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15. Investing in the Unknown and Unknowable

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David Ricardo made a fortune buying bonds from the British government four days in advance of the Battle of Waterloo.[1] He was not a military analyst, and even if he were, he had no basis to compute the odds of Napoleon's defeat or victory, or hard-to-identify ambiguous outcomes. Thus, he was investing in the unknown and the unknowable. Still, he knew that competition was thin, that the seller was eager, and that his windfall pounds should Napoleon lose would be worth much more than the pounds he'd lose should Napoleon win. Ricardo knew a good bet when he saw it.

This essay discusses how to identify good investments when the level of uncertainty is well beyond that considered in traditional models of finance. Many of the investments considered here are one-time only, implying that past data will be a poor guide. In addition, the essay will highlight investments, such as real estate development, that require complementary skills. Most readers will not have such skills, but many will know others who do. When possible, it is often wise to make investments alongside them.

Though investments are the ultimate interest, the focus of the analysis is how to deal with the unknown and unknowable, hereafter abbreviated ***uU***. Hence,

[1] An earlier version of this paper appeared as "Investing in the Unknown and Unknowable," *Capitalism and Society* 1(2), 2006, Berkeley Electronic Press, www.bepress.com/cas/vol1/iss2/art5.

I will sometimes discuss salient problems outside of finance, such as terrorist attacks, which are also unknown and unknowable.

This essay takes no derivatives, and runs no regressions.[2] In short, it eschews the normal tools of my profession. It represents a blend of insights derived from reading academic works and from trying to teach their insights to others, and from lessons learned from direct and at-a-distance experiences with a number of successful investors in the ***uU*** world. To reassure my academic audience, I use footnotes where possible, though many refer to accessible internet articles in preference to journals and books. Throughout this essay, you will find speculations and maxims, as seems called for by the topic. They are labeled in sequence.

This informal approach seems appropriate given our present understanding of the topic. Initial beliefs about this topic are highly uncertain, or as statisticians would phrase it: "Prior distributions are diffuse." Given that, the judicious use of illustrations, and prudent attempts to provide taxonomies and sort tea leaves, can substantially hone our beliefs, that is, tighten our future predictions.

Section 15.1 of this chapter talks about risk, uncertainty, and ignorance, the last carrying us beyond traditional discussions. Section 15.2 looks at behavioral economics, the tendency for humans to deviate in systematic ways from rational decisions, particularly when probabilities are involved, as they always are with investments. Behavioral economics pervades the ***uU*** world. Section 15.3 addresses the role of skilled mathematical types now so prevalent in finance. It imparts a general lesson: If super-talented people will be your competitors in an investment arena, perhaps it is best not to invest. Its second half discusses a dispute between math types on money management, namely how much of your money to invest when you do have an edge. Section 15.4 details when to invest when you can make more out of an investment, but there is a better informed person on the other side of the transaction. Section 15.5 tells a Buffett tale, and draws appropriate inferences. Section 15.6 concludes the discussion.

15.1. RISK, UNCERTAINTY, AND IGNORANCE

15.1.1. Escalating Challenges to Effective Investing

The essence of effective investment is to select assets that will fare well when future states of the world become known. When the probabilities of future states of assets are known, as the efficient markets hypothesis posits, wise investing

[2] Ralph Gomory's (1995) literary essay on the unknown and unknowable provided inspiration. Miriam Avins provided helpful comments. Nils Wernerfelt provided effective research assistance.

involves solving a sophisticated optimization problem. Of course, such probabilities are often unknown, banishing us from the world of the capital asset pricing model (CAPM), and thrusting us into the world of uncertainty.[3]

Were the financial world predominantly one of mere uncertainty, the greatest financial successes would come to those individuals best able to assess probabilities. That skill, often claimed as the domain of Bayesian decision theory, would swamp sophisticated optimization as the promoter of substantial returns.

The real world of investing often ratchets the level of nonknowledge into still another dimension, where even the identity and nature of possible future states are not known. This is the world of ignorance. In it, there is no way that one can sensibly assign probabilities to the unknown states of the world. Just as traditional finance theory hits the wall when it encounters uncertainty, modern decision theory hits the wall when addressing the world of ignorance. I shall employ the acronym ***uU*** to refer to situations where both the identity of possible future states of the world as well as their probabilities are unknown and unknowable. Table 1 outlines the three escalating categories; entries are explained throughout the paper.

This essay has both dreary and positive conclusions about investing in a ***uU*** world. The first dreary conclusion is that unknowable situations are widespread and inevitable. Consider the consequences for financial markets of global warming, future terrorist activities, or the most promising future technologies. These outcomes are as unknowable today as were the 1997 Asian meltdown, the 9/11 attacks, or the NASDAQ soar and swoon at the end of the century, shortly before they were experienced.

These were all aggregate unknowables, affecting a broad swath of investors. But many unknowables are idiosyncratic or personal, affecting only individuals or handfuls of people, such as: If I build a 300-home community ten miles to the west of the city, will they come? Will the Vietnamese government let me sell my insurance product on a widespread basis? Will my friend's new software program capture the public fancy, or, if not, might it succeed in a completely different application? Such idiosyncratic ***uU*** situations, I argue below, present the greatest potential for significant excess investment returns.

The second dreary conclusion is that most investors—whose training, if any, fits a world where states and probabilities are assumed known—have little idea of how to deal with the unknowable. When they recognize its presence, they tend to steer clear, often to protect themselves from sniping by others. But for all but the simplest investments, entanglement is inevitable—and when investors do get entangled they tend to make significant errors.

[3] The classic description of uncertainty, a situation where probabilities could not be known, is due to Frank Knight (1921).

TABLE 15.1.
Escalating Challenges to Effective Investing

	Knowledge of States of the World	Investment Environment	Skills Needed
Risk	Probabilities known	Distributions of returns known	Portfolio optimization
Uncertainty ***U***	Probabilities unknown	Distributions of returns conjectured	Portfolio optimization Decision theory
Ignorance ***uU***	States of the world unknown	Distributions of returns conjectured, often from deductions about other's behavior; complementary skills often rewarded alongside investment	Portfolio optimization Decision theory Complementary skills (ideal) Strategic inference

The first positive conclusion is that unknowable situations have been and will be associated with remarkably powerful investment returns. The second positive conclusion is that there are systematic ways to think about unknowable situations. If these ways are followed, they can provide a path to extraordinary expected investment returns. To be sure, some substantial losses are inevitable, and some will be blameworthy after the fact. But the net expected results, even after allowing for risk aversion, will be strongly positive.

Do not read on, however, if blame aversion is a prime concern: The world of ***uU*** is not for you. Consider this analogy. If in an unknowable world none of your bridges falls down, you are building them too strong. Similarly, if in an unknowable world none of your investments looks foolish after the fact, you are staying too far away from the unknowable.

Warren Buffett, a master at investing in the unknowable, and therefore a featured player in this essay, is fond of saying that playing contract bridge is the best training for business. Bridge requires a continual effort to assess probabilities in, at best, marginally knowable situations, and players need to make hundreds of decisions in a single session, often balancing expected gains and losses. But players must also continually make peace with good decisions that lead to bad outcomes, both one's own decisions and those of a partner. Just this peacemaking skill is required if one is to invest wisely in an unknowable world.

15.1.2. The Nature of Unknowable Events

Many of the events that we classify as unknowable arrive in an unanticipated thunderclap, giving us little or no time to anticipate or prepare. But once they happen, they do not appear that strange. The human mind has an incredible ability to find a rationalization for why it should have been able to conjecture the terror attack of 9/11; or the Asian tsunamis of 1997 and 2005, respectively caused by currency collapse and underwater earthquake. This propensity to incorporate hindsight into our memories—and to do so particularly when Monday morning quarterbacks may attack us—hinders our ability to anticipate extreme events in the future. We learn insufficiently from our misestimates and mistaken decisions.

Other unknowable events occur over a period of time, as did the collapse of the Soviet Union. Consider most stock market swings. Starting in January 1996, the NASDAQ rose fivefold in four years. Then it reversed field and fell by two-thirds in three years. Similarly, the 50% collapse in the broad stock market from May 2008 till March 2009 was a fairly steady progression, with only a brief period of truly steep decline in fall 2008. Such developments are hardly thunderclaps. They are more like blowing up a balloon and then dribbling out the air. In retrospect, these remarkable swings have lost the flavor of an unknowable event, even though financial markets are not supposed to work that way. If securities prices at any moment incorporate all relevant information, a property that is usually posited, long-term movements in one direction are hardly possible, since strong runs of unanticipated good news or bad news will be exceedingly rare. Similarly, the AIDS scourge now seems familiar territory, though 25 years ago—when there had been only 31 cumulative deaths in the United States from AIDS—no one would have predicted a worldwide epidemic killing tens of millions and vastly disrupting the economies of many poor nations.

Are ***uU*** events to be feared? Warren Buffett once noted that virtually all surprises are unpleasant. Most salient ***uU*** events seem to fall into the left tail of unfortunate occurrences. This may be more a matter of perception than reality. Often an upside unknowable event, say the diminution of terror attacks or recovery from a dread disease, is difficult to recognize. An attack on any single day was not likely anyway, and the patient still feels lousy on the road to recovery. Thus, the news just dribbles in, as in a financial market upswing. B. F. Skinner, the great behavioral psychologist, taught us that behavior conditioned by variable interval reinforcement—engage in the behavior and from time-to-time the system will be primed to give you a payoff—was the most difficult to extinguish. Subjects could never be sure that another reward would not be forthcoming. Similarly, it is hard to discern when a string of inconsistently

spaced episodic events has concluded. If the events are unpleasant, it is not clear when to celebrate their end.

Let us focus for the moment on thunderclap events. They would not get this title unless they involved something out of the ordinary, either good or bad. Casual empiricism—judged by looking at local, national, and international headlines—suggests that thunderclap events are disproportionately adverse. Unlike in the old television show, *The Millionaire*, people do not knock on your door to give you a boatload of money, and in Iraq terror attacks outnumber terrorist arrests manifold.

The financial arena may be one place with an apparently reasonable ratio of upside to downside ***uU*** events, particularly if we include events that are drifts and not thunderclaps. By the end of 2004, there were 2.5 million millionaires in the United States, excluding housing wealth (money.cnn.com/2005/06/09/news/world_wealth/). Many of these individuals, no doubt, experienced upside ***uU*** events. Some events, such as the sustained boom in housing prices, were experienced by many, but many upside events probably affected only the individual and perhaps a few others. Such events include an unexpected lucrative job, or having a business concept take a surprisingly prosperous turn, or having a low-value real estate holding explode in value, and so on.

