematize the myriad ways in which people come to hold subjective beliefs of this sort, Bayes’ Theorem, named after the Reverend Thomas Bayes, who lived in England in the early 18th century, offers a way of combining one’s prior belief in the likelihood of an event’s occurring with specific data bearing on its occurrence. In some cases, as in the example below, the prior belief may be based on frequentist statistics. We’ll introduce *Bayesian statistics* with a simple problem, initially formulated by Amos Tversky and Daniel Kahneman:⁸⁶

The Taxi Problem (in handout)⁸⁷

A taxicab was involved in a hit-and-run accident at night. Two taxi companies, the Green and the Blue, operate in the city. You are given the following information:

1. 85% of the taxis in the city are Green; 15% are Blue. (The prior belief—in this case based on frequentist statistics about the base rate.)
2. A witness identified the taxi as a Blue taxi. (The specific data.) The court tested her ability to identify taxis under appropriate visibility conditions. When presented with a sample of taxis (half of which were Blue and half of which were Green), the witness made correct identifications in 80% of the cases and erred in 20% of the cases.

What is the probability that the taxi involved in the accident was Blue rather than Green?

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The equation for Bayes’ Theorem is⁸⁸

$$P(H|D) = \frac{P(D|H) P(H)}{P(D)}$$

—where H means Hypothesis (the thing that you’re trying to prove or disprove) and D means Data (the particular evidence bearing on the hypothesis).

⁸⁶ Amos Tversky and Daniel Kahneman, Evidential Impact of Base Rates, in Daniel Kahneman, Paul Slovic, and Amos Tversky, *Judgment Under Uncertainty: Heuristics and Biases* (Cambridge University Press, 1982), 153–163, [ISBN 978-0-521-28414-1](#).

⁸⁷ This problem is borrowed from Brest and Krieger, *Problem Solving, Decision Making, and Professional Judgment* (2010).

⁸⁸ In case you didn’t take a course in probability and statistics, or just don’t remember it, the vertical bar “|” means “given,” so “A|B” means “A given or in the event of B,” and P(A|B) means “the probability of A occurring given that B is known to have occurred.” To use one of my favorite examples, which also illustrates the point that P(A|B) isn’t the same as P(B|A), consider: P(pregnant | female) and P(female | pregnant).

We'll substitute B (Blue) for H (Hypothesis) and SB (witness says "blue") for D (data). So we're solving for the probability that the taxi was actually blue when the witnesses says it was blue.

$$P(B|SB) = \frac{P(SB|B) P(B)}{P(SB)}$$

- The hypothesis is that the taxi was Blue (B).
- The data is that the eyewitness said taxi is Blue (SB).
- P(B) is the prior probability—the likelihood that the taxi involved in the accident was Blue assuming that you have no information other than percentage of Blue taxis in the city, or 0.15. This number is also called the *base rate* of taxis in the city.
- Our goal is to determine P(B|SB)—the likelihood that the taxi was Blue when the eyewitness says it was Blue.
- P(SB|B) is the probability that the eyewitness says that the taxi is Blue when it actually is Blue, or 0.8.
- Now let's calculate the denominator, P(SB)—the total probability that the witness will say that the taxi was Blue. This is somewhat complicated. To compute this, we need to consider how frequently she'll report a taxi as Blue both when it's Blue and when it's Green. Recall that the witness's identification is correct 0.8 of the time and wrong 0.2 of the time, and that 0.15 of the taxis are Blue, and that 0.85 of the taxis are Green.
- What are all the instances in which the witness will say the taxi is Blue?
 - The probability that the taxi is Blue and the witness says it's Blue = $0.15 \times 0.8 = 0.12$.
 - The probability that the taxi is Green and the witness says it's Blue = $0.85 \times 0.2 = 0.17$.
 - Thus, $P(SB) = 0.12 + 0.17 = 0.29$.

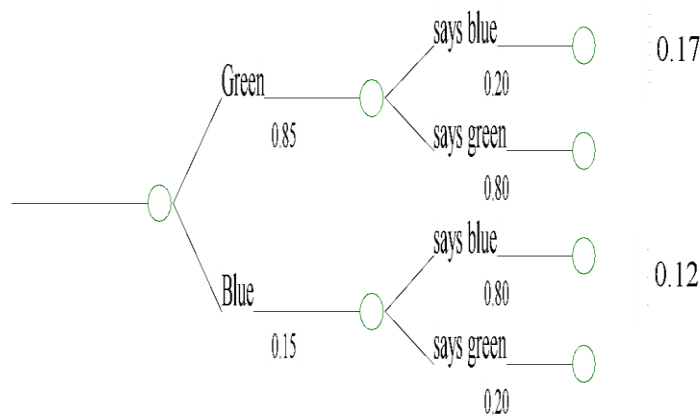
Putting it all together

$$P(B|SB) = \frac{0.8 \times 0.15}{0.29} = 0.41 \text{ or } 41 \text{ percent}$$

You may find the equation for Bayes' Theorem quite unintuitive. Consider an alternative approach using a tree structure of the sort that we'll employ below when we consider decision making under risk. The only axiom of probability that you need to know is the *multiplication rule* for two independent events. Two events are independent if the occurrence of one does not change the probability of the occurrence of the other. That is, A and B are independent if $P(B) = P(B|A)$ and similarly, $P(A) = P(A|B)$. That is, probability of A is the same whether or not we observe B and vice versa. The multiplication rule holds that:

$$P(A \& B) = P(A)P(B)$$

With this in mind, let's solve the taxi problem with a decision tree (see page 51):



The leftmost branches are the base rates for Green and Blue taxis in the city. The second set of branches reflects the witness's 80% accuracy (and 20% inaccuracy) in identifying the color of the particular taxi. Using the multiplication rule, we see that the probability that when she says that the taxi is Blue it actually is Blue is 12%, and the probability that it's actually Green when she says it's Blue is 17%.

$$P(B \ \& \ SB) = P(B) * P(SB|B) = 0.15 * 0.80 = 0.12$$

$$P(G \ \& \ SB) = P(G) * P(SB|G) = 0.85 * 0.20 = 0.17$$

The witness says the taxi was Blue 17+12= 29 out of 100 times, but is correct only 12, or 41%, of those times. Thus, the likelihood that the taxi was actually Blue is only 41%.

Problem: Applying Bayes' Theorem

A U.S. traveler returns from a trip to Bhutan with symptoms common to malaria as well as many other infections: fever, chills, sweating, headache, and fatigue. He tests positive for malaria in a blood test, which has both a true positive and a true negative rate of 0.95—that is, the test only gives an incorrect result 5% of the time. The Centers for Disease Control and Prevention (CDC) report that the estimated relative risk of malaria for U.S. travelers to Bhutan is “very low.”⁸⁹ Interpret this to mean that 10% of travelers who have these symptoms have malaria. The recommended treatment for malaria would be dangerous for this individual's health, but malaria would be even more dangerous. What is the likelihood that the traveler has malaria?

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⁸⁹ See <http://wwwnc.cdc.gov/travel/yellowbook/2016/infectious-diseases-related-to-travel/yellow-fever-malaria-information-by-country/bhutan#seldyfm707>.

EXPECTED UTILITY UNDER RISK

The cost-benefit equation (discussed in the prior section) embodies the concept of expected utility for decision making where the outcome is considered to be certain. But it does not account for situations where there is not 100% certainty, but only some lesser probability of achieving the beneficial outcome. In that case, we multiply the benefit by the likelihood of success—

$$\text{Benefit} \times \text{Likelihood of Success}$$

—to get the *expected utility* or *expected value*.

As we discussed at the beginning of this essay, the *utility* of an outcome is a subjective measure of how useful an outcome would be to a particular individual. For example, the Bernoulli curve suggests that \$100 will mean more to a student whose total wealth is \$10,000 than to a millionaire. By contrast, the *value* of an outcome is just money: \$100 has the same value for both the student and the millionaire, although not the same utility.

The *likelihood of success* is the likelihood that the benefit will actually occur. For example, if you have bet on the die turning up on any particular face, the likelihood of success is 1/6.

The word *expected* reflects the fact that decisions are necessarily made in advance and that they must take into account likelihood of an event occurring. You have to make your bet *before* rolling the die.

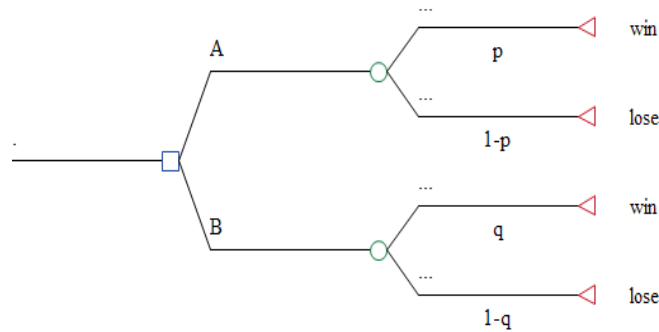
For example, the *expected value* of each of the following is exactly the same (\$100):

1. A certain benefit of \$100.
2. A 50% chance of a benefit of \$200.
3. A 10% chance of a benefit of \$1,000

The concept of expected value does not take into account the diminishing marginal utility of wealth described by the Bernoulli curve (page 16) or (what turns out to be the other side of the coin) the fact that some people may not only prefer the first choice to the others, but may be willing to sacrifice some expected value in order to avoid the risk choices. See page 63.

THE DECISION TREE: A MODEL FOR DECISION MAKING IN CONDITIONS OF RISK

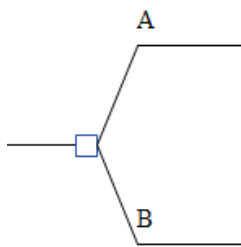
Decision trees provide a simple but powerful model for making choices in conditions of risk. They calculate expected value (just money) rather than subjective utility. Here is an example of two lotteries, A and B, that you might choose between:



- The branches on the left, A and B, represent the possible choice. Their junction is called a *decision node* and is usually indicated by a square; this is a point where a decision maker chooses his or her course of action.
- The second branch points are determined by chance, not by the decision maker, and are usually indicated with a circle as a *chance node*. The probabilities on the branches estimate the likelihood of each possible outcome. An essential feature of a chance node is that the possible outcomes—in our case there are only two, but there could be more—are mutually exclusive and collectively exhaustive (MECE). That is, the chance node includes all possible outcomes, and the sum of the probabilities is 100%.
- Finally, the payoffs are indicated at the right of each branch.

To determine the expected value of a particular choice, say A, multiply each possible outcome by its respective probability and add them. (Recall the multiplication rule in the preceding section on Bayes' Theorem.)

Problem: What is the expected value of lotteries A and B?



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Decision trees are commonly used to help make public policy and business choices in conditions of risk. The basic elements of the decision tree are the same costs and benefits that go into CBA, discussed above—with the added twist that the likelihood of particular assumptions underlying the analysis is a *probability* of less than 1.0, or 100%.

Consider this example, based on the problem confronting President Gerald Ford and his administration in 1976. A few infections stemming from the H1N1 “swine flu” virus had cropped up at Fort Dix, New Jersey. The virus was similar to the one that caused a worldwide epidemic that claimed 20 million lives in 1918–1919. The federal government was considering launching a massive vaccination program.⁹⁰ Let’s suppose that the government had the following options:

1. *Do nothing*. This would be a bet on an epidemic’s not occurring. If an epidemic did occur, however, it would take many months to launch the program from scratch.
2. Order and *stockpile the vaccines* and create the infrastructure for a vaccination program, but delay implementation pending evidence of an influenza outbreak beyond Fort Dix. It takes about 2 weeks for a person to develop immunity after being inoculated, however; so if an epidemic occurred, hundreds of thousands of people might become infected before the vaccines were deployed. (To keep things simple, we will omit this option from the decision tree problem.)
3. Embark on a *national immunization campaign* to immunize the entire population.
4. Embark on a *national immunization campaign* to immunize highly vulnerable people.

The process of identifying the costs and benefits of a vaccination program is the same as that used by the FDA (above) in considering the graphic warning labels. In the case of the vaccination program:

Costs

- *Administering the program*—for example, purchasing vaccines, recruiting and injecting people, administrative expenses. Sufficient vaccine doses would be ordered to serve the entire population, but the costs of administering the vaccine would depend on the number of doses actually administered.
- *Adverse reactions* to the vaccinations, causing loss of work days or death.

Benefits

The benefits are the difference between the status quo—the costs of inaction—and the positive effects of the program. For sake of illustration, the main categories we will consider are:

⁹⁰ The example is inspired by the excellent decision analysis done by Stephen C. Schoenbaum, Barbara J. McNeil, and Joel Kavet, *The Swine-Influenza Decision*, 295 N Engl J Med 759–765 (1976). For teaching purposes, the example takes many liberties with their analysis.

- *Medical expenses avoided*—for example, physicians, hospitals, drugs.
- *Avoidance of lost wages from illness*, or of life earnings if the illness is fatal.

Health experts estimated that there would be over 56 million cases of influenza if an epidemic occurred, with the following consequences. (What we characterize as the “costs” of deaths and illnesses are the costs of the epidemic, not of a program to address it.)

- 48,000 excess deaths (i.e., deaths that would not otherwise have occurred), at an average cost per death (including medical costs and lifetime wages lost) of \$67,819, and total overall cost of \$3,255,311,475.
- 53,200,000 non-fatal illnesses, at an average cost per illness of \$57, with total overall cost of \$3,019,688,525.
- Thus, the total cost of an untreated epidemic would be \$6,275,000,000.

Looking just at the most vulnerable, or high-risk, segment of the population (e.g., persons 65 years old and older), this group, which accounts for 22.5% of the population, would account for half the hospitalizations and 75% of the excess deaths and just under half the costs of the untreated epidemic.

- 36,000 excess deaths (i.e., deaths that would not otherwise have occurred), at an average cost per death (including medical costs and lifetime wages lost) of \$43,478, and total overall cost of \$1,565,200,000.
- 27,000,000 non-fatal illnesses, at an average cost per illness of \$57, with total overall cost of \$1,548,838,950.
- Thus, the total cost for the high-risk population of an untreated epidemic would be \$3,114,038,950.

All things considered—including refusals to be vaccinated and ineffective vaccination—these are the predicted costs and net benefits of the three courses of action:

A. *Do nothing.*

- Implementation Costs: \$0
- Benefits
 - If the epidemic *does not* occur: \$0.
 - If the epidemic occurs: a total negative benefit, or cost,⁹¹ to the United States of \$6.275 billion—the result of 48,000 deaths and 53.2 million illnesses.

B. *Offer to vaccinate everyone in the population.*

- Implementation Costs:⁹² \$271 million
- Benefits
 - If the epidemic does not occur: \$0.

⁹¹ In CBA, “costs” are the costs of taking action, and the costs of inaction are best thought of as negative benefits.

⁹² Administration of the program plus adverse effects.

- If the epidemic *occurs*: \$2.86 billion (improvement over doing nothing) because of 21,840 (of 48,000) deaths avoided and 24 million (of 53 million) illnesses avoided.⁹³
- C. *Offer to vaccinate only high risk residents.*
 - Implementation Costs: \$94 million
 - Benefits
 - If the epidemic *does not* occur: \$0.
 - If the epidemic *occurs*: \$1.4 billion (improvement over doing nothing) because of 16,380 (of 36,000) deaths avoided and 12.3 million (of 27 million) illnesses avoided.⁹⁴

With these numbers in mind, let's construct a decision tree.

- The decision node shows the three choices.
- Each decision is then followed by a chance node, in which the epidemic does or does not occur.
- Each chance node is followed by a dollar *payoff*. The dollar number at the end of each branch is based on the benefit, which happens only if the epidemic occurs, minus the cost of the vaccination program.⁹⁵

There remains the crucial question of the *likelihood of an epidemic*. With only a few cases occurring at Fort Dix, there was no actuarial data available to inform the decision. A group of public health advisors to the government used the so-called Delphi Technique to aggregate the opinions of a number of health experts.⁹⁶ Estimates of the likelihood of the epidemic ranged from 0.02 to 0.40. The advisors used 0.10 as the probability that an epidemic would occur.

The decision tree below compares the expected value of different strategies:

Solving, or "rolling back," the tree shows the value of the alternatives in light of the 10% probability of an epidemic's occurring. There are two ways of representing the data. One is to treat the status quo of doing nothing as having zero costs and zero benefits, and then summing (1) the costs of a vaccination program and (2) the (probabilistic) benefits of a vaccination program, and subtracting the benefits from the costs.

⁹³ Nonetheless, 26,160 would die and 29 million would be ill.

⁹⁴ In this case, 31,620 nonetheless would die (19,620 in the vulnerable population and 12,000 others in the general population) and 40.9 million would be ill (14.7 million vulnerable and 26.2 million others).

⁹⁵ The cost is the same whether or not the epidemic occurs.

