Introduction

1. Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York: Random House, 2007). Regarding Taleb's criticism of value at risk, a statistical risk management metric, see "The Jorion-Taleb Debate," April 1997, at http://DerivativesStrategy.com.

2. As Malcolm Gladwell puts it, "I think that the task of figuring out how to combine the best of conscious deliberation and instinctive judgment is one of the great challenges of our time." Gladwell, *Blink: The Power of Thinking Without Thinking* (New York: Little, Brown, 2005), 269.

3. Because of accelerating capacity growth in processors, memory, and bandwidth, futurologist Ray Kurzweil predicts that the computational power of a typical personal computer will match that of the human brain sometime around 2020. Kurzweil, *The Singularity Is Near: When Humans Transcend Biology* (New York: Viking Penguin, 2005), 70.

Chapter 1

1. James Gleick, *Chaos: Making a New Science* (New York: Viking, 1987), 11–31.

2. William A. Sherden, *The Fortune Sellers: The Big Business of Buying and Selling Predictions* (New York: Wiley, 1998), 31–54.

3. American Meteorological Society, "Weather Analysis and Forecasting," *Bulletin of the American Meteorological Society* 88 (August 8, 2007).

4. A. J. Simmons and A. Hollingsworth, "Some Aspects of the Improvement in Skill of Numerical Weather Prediction," *Quarterly Journal of the Royal Meteorological Society* 128 (2002): 647–77.

5. Ibid., 648–52.

6. Sherden, *Fortune Sellers,* 61–72. For a more recent discussion with similar conclusions, see Michael F. Bryan and Linsey Molloy, "Mirror, Mirror, Who's the Best Forecaster of Them All?" *Federal Reserve Bank of Cleveland Economic Commentary*, March 13, 2007.

7. Tonis Vaga, *Profiting from Chaos: Using Chaos Theory for Market Timing, Stock Selection, and Option Valuation* (New York: McGraw-Hill, 1994), 33–37.

8. Robert J. Geller, David D. Jackson, Yan Y. Kagan, and Francesco Mulargia, "Earthquakes Cannot Be Predicted," *Enhanced Perspectives* 275.5306 (1996): 1616.

9. Robert J. Shiller, "From Efficient Market Theory to Behavioral Finance," *Cowles Foundation Discussion Paper,* no. 1385 (October 2002): 4, 14, 21. Shiller's arguments may seem convincing, but there are other potential explanations for why stock prices are more volatile than dividends. One is that stock prices fluctuate because of changes in the risk premiums with which investors discount future dividends to present value. These risk premiums could change as investors continually reassess the probability of economic downturns or stock market crashes. See Jessica A. Wachter, "Can Time-Varying Risk of Rare Disasters Explain Aggregate Stock Market Volatility?" draft Working Paper, October 8, 2008, Wharton School of Business, at http://finance.wharton.upenn.edu/~jwachter/.

10. The classic formula is spelled out in Charles P. Kindelberger, *Manias, Panics, and Crashes* (New York: Wiley, 1996).

11. Edward Chancellor, *Devil Take the Hindmost* (Basingstoke, UK: Macmillan, 1999), 58–95.

12. Gustave Le Bon, *The Crowd: A Study of the Popular Mind* (1895), 1, 2, 14, 22. Contrarian investor David Dreman cites Le Bon's observations as an accurate description of market dynamics. See Dreman, *Contrarian Investment Strategies: The Next Generation* (New York: Simon & Schuster, 1998), 356–57.

13. Solomon Asch, "Opinions and Social Pressure," 1955, at www.panarchy.org/asch/social.pressure.1955.html.

14. S. Bikhchandani, D. Hirshleifer, and I. Welch, "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," *Journal of Political Economy* 100 (October 1992).

15. For a description of Ising models, see Philip Ball, *Critical Mass: How One Thing Leads to Another* (New York: Farrar, Straus and Giroux, 2004), 87–93. Didier Sornette, in *Why Stock Markets Crash: Critical Events in Complex Financial Systems* (Princeton, NJ: Princeton University Press, 2003), extends the Ising model approach (pp. 123–30) to predict the exponential shapes characteristic of market bubble episodes.

16. Walter Bagehot, *Lombard Street: A Description of the Money Market* (1873).

17. Ball, *Critical Mass*, 156–77.

18. Herbert Simon, *The Sciences of the Artificial* (Cambridge: Massachusetts Institute of Technology Press, hereafter referred to as MIT Press, 1996), 36–37.

19. For example, Richard W. Roll, "The International Crash of October 1987," in *Black Monday and the Future of Financial Markets*, ed. Robert W. Kamphuis and Roger C. Kormendi (Chicago: Mid America Institute for Public Policy Research, 1989).