We hear about the lottery winner—the big pot, the thunderclap, and the gain for one individual makes it newsworthy. In contrast, the tens of thousands of ***uU*** events that created thousands of new real estate investment millionaires are mostly reported in dry aggregate statistics. Moreover, contrary to the ads in the back of magazines, there is usually not a good way to follow these "lucky folks," since some complementary skill or knowledge is likely to be required, not merely money and a wise choice of an investment. Thus, many favorable ***uU*** financial events are likely to go unchronicled. By contrast, bad news financial events, such as the foreclosure explosion of 2008–09, like other bad news events, such as murders and fires, tend to get media attention. In drawing inferences about the distribution of financial ***uU*** events, it is dangerous to rely on what you read in the papers.

To return to the Pollyannish side, it is worth noting the miracles of percentage symmetry given extreme events. Posit that financial prices move in some symmetric fashion. Given that negative prices are not possible, such changes must be in percentage rather than absolute terms.[4] We will not notice any

[4] This is sometimes expressed that things move geometrically rather than arithmetically, or that the logarithm of price has a traditional symmetric distribution. The most studied special case is the lognormal distribution. See "Life is log-normal" by E. Limpert and W. Stahel, http://www.inf.ethz.ch/personal/gut/lognormal/brochure.html, for an argument on the widespread applicability of this distribution.

difference between percentage and absolute if changes are small relative to the mean. Thus, if a price of 100 goes up or down by an average of 3 each year, or up by a ratio of 103/100 or down by 100/103 hardly matters. But change that 3 to a 50, and the percentage symmetry helps a great deal. The price becomes 100(150/100) or 100(100/150), which has an average of 117. If prices are anything close to percentage symmetric, as many believe they are, then big swings are both enemy and friend: enemy because they impose big risks, friend because they offer substantial positive expected value.

Many millionaires have made investments that multiplied their money 10-fold, and some 100-fold. The symmetric geometric model would expect events that cut one's stake to 1/10 or 1/100 of its initial value to be equally likely. The opportunity to get a 10 or 100 multiple on your investment as often as you lose virtually all of it is tremendously attractive.

There is, of course, no reason why investments must yield symmetric geometric returns. But it would be surprising not to see significant expected excess returns to investments that have three characteristics addressed in this essay: (1) ***uU*** underlying features, (2) complementary capabilities are required to undertake them, so the investments are not available to the general market, and (3) it is unlikely that a party on the other side of the transaction is better informed. That is, ***uU*** may well work for you, if you can identify general characteristics of when such investments are desirable, and when not.

These very attractive three-pronged investments will not come along everyday. And when they do, they are unlikely to scale up as much as the investor would like, unlike an investment in an underpriced New York Stock Exchange (NYSE) stock, which scales nicely, at least over the range for most individual investors. Thus, the ***uU***-sensitive investor should be constantly on the lookout for new opportunities. That is why Warren Buffett trolls for new businesses to buy in each Berkshire-Hathaway annual report, and why most wealthy private investors are constantly looking for new instruments or new deals.

15.1.3. Uniqueness

Many ***uU*** situations deserve a third ***U***, for unique. If they do, arbitrageurs—who like to have considerable past experience to guide them—will steer clear. So too will anybody who would be severely penalized for a poor decision after the fact. An absence of competition from sophisticated and well-monied others spells the opportunity to buy underpriced securities.

Most great investors, from David Ricardo to Warren Buffett, have made most of their fortunes by betting on ***uUU*** situations. Ricardo allegedly made 1 million

pounds (over $50 million today)—roughly half of his fortune at death—on his Waterloo bonds.[5] Buffett has made dozens of equivalent investments. Though he is best known for the Nebraska Furniture Mart and See's Candies, or for long-term investments in companies like the Washington Post and Coca Cola, insurance has been Berkshire Hathaway's firehose of wealth over the years. And insurance often requires ***uUU*** thinking, and careful analysis of when to proceed and when to steer clear. Buffett and Berkshire know when the unknowables in a situation make clear steering the wise course. No insurance of credit default swaps for them. However, a whole section below discusses Buffett's success with what many experts saw as a ***uUU*** insurance situation, so they steered clear; but he saw it as offering excess premium relative to risk, so he took it all.

Speculation 1: ***uUU*** investments—unknown, unknowable, and unique—drive off speculators, which creates the potential for an attractive low price.

Some ***uU*** situations that appear to be unique are not, and thus fall into categories that lend themselves to traditional speculation. Corporate takeover bids are such situations. When one company makes a bid for another, it is often impossible to determine what is going on or what will happen, suggesting uniqueness. But since dozens of such situations have been seen over the years, speculators are willing to take positions in them. From the standpoint of investment, uniqueness is lost, just as the uniqueness of each child matters not to those who manufacture sneakers.

15.1.4. Weird Causes and Fat Tails

The returns to ***uUU*** investments can be extreme. We are all familiar with the bell curve (or normal distribution), which nicely describes the number of flips of a fair coin that will come up heads in a large number of trials. But such a mechanical and controlled problem is extremely rare. Heights are frequently described as falling on a bell curve. But, in fact, there are many too many people who are extremely tall or extremely short, due, say, to glandular disturbances or genetic abnormalities. The standard model often does not apply to observations in the tails. So too with most disturbances to investments. Whatever the

[5] Ricardo's major competitors were the Baring Brothers and the Rothschilds. Do not feel sorry for the Rothschilds. In the 14 years from 1814 to 1828 they multiplied their money 8-fold, often betting on ***UU*** situations, while the Baring Brothers lost capital. www.businessweek.com/1998/49/b3607071.htm. Analysis based on Niall Ferguson's House of Rothschild.

explanation for the October 1987 crash, it was not due to the usual factors that are used to explain market movements.[6]

More generally, movements in financial markets and of investments in general appear to have much thicker tails than would be predicted by Brownian motion, the instantaneous source of bell curve outcomes. That may be because the fundamental underlying factors produce thicker tails, or because there are rarely occurring anomalous or weird causes that produce extreme results, or both. The ***uU*** and ***uUU*** models would give great credence to the latter explanation, though both could apply.[7]

15.5.5. Complementary skills and *uU* investments

A great percentage of ***uU*** investments, and a greater percentage of those that are ***uUU***, provide great returns to a complementary skill. For example, many of America's great fortunes in recent years have come from real estate. These returns came to people who knew where to build, and what and how. Real estate developers earn vast amounts on their capital because they have complementary skills. Venture capitalists can secure extraordinary returns on their own monies, and charge impressive fees to their investors, because early stage companies need their skills and their connections. In short, the return to these investments comes from the combination of scarce skills and wise selection of companies for investment. High tech pioneers—Bill Gates is an extreme example—get even better multiples on their investment dollars as a complement to their vision and scientific insight.[8]

[6] Hart and Tauman (2004) show that market crashes are possible purely due to information processing among market participants, with no new information. They observe that the 1987 crash—20% in a day—happened despite no new important information becoming available, or negative economic performance after the crash. Market plunges due to ordinary information processing defies any conventional explanation, and is surely a ***UU*** event.

[7] Nassim Taleb and Benoit Mandelbrot posit that many financial phenomena are distributed according to a power law, implying that the relative likelihood of movements of different sizes depends only on their ratio. Thus, a 20% market drop relative to a 10% drop is the same as a 10% drop relative to a 5% drop (www.fooledbyrandomness.com/fortune.pdf). Power distributions have fat tails. In their empirical studies, economists frequently assume that deviations from predicted values have normal distributions. That makes computations tractable, but evidence suggests that tails are often much thicker than with the normal (Zeckhauser and Thompson 1970).

[8] Complementary skills can also help the less affluent invest. Miriam Avins, a good friend, moved into an edgy neighborhood in Baltimore because the abandoned house next door looked like a potential community garden, she knew she had the skills to move the project forward, and she valued the learning experience the house would bring to her family. Her house value doubled in 3 years, and her family learned as well.

Alas, few of us possess the skills to be a real estate developer, venture capitalist, or high-tech pioneer. But how about becoming a star of ordinary stock investment? For such efforts an ideal complementary skill is unusual judgment. Those who can sensibly determine when to plunge into and when to refrain from ***uUU*** investments gain a substantial edge, since mispricing is likely to be severe.

Warren Buffett's unusual judgment operates with more prosaic companies, such as oil producers and soft drink firms. He is simply a genius at everyday tasks, such as judging management capability or forecasting company progress. He drains much of the unknowable in judging a company's future. But he has other advantages. A number of Buffett's investments have come to him because companies sought him out, asking him to make an investment and also to serve on their board, valuing his discretion, his savvy, and his reputation for rectitude—that is, his complementary skills, not merely his money. And when he is called on for such reasons, he often gets a discounted price. Buffett flubbed it when he invested heavily in companies like Goldman Sachs and General Electric in fall 2008, but his pain was surely diminished because he had a 10% preferred coupon in both companies, quite apart from the now well-out-of-the-money options he received. Those like Buffett who can leverage complementary skills in stock market investment will be in a privileged position of limited competition. But that will accomplish little if they do not show courage and make big purchases where they expect high payoffs. The lesson for regular mortals is not to imitate Warren Buffett; that makes no more sense than trying to play tennis like Roger Federer. Each of them has an inimitable skill. If you lack Buffett capabilities, you will get chewed up as a bold stock picker.

Note, by the way, the generosity with which great investors with complementary skills explain their successes—Buffett in his annual reports, any number of venture capitalists who come to lecture MBAs, and the highly successful investors who lecture my executive students about behavioral finance.[9] These master investors need not worry about the competition, since few others possess the complementary skills for their types of investments. Few ***uU*** investment successes come from catching a secret, such as the whispered hint of "plastics" in the movie *The Graduate*. Mayer Amschel Rothschild had five sons who were bright, disciplined, loyal, and willing to disperse. These were the complementary skills. The terrific investments in a ***uU*** world—and the Rothschild fortune—followed.

[9] They speak to my Investment Decisions and Behavioral Finance executive program at Harvard. The first was Charlie Munger, Buffett's partner, in the 1980s. The two most recent were Jeremy Grantham of GMO and Seth Klarman of the Baupost Group. Some investment wizards do have a "magic sauce" that they will not reveal. Thus, the unbelievably successful Renaissance Technologies hedge fund, which relies on mathematical and computer models, reveals nothing.