⁹⁶ See https://en.wikipedia.org/wiki/Delphi_method.

		probability	cost - i.e., administer vaccine + adverse reactions	benefit - i.e., value of lives saved and illnesses avoided	net benefit - i.e., benefit - cost	value of arm -- i.e., net benefit x probability	Value of branch -- i.e., sum of epidemic and no epidemic
What to do?	Nothing	epidemic occurs	10%	\$0	\$0	\$0	\$0
		no epidemic	90%	\$0	\$0	\$0	
	vaccinate all	epidemic occurs	10%	\$271,320,886	\$2,855,125,000	\$2,583,804,114	\$14,191,614
		no epidemic	90%	\$271,320,886	\$0	(\$271,320,886)	
	vaccinate vulnerable	epidemic occurs	10%	\$94,084,082	\$1,416,887,722	\$1,322,803,640	\$47,604,690
		no epidemic	90%	\$94,084,082	\$0	(\$94,084,082)	

Alternatively, one might treat the status quo as the harm predicted to be caused by an epidemic and calculate the reduction of harm yielded by a vaccination program.

		probability	cost - i.e., administer vaccine + adverse reactions	benefit - i.e., negative value of deaths and illnesses	net benefit - i.e., benefit - cost	value of arm -- i.e., net benefit x probability	Value of branch -- i.e., sum of epidemic and no epidemic
What to do?	Nothing	epidemic occurs	10%	\$0	(\$6,275,000,000)	(\$6,275,000,000)	(\$627,500,000)
		no epidemic	90%	\$0	\$0	\$0	
	vaccinate all	epidemic occurs	10%	\$271,320,886	(\$3,419,875,000)	(\$3,691,195,886)	(\$613,308,386)
		no epidemic	90%	\$271,320,886	\$0	(\$271,320,886)	
	vaccinate vulnerable	epidemic occurs	10%	\$94,084,082	(\$4,858,112,278)	(\$4,952,196,360)	(\$579,895,310)
		no epidemic	90%	\$94,084,082	\$0	(\$94,084,082)	

The former representation is consistent with our approach to the cost-benefit problem in the preceding section; the \$14,191,614 million is the probabilistic benefit in lives saved minus the cost of the program. The latter is consistent with the way that citizens, politicians, and even policy makers might describe the program.

Of course, the result is the same whichever representation one uses. With a 10% chance of an epidemic, doing nothing would cost the nation \$627.5 million from deaths and illnesses, vaccinating the entire population would yield a net benefit of \$14.2 million, and vaccinating only high-risk people would yield a net benefit of \$47 million. The fact that one strategy (in this case, vaccinating the high-risk population) is most cost-effective (i.e., saves the most lives per dollar) does not foreclose another strategy (vaccinating the entire population) that is less cost-effective but protects more people.⁹⁷

⁹⁷ For example, in this case—ignoring the illnesses and considering only deaths—you might decide that while vaccinating the high-risk people only costs about \$5,700 per life saved and vaccinating the whole population costs about \$12,300 per life saved, you would rather save the additional 5,600 lives than take the higher expected return.

For all their value of decision trees in structuring and analyzing problems, you should be aware of their limitations.

- Estimates of the probabilities of the occurrence of events are often based on informed guesswork rather than robust actuarial datasets and therefore come with large margins of error. Coupled with the psychological phenomenon of *anchoring* (discussed below), they may lead one to place more weight on the results than is justified.
- Although placing a value on human lives and health is essential for making some important policy decisions, there is considerable controversy about whether, when, and how to do this. And members of the lay public are likely to be skeptical about the concept or horrified by it.
- Unless the probability of a disaster were vanishingly small, the political fallout from spending a lot of money to mitigate a disaster that did not occur would likely be far smaller than the consequences of inaction if the disaster did in fact occur.

Decision Tree Problem: The Looming Storm

You are advising the mayor of a city that has some low-lying areas near the coast housing about 30,000 residents. The National Weather Service is predicting that a storm will hit the city in 3 days, with these probabilities of death or serious injury for those in the storm's path:

- 50% chance that it will be minor and won't cause any deaths or serious injuries.⁹⁸
- 30% chance that it will be extremely dangerous and that 1,000 residents will be seriously injured or killed.
- 20% chance that it will be catastrophic, and that 5,000 residents will be seriously injured or killed.

Based on the Environmental Protection Agency's current assessment of the "value of a statistical life," the average cost of injury and death per resident will be \$800,000.

The mayor is considering whether to:

- Do nothing, or
- Order evacuation and provide transportation and long-term shelter for the residents. The estimated cost is \$25,000 per person.

Draw a decision tree to represent this problem. The mayor says that she may take other considerations into account, but she asks you to tell her what decision a cost-benefit analysis would suggest.

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⁹⁸ For a description of the standard hurricane categories, see <http://www.nhc.noaa.gov/aboutsshws.php>.

Broader Lessons from the 1976 Swine Flu Vaccination Program⁹⁹

The actual Swine Flu Vaccination Program, on which the preceding example is based, offers some lessons about the intersections of science and policy and the implementation of complicated programs.

In February, 1976, some recruits at Fort Dix, New Jersey, developed influenza-like illnesses later identified by the CDC as caused by a “swine flu” virus (so called because of its prevalence among pigs). This was similar to the virus believed to be responsible for the devastating pandemic of 1918, which killed 500,000 people in the United States alone.

The CDC, the Advisory Committee on Immunization Practices (ACIP) of the United States Public Health Service, and the secretary of the Department of Health Education and Welfare (HEW)¹⁰⁰ weighed several alternative courses of action. As mentioned above, the possibilities essentially included:

1. *Do nothing*. This would be a bet on an epidemic’s not occurring. Most optimistically, it would take many months to launch the program from scratch.
2. Order and *stockpile the vaccines* and create the infrastructure for a vaccination program, but delay implementation pending evidence of an influenza outbreak beyond Fort Dix. It takes about 2 weeks for a person to develop immunity after being inoculated, however; so if an epidemic occurred, hundreds of thousand people might become infected before the vaccines were deployed. (To keep things simple, we will omit this option from the decision tree problem.)
3. Embark on a *national immunization campaign to immunize the entire population*.
4. Embark on a *national immunization campaign to immunize highly vulnerable people*.

Although there were no cases of influenza in the general population and only a few at Fort Dix, the first two options were quickly discarded. It was impossible to estimate the severity of a pandemic if it developed. And if it did, government officials would be responsible if the vaccine doses were sitting on warehouse shelves or, worse yet, if they hadn’t even been ordered. HEW Secretary David Matthews recollected:

As soon as I heard about swine flu and its implications for a pandemic, I realized that the political system would have to respond. . . . We had to assume a probability greater than zero, and that’s all that we needed to know. You can’t face the electorate later and say that the



SOURCE: Gerald R. Ford Presidential Library: B1874-07A. Image in the public domain.

⁹⁹ The following summary of the events is based largely on Arthur Silverstein, *Pure Politics and Impure Science* (1981), and David Sencer and J. Donald Millar, *Reflections on the 1976 Swine Flu Vaccination Program*, 12 *Emerging Infectious Diseases* 1 (January 2006), www.cdc.gov/eid.

¹⁰⁰ HEW was the predecessor of today’s Department of Health and Human Services (HHS).

probability was so low that the costs outweighed its benefits. The people would never forgive us.¹⁰¹

In March, 1976, ACIP recommended launching a massive immunization program to prevent a possible pandemic. The decision carried a particular urgency. The pharmaceutical industry had just finished manufacturing the regular annual vaccine to be used in the 1976–1977 influenza season. At that time, influenza vaccine was produced in fertilized hen’s eggs from special flocks of hens. Roosters used for fertilizing the hens were still available; but if they were slaughtered, as was customary, the industry could not resume production for several months.

David Sencer, director of the CDC, wrote a memorandum to the secretary of HEW urging immediate action to vaccinate all Americans, though acknowledging that “we have not undertaken a health program of this scope and intensity before in our history. There are no precedents, nor mechanisms in place that are suited to an endeavor of this magnitude.”

Who should announce this unprecedented campaign? Some thought that, in light of the uncertainties involved, it should be the secretary of HEW, or even a lower level official. But President Ford wanted to lend the weight of his office to the program. Late in March 1976, joined by the polio vaccine pioneers, Albert Sabin and Jonas Salk, the president announced the creation of a National Influenza Immunization Program (NIIP) within the CDC, with the goal of immunizing “every man, woman, and child.” The press soon wondered whether the president’s motivations were entirely public-regarding; he was in a tight Republican primary race with Ronald Regan and had been defeated in North Carolina just the day before.

Congress soon authorized the expenditure of \$137 million for the NIIP, which the press mischaracterized as \$1.9 billion because the program was included in a larger authorization package.

The government ordered large-scale production of the swine flu vaccine. The process encountered several setbacks, which led to the production of fewer doses of the vaccine over a longer period than expected. Field trials of the vaccine indicated that it was highly effective, with few side effects, in older adults (who may have been exposed to similar viruses earlier in their lives). It was less effective in younger adults. And it required two doses, with excessive side effects, in children 3–10 years old.

Before the manufacturers were willing to deliver the vaccines, they demanded that the federal government indemnify them against claims from adverse reactions. Although congressional lawmakers believed this to be considerable overreaching, Congress eventually acquiesced—though by this time implementation of the program was delayed for several months. The congressional decision was influenced in part by the deaths of a number of attendees at an American Legion convention in Philadelphia, initially attributed to the flu virus, but later diagnosed as an infection from bacteria in the hotel’s water system, soon named “Legionnaires Disease.”

The delays seriously compromised state health organizations ability to mobilize to deliver the shots. During the same time, with nonappearance of cases of swine flu, public

¹⁰¹ The prediction that “the people would never forgive us” seems very plausible in light of the phenomenon of hindsight bias, discussed at page 75.

support for the vaccination program eroded. Even Dr. Sabin, who had stood by the president's side when the program was announced, now suggested that the government should stockpile the vaccine but hold off administering it until there were signs of the flu among the population. By October, only 53% of Americans intended to get vaccinated. Nonetheless, by mid-December, the NIIP had immunized 45 million people, nearly a quarter of the eligible population, and doubling the level of immunization for persons deemed to be at high risk.

Then, in October, three elderly people in Pittsburgh died of heart attacks immediately after receiving swine flu vaccinations at the same clinic. The NIIP might have survived what the health experts regarded as pure coincidences, but it did not survive the occurrences of Guillain-Barré syndrome (GBS)¹⁰² that soon followed among people receiving vaccinations. Although there were many possible reasons for GBS, some respected epidemiologists believed that there was a statistically significant relationship between the vaccine and cases of GBS. Needless to say, the connections were highlighted by the press.

In December 1976, the government placed a moratorium on further vaccinations until the relationship with GBS could be explored. The NIIP was never revived, though immunization was reinstated for some high-risk populations.

A *New York Times* op-ed article, published after announcement of the moratorium, attributed the NIIP to "political expediency" and "the self-interest of government health bureaucracy." The article suggested that the NIIP had been a political ploy by the CDC to "increase the size of its empire and multiply its budget." Articles in a major medical journal referred to the program's proponents as "panic mongers." And President Ford was accused of using the program as a way to sway a close primary race against Ronald Reagan.

Nonetheless, the NIIP had been supported by a broad array of health experts and by a carefully done epidemiological cost-benefit study.¹⁰³ Assuming that the program was at least well intentioned, what went wrong? In reflecting on the events, David Sencer, the director of the CDC and J. Donald Millar, director of the NIIP, suggested:

- The press's mischaracterization of the program's \$137 million cost as \$1.9 billion remained in the public's minds.
- The announcement of the NIIP at a presidential press conference together with photographs of President Ford being vaccinated fueled suspicions that the program was politically motivated rather than a public health response to a possible catastrophe.
- The announcement by the president also made it difficult to modify or stop the program when problems later developed.

¹⁰² Guillain-Barré syndrome "is a rapid-onset muscle weakness as a result of damage to the peripheral nervous system. Many experience changes in sensation or develop pain, followed by muscle weakness beginning in the feet and hands. The symptoms develop over half a day to two weeks. During the acute phase, the disorder can be life-threatening with about a quarter developing weakness of the breathing muscles and requiring mechanical ventilation." https://en.wikipedia.org/wiki/Guillain%E2%80%93Barr%C3%A9_syndrome.

¹⁰³ S.C. Schoenbaum, B.J. McNeil, and J. Kavat, *The swine-influenza decision*, 295 *N Engl J Med.* 759–765 (1976).

- The fact that subsequent announcements about the program were made by officials of HEW rather than the CDC or other health agencies supported the idea that the program was politically motivated.
- The government's willingness to indemnify the vaccine manufacturers was interpreted as an admission that the vaccine could cause harm.
- The vividness of the (albeit few) cases of Guillain-Barré syndrome among people receiving the vaccine,¹⁰⁴ coupled with the fact that no cases of the dreaded influenza occurred, made it appear that the vaccine was doing far more harm than good.

In *Pure Politics and Impure Science*, Arthur Silverstein, an immunologist, makes observations both about the intersection of science and politics and the challenges of implementing a complex program. With respect to the former, he writes:¹⁰⁵

The swine flu affair brings into sharp focus the curious relationship that exists between scientific advisors and the government they serve. The layman (and the politician) somehow persist in their belief that Science deals in absolute and immutable truths, and consequently they are repeatedly frustrated when scientists testify on all sides of important national issues like energy, the safety of nuclear plants, safeguarding the environment, or the integrity of the ozone layer above the earth. When the public and the politician expect clear pronouncements from a scientific monolith, they often find reputable scientists differing not only on the solutions to problems but even on whether the problem exists. Does saccharine cause cancer? Can we and should we spend \$10 to \$20 billion to put a man on the moon? Should we concentrate our present efforts on solar energy, or on nuclear fusion, to solve the energy problem. "Science" cannot provide definitive answers to most of these questions; at best it can only provide the best information it has at the time, even if it is uncertain and conflicting. In our society, it is ultimately the politician who must decide on these matters, and woe betide the politician who neglects political realities: the perceived needs of the society, the concerns and claim or his constituents, the economic and political costs of the various solutions, and the relative value of other desirable programs within the limitations of a finite budget.¹⁰⁶

On the broader issue, Silverstein writes:

A review of the events from March to December of 1976 suggests that those responsible for the implementation of the National Influenza Immunization Program were guilty of extreme over optimism at best and of unfortunate naiveté at worst. In order to achieve the goals originally set by the Advisory Committee on Immunization Practices and by the CDC and declared in somewhat expanded form by President Ford, *everything* had to work perfectly and with clockwork precision. . . .

[In fact,] almost everything that *could* go wrong *did* go wrong; but . . . few of the problems could have been precisely predicted beforehand. This fact, however, does not

¹⁰⁴ There are obvious parallels with the recent movement linking conventional childhood vaccines with autism against all epidemiological evidence.

¹⁰⁵ Silverstein, Arthur. *Pure Politics / Impure Science*. P. 136. © The Johns Hopkins University Press. Reprinted with permission of Johns Hopkins University Press.

¹⁰⁶ Silverstein, *supra*, at 136-137. © The Johns Hopkins University Press. Reprinted with permission of Johns Hopkins University Press.

exculpate the program's managers. It only serves to point out the inherent defect of planning a program based upon optimistic "best-case" rather than upon pessimistic "worst-case" estimates. What is probably required in such ventures is an approach that involves hoping for the best, but preparing for the worst.

From the earliest stages of the program, and throughout its existence, the planners would have benefited immeasurably by having a group of knowledgeable and practical people do little more than to explore the possible workings of Murphy's law on the swine flu program. *What if* the yield per egg is less than two doses of vaccine? *What if* the field trials show that a single dose of vaccine is less effective than predicted, or that children . . . do not respond to the vaccine with adequate immunity, or *what if* vaccine side effects prove to be more severe than expected. *What if* the improbable occurs, and a few people drop dead of heart attacks in the immunization lines? *What if* swine flu comes prematurely, before the populace has been immunized? *What more should we do* to help the mass media educate the public, and to help defuse negative influences on the program?

And, finally, questions should continually have been asked in the form, *What are the implications for the program* of . . .? In April and May of 1976, someone knowledgeable should have asked what were the implications for the program of the increasing rumblings about insurance liability emanating from the vaccine manufacturers and later from the insurance industry. In June, the same questions should have been seriously asked about children's shots and about the defection of Dr. Sabin . . . to the ranks of those who advocated stockpiling the vaccine and holding off on the immunization program. In August, someone should have examined the implications of the serious production lags that had resulted from the delayed settlement of the insurance liability controversy.

In *The Day After an AIDS Vaccine is Discovered: Management Matters*, Martin Levin draws on the 1976 Swine Flu Vaccination Program to speculate about why the discovery of an effective AIDS vaccine would not likely lead to a quick decrease in HIV/AIDS-related illnesses and deaths.