20. Fischer Black, "An Equilibrium Model of the Crash," in *National Bureau of Economic Research Macroeconomics Annual*, ed. Stanley Fischer (Cambridge: MIT Press, 1988).

21. George Soros, *The Alchemy of Finance: Reading the Mind of the Market* (New York: Simon and Schuster, 1994), 27–80.

22. Morris A. Davis and Michael G. Palumbo, "A Primer on the Economics and Time Series Econometrics of Wealth Effects," Finance and Economics Discussion Series 2001–09, Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board, Washington, DC.

23. Hyman Minsky, *Stabilizing an Unstable Economy* (New Haven, CT: Yale University Press, 1986).

24. Ben S. Bernanke, *Essays on the Great Depression* (Princeton, NJ: Princeton University Press, 2000), 25–27, 42, 89–107.

25. Ibid., 108–56.

26. Michael Pettis, *The Volatility Machine: Emerging Economies and the Threat of Financial Collapse* (New York: Oxford University Press, 2001).

27. Avanidhar Subrahmanyam and Sheridan Titman, "Feedback from Stock Prices to Cash Flows," Anderson Graduate School of Management, Paper 23 (1998).

28. This is an extremely simplistic synopsis of the Merton model for treating debt under an option valuation approach. See Robert C. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance* 29 (1974): 449–70.

29. Quoted in Peter J. Tanous, *Investment Gurus* (New York: Prentice Hall Press, 1997), 353.

30. Judea Pearl, *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference* (San Francisco: Morgan Kaufmann Publishers, 1988), 381–82.

31. University of Chicago researchers Lubos Pastor and Pietro Veronesi argue that "learning is facilitated by the existence of vast quantities of financial data, but it is also hampered by the large amount of randomness pervading financial markets." They describe how valuation models that incorporate Bayesian updating and uncertainty can explain seemingly irrational phenomena, like the high valuations of technology stocks (a rational function of uncertainty, in their view) or the subsequent crash (when investors learn of the true profitability of the firms). They point out that the stocks of younger firms have higher volatility and prices than those of older firms; a phenomenon that they conjecture reflects greater initial uncertainty about the business models, which diminishes as investors learn about the firms over time. Learning may explain why individual investors trade excessively (it helps them learn about their stock-picking skills) or why venture capital firms' performance is persistent (they may learn valuable information from their investments). See Pastor and Veronesi, "Learning in Financial Markets," *Annual Review of Financial Economics* (2009), and Andrew W. Lo, "Reconciling Efficient Markets with Behavioral Finance: The Adaptive Markets Hypothesis," *The Journal of Investment Consulting* 7:2 (2005).

32. This terminology comes from Philip Tetlock, who studied the forecasting accuracy of a panel of political experts. Tetlock uses the term *calibration* to refer to the degree to which subjective probabilities (forecasts) were aligned with objective frequencies. *Discrimination* measures the ability of forecasters to do better than predicting base rates by assigning high probabilities to events that actually occur and near-zero probabilities to events that do not. See Tetlock, *Expert Political Judgment: How Good Is It? How Can We Know?* (Princeton, NJ: Princeton University Press, 2005), 47–49.

33. J. Edward Russo and Paul J. H. Schoemaker, "Managing Overconfidence," *Sloan Management Review* 33:2 (1992), 10–11. The authors argue that in order to learn from experience (and thus improve calibration and forecasting accuracy), forecasters must get feedback on and be held accountable for their predictions.

34. Christopher Cherniak describes the "minimal rationality" that characterizes human cognition as evolving in a social context, where people vet what they know not only against their own beliefs but also against the shared knowledge of the community. "Doctrines like 'Ignorance of the law is no excuse' indicate that the agent is held to a standard of care that includes responsibility for collecting information by consulting appropriate experts in the community" (Cherniak, *Minimal Rationality* [Cambridge: MIT Press, 1986], 115).

35. Risk premiums cannot be directly observed. They can be estimated as the difference between equity returns and U.S. Treasury bond returns, but equity risk premiums have fluctuated across different periods, and there has been enormous variability in the risk premium from year to year. See Bradford Cornell, *The Equity Risk Premium: The Long-Run Future of the Stock Market* (New York: Wiley, 1999).

36. The concept of the "null hypothesis" is commonly used in statistical hypothesis testing. Bayesian statisticians prefer to think of new evidence modifying the "prior distribution" (or theory) before conducting the experiment. For the Bayesian point of view, see Colin Howson and Peter Urbach, *Scientific Reasoning: The Bayesian Approach*, 3rd ed. (Chicago: Open Court, 2006).