Before presenting a maxim about complementary skills, I present you with a decision problem. You have been asked to join the Business Advisory Board of a company named Tengion. Tengion was founded in 2003 to develop and commercialize a medical breakthrough: "developing new human tissues and organs (*neo-tissues* and *neo-organs*) that are derived from a patient's own cells . . . [this technology] harnesses the body's ability to regenerate, and it has the potential to allow adults and children with organ failure to have functioning organs built from their own (*autologous*) tissues." (www.tengion.com/)

This is assuredly a ***uU*** situation, doubly so for you, since until now you had never heard the term neo-organ. A principal advantage of joining is that you would be able to invest a reasonable sum on the same basis as the firm's insiders and venture capitalists. Would you choose to do so?

I faced this decision problem because I had worked successfully with Tengion's president on another company many years earlier. He was an individual of high capability and integrity. I was delighted with the ***uU*** flavor of the situation, and chose to join and invest because I would be doing so on the same terms as sophisticated venture capital (VC) firms with track records and expertise in relevant biotech areas. They would undertake the due diligence that was beyond my capability. This was an investment from which virtually everyone else would be excluded. In addition, it would benefit from the complementary skills of the VCs.

15.1.6. Sidecar Investments

Such undertakings are "sidecar investments"; the investor rides along in a sidecar pulled by a powerful motorcycle. Perhaps the premier sidecar investment ever available to the ordinary investor was Berkshire Hathaway, many decades back. One could have invested alongside Warren Buffett, and had him take a ridiculously low compensation for his services. (In recent years, he has been paid $100,000, with no bonus or options.) But in 1960 who had heard of Warren Buffett, or knew that he would be such a spectacular and poorly compensated investor? Someone who knew Buffett and recognized his remarkable capabilities back then was in a privileged ***uU*** situation.

Maxim A: Individuals with complementary skills enjoy great positive excess returns from ***uU*** investments. Make a sidecar investment alongside them when given the opportunity.

Do you have the courage to apply this maxim? It is January 2006 and you, a Western investor, are deciding whether to invest in Gazprom, the predominantly

government-owned Russian natural gas giant in January 2006. Russia is attempting to attract institutional investment from the West; the stock is sold as an American depository receipt (ADR), and is soon to be listed on the over-the-counter (OTC) exchange; the company is fiercely profitable, and it is selling gas at a small fraction of the world price. On the upside, it is generally known that large numbers of the Russian elite are investors, and here and there it is raising its price dramatically. On the downside, Gazprom is being employed as an instrument of Russian government policy; for example, gas is sold at a highly subsidized price to Belarus, because of its sympathetic government, yet the Ukraine is being threatened with more than a fourfold increase in price, in part because its government is hostile to Moscow. And the company is bloated and terribly managed. Finally, experiences, such as those with Yukos Oil, make it clear that the government is powerful, erratic, and ruthless.

This is clearly a situation of ignorance, or ***uU***. The future states of the world are simply not known. Will the current government stay in power? Will it make Gazprom its flagship for garnering Western investment? If so, will it streamline its operations? Is it using foreign policy concerns as a device mainly to raise prices, a strong positive, and is it on a path to raise prices across the board? Will it complete its proposed pipelines to Europe? What questions haven't you thought of, whose answers could dramatically affect your payout? Of course, you should also determine whether Western investors have distinct disadvantages as Gazprom shareholders, such as unique taxes and secondary voting status. Finally, if you determine the investment is favorable given present circumstances, you should ask how quickly Russia could change conditions against outsiders, and whether you will be alert and get out if change begins.

You could never learn about the unknowables sufficiently well to do traditional due diligence on a Gazprom investment. The principal arguments for going ahead would be that speculation 1 and maxim A apply. If you could comfortably determine that the Russian elite was investing on its own volition, and that foreigners would not be discriminated against, or at least not quickly, this would make a sensible sidecar investment.[10]

15.2. BEHAVIORAL ECONOMICS AND DECISION TRAPS

Behavioral decision has shaken the fields of economics and finance in recent decades. Basically, this work shows in area after area that individuals systematically

[10] This investment was proposed when this chapter was presented as a paper at a conference sponsored by the Wharton School on January 6, 2006. The price was then 33.60. The stock peaked above 60 in spring 2008, but then collapsed with oil prices and the Russian stock market.

deviate from making decisions in a manner that would be admired by Jimmie Savage (1954) and Howard Raiffa (1968), pioneers of the rational decision paradigm. As one illustration, such deviators could be turned into money pumps: They would pay to pick gamble B over gamble A. Then with A reframed as A′, but not changed in its fundamentals, they would pay to pick A over B.

That is hardly the path to prudent investment, but, alas, behavioral decision has strong descriptive validity. Behavioral decision has important implications for investing in ***uU*** situations. When considering our own behavior, we must be extremely careful not to fall prey to the biases and decision traps it chronicles. Almost by definition, ***uU*** situations are those where our experience is likely to be limited, where we will not encounter situations similar to other situations that have helped us hone our intuition.

Virtually all of us fall into important decision traps when dealing with the unknowable. This section discusses two, overconfidence and recollection bias, and then gives major attention to a third, misweighting differences in probabilities and payoffs. But there are dozens of decision traps, and some will appear later in this essay. The Nobel Prize-winning work of Daniel Kahneman and Amos Tversky (the latter was warmly cited, but died too soon to win),[11] and the delightful and insightful *Poor Charlie's Almanack*, written by Charles Munger (Warren Buffett's partner) respectively provide academic and finance-oriented discussions of such traps.

There are at least three major objections to behavioral economics: First, in competitive markets, the anomalies it describes will be arbitraged away. Second, the anomalies appear only in carefully crafted situations; they are much like optical illusions, intriguing but rarely affecting everyday vision. Third, they describe the way people do behave, but not the way they should behave. The first objection is tangential to this discussion; competitive markets and arbitrage are not present in many ***uU*** situations, and, in particular, not the ones that interest us. The second objection is relatively unimportant because, in essence, ***uU*** situations are those where optical illusions rule the world. A ***uU*** world is not unlike a fun house. Objection three I take up seriously below; this essay is designed to help people behave more rationally when they invest.

Let us first look at the biases.

15.2.1. Overconfidence

When individuals are assessing quantities about which they know very little, they are much too confident of their knowledge (Alpert and Raiffa 1982).

[11] See nobelprize.org/nobel_prizes/economics/laureates/2002/public.html.

Appendix A offers you a chance to test your capabilities in this regard. For each of eight unknown quantities, such as the area of Finland, you are asked to provide your median estimate, then your 25th and 75th percentile estimates (i.e., it is one-quarter likely the true value will be more extreme than either of the two), and then your 1st and 99th percentiles, what are referred to as surprise points. In theory, an individual should have estimates outside her surprise points about 2% of the time. In fact, even if warned about overconfidence, individuals are surprised about 35% of the time.[12] Quite simply, individuals think they know much more about unknowable quantities than they do.

Speculation 2: Individuals who are overconfident of their knowledge will fall prey to poor investments in the ***uU*** world. Indeed, they are the green plants in the elaborate ecosystem of finance where there are few lions, like Warren Buffett; many gazelles, like you and me; and vast acres of grass ultimately nourishing us all.

15.2.2. Recollection Bias

A first lesson in dealing with ***uU*** situations is to know thyself. One good way to do this is to review successes and failures in past decisions. However, since people do not have a long track record, they naturally turn to hypotheticals from the past: Would I have judged the event that actually occurred to be likely? Would I have made that good investment and steered clear of the other bad one? Would I have sold out of NASDAQ stocks near New Year 2001? Alas, human beings do not do well with such questions. They are subject to substantial recollection bias.[13]

Judging by articles in the *New York Times* leading up to September 11, 2001, there was virtually no anticipation of a major terrorist attack on the United States; it was a clear ***uUU*** event. But that is not what respondents told us one to three years later. They were asked to compare their present assessments of the likelihood of a massive terrorist attack with what they estimated that likelihood to be on September 1, 2001. Of more than 300 Harvard Law and Kennedy School students surveyed, 31% rated the risk as now lower, and 26% rated the risk as the same as they had perceived the 9/11 risk before the event.[14] We can

[12] Approximate average from Investment Decisions and Behavioral Finance, executive program, annually, fall 2001–2006, and API-302, Analytic Frameworks for Policy course. The former is chaired, the latter taught by Richard Zeckhauser, Kennedy School, Harvard University.

[13] See Gilbert (2006) for insightful discussions of the problems of rationalization and corrigibility.

[14] See Viscusi and Zeckhauser (2005).

hardly be confident that investors will be capable of judging how they would have assessed ***uU*** risks that occurred in the past.

15.2.3. Misweighting Probabilities and Preferences

The two critical components of decision problems are payoffs and probabilities. Effective decision requires that both be carefully calibrated. Not surprisingly, *prospect theory*, the most important single contribution to behavioral decision theory to date, finds that individuals' responses to payoffs and probabilities are far from rational.[15] To my knowledge, there is no tally of which contributes more to the loss of expected utility from the rational norm. (Some strong supporters of behavioral decision theory, however, think it is our norms that are misguided, and that the way the brain naturally perceives outcomes, not the prescriptions of decision theorists and economists, should be the guideline.) Whether drawing from prospect theory or observation, it seems clear that individuals draw insufficient distinctions among small probabilities. Consider the experiment shown in table 15.2, in which an individual is asked to pick A or B.

A rational, risk-averse individual should opt for B, since it offers a higher expected value—$25 versus $20—and less risk. Yet past experiments have shown that many individuals choose A, since in accordance with prospect theory they do not distinguish sufficiently between two low-probability events. We speculate further that if we used named contingencies—or example, the Astros or the Blue Jays win the World Series—alongside their probabilities, the frequency of preference for A would increase. The contingencies would be selected, of course, so that their likelihood of occurrence, as indicated by odds in Las Vegas, would match those in the example above.

This hypothetical experiment establishes a baseline for another one that involves ***uU*** events. This time the prizes are based on events that are as close to the spectrum of ***uU*** events as possible, subject to the limitation that they must be named.[16] Thus, a contingency might be that a 10,000-ton asteroid passed within 50,000 miles of Earth within the past decade, or that more than a million mammals crossed the border from Tanzania to Kenya last year. To begin our experiment, we ask a random sample of people to guess the likelihood of these contingencies. We then alter the asteroid distance or the number of animals in

[15] Kahneman and Tversky (1979).

[16] This illustration employs events that may have happened in the past, but subjects would not know. The purpose is to make payoffs immediate, since future payoffs suffer from a different form of bias.