The subtitle of Levin's article, "Management Matters," emphasizes the point that the implementation of a program is not a mechanical process, but rather "a process of policy making through learning by doing," which "occurs in the field through a process of iteration, adaptation, and ex post facto error corrections." Referring to the Swine Flu Vaccination Program, Levin writes:

The management problems and delays will result from many serious conflicts: scientific controversy over the vaccine's effectiveness and safety; threats of lawsuits over side effects and demands of manufacturers calling for indemnification from them; professional and institutional timidity among health care providers; media sensationalization of rare cases. All these conflicts will discourage the public from embracing the vaccination program. A lack of leadership is likely because this is all so controversial, and because formal authority is so fragmented in the health care field. But even with the best of leadership, any vaccine program will find its implementation and management difficult because it will face a complex situation filled with booby traps . . .

The preceding discussion has focused on identifying the ways that implementation of strategies or programs can go wrong, with the goal of anticipating and working around the problems. But especially in complex environments and interdependent systems, more things

can go wrong than one can identify. Addressing failures in these situations may call for resilience, which Judith Rodin, in her book, *The Resilience Dividend: Being Strong in a World Where Things Go Wrong*, defines as “the capacity of any entity . . . to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience.”¹⁰⁷

Although much of her book focuses on resilience to earthquakes, floods, and similar natural disasters, one of Dr. Rodin’s examples is drawn from the CDC’s dealing with a later and actual global swine flu epidemic, in 2009–2010.¹⁰⁸

Fortunately, the CDC already had a structure in place that enabled it to rapidly distribute the H1N1 vaccine throughout the United States. They repurposed the Vaccines for Children Program, originally developed to provide vaccines at no cost to kids who might not get vaccinated because their families did not have the ability to pay. The program was already reaching approximately 40,000 clinicians, and, in just a few weeks, the CDC was able to scale it up to more than 80,000 clinicians. The CDC was thus able to provide the flu vaccines to any doctor who requested them within that system and ended up making more than 300,000 deliveries . . .

By repurposing a program that is already in place, you avoid the problems, inefficiencies, and confusion that arise when people are asked to follow an emergency plan that is unfamiliar and possibly untested . . .

But to scale up a system, and for any response to be effective . . . the existing infrastructure has to be robust, diverse, and have the capacity to be scaled. For the health and well-being infrastructure, that means including entities beyond hospitals and ambulances and their transportation and communications systems in the process. You have to make sure that the infrastructure for water supply management and protection, sanitation quality management, and medical surge capacity are in place.

ATTITUDES TOWARD RISK

Recall the problem on page 52, where we asked you to compute the expected value of two lotteries. Lottery A has an expected value of \$200 and Lottery B has an expected value of \$54. If your decision were based solely on expected value, there’s no question about which one to choose. But which one would you actually choose? Here we return to the concept of expected utility, which takes account of people’s different risk tolerances.

Suppose that three different people are offered a choice between (1) a certain sum of money and (2) a 50% chance to win \$100 (and a 50% chance to win nothing):¹⁰⁹

- If Natalie is indifferent between a certain \$50 and a 50% chance to win \$100, both of which have an expected value of \$50, she is risk-neutral.

¹⁰⁷ Judith Rodin, *The Resilience Dividend: Being Strong in a World Where Things Go Wrong* (2014), 3. See also Karl Weick and Kathleen Sutcliffe, *Managing the Unexpected: Assuring High Performance in an Age of Complexity* (1981).

¹⁰⁸ Rodin at 127–128.

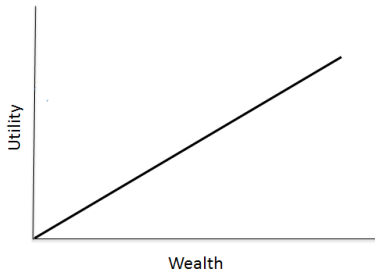
¹⁰⁹ The following example draws heavily on https://en.wikipedia.org/wiki/Risk_aversion.

- If Avery would accept a certain payment of less than \$50 (e.g., \$40) rather than taking the bet, he is risk averse. Avery is willing to sacrifice some expected value—called the “risk premium”—to avoid the risk.
- If Shirley would accept the bet even when the guaranteed payment is more than \$50 (for example, \$60), she is risk seeking—and willing to sacrifice some expected value for the gamble.

As it turns out, risk aversion is the other side of the coin of the declining marginal utility of wealth. Let’s first consider Natalie, who is not risk averse. For Natalie, every dollar gained provides another unit of utility.

Amount	Total Utility
\$0	0
\$40	4
\$50	5
\$100	10

Her utility function can be graphed as a straight line:

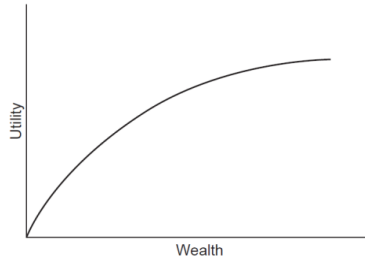


For Natalie, a 50% chance of winning \$100 has the same utility (5 utils) as a certain \$50.

Now let’s look at Avery, whose utility function exhibits declining marginal utility. While Natalie’s \$50 gain gave her 5 utils, Avery’s gain of \$50 gives her only 4.

Amount	Total Utility
\$0	0
\$40	3.5
\$50	4
\$100	6

Avery’s utility function follows Bernoulli’s famous curve (discussed above on bhuta 15).



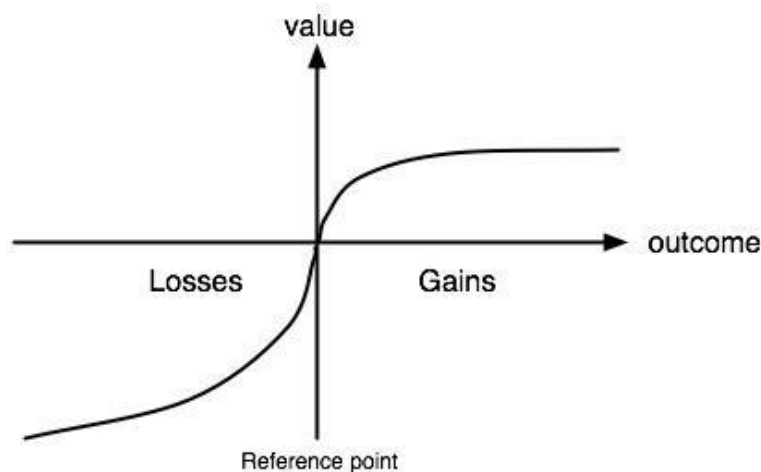
So given a choice between a certain \$50 (4 utils) and a 50% chance of \$100 (3 utils), Avery chooses the former. That's risk aversion.

We'll return to risk-seeking Shirley in the discussion of prospect theory immediately below.

Risk Attitudes and Prospect Theory

Kahneman and Tversky Epidemic Problem (handout)

Many of us are risk-averse much of the time. But in what may be their most important contribution to the psychology of judgment and decision making, Amos Tversky and Daniel Kahneman observed that people's risk attitudes may depend on how choices are *framed*. This tendency, termed *prospect theory*, is reflected in the following graph.¹¹⁰



The curve on the upper right of the reference point is shaped like Bernoulli's curve, reflecting risk aversion. But the curve on the lower left reverses direction and signals risk seeking. Just as the downward convexity of the curve in the domain of gains represents risk aversion, the upward convexity of the curve in the domain of losses reflects risk seeking.

¹¹⁰ See https://en.wikipedia.org/wiki/Prospect_theory#/media/File:Valuefun.jpg.

The two central insights of prospect theory are the phenomena of the “endowment effect” and “loss aversion.” The endowment effect is that people ascribe more value to an item that they own than the same item if they do not own it. In one classic experiment, participants who were given Swiss chocolate bars were unwilling to trade them for coffee mugs (of approximately the same retail value), while participants who were given coffee mugs were unwilling to trade them for Swiss chocolate bars.¹¹¹ The phenomenon extends to intangible goods as well, for example, the valuation of environmental goods in Korobkin’s study described above.

One major explanation for the endowment effect is that humans are loss averse, and that giving up an item that you own feels like a loss. The phenomenon of loss aversion is reflected in the fact that the “losses” curve in the prospect theory graph goes down more steeply from the origin than the “gains” curve goes up. That is, a loss of a particular amount feels worse than a gain of the same value feels good. The phenomenon is captured in the phrase “losses loom larger than gains.”

Kahneman and Tversky demonstrated the phenomenon of risk aversion in the domain of gains and risk seeking in the domain of losses with the following experiment. All participants were given this problem.¹¹²

Imagine that the United States is preparing for the outbreak of a rare virus, which is expected to hit the United States next year and projected to kill 6,000 people. Two alternative programs to combat the disease have been proposed by the Department of Health and Human Services.

One group was told that the exact scientific estimates of the consequences of the two treatment programs are as follows:

- If program A is adopted, 2,000 people will be saved.
- If program B is adopted, there is a one-third probability that 6,000 people will be saved and a two-third probability that no people will be saved.

The other group was told that the exact scientific estimates of the consequences of the two treatment programs are as follows:

- If program C is adopted, 4,000 people will die.
- If program D is adopted, there is a one-third probability that nobody will die and a two-thirds probability that 6,000 people will die.

While the problem for the first group was framed in terms of gains, the same information was framed for the second group in terms of loss. Choices A and C are identical and certain. Choices B and D are also identical, but present uncertain outcomes. Participants in

¹¹¹ Jack L. Knetsch, *The endowment effect and evidence of nonreversible indifference curves*, 79 *American Economic Review* 1277–1284 (1989).

¹¹² Amos Tversky and Daniel Kahneman, *The Framing of Decisions and the Psychology of Choice*. *Science* (1981).

both groups were asked which program they would choose. The large majority in the first (framed) group made the risk-averse choice, A, while the large majority in the second (loss-framed) group made the risk-seeking choice, D.

Note that this behavior violates the expected utility theory axiom of invariance, described above. Note also that it only takes a change in how the decision is framed to invert Bernoulli's curve and change risk-averse Avery to risk-seeking Shirley.

The basic findings of prospect theory have been replicated in many other experiments and observed in the real world. For example, in litigation, plaintiffs (who are focused on the prospect of a favorable outcome as a gain) tend to be risk averse and are therefore prone to settle, while defendants (who are focused on the prospect of a loss) tend to be risk seeking and are prone to litigate.¹¹³

Against Ebola Foundation Problem

The Against Ebola Foundation wishes to make grants to address a new version of the pandemic-causing virus. In addition to being highly contagious the virus has the unfortunate quality of mutating quickly, rather like flu viruses, so that in the (unlikely) event that a vaccine were developed against next year's version, it would not be effective the following year.

The foundation is willing to spend its entire next year's grants budget of \$10 million on either or both of the following projects. You are asked to advise the foundation's board on what decision to make among these (and only these) possibilities. For purposes of the problem, accept the facts and numbers given, even if you have reason to question them.

1. For a cost of \$50 per unit, the foundation can support the manufacture and distribution of protective suits to be worn by the relatives caring for an Ebola patient in their home. The foundation estimates that one in every four units will be effectively used to prevent an infection. The foundation's \$10 million investment would support the distribution of 200,000 protective suits, preventing 50,000 cases of infection (= \$200 per infection prevented). The suits cannot be reused next year.
2. For a cost of \$10 million, the foundation could support researchers developing a vaccine against Ebola. If the vaccine is successful, it could save an estimated 1 million people from contracting Ebola (= \$10 per infection prevented) during the year it was effective. But there is only a 10% of success (\$100 per probable infection prevented) and, of course, a 90% chance of not achieving anything. Moreover, the nature of the development work is such that knowledge gained in trying to develop next year's vaccine will not be useful for the development of future vaccines. A reduction in the \$10 million investment in the vaccine will lead to a proportionate decrease in the potential number of lives saved.

¹¹³ Chris Guthrie, *Prospect Theory, Risk, Preference, and the Law*, 97 Nw. U.L. Rev. 1115 (2003); Jeffrey Rachlinski, *Gains, Losses and the Psychology of Litigation*, 70 So. Cal. L. Rev. 113 (1996); Guthrie, *Prospect Theory*, supra; Russell Korobkin and Chris Guthrie, *Psychology, Economics, and Settlement: A New Look at the Role of the Lawyer*, 76 Texas L. Rev. 77 (1997). The risk attitudes are reversed in the case of very low probability gains and losses. Chris Guthrie, *Framing Frivolous Litigation: A Psychological Theory*, 67 University of Chicago Law Review 163 (2000).

A. If you had to choose **either** 1 or 2, which one would you choose

1 or 2 _____

B. The foundation could apportion its grants budget between the protective suits and the vaccine. Assume that a lower grant for the vaccine reduces the likelihood of success proportionately, for example, a \$5 million grant reduces the probability of success to 5%.

If you could **apportion** the \$10 million between 1 and 2, would you do so and what allocation would you recommend.

If yes: \$ for 1 ____ \$ for 2 ____
====

ClimateWorks Problem (Appendix)

THE LIMITS OF EXPECTED UTILITY ANALYSIS: UNCERTAINTY, OR AMBIGUITY, AND VIOLATIONS OF THE AXIOM OF CONTINUITY

Expected utility analysis requires the specification of probabilities, but policy makers confront many real-world situations in which this is not possible, or where the margins of error are so large as to make the specification illusory. These are termed conditions of *uncertainty* or *ambiguity* rather than risk.

Earlier in this section, we discussed the phenomenon of risk aversion. People are also quite averse to having to make decisions in conditions of uncertainty or ambiguity, if only because of the anxiety occasioned by having no idea about the extent of the risk. Doubtless, this aversion contributes to anxiety about terrorism.¹¹⁴

Many catastrophic scenarios—ranging from the consequences of climate change to the possibility of a high-energy particle accelerator or nanotechnology destroying life on earth—arguably fit this description. Some commentators argue that, such cases should be governed by the principle of *maximin*, which counsels choosing the policy with the best worst-case outcome, or by the “precautionary principle.” Cass Sunstein¹¹⁵ and Richard Posner¹¹⁶ disagree, arguing that the conventional tools of expected utility analysis are adequate to the task. My own view is that the best one can do in conditions of uncertainty or ambiguity is to adopt an *expected return attitude*, taking into account one’s best-informed guess about probabilities as well as

¹¹⁴ Robin Hogarth and Howard Kunreuther, *Decision Making Under Uncertainty: The Effects of Role and Ambiguity*, in *Decision Making and Leadership* 189 (Frank Heller, ed., New York: Cambridge University Press, 1992).

¹¹⁵ Sunstein, *Worst Case Scenarios* (2007); Sunstein, *Laws of Fear* (2005).

¹¹⁶ Richard Posner, *Catastrophe: Risk and Response* (2005).

specifiable costs and benefits—while acknowledging the limits of intuitive judgment discussed in the following section.

Even when the risk of catastrophe can be quantified, people may violate the *continuity* axiom of expected utility theory, which posits that if there are three lotteries (A, B, and C) and you prefer A to B and B to C, then there must be a possible combination of A and C in which you would be indifferent between this mix and the lottery B. This means that there is *some* probability such that the decision maker is indifferent between the “best” and the “worst” outcome. But, consider this hypothetical involving these three possible outcomes. In B you have a full rich life; in A, you have a full rich life—plus an extra dollar of income; in C you have a life of excruciating pain and misery. Is there any probability p such that you would be indifferent between the prospect of either A with a probability p or C with a probability $1-p$?¹¹⁷

¹¹⁷ Larry S. Temkin, *Weighing Goods: Some Questions and Comments*, 23 *Phil. & Public Affairs* 350 (1994).

V – The Intuitive Empiricist’s Perspective and Errors

Frequentist and Bayesian statistics offer methods for estimating probabilities. But in everyday life, people usually do not have the time, cognitive power, data, or inclination to use these formal methods, and instead rely on intuitions, mental shortcuts, and heuristics. These nearly automatic judgments are prone to systematic errors, or biases. The study of these errors is a central agenda of the psychology of judgment and decision making (JDM), pioneered by Amos Tversky and Daniel Kahneman.¹¹⁸ These errors are relevant to the preceding section because they can distort people’s estimations of risks. More broadly, they bear on all of the issues of this paper—and then some—because they lead people to make erroneous empirical judgments about all sorts of important matters.

Before discussing a few specific phenomena, it is useful to mention the two systems’ framework developed by these two pioneers in the psychology of judgment and decision making and their colleagues.¹¹⁹

System 1 (Intuitive)	System 2 (Reflective)
Process Characteristics	
Automatic	Controlled
Effortless	Effortful
Associative	Deductive
Rapid, parallel	Slow, serial
Process opaque	Self-aware
Skilled action	Rule application
Content on Which Processes Act	
Affective	Neutral
Causal propensities	Statistics
Concrete, specific	Abstract
Prototypes	Sets

What they termed System 1 is unconscious, intuitive, and rapid. Like a giraffe being pursued by a tiger, you don’t have to engage in deep thought when you are assailed by a person with a knife or by a car barreling down the street. Guessing a person’s emotional state from a facial expression or body language, or indeed, recognizing a particular person at all, is a paradigmatically System 1 task. By contrast, System 2 is conscious, cognitive, effortful, and slow. Numerical calculations are paradigmatic.