37. John Maynard Keynes, *The General Theory of Employment* (New York: Harcourt, Brace, 1912).

38. Karl Popper, *Conjectures and Refutations* (New York: Basic Books, 1963). While some argue that Popper's approach is too strict, there is a great deal of wisdom in his definition of a scientific proposition. The U.S. courts have adopted falsifiability as a standard for vetting expert witnesses and other presumed scientific evidence. See Kenneth R. Foster and Peter W. Huber, *Judging Science: Scientific Knowledge and the Federal Courts* (Cambridge: MIT Press, 1997).

39. Kenneth A. Posner and Vivian Wang, "In the Long Term, Pricing Trumps Losses, but the Short Term Could Still Be Volatile," Morgan Stanley Research, October 26, 2007.

40. Kenneth A. Posner and Vivian Wang, "Prime Mortgage Credit Now Deteriorating Rapidly—Reiterate FNM Underweight," Morgan Stanley Research, February 8, 2008.

41. Kenneth A. Posner and Vivian Wang, "Downgrading FNM to Underweight on Risk of Higher Losses," Morgan Stanley Research, January 18, 2008.

42. Kenneth A. Posner and Vivian Wang, "Upgrading FNM to Equal-weight: Waiting for Credit to Stabilize," Morgan Stanley Research, March 5, 2008.

Chapter 2

1. Nassim Nicholas Taleb draws a distinction between totally unpredictable Black Swans and what he calls "near-black" or "gray" swans that may be predictable. He also acknowledges that "severe Black Swans" may occur when surprises could have been predicted but people misunderstood the sources of uncertainty or "lack imagination" in their forecasts. Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York: Random House, 2007), 36–37.

2. Kenneth A. Posner and Athina Meehan, "Providian Corp: Betting on Legal/Regulatory Resolution," Morgan Stanley Dean Witter Research, April 5, 2005.

3. John C. Hull, *Options, Futures, and Other Derivatives,* 5th ed. (Upper Saddle River, NJ: Pearson/Prentice Hall, 2003), 392–94. In this example, we assumed no rate of growth in the stock price.

4. Robert T. Clemen, *Making Hard Decisions: An Introduction to Decision Analysis* (Boston: South-Western College Publishing, 1996), 70–74. See also Judea Pearl, *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference* (San Mateo, CA: Morgan Kaufmann Publishers, 1988), 13, 306–12.

5. There are plenty of examples in Keith M. Moore, *Risk Arbitrage: An Investor's Guide* (New York: Wiley, 1999).

6. Richard Berner, "US Economics: Recession in Smokestack America," Morgan Stanley Dean Witter Research, November 24, 2000.

7. Richard Jeffrey, *Subjective Probability: The Real Thing* (New York: Cambridge University Press, 2004), 76.

8. I first encountered the idea of calibrating a valuation model to current market prices in Alfred Rappaport and Michael J. Mauboussin, *Expectations Investing: Reading Stock Prices for Better Returns* (Cambridge: Harvard Business Press, 2001).

9. Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory*, 2nd ed. (Hoboken, NJ: Wiley-Interscience, 2006), 25–27.

10. Kenneth A. Posner, Mita Nambiar, and Athina Meehan, "Consumer Credit Cycle: Sweet Spot to Persist," Morgan Stanley Dean Witter Research (September 8, 2000), 3.

11. Kenneth A. Posner, Michael D. Courtian, and Athina Meehan, "Introducing the Weekly Pulse," Morgan Stanley Dean Witter Research, October 26, 2000.

12. Kenneth A. Posner, Athina Meehan, and Mita Nambiar, "Flying by the Numbers," Morgan Stanley Dean Witter Research, January 8, 2001.

13. Kenneth A. Posner and Athina L. Meehan, "Surfing the Loss Wave," Morgan Stanley Dean Witter Equity Research, April 2, 2001.

14. Kenneth A. Posner, Athina Meehan, and Mita Nambiar, "Surfing the Loss Wave III: Time to Trim," Morgan Stanley Dean Witter Research, June 14, 2001, and "Providian Corp.: Industry Risk Intensifying; Downgrade to Neutral," June 12, 2001.

15. Kenneth A. Posner and Athina Meehan, "Providian Corp.: All the King's Horses," Morgan Stanley Research, March 27, 2002.

Chapter 3

1. For references, see Paul J. Healey and Don A. Moore, "Bayesian Overconfidence," Working Paper, available at http://cess.nyu.edu/exp_seminar/fall_08_papers/Healy_Moore-Overconfidence.pdf.

2. CIT model portfolio short position contained in Kenneth A. Posner and Andy Bernard, "Specialty Finance: Betting on the Tortoise: Upgrading DFS to Overweight-V," Morgan Stanley Research, February 22, 2008, 14.