Table 15.2
Lottery Choice: Payoffs Versus Probabilities

	Payoff	Probability
A	$2000	0.01
B	$1000	0.025

Table 15.3
Lottery Choice: Payoffs versus Probability or ***uU*** Event

	Payoff	Required contingency
C	$2000	Draw a 17 from an urn with balls numbered 1 to 100
D	$1000	10,000-ton asteroid passed within 40,000 miles of Earth

the question until the median answer is 0.03. Thus, if 50,000 miles got a median answer of 0.05, we would adjust to 40,000 miles, and so on.

We now ask a new group of individuals to choose between C and D, assuming that we have calibrated the asteroid and mammal question to get to 0.03 (see table 15.3). Lotteries C and D should yield their prizes with estimated probabilities of 1 and 3%, respectively. Still, we suspect that many more people would pick C over D than picked A over B, and that this would be true for the animal movement contingency as well.[17]

A more elaborated version of this problem would offer prizes based on alternative ***uU*** contingencies coming to pass. For example, we might recalibrate the mammal-crossing problem to get a median response of 0.01. We would then have the choices shown in table 15.4. Here the values have been scaled so the median response is three times higher for the asteroid event than the animal crossing. We would conjecture again that E would be chosen frequently.[18] People do not like to rely on the occurrence of ***uU*** events, and choices based on distinguishing among their probabilities would be an unnatural act.

[17] The experiment is at a disadvantage in getting this result, since peoples' assessments of the contingencies' probabilities would vary widely. Some would pick D because they attached an unusually high probability to it. In theory, one could ask people their probability estimate after they made their choice, and then look only at the answers of those for whom the probability was in a narrow range. However, individuals would no doubt adjust their retrospective probability estimates to help rationalize their choice.

[18] This experiment and the choice between lotteries C and D above only approximate those with numerical probabilities, since they are calibrated for median responses and individuals' estimates will differ.

TABLE 15.4
Lottery Choice: Payoffs versus *uU* Events

	Payoff	Required contingency
E	$2000	Calibrated large number of animals crossed the Tanzania–Kenya border
F	$1000	10,000 ton-asteroid passed within 40,000 miles of Earth

Daniel Ellsberg (1961) alerted us to ambiguity aversion long before he created a ***uU*** event by publishing the Pentagon papers. In an actual experiment, he showed, in effect, that individuals preferred to win a prize if a standard coin flip came up heads, rather than to win that prize by choosing either heads or tails on the flip of a mangled coin whose outcome was difficult to predict.[19] Such ambiguity aversion may be a plausible heuristic response to general decisions under uncertainty, since so often there is a better-informed person on the other side—such as someone selling a difficult-to-assess asset.[20] Whatever the explanation, ambiguity aversion has the potential to exert a powerful effect. Extending Ellsberg one step further, it would seem that the more ambiguous the contingencies, the greater the aversion. If so, ***uU*** investments will drive away all but the most self-directed and rational thinking investors. Thus, speculation 1 is reinforced.

15.3. MATH WHIZZES IN FINANCE AND CASH MANAGEMENT

The major fortunes in finance, I would speculate, have been made by people who are effective in dealing with the unknown and unknowable. This will probably be truer still in the future. Given the influx of educated professionals into finance, those who make their living speculating and trading in traditional markets are increasingly up against others who are tremendously bright and tremendously well-informed.[21]

[19] In fact, Ellsberg's experiment involved drawing a marble of a particular color from an urn. Subjects preferred a situation where the percentage of winning marbles was known, even if they could bet on either side when it was unknown.

[20] Fox and Tversky (1995, page 585) found that ambiguity aversion was "produced by a comparison with less ambiguous events or with more knowledgeable people. . . . [it] seems to disappear in a noncomparative context." Ambiguity aversion is still relevant for investments, if alternative investments are available and contemplated.

[21] Paul Samuelson, who attends closely to most aspects of the finance field, attests to this challenge. He observed that Renaissance Technology, run by former Stony Brook math professor James Simons, is "perhaps the only long-time phenomenal performer [in traditional financial markets] on a risk-corrected basis." Private communication, June 15, 2006.

By contrast, those who undertake prudent speculations in the unknown will be amply rewarded. Such speculations may include ventures into uncharted areas, where the finance professionals have yet to run their regressions, or may take completely new paths into already well-traveled regions.[22] It used to be said that if your shoeshine boy gives you stock tips it's was time to get out of the market. With shoeshine boys virtually gone and finance Ph.D.'s plentiful, the new wisdom might be

> When your math whiz finance Ph.D. tells you that he and his peers have been hired to work in the XYZ field, the spectacular returns in XYZ field have probably vanished forever.

Similarly, the more difficult a field is to investigate, the greater will be the unknown and unknowables associated with it, and the greater the expected profits to those who deal sensibly with them. Unknowables can't be transmuted into sensible guesses, but one can take one's positions and array one's claims so that unknowns and unknowables are mostly allies, not nemeses. And one can train to avoid one's own behavioral decision tendencies, and to capitalize on those of others.

Assume that an investor is willing to invest where he has an edge in ***uU*** situations. How much capital should then be placed into each opportunity? This problem is far from the usual portfolio problem. It is afflicted with ignorance, and decisions must be made in sequential fashion. Math whizzes have discussed this problem in a literature little known to economists, but frequently discussed among gamblers and mathematicians. The most famous contribution is an article published 50 years ago by J. L. Kelly, an AT&T scientist. His basic formula, which is closely related to Claude Shannon's information theory, tells you how much to bet on each gamble as a function of your bankroll, with the probability of winning and the odds as the two parameters. Perhaps surprisingly, the array of future investment opportunities does not matter.

Kelly's Criterion, as it is called, is to invest an amount equal to $W - (1 - W)/R$, where W is your probability of winning, and R is the ratio of the amount you

[22] I saw such path blazing by my former business partner Victor Niederhoffer in the 1970s, when he ventured into commodity investing. His associates hand recorded commodity prices at 15-minute intervals. He lined up a flotilla of TRS-80 Radio Shack computers to parallel process this information. His innovative data mining, spurred by accompanying theories of how markets behave, gave him a giant advantage over major investment houses. Niederhoffer continues along unusual paths, now making a second fortune after losing his first in the collapse of the Thai baht in 1997. www.greenwichtime.com/business/scn-sa-black1jun18,0,3887361.story?page=5&coll=green-business-headlines

win when you win to the amount you lose when you lose.[23] Thus, if you were 60% likely to win an even money bet, you would invest $0.6 - (1 - 0.6)/1 = 0.2$ or 20% of your capital.

It can be shown that given sufficient time, the value given by any other investment strategy will eventually be overtaken by value following the Kelly criterion, which maximizes the geometric growth rate of the portfolio. That might seem to be definitive. But even in the mathematical realm of optimal dynamic investment strategies, assuming that all odds and probabilities are known, we encounter a ***uU*** situation.

Paul Samuelson, writing in a playful mood, produced an article attacking the Kelly criterion as a guide for practice. His article uses solely one-syllable words. His abstract observes: "He who acts in N plays to make his mean log of wealth as big as it can be made will, with odds that go to one as N soars, beat me who acts to meet my own tastes for risk."[24] In short, Samuelson shows that the Kelly criterion, though mathematically correct, does not tell us how much to invest when one has an edge, since it ignores the structure of preferences.

I lack both the space and capability to straighten out the sequential investment problem. But a few observations may be worthwhile: (1) Most ***uU*** investments are illiquid for a significant period, often of unknown length. Monies invested today will not be available for reinvestment until they become liquid. (2) Markets charge enormous premiums to cash out illiquid assets.[25] (3) Models of optimal sequential investment strategies tend to assume away the most important real-world challenges to such strategies, such as uncertain lock-in periods. (4) There are substantial disagreements in the literature even about "toy problems," such as those with immediate resolution of known-probability investments. The overall conclusion is that (5) money management is a challenging task in ***uU*** problems. It afflicts even those with a substantial edge when making such investments. And when the unknowable happens, as it did with the air-pocket plunge in the 1987 stock market or the 1997 Asian crisis, unforeseen short-term money-management problems—e.g., transferring monies across markets in time to beat margin calls—tend to emerge. These five points imply that even if it were clear how one should invest in a string of favorable gambles each of which is resolved instantaneously, that would help us little in the real world of ***uU*** investing, which presents a much more difficult task.

[23] www.investopedia.com/articles/trading/04/091504.asp. In an interesting coincidence, Elwyn Berlekamp, a distinguished Berkeley math professor who was Kelly's research assistant, was an extremely successful investor in a brief stint managing a fund for James Simons. See endnote 14.

[24] Samuelson, P. A. (1979). "Why we should not make mean log of wealth big though years to act are long. *Journal of Baking and Finance* 3, 305–07.

[25] For example, in real estate, a limited partnership interest that will come due in a few years is likely to sell about 30% below discounted expected future value. The significant discount reflects the complementary skills of acquirers, who must be able to assess and unlock the value of idiosyncratic partnerships. Personal communication, Eggert Dagbjartsson, Equity Resource Investments, December 2005. That firm earns substantial excess returns through its combination of effective evaluation of ***UU*** situations, the ability to structure complex financial transactions, and the unusual complementary skill of being able to deal effectively with a great range of general partners. Experience with Dagbjartsson's firm—at which the author is a principal—helped inspire this paper.

15.4. INVESTING WITH SOMEONE ON THE OTHER SIDE

One of the more puzzling aspects of the financial world is the volume of transactions in international currency markets. Average daily volume is $1.9 trillion, which is slightly more than all U.S. imports in a year. There are hedgers in these markets, to be sure, but their volume is many times dwarfed by transactions that cross with sophisticated or at least highly paid traders on both sides. Something no less magical than levitation is enabling all players to make money, or think that they are making money.

But let us turn to the micro situation, where you are trading against a single individual in what may or may not be a ***uU*** situation. If we find that people make severe mistakes in this arena even when there is merely risk or uncertainty, we should be much more concerned, at least for them, when ***uU*** may abound.

15.4.1. Bazerman-Samuelson Example and Lessons

Let us posit that you are 100% sure that an asset is worth more to you than to the person who holds it—indeed, 50% more. But assume that she knows the true value to her, and that it is uniformly distributed on [0,100], that is, her value is equally likely to be 0, 1, 2, . . . , 100. In a famous game due to Bazerman and Samuelson (1983), hereafter BS, you are to make a single bid. She will accept if she gets more than her own value. What should you bid?