As smart as we are, humans lack the brainpower to apply System 2 processes to moment-to-moment decisions. Nonetheless, System 1 generally gets us through our daily lives pretty well, and is often corrected by System 2 when necessary—but sometimes not, which is the subject of this section.

¹¹⁸ See, e.g., *Heuristics and Biases: The Psychology of Intuitive Judgment* (2002).

¹¹⁹ Daniel Kahneman and Shane Frederick, Representativeness Revisited: Attribute Substitution in Intuitive Judgment, in *Heuristics and Biases: The Psychology of Intuitive Judgment*, supra, at 49. For a highly accessible discussion of the concept and particular phenomena, see Daniel Kahneman, *Thinking Fast and Slow*.

Problem: Bat and Ball

Write down your answer in 5 seconds.

Together, a bat and a ball cost \$1.10. The bat costs a dollar more than the ball.
How much does the ball cost?
If you got the answer wrong, how does this relate to the two systems?

$01.1\$ = (1\$) 50.0\$ + (1\$) 50.1\$$
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THE AVAILABILITY HEURISTIC

The availability heuristic is a mental shortcut that estimates the likelihood of events by how *many* quickly come to mind or how *easily* they come to mind. While the heuristic is often helpful, it can result in erroneous, even illogical estimates. For example, people asked whether there are more words in the English language ending in “n” or “ing” tend to select the latter, even though it is a subset of the former. It is easier to think of words ending in “ing” and you can come up with more examples of such words in a given period of time.¹²⁰

Availability Problem (in handout)

In another little experiment, people were able to identify more “dairy foods” than “white foods” in a supermarket. And when asked whether a long list of names contained more women’s or men’s names, people responded that the list contained more men when some of the men on the list were especially well known, and more women when some of the women were better known.¹²¹

People tend to use the ease, or fluency, of thinking about items as a heuristic for determining how many such items there are. For example, a UCLA professor asked a randomly selected half of the class to suggest 2 ways to improve his course, and the other half to suggest 10 ways. Students presented with the latter question struggled to think of more ideas for improvement and thus rated the course more highly than students who were only asked to think of two improvements; the students with the tougher task misinterpreted difficulty in recalling improvements to mean that the class needed fewer improvements in general.¹²²

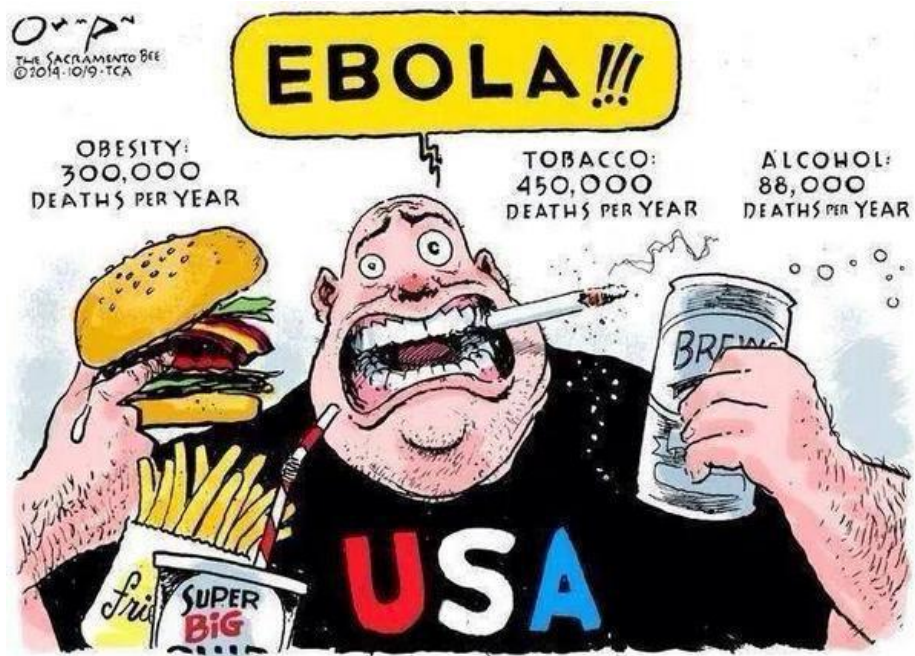
Vividness

¹²⁰ Amos Tversky and Daniel Kahneman, *Judgment under uncertainty: Heuristics and biases*, 185 Science 4157: 1124–1131 (1974).

¹²¹ Sunstein, *Worst Case Scenarios* 54 (2007).

¹²² Jamie Madigan, *The Availability Heuristic Is Always On*, Psychology Today (April 15, 2013), <https://www.psychologytoday.com/blog/mind-games/201304/the-availability-heuristic-is-always>.

Events are often particularly easy to recall if they are vivid and have emotional salience. For instance, watching a house burn will create a far greater impact on someone than reading about it in the news.¹²³



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Detailed descriptions or emotionally gripping imagery associated with an event, like a news report detailing someone's horrible injuries in a car accident, are more available to memory than (inevitably) pallid statistics. If you or someone you know is involved in an event, or if you were a witness, *emotional interest* may make it easier to recall. In general, there is a strong correlation between media coverage and errors in estimation of risk.

A study by Paul Slovic found that people overestimate rare causes of death and underestimate common causes. Participants believed that accidents caused as many deaths as did diseases, even though disease claims around 15 times as many lives. Similarly, homicides were judged to be as frequent as stroke, even though stroke causes many more deaths. Other highly publicized or salient yet rare causes of death like botulism and tornadoes were also hugely overestimated.¹²⁴

The availability of vivid events contributes to what Cass Sunstein has termed "probability neglect." In one experiment Sunstein examined the effect of salient descriptions on people's willingness to pay (WTP) to reduce slight arsenic levels in water.¹²⁵ One group of participants was told that the risk of cancer due to arsenic was 1 in 1,000,000 while another

¹²³ Sunstein, *Laws of Fear* 37. The following cartoon, Voices: Jack Ohman: *Americans' Concern Over Ebola* is reprinted with permission from the *Sacramento Bee*.

¹²⁴ Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein, Rating the Risks, in Paul Slovic, *The Perception of Risk* 105 (London: Earthscan Publications, 2000).

¹²⁵ Cass Sunstein, *Laws of Fear* 78 (Cambridge, United Kingdom: Cambridge University Press, 2005).

group was told it was 1 in 100,000. Each group was subdivided, with some participants asked their WTP to reduce the risk without having heard any description of the cancer, while others were presented with a description in which the disease was described as “very gruesome and intensely painful, as the cancer eats away at the internal organs of the body.” Here are the results:

Probability	Unemotional description (mean WTP)	Emotional description (mean WTP)
1/1,000,000	\$71.25	\$132.95
1/100,000	\$194.44	\$241.30

The experiment has several outcomes worth noting:

- A 10-fold increase in the probability of getting cancer resulted in an increase in WTP, but nowhere near 10 times
- The emotional description of cancer significantly increased the WTP for both the higher and lower risk of getting cancer.
- The percentage increase in WTP for the greater risk of getting cancer was much greater for participants presented with unemotional than the emotional description.¹²⁶

Sunstein’s major point is that “the effect of merely making the description of the outcome more emotional was about half as large as a tenfold increase in the actual risk. . . .” [W]hen the question was designed to trigger especially strong emotions, variations in probability had little effect on WTP”—this is phenomenon of probability neglect.

Dan Kahan writes that the “ready availability of mishaps such as the Chernobyl nuclear accident, the 911 attack, and the Columbine school-shooting massacre, for example, are thought to explain why members of the public tend to overestimate the risks of nuclear power generation, of terrorist attacks, of accidental handgun shootings and the like, particularly in relation to less dramatic hazards.”¹²⁷ In contrast, Americans tend to underestimate risks of climate change because no profound events have taken place to make an indelible mark on the public.¹²⁸ In fact, people are more likely to fear the depletion of the ozone layer rather than climate change because the image of a hole in a protective atmospheric shield, as well as the risks of skin cancer, are more vivid to the public.¹²⁹

¹²⁶ In reading the manuscript, Richard Revesz notes that while the percentage increase is much greater, the absolute increase in risk was moderate—194.44 minus 71.25 compared to 241.30 minus 132.95.

¹²⁷ Dan M. Kahan, Cultural Cognition as a Conception of the Cultural Theory of Risk, in *Handbook of Risk Theory: Epistemology, Decision Theory, Ethics and Social Implications of Risk* 725–760 (Springer London, Limited, R. Hillerbrand, P. Sandin, S. Roeser, and M. Peterson, eds., 2012), p. 30 [hereafter, Cultural Cognition].

¹²⁸ Sunstein, *Worst Case Scenarios*, supra, at 60.

¹²⁹ Id. at 278–279.

ANCHORING AND INSUFFICIENT ADJUSTMENT

Though not as relevant to estimating probabilities as the availability heuristic, it's worth saying a word about a close cousin of availability—the phenomenon of *anchoring* and insufficient adjustment.

Anchoring and adjustment is often an effective way to estimate something when you do not have complete information on a subject. Suppose that you're trying to estimate what year Martin Luther King was assassinated. You know that he was a leader in the civil rights movement and you recall the date in the name of the Civil Rights Act of 1964. Believing that Dr. King lived beyond the date of its enactment but not much longer, you adjust upward, perhaps coming close to the actual date of 1968.

However, the anchoring phenomenon can lead to comedic misestimations. When participants were asked, "Is the population of Chicago greater or less than 200,000?" (thus anchoring them on this very low number) and then asked, "What is the actual population of Chicago?" the average estimate was 600,000; when asked if the population was greater or less than 5 million, the average answer was 5,050,000.¹³⁰ (The actual population is about 3 million.)

The phenomenon may have two causes. First, it is cognitively effortful to adjust, and people may lose attention or willpower before they adjust fully; second, the anchor may create a mental image of the object or situation that maintains power (cf. availability) as you adjust. Both may be at play in an experiment in which professional real estate appraisers were given identical packets describing residences except for the owners' asking price, which varied. Even though the asking price is, at best, a poor indication of the actual value of the property, its anchoring effect resulted in a strong positive correlation with the appraiser's ultimate estimate.¹³¹ Lawyers and business people involved in negotiations may make an opening offer to anchor the other party on a high or low number with the goal of inducing the ultimate outcome in their favor.

Anchoring Problems (in handout)

BASE RATE NEGLECT

Unless they were already familiar with Bayes' Theorem, most people given the taxi problem in the preceding section gave too much credence to the eyewitness identification and essentially ignored the base rate of green and yellow taxicabs in the city. By the same token, many respondents overweight the test for malaria in the problem on page 50, without regard to the low base rate of the disease for U.S. travelers to Bhutan.

One reason for this is that Bayes' Theorem is not obvious: combining the two sorts of information is difficult. But this does not explain why people tend to greatly overweight the

¹³⁰ Karen E. Jacowitz and Daniel Kahneman, *Measures of Anchoring in Estimation Tasks*, 21 *The Personality and Social Psychology Bulletin* 11: 1163 (November 1995).

¹³¹ Gregory B. Northcroft and Margaret A. Neal, *Experts, Amateurs, and Real Estate: An Anchoring-and-Adjustment Perspective on Property Pricing Decisions*, *Organisational Behaviour and Human Decision Processes* 39 (1987).

eyewitness identification or lab test. The answer may lie in its availability compared to the pallid statistics of the base rate. Some support for this comes from responses to a variant of the taxi problem where, rather than being told that 85% of the taxis in the city are green and 15% blue, people were told that green taxis were involved in 85% of *accidents* in the city. This made the base rate more vivid—you might have an image of accidents and a stereotype of reckless green-taxi drivers—and respondents took greater account of the base rate. Even in this version of the problem, however, people gave undue weight to the eyewitness’s testimony.

In some cases, base rate neglect may be exacerbated by what Kahneman and Tversky termed the *representative heuristic*—the tendency to give too much weight to a description that seems highly representative of a category. Consider this problem:¹³²

Jack is a 45-year-old man. He is married and has four children. He is generally conservative, careful, and ambitious. He shows no interest in political and social issues and spends most of his free time on his many hobbies, which include home carpentry, sailing, and mathematical puzzles. Is he more likely to be a lawyer or an engineer?

The description was designed to evoke the stereotype of an engineer, and most participants in an experiment judged Jack more likely to be an engineer. Indeed, the stereotype was so powerful that the participants said he was likely to be an engineer even when they were told that the descriptions came from a sample of people of whom 70% were lawyers and 30% were engineers.

HINDSIGHT BIAS

As the saying goes, “hindsight is 20/20.” It’s easier to understand the risks of an event’s occurrence after the outcome is known. Hindsight bias describes our tendency, after an event has occurred, to erroneously believe that we knew the risks beforehand. Hindsight bias is the result of the natural and often productive cognitive process of taking into account a known outcome when making probabilistic inferences. Revising probability estimates based on sound statistical principles (e.g., an adequate sample size) improves future predictions.

The problem occurs when we blame ourselves for an outcome we could not have predicted or, worse, impose blame or liability on others under the erroneous belief that any reasonable observer should have made the prediction beforehand. “Monday morning quarterbacking” is a relatively benign example.

You have almost surely experienced the phenomenon yourself, and it has been confirmed by many lab experiments. In one study, participants were given identical descriptions of a medical procedure. They were then randomly told that the outcome was either good or bad and then asked if the procedure was medical malpractice. Consistent with hindsight bias, the levels of reported malpractice were much higher when the outcome was poor than when it

¹³² Amos Tversky and Daniel Kahneman, Causal Schemas in Judgments Under Uncertainty (1973), in *Heuristics and Biases*, supra, at 117.

was good.¹³³ The group that was told the outcome was poor made faulty hindsight estimates of the (ex ante) probability of a poor outcome.

College students were asked to predict the U.S. Senate vote on Supreme Court nominee Clarence Thomas. Before the vote occurred, 58% of students predicted his approval. However, a week after Thomas was confirmed, 78% of students said they had previously believed that he would be approved.¹³⁴

Efforts to mitigate hindsight bias have not been successful. Explaining the phenomenon to people before they make a judgment has no effect. Nor does asking people to imagine different ways in which the event might have turned out; people's imaginations are overwhelmed by the availability of the actual outcome. The law sometimes works around the problem by restricting some judgments in hindsight. For example, the business judgment rule creates a strong presumption protecting corporate managers' business and investment decisions.

THE ROLE OF EMOTIONS

In describing the availability heuristic, we noted that vivid, emotionally gripping events tend to stick in our minds. They are readily recalled when we estimate the likelihood of such events, leading us to overestimate their frequency. The availability heuristic can have important policy and personal consequences. For example, flood and earthquake insurance purchases skyrocket in the aftermath of a natural disaster, but as time goes on and the event fades from memory, the purchases decline. Vivid images of nuclear incidents and meltdowns may lead policy makers to believe that nuclear energy is not as safe as coal-powered energy, whose risks are relatively invisible.

Whether they affect our estimations of probability or not, the *acceptability* of risks is affected by various factors¹³⁵ that may cause a sense of "outrage," including that the risk seemed:

- Dreadful
- A clear enemy
- Unfamiliar
- Out of an individual's control
- Unnatural
- Act of commission (as distinguished from omission)
- A violation of trust

Outrage influences people's reactions to risk. High-outrage events tend to increase the perceived risk of an event. For instance, terrorism is one of the highest-outrage events, which is

¹³³ Thomas B. Hugh, and G.D. Tracy, *Hindsight bias in medicolegal expert reports*, 176 *Medicine and the Law* 277–278 (2002).

¹³⁴ David G. Meyers, *Exploring Social Psychology*, (New York: McGraw-Hill, 1994), 15–19.

¹³⁵ Timur Kuran and Cass Sunstein, *Availability Cascades and Risk Regulation*, 51 *Stanford Law Review* 4: 683–768 (Apr. 1999).

part of the reason it elicits such a strong public response in comparison with corresponding responses to the dangers of heart disease when the latter is statistically far more risky.¹³⁶

Dread

People tend to overestimate the likelihood of a harm if it is particularly “dreadful,” or of high consequence. This echoes the availability heuristic and vividness of a risk.

For instance, in the aftermath of the September 11 attacks, Americans avoided the dread risk in flying. A study hypothesized that as a result, one would expect an increase in car accident fatalities, as Americans would be more likely to drive some of these unflown miles. Data from the U.S. Department of Transportation from the 3 months following the attacks indicated not only that traffic deaths increased but also that the number of deaths on the road was higher than the number of passengers killed on the four fatal flights combined.¹³⁷

People’s sense of dread—and this may be true for some of the other phenomena mentioned below—can be affected by the way a decision is framed. We saw an example of this in Kahneman and Tversky’s vivid virus epidemic program in the handout and discussed on page 65. In a different study, conducted by Tversky, among others,¹³⁸ participants (comprised of patients, physicians, and students) were asked to choose between two treatments for lung cancer: (1) radiation, which had no immediate risk of death but a less favorable prognosis for longevity, and (2) surgery, which had a nontrivial risk of death but a better prognosis for the long term: One group of participants was given the problem in a “mortality” frame, the other in a “survival” frame:

Mortality Frame	Survival Frame
Surgery	Surgery
10 percent die during treatment	90 percent survive treatment
32 percent will die within 1 year	68 percent survive at least 1 year
66 percent will die within 5 years	34 percent survive at least 5 years
Radiation Therapy	Radiation Therapy
0 percent die during treatment	100 percent survive treatment
23 percent will die within 1 year	77 percent survive at least 1 year
78 percent will die within 5 years	22 percent survive at least 5 years

When the choice was framed in terms of mortality, 50% of the participants opted for surgery. But when the choice was framed in terms of survival, 84% opted for surgery.

The experimenters attribute the outcome that surgery was much more attractive when the outcomes were framed in terms of the probability of survival “to the fact that the risk of

¹³⁶ Sunstein, *Worst Case Scenarios* 64.

¹³⁷ Gerd Gigenrenzer, *Dread Risk, September 11, and Fatal Traffic Accidents*, 15 *Psychological Science* 4: 286–287 (Apr. 2004).

¹³⁸ B.J. McNEIL, S.G. PAUKER, H.C. SOX JR., AND A. TVERSKY, *ON THE ELICITATION OF PREFERENCES FOR ALTERNATIVE THERAPIES*, 306 *N ENGL J MED*. 21: 1259–1262 (MAY 27, 1982), DESCRIBED IN THOMAS GILOVICH AND LEE ROSS, *THE WISEST ONE IN THE ROOM* 94–95 (2015).

perioperative death looms larger when it is presented in terms of mortality than when it is presented in terms of survival.”

A Clear Enemy

If a harm has a clear identity, like a face and a narrative, the public is more likely to support an aggressive response. The presence of an “enemy” and their narrative, like al-Qaeda and ISIS leaders and jihadi philosophy, is more likely to resonate with the public than a faceless threat, like the numerous companies worldwide that contribute to climate change with harmful emissions. The lack of a clear narrative, enemy, and overt consequences makes people underestimate the risk and consequences of climate change. As Sunstein comments, “In the case of terrorism, a ‘we/they’ narrative fits the facts; in the context of climate change, those who are the solution might well be the problem.”¹³⁹

Familiarity

If a hazard seems more “familiar” to us, we are less likely to believe that it is risky. Familiar risks, such as driving, engender less outrage than unfamiliar risks, such as airplane crashes, even though—notwithstanding their vivid media coverage—it’s considerably more dangerous to ride in a car than in an airplane.

The mere sense that something is unfamiliar can result in higher perceptions of risk. Food additives were rated as more harmful when their names were difficult to pronounce, while easier-to-pronounce food additives did not make subjects fearful. When amusement park rides had complicated, difficult-to-pronounce names, people perceived the rides as more likely to induce nausea (an undesirable risk) as well as more exciting and adventurous (a desirable risk) than rides given simpler names.¹⁴⁰

Control

In addition to driving a car being familiar, people believe that the activity is less risky than, say, being an airline passenger because they feel more in control in the former case. Being able to maneuver a vehicle yourself feels less risky than entrusting your safety to an airplane pilot. Similarly, people feel more vulnerable to environmental health hazards than similar hazards over which they have personal control.¹⁴¹ People perceive the probability of winning the lottery to be higher if they select the lottery numbers themselves, which gives them an illusion of control over the outcome.¹⁴²

¹³⁹ Sunstein, *Worst Case Scenarios* 64.

¹⁴⁰ Hyunjin Song and Norbert Schwarz, *If It’s Difficult to Pronounce, It Must Be Risky: Fluency, Familiarity, and Risk Perception*, 20 *Psychological Science* 2: 135–138 (Feb. 2004).

¹⁴¹ Glynis Breakwell, *The Psychology of Risk* (Cambridge, United Kingdom: Cambridge University Press, 2014), 74.

¹⁴² W. Brun, Risk perception: Main issues, approaches and findings, in *Subjective Probability* (Chichester: John Wiley and Sons, G. Wright and P. Ayton, eds., 1994), pp. 395–420.

Nature

People assume that nature is benign compared to human technology, and tend to experience more outrage toward risks created by the latter. Altering what exists naturally often inherently feels wrong to people and thus induces outrage, even if a natural hazard poses a more significant risk (i.e., natural occurring carcinogens in food) than a man-made one. For instance, a high amount of radiation from the natural occurrence of radon in one's basement subjectively feels less bad than a much smaller amount of radiation created by human agency.¹⁴³

Omission vs. Commission

In general, people tend to regret the near-term consequences of actions more than of their inactions. Perhaps because *doing* something, such as giving your child a vaccine, is more salient than *not doing* something (cf. the availability heuristic), people tend to be willing to take greater risks through omissions than commissions. For example, the DPT vaccine, which prevents diphtheria, pertussis, and tetanus, causes permanent neurological injury in 1 out of 310,000 doses (a 0.0003% chance). Some parents prefer to subject their children to a higher probability of becoming ill or dying from one of the diseases prevented by the vaccines than to much smaller risk from their side effects.¹⁴⁴

Betrayal Aversion

People's behavior in the vaccination study may also be the result of anticipating the additional psychic harm when a product designed to protect you actually harms you. The exploding automobile airbag provides another example.¹⁴⁵

Outrage is socially, psychologically, and culturally created. And it is not immutable. Outrage sometimes dissipates when people become aware of the costs of eliminating potential hazards. This may explain why there is less concern about the health hazards of cell phones in Finland—where the mobile phone company Nokia plays an important role in the economy—than in the United States. By the same token, New York City parents found risks of asbestos less concerning when faced with the inconveniences of closed schools, even though beforehand they strongly supported eliminating asbestos in the schools.¹⁴⁶

¹⁴³ Peter M. Sandman, Neil D. Weinstein, and William K. Hallman, *Communications to Reduce Risk Underestimation and Overestimation*, 3 Risk Decision and Policy 93 (1998).

¹⁴⁴ Ilana Ritov and Jonathan Baron, Reluctance to Vaccinate: Omission Bias and Ambiguity, in *Behavioral Law and Economics* (New York: Cambridge University Press, Cass Sunstein, ed., 2000), p. 168.

¹⁴⁵ Jonathan J. Koehler and Andrew Gershoff, *Betrayal Aversion is Reasonable*, 28 Behavioral & Brain Science 556 (2005).

¹⁴⁶ Howard Margolis, *Dealing with Risk: Why the Public and the Experts Disagree on Environmental Issues* 124–125 (Chicago: University of Chicago Press, 1998).

OVERCONFIDENCE, CONFIRMATION BIAS, AND MOTIVATED REASONING

The preceding material, based on the work of Amos Tversky, Daniel Kahneman, and Cass Sunstein, treats cognitive errors and biases as a major source of the misperceptions of risk. By contrast, Dan Kahan and his colleagues in the Cultural Cognition Project¹⁴⁷ attribute people's perceptions and misperceptions of risk largely to cultural identity and values. Before turning to their work, it is useful to make a detour into research on overconfidence, confirmation bias, and motivated reasoning in circumstances where risk is not a factor.

Overconfidence

In a classic experiment, Edward Russo and Paul Schoemaker asked business executives to answer 10 questions calling for numerical estimates, asking them to provide a "low and a high guess such that you are 90 percent sure the correct answer falls between the two."¹⁴⁸ The questions included:

- Martin Luther King's age at death
- Length of the Nile River in miles
- Number of books in the Old Testament
- Diameter of the moon in miles
- Air distance from London to Tokyo

On average, respondents were wrong considerably more than 10% of the time. While these were trivia questions, professionals tended to be overconfident even their areas of expertise.

Confirmation Bias

In a classic study, Charles Lord, Lee Ross, and Mark Lepper placed participants in one of two groups, based on their strong support of or opposition to the death penalty.¹⁴⁹ The groups were randomly shown cards that summarized research indicating either that the death penalty did nor did not deter murder, and were then given more detailed information about the research, including critiques and responses to them. Not surprisingly, participants were more accepting of evidence supporting their prior views and more critical of evidence contradicting them. The authors write:

¹⁴⁷ See <http://www.culturalcognition.net/>.

¹⁴⁸ J. Edward Russo and Paul J. H. Schoemaker, *Winning Decisions: Getting it Right the First Time* 79–80 (New York: Doubleday, 2002).

¹⁴⁹ Charles G. Lord, Lee Ross, and Mark R. Lepper, *Biased Assimilation and Attitude Polarization: The Effects of Prior Theories on Subsequently Considered Evidence*, 37 *Journal of Personality and Social Psychology* 2098–2109 (1979).

[T]here can be no real quarrel with a willingness to infer that studies supporting one's theory-based expectations are more probative, or methodologically superior to, studies that contradict one's expectations. When an "objective truth" is known or strongly assumed, then studies whose outcomes reflect that truth may reasonably be given greater credence than studies whose outcomes fail to reflect that truth. Hence, the physicist would be "biased," but appropriately so, if a new procedure for evaluating the speed of light were accepted if it gave the "right answer" but rejected if it gave the "wrong answer." The same bias leads most of us to be skeptical about reports of miraculous virgin births or herbal cures for cancer, and despite the risk that such theory based and experience-based skepticism may render us unable to recognize a miraculous event when it occurs, overall we are surely well served by our bias. Willingness to interpret new evidence in the light of past knowledge and experience is essential for any organism to make sense of, and respond adaptively to, its environment.

At some point, though, what may be a reasonable skepticism about information that contradicts our prior beliefs becomes *confirmation bias*—the tendency to look for and give credit to evidence that supports those beliefs and ignore or discredit disconfirming evidence. The famous economist John Kenneth Galbraith captured the phenomenon in his quip that "faced with the choice between changing one's mind and proving that there is no need to do so, almost everyone gets busy on the proof."¹⁵⁰

This wasn't the end of the death penalty experiment, however. The researchers then gave participants cards with information contrary to the ones they were first shown. Distressingly, learning about research that opposed their prior views actually *strengthened* the participants' belief in those views. The authors note that "in their readiness to use evidence already processed in a biased manner to bolster the very theory or belief that initially 'justified' the processing bias . . . participants exposed themselves to the familiar risk of making their hypotheses unfalsifiable—a serious risk in a domain where it is clear that at least one party in a dispute holds a false hypothesis—and not allowing themselves to be troubled by patterns of data that they ought to have found troubling."

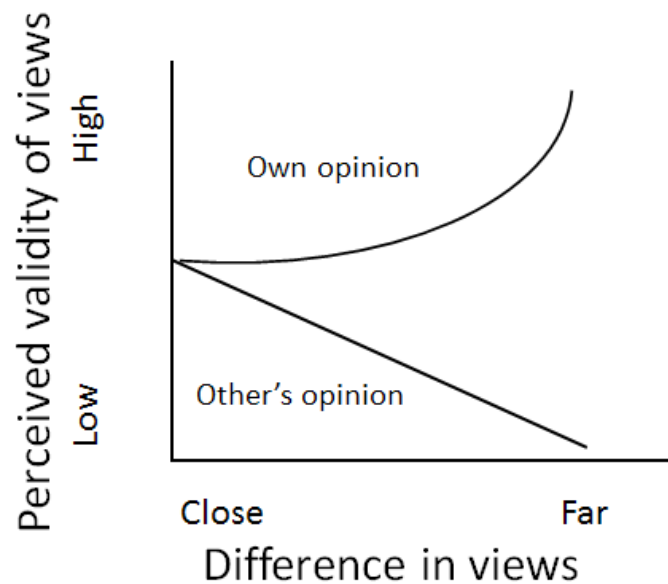
Naïve Realism

Lee Ross, Emily Pronin, and Thomas Gilovich did a number of experiments in which participants first completed a survey asking them to indicate their attitudes on controversial issues, such as affirmative action, capital punishment and abortion rights, as well as controversial public figures, such as Vice President Dick Cheney and Senator Hillary Clinton. Participants' anonymous responses were then randomly redistributed to other participants. Recipients of the responses were asked to rate how similar their views were to those of the person whose survey they had received and whether that person's views and their own reflected valid or objective considerations, such as "attention to facts," "concern with justice," and appropriate consideration of "long-term consequences," or biases such as "desire for peer approval," "wishful thinking," and "political correctness."

People thought their own attitudes reflected valid considerations to a significantly greater degree, and biases to a significantly lesser degree, than their peer's attitudes. And when

¹⁵⁰ See <http://www.brainyquote.com/quotes/quotes/j/johnkennet109909.html>.

participants perceived a discrepancy between own attitudes and those of peers, the participants assumed that their peers had been influenced more by biases than by objective factors. The chart below represents the phenomenon they describe:



In *The Wisest One in the Room*, Gilovich and Ross comments:¹⁵¹

Tellingly, the level of disagreement did not exert much influence on the degree to which participants felt their own views reflected valid considerations rather than bias (the unshaded bars in the figure). Nor did marked disagreement make them particularly open to the possibility that they had been less than objective. On the contrary, when the disagreement was greatest, participants not only tended to be especially harsh in their assessment of the other individual's views, they also tended to be especially generous in how they assessed the rationality of their own views. In all, it is hard to imagine more direct support for Benjamin Franklin's observation that "most men . . . think themselves in possession of all truth, and that wherever others differ from them, it is so far error."

Lee Ross captures the phenomena of overconfidence and confirmation bias in what he calls *naïve realism*:

1. I see actions and events as they are in reality. My perceptions and reactions are an unmediated reflection of the "real nature" of whatever it is I am responding to.
2. Other people, to the extent that they are willing and able to see things in a similarly objective fashion, will share my perceptions and reactions. (*false consensus*)

¹⁵¹ Thomas Gilovich and Lee Ross, *The Wisest One in the Room: How You Can Benefit from Social Psychology's Most Powerful Insights*, (2015) Pp. 29–30. Copyright © (2015) Simon & Schuster.

3. When others perceive some event or reacted to it differently from me, they (but not I) have been influenced by something other than the objective features of the events in question.

He suggests that the consequences of naïve realism are that:

- Partisans tend to overestimate the number of others who agree with their views, or at least the number who would agree with them if apprised of the “real” facts; partisans assume that disinterested third parties would agree with them.
- Partisans tend to see viewpoints that differ from their own, as highly revealing both of personal dispositions (for example, gullibility, aggressiveness, pessimism, or charitableness), and of particular cognitive and motivational biases.
- Partisans on both sides of an issue will typically perceive evenhanded media to be biased against them and to favor their adversaries. They are apt to see the same hostile bias in the efforts and decisions of evenhanded third-party mediators or arbitrators.
- Partisans will be polarized and extreme in their view. They will underestimate areas of agreement, and therefore underestimate the prospects of finding “common ground” through discussion or negotiation.

Together with Varda Liberman and others, Ross conducted a series of experiments to test people’s susceptibility to naïve realism in weighing their own quantitative estimates versus those of a peer. In all cases, participants were paired in dyads. In one experiment,¹⁵² somewhat akin to the Russo and Schoemaker experiment described above, Israeli business school students were asked to estimate statistics about which they were unlikely to have expertise—for example, how much an average Israeli family of four spends on food, and the size of the Druze population of Israel. Four rounds of estimates were made:

1. An initial round of independent estimates,
2. A second round of individual estimates made with the knowledge of own and partner’s initial estimates,
3. A third round of agreed-on joint estimates, and
4. A final round of individual estimates.

In the absence of any reason to believe that one has more special knowledge of the matter than one’s partner, the normative strategy would be to move halfway toward the partner’s estimate, that is, to average the two answers.¹⁵³ However, dyad members

¹⁵² V. Liberman, J.A. Minson, C.J. Bryan, and L. Ross, *Naive realism and capturing the “wisdom of dyads,”* 48 *Journal of Experimental Social Psychology* 507–512 (2011).

¹⁵³ R.P. Larrick, and J.B. Soll, *Intuitions about combining opinions: Misappreciation of the averaging principle,* 52 *Management Science* 111–127 (2006). The participants were not alerted to this phenomenon, which is a boundary version of the so-called wisdom of crowds, richly described by James Surowiecki in *The Wisdom of Crowds* (2005). If, like many people I’ve talked to, you’re skeptical about the averaging principle where only two estimates are involved, imagine that you are an observer to the different estimates of members of a dyad on a

consistently gave greater weight to their own estimates, moving, on average, only 30.4% of the distance.

The dyads were placed in two groups for the third round. One group merely exchanged estimates; the other discussed their reasons for the estimate. The joint estimates for both groups came closer to the true number, but those who discussed their estimates came even closer than those who merely exchanged the numbers. But when the participants made final individual estimates in the fourth round, they diverged from their joint estimates in the direction of their own prior estimate, and as a consequence, moved further from the true answer (though they were closer than in round two).