When asked in the classroom, typical bids will be 50 or 60, and few will bid as low as 20. Students reason that the item will be worth 50 on average to her, hence 75 to them. They bid to get a tidy profit. The flaw in the reasoning is that the seller will accept only if she will make a profit. Let's make you the bidder. If you offer 60, she will not sell if her value exceeds 60. This implies that her average value conditional on selling will be 30, which is the value of the average number from 0 to 60. Your expected value will be 1.5 times this amount, or 45. You will lose 15 on average, namely $60 - 45$, when your bid is accepted. It is easy to show that any positive bid loses money in expectation. The moral of this story is that people, even people in decision analysis and finance classrooms, where these experiments have been run many times, are very poor at taking account of the decisions of people on the other side of the table.

There is also a strong tendency to draw the wrong inference from this example, once its details are explained. Many people conclude that you should never deal with someone else who knows the true value, when you know only the distribution. In fact, BS offer an extreme example, almost the equivalent of an optical illusion. You might conclude that when your information is very diffuse and the other side knows for sure, you should not trade even if you have a strong absolute advantage.

That conclusion is wrong. For example, if the seller's true value is uniform on [1, 2] and you offer 2, you will buy the object for sure, and its expected value will be 1.5 times 1.5 = 2.25. The difference between this example and the one with the prior on [0, 1] is that here the effective information discrepancy is much smaller. To see this, think of a uniform distribution from [100, 101]; there is virtually no discrepancy. (In fact, bidding 2 is the optimal bid for the [1, 2] example, but that the extreme bid is optimal also should not be generalized.)

15.4.2. Drawing Inferences from Others

The general lesson is that people are naturally very poor at drawing inferences from the fact that there is a willing seller on the other side of the market. Our instincts and early training lead us not to trust the other guy, because his interests so frequently diverge from ours. If someone is trying to convince you that his second-hand car is wondrous, skepticism and valuing your own information highly helps. However, in their study of the heuristics that individuals employ to help them make decisions, Tversky and Kahneman (1974) discovered that individuals tend to extrapolate heuristics from situations where they make sense to those where they do not.

For example, we tend to distrust the other guy's information even when he is on our side. This tendency has serious drawbacks if you consider sidecar investing—free riding on the superior capability of others—as we do below. Consider two symmetrically situated partners with identical interests who start with an identical prior distribution about some value that is described by a two-parameter distribution. They each get some information on the value. They also have identical prior distributions on the information that each will receive. Thus, after his draw, each has a posterior mean and variance. Their goal is to take a decision whose payoff will depend on the true value. The individuals begin by submitting their best estimate, namely their means. After observing each other's means, they then simultaneously submit their new best estimate. Obviously, if one had a tight (loose) posterior his estimate would shift more (less) toward that of his partner. In theory, two things should happen: (1) The two partners should jump over each other between the first and second submission half of the time. (2) The two partners should give precisely the same estimate for the third submission.

In practice, unless the players are students of Robert Aumann[26]—his article "Agreeing to Disagree" (1976) inspired this example—rarely will they jump over each other. Moreover, on the third submission, they will not come close to convergence.

The moral of this story is that we are deeply inclined to trust our own information more than that of a counterpart, and are not well trained to know when this makes good sense and when it inclines us to be a sucker. One should also be on the lookout for information disparities. Rarely are they revealed through carnival-barker behavior. For example, when a seller merely offers you an object at a price, or gets to accept or reject when you make a bid (as with BS), he will utilize information that you do not possess. You had better be alert and give full weight to its likely value, for example, how much the object is worth on average were he to accept your bid.

In the financial world one is always playing in situations where the other fellow may have more information and you must be on your guard. But unless you have a strictly dominant action—one that is superior no matter what the other guy's information—a maximin strategy will almost always push you never to invest. After all, his information could be just such to lead you to lose large amounts of money.

Two rays of light creep into this gloomy situation: First, only rarely will his information put you at severe disadvantage. Second, it is extremely unlikely that your counterpart is playing anything close to an optimal strategy. After all, if it is so hard for you to analyze, it can hardly be easy for him.[27]

15.4.3. Absolute Advantage and Information Asymmetry

It is helpful to break down these situations into two components. First, a potential buyer's absolute advantage benefits both players. It represents the usual gains from trade. In many financial situations, as we observed above, a buyer's absolute advantage stems from her complementary skills. An empty lot in A's hands may be worth much less than it would be in B's. Both gain if A trades to

[26] Robert Aumann and Thomas Schelling won the 2005 Nobel Memorial Prize in Economics for their contributions to game theory.

[27] Given the potential for imperfect play, it is sometimes dangerous to draw inferences from the play of others, particularly when their preferences are hard to read. The Iraqi weapons of mass destruction provide a salient example. Many people were confident that such weapons were present not because of intelligence, but because they believed Saddam Hussein could have saved himself and his regime simply by letting in inspectors, who in the instance would find nothing.

B, due to absolute advantage. But such an argument would not apply if A was speculating that the British pound would fall against the dollar when B was speculating that it would rise. There is no absolute advantage in such a situation, only information asymmetries.

Second, if both parties recognize a pure asymmetric information situation, only the better informed player should participate. The appropriate drawing of inferences of "what-you-know-since-you-are-willing-to-trade" should lead to the well known no-trade equilibrium. Understanding this often leads even ordinary citizens to a shrewd strategem:

Maxim B: When information asymmetries may lead your counterpart to be concerned about trading with you, identify for her important areas where you have an absolute advantage from trading. You can also identify her absolute advantages, but she is more likely to know those already.

When you are the buyer, beware; seller-identified absolute advantages can be chimerical. For example, the seller in the bazaar is good at explaining why your special characteristics deserve a money-losing price—say it is the end of the day and he needs money to take home to his wife. The house seller who does not like the traffic noise in the morning may palter that he is moving closer to his job, suggesting absolute advantage since that is not important to you. Stores in tourist locales are always having "Going Out of Business Sales." Most swindles operate because the swindled one thinks he is in the process of getting a steal deal from someone else.

If a game theorist had written a musical comedy, it would have been *Guys and Dolls*, filled as it is with the ploys and plots of small-time gamblers. The overseer of the roving craps game is Nathan Detroit. He is seeking action, and asks Sky Masterson—whose good looks and gambling success befit his name—to bet on yesterday's cake sales at Lindy's, a famed local deli. Sky declines and recounts a story to Nathan:

> On the day when I left home to make my way in the world, my daddy took me to one side. "Son," my daddy says to me, "I am sorry I am not able to bankroll you to a large start, but not having the necessary lettuce to get you rolling, instead I'm going to stake you to some very valuable advice. One of these days in your travels, a guy is going to show you a brand-new deck of cards on which the seal is not yet broken. Then this guy is going to offer to bet you that he can make the jack of spades jump out of this brand-new deck of cards and squirt cider in your ear. But, son, do not accept this bet, because as sure as you stand there, you're going to wind up with an ear full of cider."

In the financial world at least, a key consideration in dealing with ***uU*** situations is assessing what others are likely to know or not know. You are unlikely to have mystical powers to foresee the unforeseeable, but you may be able to estimate your understanding relative to that of others. Sky's dad drew an inference from someone else's willingness to bet. Presumably Ricardo was not a military expert, but just understood that bidders would be few and that the market would over discount the ***uU*** risk.

15.4.4. Competitive Knowledge, Uncertainty, and Ignorance

Let us assume that you are neither the unusually skilled Warren Buffett nor the unusually clear-thinking David Ricardo. You are just an ordinary investor who gets opportunities and information from time to time. Your first task is to decide into which box an investment decision would fall. We start with the unknown probabilities shown in table 15.5.

The first row is welcome and relatively easy, for two reasons: (1) You probably have a reasonable judgment of your knowledge relative to others, as would a major real estate developer considering deals in his home market. Thus, you would have a good assessment of how likely you are to be in box B or box A. (2) If you are in box B, you have the edge. Box A is the home of the typical thick financial market, where we tend to think prices are fair on average.

The second row is more interesting, and brings us to the subject matter of this paper. In section 15.5, we will see Buffett sell a big hunk of reinsurance because he knew he was in box D. His premium was extremely favorable, and he knew that it was exceedingly unlikely that the other side possessed private information that would significantly shift the odds. Box C consists of situations

Table 15.5
Investing with Uncertainty and Potential Asymmetric Information

	Easy for others to estimate	Hard for others to estimate
Easy for you to estimate	Tough markets	They're the sucker
Hard for you to estimate	Sky Masterson's dad, you're the sucker	Buffett's reinsurance sale California Earthquake Authority

where you know little, and others may know a fair amount. The key to successfully dealing with situations where you find probabilities hard to estimate is to be able to assess whether others might be finding it easy.

Be sensitive to telling signs that the other side knows more, such as a smart person offering too favorable odds. Indeed, if another sophisticated party is willing to bet, and he can't know that you find probabilities hard to estimate, you should be suspicious. For he should have reasonable private knowledge so as to protect himself. The regress in such reasoning is infinite.

Maxim C: In a situation where probabilities may be hard for either side to assess, it may be sufficient to assess your knowledge relative to the party on the other side (perhaps the market).

Let us now turn to the more extreme case, situations where even the states of the world are unknown, as they would be for an angel investment in a completely new technology, or for insuring infrastructure against terrorism over a long period (see table 15.6).

In some ignorance situations, you may be confident that others know no better. That would place you in box F, a box where most investors get deterred, and where the Buffetts of this world, and the Rothschilds of yesteryear have made lots of money. Investors are deterred because they employ a heuristic to stay away from ***uU*** situations, because they might be in E, even though a careful assessment would tell them that outcome was highly unlikely. In addition, both boxes carry the Monday morning quarterback (MMQ) risk; one might be blamed for a poor outcome if one invests in ignorance, when it was a good decision that got a bad outcome; might not have allowed for the fact that others might have had better knowledge when in fact they didn't; or might not have allowed for the fact that others might have had better knowledge, when, in fact, they did, but that negative was outweighed by the positive of your absolute advantage. The criticisms are unmerited. But since significant losses were incurred, and knowledge was scant, the investment looks foolish in retrospect to

TABLE 15.6
Investing with Ignorance and Potential Asymmetric Information

	Known to others	Unknown to others
Unknown to you	Dangerous waters Monday morning quarterback risk	Low competition Monday morning quarterback risk

all but the most sophisticated. An investor who could suffer significantly from any of these critiques might well be deterred from investing.

Let us revisit the Gazprom lesson within this thought in mind. Suppose you are a Russia expert. It is still almost inevitable that real Russians know much more than you. What then should you do? The prudent course, it would seem, would be first to determine your MMQ risk. It may actually be reduced due to your largely irrelevant expertise. But if MMQ is considerable, steer clear. If not, and Russian insiders are really investing, capitalize on box E, and make that sidecar investment. You have the additional advantage that few Westerners will be doing the same, and they are your prime competition for ADRs.[28]

Speculation 3: ***uU*** situations offer great investment potential given the combination of information asymmetries and lack of competition.