In another experiment,¹⁵⁴ professional school students in the United States and Israel were given a set of then politically salient questions such as:

- Given the expense associated with the development and production of electrically powered vehicles, should the federal government offer subsidies to car manufacturers and consumers to help offset these expenses?
- Should Israel agree to give up the Golan Heights in return for a full peace with Syria?

Each individual participant was first asked to state his personal views on these issues and then asked to estimate the percentage of other participants who shared his views. Each dyad member then revealed his personal views and estimates with his partner and then made individual revised estimates. Before making the next and final estimate, the participant was asked to indicate the extent that his estimate and that of his partner were influenced by three normative considerations (useful information sources; understanding of underlying issues and concerns; objective evaluation of facts) and three potential sources of bias (wishful thinking; own view on issue; agenda of political party, community, or peer group).

The results paralleled those of the first study. Moreover, participants tended to think that their estimates were based on normative considerations while their partners' estimates reflected biases. They underweighted their partner's estimate more when they disagreed with them on the underlying political issue. And, exemplifying the false consensus effect, they believed that other participants would come to the same conclusions that they did. The studies demonstrate the unfortunate consequences of naïve realism. On the positive side, however, researchers conclude:

Our studies attest to the benefit that individuals making quantitative assessments derive from mere exposure to the estimates furnished by a peer—provided that he or she has made an independent assessment and brings different sources of accuracy and bias (in particular, self-serving biases) to the task. More importantly, our studies document the incremental value of having to reach agreement (by deliberative discussion or, to a lesser extent, even the mere exchanging of bids) in the face of initial disagreement, especially large disagreements of the sort that generally make people dismissive of each other's views. Moreover, our studies also show

question about which you (literally) have no idea of the correct answer. Would you choose member A's estimate, member B's, or average them?

¹⁵⁴ J.A. Minson, V. Liberman, and L. Ross, *Two to Tango: The effect of collaborative experience and disagreement on dyadic judgment*, 37 *Personality and Social Psychology Bulletin* 1325–1338 (2011).

that these benefits persist even when dyad members are free again to give each other's prior inputs as much or as little weight as they wish in a final set of individual estimates. . . .

Dyad Experiment

Motivated Reasoning

Confirmation biases and naïve realism may be reinforced by the phenomenon of *motivated skepticism*—“the tendency of people to conform their assessment of information—whether empirical data, logical arguments, the credibility of information sources, or even what they perceive with their own senses—to some goal or interest extrinsic to forming an accurate belief.”¹⁵⁵ There have been some interesting lab studies of motivated skepticism.¹⁵⁶ Perhaps readers have had personal experiences like this: As part of an effort to keep my weight under control, I weigh myself every morning. If I'm pleased with the result, I step on the scale only once. If I'm disappointed, I'll try it a second time or check that the scale is properly zeroed.

In any event, the phenomena of confirmation bias and motivated skepticism play a key role in conspiracy theories, such as belief that Barack Obama was not born in the United States and hence ineligible to be president. A Gallup telephone poll of 1,018 adults conducted in May 2011 found that 5% of respondents believed that Obama was “definitely born in another country” and 8% believed he was “probably born in another country,” versus 47% believing he was “definitely” and 18% “probably” born in the United States. Broken down by political affiliation, the same poll found that 23% of self-identified Republicans, 14% of independents, and 5% of Democrats thought Obama was definitely or probably born in another country.¹⁵⁷

CULTURAL COGNITION AND RISK

Dan Kahan the founder of the cultural cognition project,¹⁵⁸ defines “cultural cognition” as

a species of motivated reasoning that promotes congruence between a person's defining group commitments, on the one hand, and his or her perceptions of risk and related facts, on the other. A variety of mechanisms contribute to this effect. Thus, individuals tend to selectively credit empirical information in patterns congenial to their cultural values. They are also disposed to impute knowledge and expertise to others with whom they share a cultural affinity. And they are more likely to note, assign significance to, and recall facts supportive of their cultural outlooks than facts subversive of them. These dynamics protect individuals' connection to others on whom they depend for material and emotional support.

¹⁵⁵ Dan M. Kahan, Making Climate-Science Communication Evidence-based—All the Way Down, in *Culture, Politics and Climate Change* (Routledge Press, M. Boykoff and D. Crow, eds., 2014), p. 5.

¹⁵⁶ Peter H. Ditto and David F. Lopez, *Motivated Skepticism: Use of Differential Decision Criteria for Preferred and Nonpreferred Conclusions*, 63 *Journal of Personality and Social Psychology* 568 (1992).

¹⁵⁷ See https://en.wikipedia.org/wiki/Barack_Obama_citizenship_conspiracy_theories#Opinion_surveys.

¹⁵⁸ See <http://www.culturalcognition.net/>.

Building on the phenomenon of motivated reasoning, cultural cognition theory notes that people's acceptance of or distaste for government regulation is not a purely individual characteristic but reflects peoples' cultural beliefs and values. In a review of a book by Cass Sunstein, which explains misperception of risks largely in terms of cognitive errors, Dan Kahan, Paul Slovic, and their colleagues argue that "culture is prior to facts in societal disputes over risk":¹⁵⁹

Normatively, culture might be prior to facts in the sense that cultural values determine what significance individuals attach to the consequences of environmental regulation, gun control, drug criminalization, and the like. But more importantly, culture is cognitively prior to facts in the sense that cultural values shape what individuals believe the consequences of such policies to be. Individuals selectively credit and dismiss factual claims in a manner that supports their preferred vision of the good society.

If misperceptions of risk were mainly the result of ignorance or cognitive errors, one would expect that, all things considered, the more knowledgeable people were about a phenomenon, such as climate change, the more accurately they would perceive the risk. But increasing comprehension of climate science does not seem to correlate with more accurate risk perceptions. In fact, the two are negatively correlated.¹⁶⁰ The more people learn, the more polarized their views became. In place of a cognitive theory, Kahan and his colleagues posit a *cultural theory of risk*. Associated most famously with the work of anthropologist Mary Douglas and political scientist Aaron Wildavsky, the cultural theory of risk links disputes over environmental and technological risks to clusters of values that form competing cultural worldviews—egalitarian, individualistic, hierarchical, and communitarian.

The authors go on to explain:

- *Egalitarians*, on this account, are naturally sensitive to environmental hazards, the abatement of which justifies regulating commercial activities that produce social inequality.¹⁶¹
- *Individualists*, in contrast, predictably dismiss claims of environmental risk as specious, in line with their commitment to the autonomy of markets and other private orderings.¹⁶²

¹⁵⁹ Dan M. Kahan, Paul Slovic, Donald Braman, and John Gastil, *Fear of Democracy: A Cultural Evaluation of Sunstein on Risk*, 119 Harv. L. Rev. 1071 (2006) [hereafter, *Fear of Democracy*].

¹⁶⁰ Kahan, Making Climate-Science Communication Evidence-based—All the Way Down, p. 3.

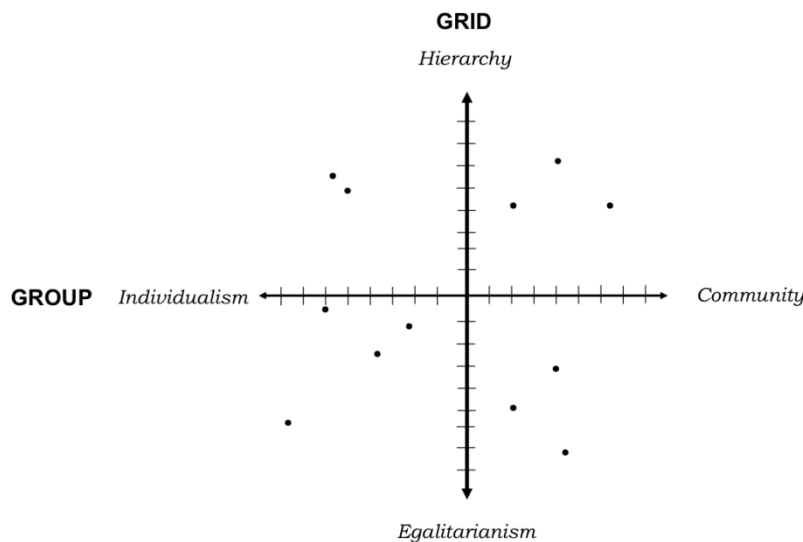
¹⁶¹ Egalitarians hold views such as: "It's old-fashioned and wrong to think that one culture's set of values is better than any other culture's way of seeing the world," or "We need to dramatically reduce inequalities between the rich and the poor, whites and people of color, and men and women." Dan M. Kahan, Paul Slovic, Donald Braman, and John Gastil, *supra*; Kahan, Cultural Cognition as a Conception of the Cultural Theory of Risk, in *Handbook of Risk Theory* (Springer Publishing, S. Roeser, ed., 2012) [hereafter, *Cultural Cognition*].

¹⁶² Individualists hold views such as: "People who are successful in business have a right to enjoy their wealth as they see fit," or "If the government spent less time trying to fix everyone's problems we'd all be a lot better off," or "Society works best when it lets individuals take responsibility for their own lives without telling them what to do." *Id.*

- *Hierarchists* are similarly skeptical because they perceive warnings of imminent environmental catastrophe as threatening the competence of social and governmental elites.¹⁶³
- *Communitarians*, by contrast to individualists, have faith in governments and accord them more responsibility and power.¹⁶⁴

Although one can imagine alternative explanations for cultural variation in risk perceptions, cultural cognition offers a distinctively psychometric one. On this view, the impact of cultural worldviews is not an alternative to, but rather a vital component of, the various psychological and social mechanisms that determine perceptions of risk. These mechanisms, cultural cognition asserts, are endogenous to culture. That is, the direction in which they point risk perceptions depends on individuals' cultural values In sum, individuals adopt stances toward risks that express their commitment to the values integral to their preferred ways of life.¹⁶⁵

These categories create a grid on which one can locate an individual's cultural worldview:



<http://www.culturalcognition.net/blog/2011/12/20/cultural-vs-ideological-cognition-part-1.html>

Individuals have “packages of risk perceptions characteristic of their groups in proportion to the strength or degree of attachment to the cultural groups with whom they are most closely affiliated.”¹⁶⁶ A point in the upper right quadrant would represent Hierarchical

¹⁶³ Hierarchists hold views such as: “We have gone too far in pushing equal rights in this country,” It seems like blacks, women, homosexuals, and other groups don’t want equal rights; they want special rights just for them,” or “A lot of problems in our society today come from the decline in the traditional family, where the man works and the woman stays home.” Id.

¹⁶⁴ Communitarians hold views such as: “It’s society’s responsibility to make sure everyone’s basic needs are met,” or “The government should do more to advance society’s goals, even if that means limiting the freedom and choices of individuals.” Id.

¹⁶⁵ *Fear of Democracy*, supra, at 193.

¹⁶⁶ Cultural Cognition 13.

Communitarianism, while a point the upper left would be Hierarchical Individualism, and so on. The further away individuals are from the origin, the more extreme their cultural views.

On the horizontal axis, a more individualistic-minded person will have a more competitive worldview; one in which people fend for themselves. At the other end of the continuum, someone culturally predisposed to communitarianism would promote solidarity and codependence. At the hierarchical end of the vertical axis, cultural views are culture determined by “explicit social classifications such as sex, color, . . . a bureaucratic office, descent in a senior clan or lineage, or point of progression through an age-grade system.”¹⁶⁷ In contrast, on the egalitarian end, “no one is prevented from participation in a social role because he or she is the wrong sex, or is too old, or does not have the right family connections.”¹⁶⁸

Kahan and his colleague write:¹⁶⁹

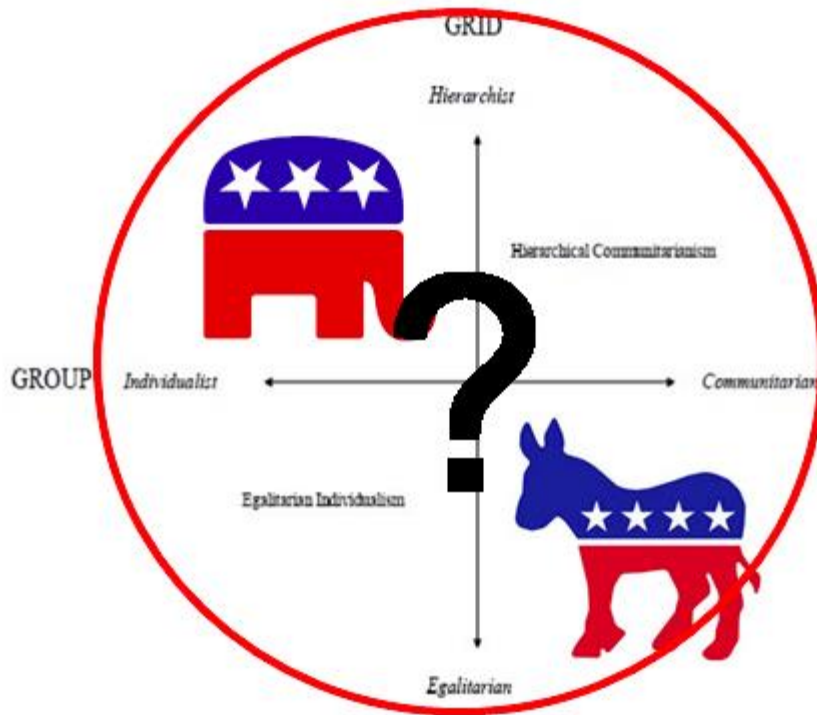
At a societal level, . . . culturally motivated cognition can be a source of intense and enduring political conflict. Citizens who subscribe to an egalitarian ethic that identifies free markets as fonts of unjust disparity readily credit evidence that commerce and industry are destroying the environment; citizens who adhere to an individualistic ethic that prizes private orderings dismiss such evidence and insist instead that needless government regulation threatens to wreck economic prosperity. Associating firearms with patriarchy, racism, and distrust, egalitarian and communitarian citizens blame accidental shootings and crime on insufficient regulation of guns; hierarchical and individualist citizens, in contrast, worry that too much regulation will render law-abiding citizens vulnerable to predation, a belief congenial to the value they attach to guns as instruments of social roles (father, protector) and symbols of virtues (self-reliance, honor) distinctive of their ways of life. Citizens who combine hierarchical and communitarian values believe that the right to abortion demeans those women who eschew the workplace to be mothers; correspondingly, they worry that abortion poses a health risk to women. Citizens who combine egalitarian and individualist values, and who assign status to women as well as men for professional and commercial success, believe that restrictions on abortion put women’s health in danger. Myriad other issues—from the risks and benefits of the HPV vaccine for schoolgirls to the efficacy of legally mandated medical treatment for (noninstitutionalized) mentally ill persons—divide citizens along lines that correspond to the social meanings these policies connote within opposing ways of life.

With the acknowledgement that Kahan resists this oversimplification, it seems a reasonable approximation to treat the upper left quadrant as conservative Republicans (hierarchical and individualistic) and the lower right as liberal Democrats (egalitarian and communitarian).

¹⁶⁷ Kahan, *Cultural Cognition* 3–4.

¹⁶⁸ *Id.* at 4.

¹⁶⁹ “They Saw a Protest,” *supra*.



<http://www.culturalcognition.net/blog/2012/6/21/politically-nonpartisan-folks-are-culturally-polarized-on-cl.html>

In a review of Chris Mooney's *The Republican Brain*,¹⁷⁰ David Roberts writes:

On average, conservatives prefer simplicity and clear distinctions, where liberals display “integrative complexity” and are more comfortable with ambiguity and nuance. Conservatives are “hierarchs” and highly sensitive to in-group/out-group distinctions, where liberals are egalitarians. Conservatives come to decisions quickly and stick to them; liberals deliberate, sometimes to the point of dithering. Conservatives are more sensitive to threats while liberals are more open to new experiences.¹⁷¹

Mooney notes that

Kahan's way of explaining conservatives, based on their moral values, is closely related to other approaches, like the well-known one of University of Virginia social psychologist Jonathan Haidt. Haidt does it a little differently, talking about the different “moral foundations” of liberals and conservatives. . . . For Haidt, liberals care about fairness or equality, and they care about protecting people from harm. This is roughly analogous to egalitarianism and communitarianism. Conservatives, however, have other “moral foundations”: They care about respect for authority (e.g., hierarchy). They care about loyalty to the group (or to put a more

¹⁷⁰ Chris Mooney, *The Republican Brain: The Science of Why They Deny Science—and Reality* (John Wiley & Sons, 2012).

¹⁷¹ See <http://grist.org/politics/a-chat-with-chris-mooney-about-the-republican-brain/>.

negative spin on it, tribalism). And they care about purity or sanctity and whether someone does something perceived to be, you know, disgusting (especially sexually).”¹⁷²

Roberts further writes that

Mooney emphasizes that no substantive belief is “hard-wired.” Our nature does not determine our fate any more than our nurture does. These are averages and tendencies, not destinies, and individuals can be found all along a broad spectrum. Some of the scientific results, particularly the ones related to genetics, are early and highly tentative. Nonetheless, the totality of the science is substantial enough that it no longer makes sense to ignore it. The way we think about politics and democracy must incorporate a fuller picture of human cognition and cultural identity.”

Although cultural cognition is particularly concerned with the perception of risks, it also provides an explanation for differing perceptions of ordinary facts. In “*They Saw a Protest: Cognitive Illiberalism and the Speech-Conduct Distinction*,”¹⁷³ Dan Kahan and his colleagues replicated a famous 1954 study of how partisans watching a Dartmouth-Princeton football game “saw” the other team, but not their own, committing fouls.¹⁷⁴

Participants in the Kahan study were shown the identical video of a political demonstration. Half were told that the demonstrators were protesting outside of an abortion clinic; the other half were told that the demonstrators were protesting the military’s “don’t ask, don’t tell” policy outside a military recruitment center. The participants were asked whether the protesters went beyond protected speech and obstructed people’s ability to enter and exit the facilities.

In brief, about three-quarters of the participants who favored a woman’s right to an abortion believed that the protesters at the abortion clinic engaged in coercive behavior, while about three-quarters of those who opposed this right thought they did not behave coercively. About three-quarters of participants who favored gay and lesbian rights believed the protesters at the recruitment center engaged in coercive behavior, while a roughly equal number holding different views thought that the protesters did not behave coercively.¹⁷⁵

Hastorf and Cantril conclude their study of the Dartmouth-Princeton football game:

It seems clear that the “game” actually was many different games and that each version of the events that transpired was just as “real” to a particular person as other versions were to other people. . . . There is no such “thing” as a “game” existing “out there” in its own right which people merely “observe.” The “game” “exists” for a person and is experienced by him only in so far as certain happenings have significances in terms of his purpose. Out of all the occurrences

¹⁷² See <http://www.desmogblog.com/uneasy-relationship-between-explaining-science-conservatives-and-explaining-conservatives-scientifically>.

¹⁷³ Dan M. Kahan, David A. Hoffman, Donald Braman, Danieli Evans, and Jeffrey J. Rachlinski, 64 *Stan. L. Rev.* 851 (2012).

¹⁷⁴ Albert Hastorf and Hadley Cantril, *They Saw a Game: A Case Study*, 49 *Abnormal & Soc. Psychol.* 129 (1954).

¹⁷⁵ The study was more nuanced, breaking down the participants into the categories of “cultural cognition,” discussed below.

going on in the environment, a person selects those that have some significance for him from his own egocentric position in the total matrix.

Beyond the playing field, Kahan and colleagues describe the threat that such “cognitive illiberalism” presents to decision making in a democratic society—or more broadly to any form of rational decision making: “Because their perceptions of risk and related facts are unconsciously motivated by their defining commitments, even citizens who are genuinely committed to principles of liberal neutrality are likely to end up persistently divided along cultural lines—not over the proper ends of law (physical security, economic prosperity, public health, and the like) but over the means for securing them.”

Cultural cognition acts through various mechanisms.

Cultural Availability

As discussed earlier, the availability heuristic affects our perceptions of risk, especially in the wake of emotionally vivid events. People are more likely to notice, assign significance to, and recall information and events consistent with their cultural predispositions.

Culturally Biased Assimilation and Polarization

The death penalty study described above suggested that we tend to agree with arguments and evidence consistent with our beliefs and discredit information that contradicts them. The more information we receive, the more polarized our views become. The same phenomenon pervades our perception of risks. For example, participants in a 2009 study were exposed to various levels of information about nanotechnology. People presented with no information on nanotechnology perceived the risks to be about the same regardless of their cultural archetypes. When exposed to information, however, people formed opposing views grounded in their cultural worldviews. Kahan explains that “they attended to information in a biased manner supportive of a predisposition toward risk.”¹⁷⁶

This predisposition not only endows culturally diverse individuals with opposing “prior” beliefs about risk. It also decisively regulates their experience with information about the truth or falsity of those beliefs. People with opposing predispositions seek out support for their competing views through opposingly biased forms of information search. What’s more, they construe or assimilate information, whatever its provenance, in opposing ways that reinforce the risk perceptions they are predisposed to form. As a result, individuals end up in a state of cultural conflict—not over values, but over *facts*—that the mere accumulation of empirical data cannot be expected readily to dispel.

When a wide variety of information is available on a hotly contested topic like climate change, ordinary citizens can feel overwhelmed by the evidence and arguments. So, they defer to those who they believe to be experts. And more often than not, the people they perceive as experts are ones who exhibit similar cultural dispositions. “Those who don’t possess very much

¹⁷⁶ Id. at 26.

scientific knowledge and who can't engage in the sort of technical reasoning necessary to understand scientific evidence must necessarily rely on imperfect heuristics to figure out what is known to science. One of these might involve finding out what others who share their values think and basically deferring to them."¹⁷⁷

One factor that contributes to this phenomenon is the way cultural predispositions affect our perceptions of an expert's opinion.¹⁷⁸ Kahan writes:

We asked each subject to imagine a friend was trying to make up his or her mind on the existence and effects of climate change, on the safety of nuclear power, or on the impact on crime of allowing private citizens to carry concealed handguns. The friend, we advised, was planning to buy a book to study up on the subject, but before doing so wanted the subject's advice on whether the book's author was a "knowledgeable and trustworthy expert." Subjects were shown the authors' *curriculum vitae*, which indicated that the author had received a Ph.D. from one elite university, was on the faculty of another, and was a member of the National Academy of Sciences. The experimental manipulation involved what the author had *written*: for each topic—climate change, nuclear power, and concealed handguns—subjects were randomly assigned a book excerpt in which the author expressed either the "high risk" or "low risk" position. As we hypothesized, subjects were overwhelmingly more likely to find that the author was a "knowledgeable and trustworthy" expert when the author was depicted as taking a position *consistent* with the subjects' own cultural predisposition than subjects were if the author was assigned the opposing position.

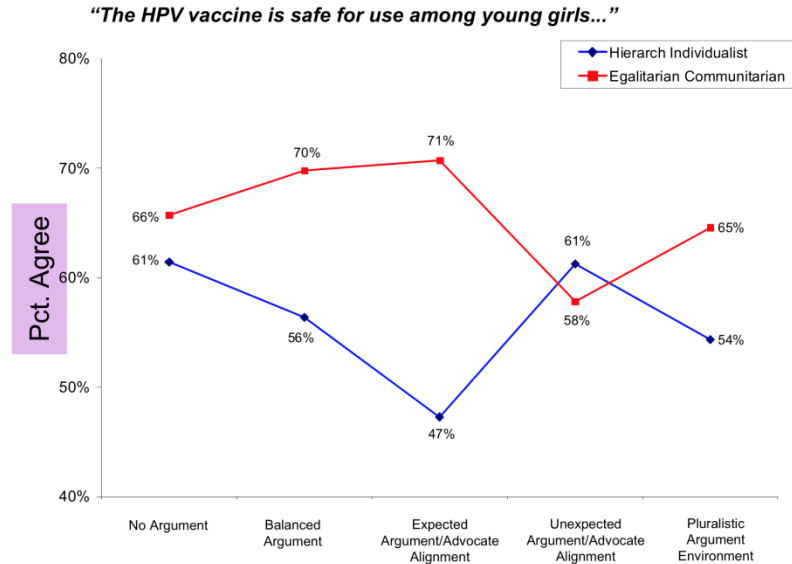
All of this comes together in Kahan's "cultural credibility heuristic"—people's tendency to defer to who they perceived as experts to guide them towards what evidence to believe and how they should perceive risk. One study analyzed people's risk perceptions of the HPV (human papillomavirus) vaccine. Since HPV is a sexually transmitted infection (STI), doctors recommend that girls be vaccinated by age 12, before becoming sexually active. Many states aim to make the vaccine a requirement for school enrollment. Opponents contend that vaccination will encourage young girls to have sex and increase unprotected sex, putting the same girls at risk for other STIs. They also cite harmful side effects of the vaccine.

Participants in the study were separated into five groups. The first received no information about the vaccine. The second was provided with balanced information of risks and benefits. The third, fourth, and fifth received the same arguments as the second, but this time the arguments were attributed to fictional "experts" with obviously differing cultural worldviews along the axes described above.¹⁷⁹ The results of the study are indicated in this chart:

¹⁷⁷ Kahan, *Making Climate-Science Communication Evidence-based—All the Way Down* 9.

¹⁷⁸ Kahan, *Cultural Cognition* 33.

¹⁷⁹ *Id.* at 35.



<http://www.culturalcognition.net/blog/2013/1/21/a-case-study-the-hpv-vaccine-disaster-science-of-science-com.html>

Identity-protective cognition came into play. In the group without information, everyone perceived the risks as about the same. With information, groups began to diverge along cultural lines, following the biased assimilation and polarization effect. Using our simplified approach, we can think of hierarchy-individualists in the graph above as conservatives and egalitarian-communitarians representing Liberals. Conservatives tended to perceive the risks of vaccination as large because of associations of the vaccine with premarital sex and because of their cultural opposition to state-sponsored public health measures. By contrast, liberals saw little risk in vaccination, motivated by their opposition to culturally imposed sexual norms and by favorable views of state-sponsored public health measures, respectively.

The greatest divide came when advocates argued for positions to which they were expected to be predisposed—that is, conservatives advocated against the vaccine and liberals argued for it. But when the same advocates argued the opposite, unexpected view (i.e., hierarchs and individualists advocated for the vaccine) risk perceptions began to converge again. This reveals an important point: people trust culturally similar advocates, and when potentially threatening positions are supported by these advocates (“unexpected alignment”), they are more open-minded about the information.

This may have important implications for how advocates or policy makers present information to the public. Identifying advocates with unexpected alignments and using them to promote a product or policy can be more effective in softening the opposition. For example, a trusted church pastor in a conservative neighborhood taking a pro-gay marriage stance may influence members of his congregation to be more open-minded about the subject.

Cultural Identity-protective Cognition

Experts aside, people are inclined to conform their views to others having the same “identity.” Being a part of a group with a shared identity has various benefits. For example,

joining a club can expand an individual's social circle, provide networking opportunities, or promote his or her status in the community. Holding beliefs contrary to the group risks exclusion. As a result, people "are motivated, unconsciously, to conform all manner of attitudes, including factual beliefs, to ones that are dominant within their self-defining reference groups."¹⁸⁰ When the consequences of contradicting one's peers can be harmful, individual tend to take on their group's views.

Cultural identity-protective cognition may contribute to different risk perceptions by people of different racial and ethnic groups and different genders. For example, white males, who tend to be more hierarchical than members of other groups, perceive all types of risks as less serious than women see them and less serious than men of other races see them. White men resist claims that activities that preserve their cultural dominance are a threat to society. For example, they are more likely to downplay environmental risks than their female counterparts because the men achieve social status by occupying high-ranking positions in industry and government more than women do.¹⁸¹ Because men are expected to fulfill roles of protectors and providers and display virtues of bravery, white males perceived gun risks to be lower and resisted restrictions on gun ownership more than women.¹⁸²

Reducing Bias through Cultural Identity Affirmation

How can you present information in a way that will minimize polarization and bias? Kahan writes:¹⁸³

Don't simply bombard people with information if you are trying to make them more receptive to risks. Doing that can actually provoke a cultural-identity-protective backlash that makes certain groups even more disposed to disbelieve that the risk is a real or a serious one. Information can help, but it has to be framed in a way that *affirms* rather than threatens the cultural identities of potential risk skeptics. One way of doing that is through policy solutions that are culturally affirming of the skeptics' identities.

He suggests that one should "disentangle knowledge and identity"¹⁸⁴ by avoiding attributing scientific facts to a specific worldview. One experiment analyzed reactions to scientific evidence of global warming. There was considerable polarization within a group that was simply given information about carbon emission reductions; the information triggered some participants' defense of industry and free markets, and others' skepticism about business. There was considerably less polarization with a group that was first given information about geoengineering as a possible solution. Polarization regarding the existence of climate change dissipated in the group that was provided information about geoengineering. Kahan writes: "This technology resonates with the values of cultural groups whose members prize the use of

¹⁸⁰ Id. at 21.

¹⁸¹ Id. at 23.

¹⁸² Id. at 24.

¹⁸³ Id. at 40.

¹⁸⁴ Dan M. Kahan, What is the "Science of Science Communication"? 14 *Journal of Science Communication* 3: 1–12 (February 8, 2015); Yale Law School, Public Law Research Paper No. 539, p. 7.

human ingenuity to overcome environmental limits. By affirming rather than denigrating their cultural identities, the information on geoengineering dissolved the conflict those individuals experienced between crediting human-caused global warming and forming stances that express their defining commitments.”¹⁸⁵

To generalize, people are less likely to assimilate information in a biased form when they can affirm their identity, thus boosting their self-esteem and security, before they are presented with information that threatens their identity. Geoffrey Cohen and David Sherman describe the defense and rejection of threats to one’s identity (cultural identity and otherwise) as our “psychological immune system.”¹⁸⁶ They have developed “values affirmation exercises” that blunt the immune system’s rejection of unwelcome information.

For example, smokers feel threatened by information about the health hazards of this habit, and engage in denial. But when smokers (across cultural archetypes) were first asked to complete a self-affirmation exercise in which they listed their own desirable personal qualities *before* being shown information about the health risks of smoking, they were more open to the information about the dangers of smoking and distressed about the habit. They expressed more confidence in their ability to quit, and felt a stronger motivation to quit.¹⁸⁷ Along similar lines, people at risk of diabetes who had previously refused screening tests and medical advice were less resistant after completing values affirmation exercises.¹⁸⁸

Most relevant to cultural cognition, when people who possessed different views engaged in self-affirmation before negotiating real-life disputes, they were more open to threatening political information and negotiated better.¹⁸⁹ Notably, among people in Israel and Bosnia (two perpetually conflict-ridden nations), those who were affirmed before entering a dispute were more likely to acknowledge the harms inflicted by their own group.¹⁹⁰ In the 2008 election, Democrats and Republicans who participated in self-affirmation exercises were less partisan in their evaluations of Barack Obama’s performance in debates.¹⁹¹

Cohen and Sherman conclude: “First, affirmation enables more balanced information processing. Without the self on trial, people are better able to evaluate evidence on its merits. Thus, affirmation does not produce change by itself but enables change to occur if evidence warrants it. Second, . . . affirmation promotes change among people under consistent psychological threat—people whose behavior puts them at risk for a health condition and who thus have cause to feel that their self-integrity is under threat.”¹⁹²

Problem: Open Carry

In advocating for the Texas law that permits residents to openly carry guns, the lieutenant governor asserted that “where states have open carry or concealed carry, crime is down 25 percent, murders are down. Having law abiding citizens having guns is a good thing.”

¹⁸⁵ Id. at 7.

¹⁸⁶ Geoffrey L. Cohen and David K. Sherman, *The Psychology of Change: Self-Affirmation and Social Psychological Intervention*, 65 Annual Review of Psychology 333–371 (2014), p. 340.

¹⁸⁷ Id. at 347–348.

¹⁸⁸ Id. at 348.

¹⁸⁹ Id. at 352.

¹⁹⁰ Id. at 353.

¹⁹¹ Id. at 353.

¹⁹² Id. at 348.

Others have questioned the fact asserted and its implicit attribution of a causal connection between right-to-carry laws and crime.¹⁹³

The governor of a different state that currently does not permit civilians to carry guns under any circumstances has asked you to assemble a “blue ribbon” task force to help her determine whether to propose adoption of either concealed or open carry legislation. She wants the task force to include a few leaders from business, civil society, education, and law enforcement as well as representatives of the [National Rifle Association](#) and the [Brady Campaign to Prevent Gun Violence](#). In preparation for the first meeting, the governor asks you to lay out the costs and benefits of the proposed change.

How will you organize the meetings to maximize the chances of the task force’s achieving a consensus?

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¹⁹³ See, e.g., <http://www.politifact.com/truth-o-meter/statements/2016/jan/03/dan-patrick/texas-lt-gov-dan-patrick-claims-states-where-peopl/>.

APPENDIX

ClimateWorks Foundation Case Study¹⁹⁴

In 2007, a group of foundations funded California Environmental Associates (CEA) to help develop a comprehensive strategy for how philanthropists could “turn the tide against global warming.” California Environmental Associates surveyed the scientific and economic literature and got input from more than 150 of the world’s leading experts on energy and climate change. In its report, *Design to Win*, CEA described its work in this way:

We developed an exhaustive list of possible interventions and used existing mitigation models to quantify each strategy’s expected cost and emissions reduction . . . as we prioritized the initiatives, we were guided by philanthropy’s comparative advantages . . . [of] longer time horizons and [the ability to] tolerate more risk. Besides being more patient investors, philanthropists have a strong tradition of filling gaps, spurring step-changes in technology and pursuing programming that transcends both national boundaries and economic sectors. Such capacities are exactly what are needed to tackle global warming.