Boxes E and F are also the situations where other players will be attempting to take advantage of us and, if it is our inclination, we might take advantage of them. This is the area where big money changes hands.

A key problem is to determine when you might be played for a sucker. Sometimes this is easy. Anyone who has small oil interests will have received many letters offering to buy, no doubt coming from people offering far less than fair value. They are monopsonists after all, and appropriately make offers well below the market. They may not even have any inside knowledge. But they are surely taking advantage of the impulsive or impatient among us, or those who do not understand the concepts in this paper.

Being a possible sucker may be an advantage if you can gauge the probability. People are strongly averse to being betrayed. They demand much stronger odds when a betraying human rather than an indifferent nature would be the cause of a loss (Bohnet and Zeckhauser 2004). Given that, where betrayal is a risk, potential payoffs will be too high relative to what rational decision analysis would prescribe.

15.4.5. Investing in *UU* with Potentially Informed Players on the Other Side

Though you may confront a ***uU*** situation, the party or parties on the other side may be well informed. Usually you will not know whether they are. Gamblers opine that if you do not know who the sucker is in a game that you are the

[28] In January 2006, Gazprom traded in the west as an ADR, but soon became an over-the-counter stock.

sucker. That does not automatically apply with ***uU*** investments. First, the other side may also be uninformed. For example, if you buy a partially completed shopping center, it may be that the developer really did run out of money (the proffered explanation for its status) as opposed to his discovery of deep tenant reluctance. Second, you may have a complementary skill, such as strong relations with WalMart, that may give you a significant absolute advantage multiple.

15.4.6. The Advantage Multiple Versus Selection Formula

Let us simplify and leave risk aversion and money management matters aside. Further posit, following BS, that you are able to make a credible take-it-or-leave-it offer of 1. The value of the asset to him is v, an unknown quantity. The value to you is av, where a is your absolute advantage. Your subjective prior probability distribution on v is $f(v)$. The mean value of your prior is $m < 1$.[29] In a stripped-down model, three parameters describe this situation: your advantage multiple, a; the probability that the other side is informed, p; and the selection factor against you, s, if the other side is informed.[30] Thus, s is the fraction of expected value that will apply, on average, if the other side is informed, and therefore sells only when the asset has low value to her. Of course, given the ***uU*** situation, you do not know s, but you should rely on your mean value of your subjective distribution for that parameter.

If you knew $p = 0$, that the other side knew no more than you, you would simply make the offer if $am > 1$. If you knew there were selection, that is, $p = 1$, you would invest if your multiple more than compensated for selection, namely if $ams > 1$. The general formula is that your return will be

$$am[ps + (1 - p)1] \tag{15.1}$$

Maxim D: A significant absolute advantage offers some protection against potential selection. You should invest in a ***uU*** world if your advantage multiple is great, unless the probability is high that the other side is informed and if, in addition, the expected selection factor is severe.

Following maxim D, you should make your offer when the expression in (15.1) exceeds 1.

[29] It is important that $m < 1$. Otherwise the seller would refuse your offer if he were uninformed.

[30] In health care, this process is called adverse selection, with sicker people tending to enroll in more generous health plans.

In practice, you will have a choice of offer, t. Thus, s will vary with t, that is, $s(t)$.[31] The payoff for any t will be

$$am[ps(t) + (1 - p)1] - t \tag{15.2}$$

If, at the optimal offer t^*, this quantity is positive, then you should offer t^*.

15.4.6. Playing the Advantage Multiple versus Selection Game

Our formulation posited a take-it-or-leave-it offer with no communication. In fact, most important financial exchanges have rounds of subtle back-and-forth discussion. This is not simply cheap talk. Sometimes real information is provided, such as accounting statements, geological reports, antique authentications. And offers by each side reveal information as well. Players on both sides know that information asymmetry is an enemy to both, as in any agency problem.

It is well known that if revealed information can be verified, and if the buyer knows on what dimensions information will be helpful, then by an unraveling argument all information gets revealed.[32] Consider a one-dimension case where a value can be between 1 and 100. A seller with a 100 would surely reveal, implying that the best unrevealed information would be 99. But then the 99 would reveal, and so on down through 2.

When the buyer is in a ***uU*** situation, unraveling does not occur, since he does not know the relevant dimensions. The seller will keep private unfavorable information on dimensions unknown to the buyer. She will engage in signposting: announcing favorable information, suppressing unfavorable.[33]

The advantage multiple versus selection game will usually proceed with the seller explaining why she does not have private information, or revealing private

[31] Let $\underline{x}$ be the conditional mean of $x < v$. The value of s will be constant if $\underline{x}/v$ = positive k for all v. This will be the case if $f(v)$ is homogeneous, i.e., $f(kv) = k_n f(v)$, as with the uniform or triangular distribution starting at 0.

[32] See Grossman (1981) on unraveling. If information is costly to reveal, then less favorable information is held back and signposting applies (Zeckhauser and Marks 1996).

[33] To be sure, the shrewd buyer can deduce: "Given the number of unknown dimensions I suspected, the seller has revealed relatively few. Hence, I assume that there are a number of unfavorable dimensions," etc. When seller revelation is brief, only high m buyers will make exchanges. The doubly shrewd buyer may be informed or get informed on some dimension without the seller knowing which. He can then say: "I have unfavorable information on a dimension. Unless you reveal on all dimensions, this information will stay private, and I will know that you are suppressing information." The triply shrewd buyer, knowing nothing, will make the same statement. The shrewd seller has countermeasures, such as insisting on proof that the buyer is informed, e.g., by third party attestation, and if evidence is received, then revealing some but not all, hoping to hit the lucky dimension.

information indicating that *m* and *a* are large. Still, many favorable deals will not get done, because the less-informed party cannot assess what it does not know. Both sides lose *ex ante* when there will be asymmetry on common value information, or when, as in virtually all ***uU*** situations, asymmetry is suspected.

15.4.7. Auctions as *UU* Games

Auctions have exploded as mechanisms to sell everything from the communications spectrum to corporate securities, and, in 2009, toxic assets. Economic analyses of auctions—how to conduct them and how to bid—have exploded alongside. The usual format is that an informed seller faces a group of less-knowing buyers. The usual prescription is that the seller should reveal his information about elements that will affect all buyers' valuations, such as geologic information on an oil lease or evidence of an antique's pedigree, to remove buyers' concerns about the winner's curse. The winner's curse applies when an object, such as an oil lease, is worth roughly the same to all. The high bidder should be aware that every other bidder thought it was worth less than he did. Hence, his estimate is too high, and he is cursed for winning.

Real-world auctions are often much more complex. Even the rules of the game may not be known. Consider the common contemporary auction phenomenon, witnessed often with house sales in hot markets, and at times with the sale of corporations.[34] The winner, who expected the final outcome to have been determined after one round of bidding, may be told there will be a best and final offer round, or that now she can negotiate a deal for the item.

Usually the owner of the object establishes the rules of the game. In theory, potential buyers would insist that they know the rules. In practice, they often have not. When Recovery Engineering, makers of PUR water purifiers, was sold in 1999, a "no one knows the rules" process ensued, with Morgan Stanley representing the seller. A preliminary auction was held on an August Monday. Procter and Gamble (P&G) and Gillette bid, and a third company expressed interest but said it had difficulties putting its bid together. Gillette's bid was $27 per share; P&G's was $22. P&G was told by the investment banker that it would have to improve its bid substantially. Presumably, Gillette was told little, but drew appropriate inferences, namely that it was by far high. The final auction was scheduled for that Friday at noon. Merrill Lynch, Gillette's investment banker, called early on Friday requesting a number of additional pieces of due diligence information, and requesting a delay till Monday. Part of the information was released—Gillette had had months to request it—and the auction was

[34] See Subramanian and Zeckhauser (2005), who apply the term "negotiauctions" to such processes.

delayed till 5 p.m. Friday. The P&G bid $34. At 5 p.m., Merrill Lynch called, desperate, saying it could not get in touch with Gillette. Brief extensions were granted, but contact could not be established. P&G was told that it was the high bidder. Over the weekend a final deal was negotiated at a slightly higher price; the $300 million deal concluded. But would there have been a third round of auction if Gillette had bid $33.50 that Friday? No one knows.

The Recovery board puzzled over the unknowable question: What happened to Gillette? One possibility was that Gillette inferred from the fact that it was not told its Monday bid was low that it was in fact way above other bidders. It was simply waiting for a deal to be announced, and then would propose a price perhaps $2 higher, rather than bid and end up $5 higher.[35] Gillette never came back. A while later, Recovery learned that Gillette was having—to that time unreported—financial difficulties. Presumably, at the moment of truth Gillette concluded that it was not the time to purchase a new business. In short, this was a game of unknowable rules, and unknowable strategies.[36] Not unusual.

At the close of 2005, Citigroup made the winning bid of about $3 billion for 85% of the Guangdong Development Bank, a financially troubled state-owned Chinese bank. As the *New York Times* reported the deal, Citigroup "won the right to negotiate with the bank to buy the stake." If successful there, its "control might allow Citigroup to install some new management and have some control over the bank's future . . . one of the most destitute of China's big banks . . . overrun by bad loans."[37] Citigroup is investing in a ***uU*** situation, and knows that both the rules of the game and what it will win are somewhat undefined. But it is probably confident that other bidders were no better informed, and that both the bank and the Chinese government (which must approve the deal) may also not know the value of the bank, and were eager to secure foreign control. Great value may come from buying a pig in a poke, if others also cannot open the bag.

15.4.8. Ideal Investments with High and Low Payoffs

In many ***uU*** situations, even the events associated with future payoff levels—for example, whether a technology supplier produces a breakthrough or a new

[35] Recovery created a countermeasure to raise any postdeal bid by inserting a breakup fee in its deal with P&G that declined (ultimately to 0) with the price premium paid by a new buyer.

[36] Details confirmed by Brian Sullivan, then CEO of Recovery Engineering, in personal communication, January 2006. Zeckhauser was on the Recovery board due to a sidecar privilege. He had been Sullivan's teacher, and had gotten him the job.

[37] *New York Times*, December 31, 2005, B1 and B4. Citigroup had several Chinese state-owned companies as partners, but they probably gave more political cover than knowledge of the value of the bank.

product emerges—are hard to foresee. The common solution in investment deals is to provide for distributions of the pie that depend not on what actually happens, but solely on money received. This would seem to simplify matters, but even in such situations sophisticated investors frequently get confused.