First, *Design to Win*, set out a clear goal. Experts believed that global warming of more than 2° Celsius would lead to extremely harmful impacts on human health, water availability, food production, and habitat for most species. The overwhelming majority of scientists agreed that to prevent this, the concentration of greenhouse gases in the atmosphere needed to remain below the equivalent of 450 parts per million of CO₂, which meant reducing the current trajectory of emissions by at least 30 gigatons (50% below projections) in 2030. It was an ambitious but necessary goal.

Design to Win then laid out a strategy for achieving these reductions. It identified four overarching priorities, noting upfront that there were no silver bullets—instead, multiple approaches would be needed, covering every area of energy production and use. The four priorities were:

1. *Prevent lock-in.* Bold steps were needed in the next decade to prevent a massive lock-in of emissions from new coal-fired power plants, inefficient buildings, industrial infrastructure, car-centric cities, and irreversible deforestation. We had to “stop digging a deeper hole.”
2. *Concentrate efforts geographically.* The United States, European Union, China, and India were identified as critical geographies, since they were the greatest contributors to emissions and held the greatest mitigation potential.
3. *Policy reform was essential.* A cap on carbon output and an accompanying market for emissions permits were described as important levers for achieving large scale emissions reductions.

¹⁹⁴ Adapted, with permission, from a teaching case written by June Wang, organizational learning officer of the William and Flora Hewlett Foundation to help the foundation improve its work by learning from past strategies.

4. *Target five critical sectors.* The most promising and urgent interventions were in electric power generation and use, industrial energy use, building and appliance energy efficiency, transportation efficiency, and reduced deforestation.

The report calculated that there existed about \$200 million in annual funding for climate issues, of which only a portion was devoted to *Design to Win* priorities. An additional \$600 million per year would be needed to implement the strategies in the report. Implementation called for existing organizations to work in new, more collaborative ways, and required the building of entirely new organizations where expertise did not exist. The *Design to Win* report thus laid the groundwork for the formation of the ClimateWorks Foundation. The idea of creating a new foundation as part of a network approach became core to the implementation of the strategy.

In 2008, the Hewlett, Packard, and McKnight Foundations made 5-year commitments, totaling \$1 billion to create the ClimateWorks Foundation, and asked Hal Harvey, who had been director of the Hewlett Foundation's environment program, to become chief executive officer and begin assembling a team for the new organization.

The ClimateWorks Network was designed to have 13 organizations in its fixed network that would work in close coordination. There were three types of organizations, each designed with a specific role and function to reach the ultimate goal of preventing a 2° Celsius increase:

1. The **ClimateWorks Foundation** (CWF) served as the overall coordinating and funding entity. Hewlett's \$500 million along with other funds flowed directly to ClimateWorks. ClimateWorks, in turn, would serve as a "wholesale" granter, funding five Regional Climate Foundations (RCFs) and seven Best Practice Networks (BPNs) (see below). For urgent policy priorities, it would conduct direct grant making to nongovernmental organizations and research institutions. CWF provided the infrastructure for the overall network. This included allocating resources according to the highest priorities and most promising mitigation opportunities—as identified in the "ClimateWorks Sudoku" (see Exhibit 1 below)— monitoring performance of the network, and helping the network share and learn from each other.
2. The **Regional Climate Foundations** included five entities: the Energy Foundation (United States) and its China Sustainable Energy Program, the newly formed European Climate Foundation, Shakti (India), and a future foundation in Latin America. These climate foundations were rooted in their home regions with deep in-country expertise. Their purpose was to shape and execute the regional philanthropic strategy, which included "conducting policy analyses, developing advocacy, and organizing coalitions of interest groups to advocate for approval of necessary policies.
3. The **Best Practice Networks** held technical expertise in the five sectors most responsible for greenhouse gas emissions. It included five existing organizations like the International Council on Clean Transportation, and two new organizations to be created to address building energy efficiency and industrial energy efficiency. The purpose of these networks was to share best practices and help replicate proven

projects across the globe. BPNs were not meant to be advocates; instead, it was thought “essential that decision makers view BPNs as honest brokers that produce unbiased material. The BPNs will be successful only if they are seen by key policymakers as credible go-to groups in each critical sector and country.”

Hewlett evaluated CWF against three major goals: (1) reduction of greenhouse gas emissions; (2) health of the network; and (3) reaching certain fundraising goals. In order to measure the first goal, all organizations in the network had to quantify and report on activities in carbon tons using a tool called Expected Value Analysis (see Exhibit 2). The second goal required these organizations to adopt a shared set of goals and practices to ensure that the impact of the combined institutions was greater than the sum of their parts. Exhibit 3 shows the key division of responsibilities between the ClimateWorks Foundation, RCFs, and BPNs.

The first few years at ClimateWorks were filled with a number of successes in reducing emissions. In China, annual industrial emissions were reduced by approximately 250 million metric tons, and in the United States, new fuel-economy standards were enacted that would reduce emissions by 400 million metric tons annually by the year 2030. On the network side, ClimateWorks had launched two new BPNs and the new Latin America RCF by the end of 2010, completing the network. A third-party evaluation cited that CWF was doing a good job in allocating its funds to the regions and sectors with the highest abatement possibilities based on the Expected Value Analysis data they were receiving quarterly. The evaluation also said that overall coordination was increasing across RCFs and BPNs.

While ClimateWorks was hitting a number of singles and doubles, to use a baseball analogy, they suffered a number of major strikeouts as well—some expected and some unexpected. The unexpected challenges came in the form of the biggest economic downturn since the U.S. Depression and two major losses in the climate policy arena:

- In December 2009, despite high expectations and deep engagement by many nations, the U.N. Convention on Climate Change in Copenhagen failed to agree to an international treaty on climate. Not only did this experience prove that the U.N. negotiation process was broken and would likely never lead to global commitments, it also left China and others increasingly wary of international engagement on climate change issues.
- In 2010, the U.S. Senate failed to enact comprehensive energy and climate legislation, which had seemed achievable less than a year earlier when the House passed a comprehensive climate bill and President Obama included climate change as one of his top three priorities. The combined effect of the global economic downturn, loss of a filibuster-proof Senate majority for Democrats, longer and tougher than expected fight over healthcare legislation, and attacks on climate science by fossil fuel interests seemed to have been the major factors in hindsight.

DISCUSSION QUESTIONS

- The big question: Based on CWF's performance to date, if you were the president or Board of the Hewlett Foundation, would you have voted to renew the commitment of \$500 million for another 5 years?
- Like cost-benefit analysis, expected return (ER) analysis assumes that one can assign numbers to the variables with a reasonable degree of confidence. With respect to the likelihood of success (LOS) in ER, economists distinguish between risk and uncertainty, where the former is specifiable (e.g., probability of 0.6) within some reasonable margin of error and the latter is not.
 - Can you assign numbers to the benefit and LOS in the climate strategies?
 - If not, is the analytic framework nonetheless useful?
- What strategies does ClimateWorks Foundation use to mitigate climate change?
- The CWF "Sudoku" (Ex. 2) quantifies technically feasible emissions reductions by 2030 by country/region and sector.
 - If you were CWF, how would you decide where to concentrate your work?
 - How could the ER formula aid your decision process?
- The CWF case describes some of successes, which it terms singles and doubles, and two major strikeouts: the failure to reach an international treaty in Copenhagen in 2009 and the U.S. Congress's failure to enact comprehensive energy and climate legislation in 2010.¹⁹⁵

On June 20, 2014, Stiftung Mercator hosted a conference on Science, Policy, and Philanthropy, which included a panel with James Wilsdon, Professor of Science and Democracy at the University of Sussex, and Paul Brest, former president of the William and Flora Hewlett Foundation. Professor Wilsdon criticized Hewlett and other foundations for supporting the risky and failed effort to achieve a global agreement to reduce greenhouse gas emissions at the United Nations Climate Change Conference in Copenhagen in 2009. There followed an e-mail exchange between them.

Brest to Wilsdon

We all knew that affecting the outcome in Copenhagen . . . was a high risk strategy. I told the Hewlett Foundation's board that I thought the chances of success were 5-10%. The basic framework within which anyone pursue policy advocacy is expected return: (benefit X likelihood of success)/cost. While the likelihood of success was low, we thought the benefit of either outcome was tremendous. As the saying goes, hindsight vision is 20-20; but decisions can only be made based on the odds ex ante.

So my question for you is, if either strategy had succeeded, against all odds, would you have cited the Design to Win effort as a positive example of strategic philanthropy? If not, is it because you would have plugged different numbers into the equation and, if so, what? Or do you think the strategies were poorly conceived or executed? What am I missing?

¹⁹⁵ Larry Kramer, the current president of the Hewlett Foundation, estimates that during its first 6 years, CWF achieved a reduction of 3–4 gigatons of CO₂ toward its goal of 11 GT.

Wilsdon to Brest

You're right of course that these criticisms are being made *ex post*, and it's not my purpose to question the noble intentions of those who were involved in the planning and execution of "Design to Win." But as part of any honest evaluation of the work of foundations in this area (something you yourself called for in our session), it seems to me entirely legitimate to evaluate 7-8 years on why 'Design to Win' failed in its own terms, and the lessons that this might offer to future philanthropic interventions at the science-policy interface (whether on climate, GM crops, synthetic biology, nuclear power, geoengineering or other contested issues).

Brest to Wilsdon

Evaluation can only be done *ex post* and, viewed retrospectively, the efforts to improve climate policies at Copenhagen and in the U.S. Congress were acknowledged failures. But a criticism of a strategy—especially a purposively high risk/high return strategy—must look at the decision from the *ex ante* point of view. The alternative is the well-known phenomenon of hindsight bias. I'm sure that the strategies were far from perfect, but just what do you think was wrong with them?

Wilsdon to Brest

Personally, I find it pretty shocking to spend half a billion dollars¹⁹⁶ [actually around \$18 million, but still a large number] on strategic choices that were, in your own words, "acknowledged failures", with at best a 5-10% chance of success. But I guess that's why I stick to science policy rather than writing books on "smart philanthropy."







- What is the fundamental disagreement between Brest and Wilsdon regarding the failures?
- If a strategy fails to achieve its objectives, how can you tell whether it was well- or poorly designed and implemented?
- Different philanthropists, like different investors, may have different tolerances for risk. Broadly speaking, what kinds of programs should highly risk-averse philanthropists fund, and what kind of programs might risk-tolerant philanthropists fund?
- Should a foundation be risk neutral, risk averse, or risk seeking with respect to its grants budget (not its endowment)?
- Should a foundation that is willing to take some risks with its grants budget, act like a financial manager, who seeks a portfolio of investments with a diverse range of (uncorrelated) risks? In other words, should it balance grants that are pretty risky with ones that are pretty sure to succeed? Why, or why not?
- Consider this hypothesis: A foundation with a \$100 million budget, that wishes to mitigate global warming through (risky) policy advocacy strategies, should be indifferent between (1) making a \$100 million grant to an organization it believes to be highly effective, and (2) making 10 \$10 million grants to 10 organizations it believes to be highly effective. Assume that, viewed in isolation, the ER of both strategies is the same.

¹⁹⁶ Professor Wilsdon perhaps was attributing the Hewlett Foundation's total 5-year unrestricted commitment to ClimateWorks, which covered all of the organization's activities.

- At the same panel discussion where Wilsdon criticized the risky strategies of a group of foundations that supported advocating for policies to mitigate climate change, he also argued that it was narrow-minded of those foundations to focus on policy advocacy to the exclusion of supporting (1) adaptation to the inevitable consequences of global warming, (2) the development of innovative energy-saving technologies, and (3) the development of innovative geoengineering technologies. What facts would affect your judgment on this issue?
- Attribution vs. contribution. There is much talk in the foundation and nonprofit sector about attributing outcomes to a particular organization or funder, with an emphasis on appropriate modesty in making claims. But is trying to discern attribution actually important for reasons besides PR or self-congratulation, and what might they be? Can you propose useful definitions of attribution and contribution?

Exhibit 1. ClimateWorks Sudoku

The sudoku shows the emissions reductions that are technically feasible in each region and sector in the year 2030.

	 Power	 Industry	 Buildings	 Transport	 Forests	Total	 Climate Policy
United States	1.7	0.6	0.9	0.8	0.2	4.2	*
Europe	0.8	0.5	0.6	0.3	0.2	2.4	*
China	3.5	3.2	0.6	0.4	0.3	8.0	*
India	1.3	0.9	0.2	0.1	0.1	2.6	*
Latin America	0.3	0.4	0.1	0.2	2.7	3.7	*
Rest of World	2.3	2.0	1.2	0.5	4.3	10.3	*
Total	9.9	7.6	3.6	2.3	7.8	31.2	*

Figures presented in gigatonnes (Gt), or billions of metric tons of CO₂e

Exhibit 2. Expected Value Analysis

Expected-value analysis guides investment decisions

ClimateWorks' investment decisions are guided by expected-value analysis (EVA), a tool that balances an initiative's ability to reduce emissions against the likelihood of achieving those carbon savings. In essence, EVA multiplies a strategy's mitigation potential, in tons of CO₂e, by the probability of securing the necessary policies. As shown below, the actual EVA is more nuanced. In addition to estimating the tons of emissions avoided and odds of winning a policy, the analysis also factors in ClimateWorks' contribution to the victory and the probability of implementation. Bonuses are given for policies that address carbon lock-in or cause a cascade of positive changes in the economy. The EVA also puts a premium on opportunities that are perishable. We can estimate these inputs with varying degrees of precision: the emissions figures are based on hard, quantitative data, while the probabilities in the policy world are founded on qualitative assessments that have wider error bars. These inherently subjective judgments will be pressure tested by leaders of the Network, subject to scrutiny through monitoring and evaluation procedures, and distributed via the knowledge management system.

Expected value =	Carbon analysis				"Bonuses"		
	Magnitude (CO ₂ e) X	Increment addressed (%) X	Prob. of policy win (%) X	Prob. of implement. (%) X	Inter-dependence	Perishability	Lock-in
Definition	<ul style="list-style-type: none"> Annual impact by 2030 Cumulative impact by 2030 	<ul style="list-style-type: none"> Proportion of impact addressed by initiative 	<ul style="list-style-type: none"> Probability of policy win within 3 years 	<ul style="list-style-type: none"> Probability of implement. within 3 years 	<ul style="list-style-type: none"> Impacts other initiatives? 	<ul style="list-style-type: none"> Now or never? 	<ul style="list-style-type: none"> Long-lived emissions?
Evaluation type	Hard numerical estimate	Hard numerical estimate	Estimate within ~20%	Estimate within ~20%	Qualitative assessment (high, med, low, none)		
Input							
Owner	CWF	RCFs	RCFs	RCFs	CWF	RCFs	RCFs
Support	RCFs	BPNs, field	BPNs	BPNs	RCFs, BPNs	BPNs	BPNs

Source: ClimateWorks Blueprint, June 5, 2009

Exhibit 3. Key ClimateWorks Network Processes and Division of Responsibilities

	ClimateWorks Foundation	Regional Climate Foundations	Best Practice Networks
Governance	<ul style="list-style-type: none"> Governed by independent board Informed by Management Council 	<ul style="list-style-type: none"> Governed by independent boards with a CWF rep. RCFs participate Management Council on a rotating basis 	<ul style="list-style-type: none"> BPNs with board will have a CWF rep. on board Participate in Management Council on a rotating basis
Strategy setting	<ul style="list-style-type: none"> Maintains global carbon prioritization matrix and Network strategy paper Convenes Network’s annual summit Reviews and funds Network priorities Pursues global initiatives, including research and retail grantmaking 	<ul style="list-style-type: none"> Develop regional strategies with local grantees Perform rigorous EVA as part of multi-year strategy setting and annual prioritization Seek local funding to support CW and other priorities 	<ul style="list-style-type: none"> Shape sector strategies with RCFs and CWF Perform rigorous EVA as part of multi-year strategy setting and annual prioritization Convene sector strategy groups as needed
Measurement & evaluation	<ul style="list-style-type: none"> Develops M&E process, templates, and metrics in consultation with RCFs/BPNs Evaluates RCFs and BPNs through scorecards and evaluates self 	<ul style="list-style-type: none"> Conduct M&E on own operations Submit M&E results as a requirement for funding 	<ul style="list-style-type: none"> Conduct M&E on own operations Submit M&E results as a requirement for funding
Knowledge management	<ul style="list-style-type: none"> Sets overall knowledge agenda in coordination with RCFs and BPNs Funds and operates the Network knowledge management system Uses system to inform research and assist RCFs and BPNs 	<ul style="list-style-type: none"> Identify knowledge gaps Develop and share knowledge to advance Network goals Use knowledge to build capacity and inform strategy and tactics 	<ul style="list-style-type: none"> Identify knowledge gaps Develop and share knowledge to advance Network goals Use knowledge to improve policy work

Source: *ClimateWorks Blueprint, June 5, 2009*