With venture capital in high tech, for example, it is not uncommon for those providing the capital to have a contractual claim to all the assets should the venture go belly up. Similarly, "cram down" financings, which frequently follow when startups underperform, often give venture capitalists a big boost in ownership share. In theory, such practices could provide strong incentives to the firm's managers. In reality, the managers' incentives are already enormous. Typical VC arrangements given bad outcomes cause serious ill will, and distort incentives—for example, they reward gambling behavior by managers after a bleak streak. Worse still for the VCs, they are increasing their share of the company substantially when the company is not worth much. They might do far better if arrangements specified that they sacrifice ownership share if matters turn out poorly, but gain share if the firm does particularly well.

Maxim E: In ***uU*** situations, even sophisticated investors tend to underweight how strongly the value of assets varies. The goal should be to get good payoffs when the value of assets is high.

No doubt Ricardo also took maxim E into account when he purchased the "Waterloo bonds." He knew that English money would be far more valuable if Wellington was victorious and his bonds soared in value, than if he lost and the bonds plummeted.

15.4.9. A *uU* Investment Problem

Now for a harder decision. Look at the letter in exhibit 15.1, which offers you the chance to make a modest investment in an oil well. You have never heard of Davis Oil and the letter came out of the blue, and without letterhead. You inquire, and find out that it is the company previously owned by the famous, recently deceased oilman Marvin Davis. Your interest is offered because the Davis Company bought the managing partner's interest in the prospect from a good friend and oil man who invited you into his prospect.[38] Davis is legally required to make this offer to you. Decide whether to invest or merely wait for your costless override before you read on.

[38] That man was Malcolm Brachman, president of Northwest Oil, a bridge teammate and close friend. Sadly, Malcolm had died in the interim. One consequence was that he could not advise you.

Exhibit 15.1

September 19, 2005

WORKING INTEREST OWNER: Richard Zeckhauser
Re: Well Proposal
David Petroleum Corp.
Devlin #1-12
Section 12-T8N-R19W
Washita County, Oklahoma

Gentlemen:

Davis Petroleum Corp. ("Davis") proposes the drilling of a 17,000′ Sub-Thrusted Springer test at a surface location of 660′ FNL and 1980' FWL and a bottom hole location of 1,650′ FNL and 990′ FWL of Section 12-T8N-R19W, Washita County, Oklahoma. Enclosed for your review is our AFE reflecting estimated dry hole costs of $6,869,100.00 and estimated completion costs of $2,745,400.00. As a working interest owner within the referenced unit and per the terms and conditions of that certain Order 450325, Cause CD 200100725-T, dated March 29, 2001, Davis respectfully requests that you elect one of the afforded options as follows:

1. Participate in the drilling and completing of said well by paying your proportionate share of well costs as stipulated by Order 450325;
2. Elect not to participate in the proposed test well, electing to farmout your unit interest delivering to Davis your interest at a proportionate 75% net revenue interest.

Per the terms of Order 450325 you have **15 days** upon receipt of this proposal to make your election as outlined above. Failure to respond within the 15 day period will evidence your election not to participate thus relinquishing your interest under paragraph 2, above.

Please indicate the option of your choice by signing below and returning one copy of this letter to my attention. This proposal may be terminated without further notice. Should you have any questions, please contact me at (713) 439-6750 or Bill Jaqua at (405) 329-0779.

Sincerely,
Davis Petroleum Corp.

Alan Martinkewiz
Landman

THE UNDERSIGNED HEREBY ACCEPTS OPTION NO. ____, THIS ____ DAY OF _____, 2005

By: _____
Title: _____
Company: _____

Here is what your author did. He started by assessing the situation. Davis could not exclude him, and clearly did not need his modest investment. The letter provided virtually no information, and was not even put on letterhead, presumably the favored Davis approach if it were trying to discourage investment. Davis had obviously spent a fair amount of effort determining whether to drill the well, and decided to go ahead. It must think its prospects were good, and you would be investing as a near partner.

Bearing this in mind, he called Bill Jaqua—a contact Davis identified in the letter—and asked about the well. He was informed it was a pure wildcat, and that it was impossible to guess the probability of success. Some geologic technical discussion followed, which he tried to pretend he understood. He then asked what percentage of Davis wildcat wells had been successful in recent years, and got a number of 20–25%. He then asked what the payoff was on average if the wells were successful. The answer was 10 to 1. Beyond that, if this well was successful, there would be a number of other wells drilled in the field. Only participation now would give one the right to be a future partner, when presumably the odds would be much more favorable. This appeared to be a reasonably favorable investment, with a healthy upside option of future wells attached. The clinching argument was that Jaqua courteously explained that Davis would be happy to take his interest and give him the free override, thus reinforcing the message of the uninformative letter not placed on letterhead. (It turned out that the override would have only been 1% of revenue—an amount not mentioned in the letter—as opposed to 76% if he invested.)[39] In short, the structure of the situation, and the nature of Davis's play made a sidecar investment imperative. The well has not yet been started.

Davis was in a tough situation. It had to invite in undesired partners on favorable terms when it had done all the work. It reversed the usual ploy where someone with a significant informational advantage tries to play innocent or worse, invoke some absolute advantage story. Davis tried to play up the ***uU*** aspect of the situation to discourage participation.

15.4.10. Review of the Bidding

You have been asked to address some decision problems. Go back now and grade yourself first on the overconfidence questionnaire. The answers are in the footnote.[40] You were asked about three investments: Tengion, Gazprom, and

[39] Not mentioned in the letter was that 24% went off the top to priority claims, and that Davis charges 75% if you take the free override.

[40] (1) 173,710, (2) 2716, (3) 2,007,901, (4) 130,119, (5) 13, (6) 12,212,000, (7) $259B, (8) 13.45%, (9) 853,000.

Davis Oil. Go back and reconsider your choices, and decide whether you employed the appropriate principles when making them, and then assess the more general implications for investment in ***uU*** situations. Though this essay pointed out pitfalls with ***uU*** investing, it was generally upbeat about the potential profits that reside in ***uU*** arenas. Hopefully, you have been influenced, at least a bit.

15.5. SOME CAUTIONS: HERDING, CASCADES, AND MELTDOWNS

Understanding the ***uU*** world presents great opportunity, but it also suggests some cautions. We shall focus on just three: herding, cascades, and meltdowns.

15.5.1. Herding

Animals gather together because there is safety in numbers. Investors cluster as well. That may help them fend off criticism, but it will not protect them from meltdowns in value, be they for individual assets or for the market as a whole. There are two main ingredients in such meltdowns: information cascades and fat-tailed distributions. A cascade is experienced when the information from one individual spills over to inform another individual, and when large a whole group gets informed. Fat tails, as we mentioned above, refers to the fact that financial assets have more big movements in price than experience with small movements would suggest, including some movements so large they would seem nearly impossible.

15.5.2. Information Cascades

Information cascades occur when individuals draw inferences about the information that others possess from the actions they take. Thus, one individual's information cascades to affect the action of another. The danger with an information cascade is that it is very difficult for the players to know how much information is possessed in total. When the total possessed is much less than the total assessed, prices can be well out of line. Just such a situation may be responsible for the meltdown in housing prices in the United States in 2008. Each family purchasing a house looks to comparable sales for guidance. Using that basis, it seems sensible to pay say $300,000 for this home, since other equivalent homes nearby sold for as much as $320,000. The trouble is that all the other home buyers were also relying on the market price. In effect, there was herding on the information. Everyone would be happy to know that they bought close to the correct price, namely what others would buy for in the future. But, unfortunately, there was no hard basis to determine that correct price. One possibility would be to rely on the prices in equivalent nearby towns, but this just

raises the herding on information issue one level. A whole region or nation can find its housing prices inflated.

Economists would say that there are multiple equilibria in such markets, at least one high priced and one low priced. The high-priced equilibrium of late 2007 proved to be unstable. A moderate shock knocked it away from that equilibrium, and prices spiraled downward to what will ultimately be a lower-priced equilibrium. People who bought houses in 2007 were unlikely to have thought about either information cascades or fat tails. That is, they did not contemplate that current house prices were based on little reliable information, and that big price movements, down as well as up, were quite possible.

In some circumstances, although there is abundant information in the system, and individuals closely monitor and behave in response to the actions of others, little of the information gets shared. Take a situation where each of 100 people gets a signal on whether housing prices are going down or up. The signal is not fully reliable. If prices are going down, it is 70% likely someone will get a down signal and 30% an up signal, and vice versa when the market is going up. Individuals choose whether to buy a house in numerical order, and will buy a house if, on the basis of what they know, they think prices are going up, though a small group buys because they desperately need a house. They draw inferences from the actions of others. Person 1 gets an up signal and buys a house. Person 2 can't be sure that 1 did not buy because he was desperate for a house, so his information would outweigh 1's action as a signal. Person 2 would not buy if he got a down signal, but he got an up signal. He too buys a house. Person 3 gets a down signal, but reasons that 1 and 2 probably for up signals, so his signal is outvoted; prices are likely to go up. Beyond that, everyone, whatever his signal, will buy. That is what we call an information cascade. Almost certainly, the aggregate information from all 100 people would indicate a down market, but the cascade of information from the first two individuals is what dominates the market.

15.5.3. Meltdowns

We are most likely to get prices far from equilibrium in those markets where prices rose rapidly. Individuals within might reason as follows: "Prices went up by roughly 8% each of the last three years. Thus, the price I should pay should depend not only on some multiple of rent—a normal metric—but must incorporate how much prices will go up next year. Others think that $300,000 is an appropriate price for such a house. That price builds in consensus expectations." This reasoning may be correct, but it represents a fragile situation. If prices do not go up by 8%, the price will not merely soften; it will collapse, since rapid appreciation was the basis for its high price.

Matters would be far different in unglamorous cities, say Indianapolis or Buffalo. House prices hardly budged in them for a long time. They were set in relation to rental rates, and did not rely on future expectations. In short, there was much more information in the system. People could make decisions on whether it was cheaper to rent or buy.

Experience with the NASDAQ and California home prices is instructive. From 1995 to 2000 the NASDAQ had multiplied more than six times in value before peaking in March 2000. It then fell by 60% in a year.[41] The median price of an existing detached home in California had tripled in eight years before mid-2007, and then fell in half in one year.[42]

In each case there was a dramatic run up before the big run down. Investors in the first case, and home buyers in the second were trying to guess how prices would move in the future. All participants were watching and taking comfort from the decisions of others. They moved with the herd as prices moved up. Once prices stopped their rapid ascent, they could not be sustained, since current values anticipated rapid appreciation. The participants were victims of the fat-tail phenomenon. Meltdowns were experienced.

Maxim F: When there may be herding on information, beware. Be doubly beware if the information comes from extrapolating a successful past to a successful future.

Some very major financial players ignored maxim F, to their peril. Many of our most prestigious investment houses lost many billions of dollars because they went with the herd to get a little extra kick by buying mortgage-backed securities. Perhaps more surprising, Fannie Mae and Freddie Mac effectively collapsed because they failed to examine their own markets.

The implication of maxim F is that effective decision makers must—as a recent insightful book for business and financial executives puts it in its first lesson—"Go to the Source," namely engage in the "relentless pursuit of information from the field." It tells the story of Bill George, the newly appointed president of medical equipment giant Medtronic, who went into the operating room where he witnessed the dreadful performance of the company's catheter during an angioplasty. By starting at the source, he discovered that the company's information system systematically covered up information about low quality: "People do not want to pass on bad news, and engineers [or any

[41] Yahoo! Finance.
[42] California Association of Realtors, 2008.

other group] can be in denial about a problem."[43] That last sentence distills our findings about much in the recent collapse of mortgage markets and financial institutions.

Maxim G: Be triply beware of herding when there is evidence that there have been significant changes in the basic structure of markets, however stable they have been in the past.

The mortgage market, a stable and successful market for decades, had undergone dramatic changes in the decade or so before it collapsed. Mortgages, originally the obligations of the banks that wrote them, had evolved into derivative products, with large numbers of mortgages packaged together and sold as a unit. That dramatically reduced the incentives for the banks that wrote them to scrutinize their safety. It also meant that no one really understood the risk characteristics of any package. A second major development, no doubt pushed along by the derivative developments, was that mortgages had come to be written with extraordinarily low down payments. Indeed, looking back four years from 2007, 25% of mortgages on new houses were written with down payments of 2% or less.[44]

Investment houses often warn us that past performance is not necessarily indicative of future results. Maxim G would tell us that past performance is particularly unreliable if basic assumptions from the past have been overturned. Our big losers among investment houses ignored their own warning when it came to mortgage-backed securities, and maxims F and G as well.

While issuing cautions, consider a final word about statistical inference. In the classroom, we are used to drawing inferences from multiple trials. Thus, to determine whether a new drug offers benefits, we might give it to 100 people and an existing drug to another 100, and see which performs better, say, in lowering cholesterol. This mental model of independent trials may not carry over to financial markets. The excess performance of 100 firms investing in mortgage-backed securities in a particular year is far from 100 independent trials. They will all do well if housing markets rise, but if such markets plummet, they will all be in trouble. A single year with 100 firms is closer to 1 observation than 100 independent observations. Hedge funds announced their ability to

[43] See Zeckhauser and Sandoski (2008), pages 7–43. The book's second lesson (pages 44–72) is also instructive if one wishes to elicit information from all and to avoid herding. It is "Fill a Room with Barbarians." The central finding is that "Seeking and fostering dissent provides two advantages. . . . [participants must] expose their opinions to a wide range of counterarguments . . . [and] diverse, well-founded arguments can reframe a problem so that everyone sees it in a new way."

[44] *American Housing Survey for the United States: 2007.*

do well in up or down financial markets, and from 1987 to 2007 they averaged almost a 14% return. But they were not really tested till 2008, when they were down on average 19.83% for the year.[45]

15.6. A BUFFETT TALE

Let us conclude with a happier tale. The following story encapsulates the fear of ***uU*** situations, even by sophisticated investors, and the potential for shrewd investors to take great advantage of such situations. In 1996, I was attending a National Bureau of Economic Research (NBER) conference on insurance. One participant was the prime consultant to the California Earthquake Authority. He had been trying to buy a $1 billion slice of reinsurance—to take effect after $5 billion in aggregate insured losses—from the New York financial community. The Authority was offering five times estimated actuarial value, but had no takers. It seemed exceedingly unlikely that the parties requesting coverage had inside information that a disastrous earthquake was likely. Hence, there was a big advantage, in effect $a = 5$, and p was close to 0. Maxim D—weigh absolute advantage against informational disadvantage—surely applied.

My dinner table syndicate swung into action, but ended up $999.9 million short. A couple days later, we learned that Buffett had flown to California to take the entire slice. Here is his explanation.

> . . . we wrote a policy for the California Earthquake Authority that goes into effect on April 1, 1997, and that exposes us to a loss more than twice that possible under the Florida contract. Again we retained all the risk for our own account. Large as these coverages are, Berkshire's after-tax "worst-case" loss from a true mega-catastrophe is probably no more than $600 million, which is less than 3% of our book value and 1.5% of our market value. To gain some perspective on this exposure, look at the table on page 2 and note the much greater volatility that security markets have delivered us.
>
> —Chairman's letter to the shareholders of Berkshire Hathaway, 1996, www.ifa.com/Library/Buffet.html

Reinsurance for earthquakes is certainly a venture into the unknown, but had many attractive features beyond its dramatic overpricing. Unlike most insurance, it was exceedingly unlikely that the parties taking insurance had inside

[45] Data from the Hennessee Group's Hedge Fund Index (see www.hennesseegroup.com/indices/index.html)

knowledge on their risk. Thus, Buffett—despite attention to money management—was willing to take 100% of a risk of which Wall Street firms houses rejected taking even part. Those fancy financial entities were not well equipped to take a risk on something that was hard for them to estimate. Perhaps they did not recognize that others had no inside information, that everyone was operating with the same probability. And perhaps they were just concerned about Monday morning quarterbacking.

It is also instructive to consider Buffett's approach to assessing the probabilities in this ***uU*** situation, as revealed in the same annual report:

> So what are the true odds of our having to make a payout during the policy's term? We don't know—nor do we think computer models will help us, since we believe the precision they project is a chimera. In fact, such models can lull decision-makers into a false sense of security and thereby increase their chances of making a really huge mistake. We've already seen such debacles in both insurance and investments. Witness "portfolio insurance," whose destructive effects in the 1987 market crash led one wag to observe that it was the computers that should have been jumping out of windows.

Buffett was basically saying to Wall Street firms: "Even if you hire 100 brilliant Ph.D.s to run your models, no sensible estimate will emerge." These are precisely the types of ***uU*** situations where the competition will be thin, the odds likely favorable, and the Buffetts of this world can thrive.

As Buffett has shown on repeated occasions, a multibillionaire will rush in where mathematical wizards fear to tread. Indeed, that explains much of his success. In 2006 hurricane insurance met two Buffett desiderata, high prices and reluctant competitors. So he plunged into the market: Buffett's prices are as much as 20 times higher than the rates prevalent a year ago, said Kevin Madden, an insurance broker at Aon Corp. in New York. On some policies, premiums equal half of its maximum potential payout, he said. In a May 7, 2006, interview Buffett said: "We will do more than anybody else if the price is right . . . We are certainly willing to lose $6 billion on a single event. I hope we don't" (seekingalpha.com/article/11697).

At least two important lessons emerge from thinking about the "advantage-versus-selection" problem, and observing Warren Buffett.

Maxim H: Discounting for ambiguity is a natural tendency that should be overcome, just as should be overeating.

Maxim I: Do not engage in the heuristic reasoning that just because you do not know the risk, others do. Think carefully, and assess whether they are likely to know more than you. When the odds are extremely favorable, sometimes it pays to gamble on the unknown, even though there is some chance that people on the other side may know more than you.

Buffett took another bold financial move in 2006, in a quite different field, namely philanthropy. He announced that he would give away 85% of his fortune or $37.4 billion, with $31 billion going to the Bill and Melinda Gates Foundation. Putting money with the Gates Foundation represents sidecar philanthropy. The Foundation is an extremely effective organization that focuses on health care and learning. It is soon to be led by Bill Gates, a fellow with creativity, vision, and hardheadedness as strong complementary skills, skills that are as valuable in philanthropy as they are in business.

15.7. CONCLUSION

This essay offers more speculations than conclusions, and provides anecdotal accounts rather than definitive data. Its theory is often tentative and implicit. But the question it seeks to answer is clear: How can one invest rationally in ***uU*** situations? The question sounds almost like an oxymoron. Yet clear thinking about ***uU*** situations, which includes prior diagnosis of their elements, and relevant practice with simulated situations, may vastly improve investment decisions where ***uU*** events are involved. If they do improve, such clear thinking will yield substantial benefits. For financial decisions, at least, the benefits may be far greater than are available in run-of-the-mill contexts, since competition may be limited and prices well out of line.

How important are ***uU*** events in the great scheme of financial affairs? That itself is a ***uU*** question. But if we include only those that primarily affect individuals, the magnitude is far greater than what our news accounts would suggest. Learning to invest more wisely in a ***uU*** world may be the most promising way both to protect yourself from major investment errors, and to significantly bolster your prosperity.

Appendix A

Assessing Quantities

1. Democratic votes in Montana, 2004 Presidential election*
2. Length of Congo River (in miles)
3. Number of subscribers to *Field and Stream*
4. Area of Finland (in square miles)
5. Birth rate in France per 1000 population
6. Population of Cambodia
7. Revenues of Wal-Mart stores (largest in U.S.), 2003
8. Annual percent yields on 30-year treasury bonds in 1981 (This year had the highest rate over the 1980–1998 period.)
9. Number of physicians in the United States, 2002
10. Number of electoral votes going to the Republican presidential candidate in 2008 (out of 538)
11. Value of Dow Jones Average on December 31, 2006 (on 6/30/06 closed at 11,150)
12. Value of the NASDAQ on December 31, 2006 (on 6/30/06 closed at 2172)

* Question 1, www.uselectionatlas.org/RESULTS/state.php?f=0&year=2004&fips=30; questions 2–6, *1995 Information Please Almanac*; question 8, *1999 Wall Street Journal Almanac*; questions 7 and 9, *World Almanac 2005*.

TABLE 15.7

	1st %ile	25th %ile	50th %ile	75th %ile	99th %ile
Democratic votes MT 2004 presidential election					
Congo River (length in miles)					
Field & Stream (number of subscribers)					
Finland (area in square miles)					
Birth rate of France (per thousand)					
Population of Cambodia					
Revenues of Wal-Mart stores, 2003					
% Yields on 30-year bonds, 1981					
Number of physicians in U.S., 2002					
Number of electoral college votes, Republican presidential candidate in 2008					
Dow Jones Average 12/31/06 (on 6/30/06 closed at 11,150)					
Value of NASDAQ 12/31/06 (on 6/30/06 closed at 2172)					

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