3. For an example of one of these tests, see Max Bazerman, *Judgment in Managerial Decision Making*, 6th ed. (Hoboken, NJ: Wiley, 2006), 34. For a survey of results across a range of experiments that measured overconfidence on the part of test subjects, see Sarah Lichtenstein, Baruch Fischhoff, and Lawrence D. Phillips, "Calibration of Probabilities: The State of the Art to 1980," in *Judgment Under Uncertainty: Heuristics and Biases*, ed. Daniel Kahneman, Paul Slovic, and Amos Tversky (Cambridge, UK, and New York: Cambridge University Press, 1982).

4. Some researchers have argued that overconfident traders are more aggressive than rational traders at exploiting mispricings caused by liquidity or noise traders; thus they expect to find in long-run equilibrium that overconfident traders make up a substantial fraction of the trading population. Other reasons cited in the academic literature for overconfident traders to persist include the tendency of rational traders to cut back on their own trades when they realize that overconfident traders are buying or selling aggressively. See Guo Ying Luo and David A. Hirshleifer, "On the Survival of Overconfident Traders in a Competitive Securities Market," *Journal of Financial Markets* 4:1 (January 2001).

5. Robert A. Burton, M.D., *On Being Certain: Believing You Are Right Even When You're Not* (New York: St. Martin's Press, 2008), 11, 16–17, 22–27, 39, 114–19, 134–35.

6. Quoted in Thomas Kida, *Don't Believe Everything You Think: The 6 Basic Mistakes We Make in Thinking* (Amherst, NY: Prometheus Books, 2006).

7. Gary Klein, *The Power of Intuition: How to Use Your Gut Feelings to Make Better Decisions at Work* (New York: Broadway Books, Random House, 2008), 68, 92.

8. The horse racing study is discussed in Richard J. Heuer, Jr., *Psychology of Intelligence Analysis* (New York: Novinka Books, 2006), 68. The study on predicting suspects' guilt is discussed in Carol Tavris and Elliot Aronson, *Mistakes Were Made (But Not By Me): Why We Justify Foolish Beliefs, Bad Decisions, and Hurtful Acts* (Orlando, FL: Harcourt, 2007), 145. The reference to clinical psychologists comes from David Dreman, *Contrarian Investment Strategies: The Next Generation* (New York: Simon & Schuster, 1998), 80. Also see, for example, Stuart Oskamp, "Overconfidence in Case-Study Judgments," in *Judgment Under Uncertainty*.

9. Malcom Gladwell, *Blink: The Power of Thinking Without Thinking* (New York: Little, Brown, 2005), 139.

10. Don A. Moore and Paul J. Healy, "The Trouble with Overconfidence," *Psychological Review* 115:2 (2008).

11. Ibid.

12. Brett N. Steenbarger, *The Psychology of Trading: Tools and Techniques for Minding the Markets* (Hoboken, NJ: Wiley, 2002).

13. Perry Mehrling, *Fischer Black and the Revolutionary Idea of Finance* (Hoboken, NJ: Wiley, 2005), 283.

14. Kent Daniel, David Hirshleifer, and Avanidhar Subrahmanyam, "A Theory of Overconfidence, Self-Attribution, and Security Market Under- and Over-reactions," Working Paper, February 19, 1997.

15. For example, during the Cold War, roughly 80% of information about the Soviet Union came from classified sources and only 20% from open sources. Today, 80% is open source. The data are taken from Mark M. Lowenthal, *Intelligence: From Secrets to Policy*, 3rd ed. (Washington, DC: CQ Press, 2006), 102. The importance of open-source information is one of the key themes of Gregory F. Treverton, *Reshaping National Intelligence for an Age of Information* (Cambridge, UK, and New York: Cambridge University Press, 2003). For example (p. 10), "The more-open world is blurring the distinction between collection and analysis. The best looker is not a spymaster, much less an impersonal satellite, but someone steeped in the substance at hand—in short, an analyst." Also, see Robert M. Clark, *Intelligence Analysis: A Target-Centric Approach*, 2nd ed. (Washington, DC: CQ Press, 2007), 87, 124.

16. Kahneman and Tversky, "On the Psychology of Prediction," in *Judgment Under Uncertainty*, 49.

17. Kenneth A. Posner, Tony Kim, and David Brown, "Countrywide Financial Corp.: Market Misprices Risk—Upgrade/Option Strategies," Morgan Stanley Research, May 11, 2006.

18. Kenneth A. Posner, "Countrywide Financial Corp.: Countrywide's Liquidity Having Become an Issue, We Downgrade to Equal-Weight," Morgan Stanley Research, August 17, 2007.

19. For a discussion of why loan level models are not suitable for aggregate forecasting, see Tony Hughes and Robert J. Stewart, "Forecasting and Stress Testing Using Model Pool Level Data," *Moody's Economy.com Regional Financial Review*, August 2008. For a description of micro-macro calibration, see Cris DeRitis and Tony Hughes, "The Moody's CreditCycle Approach to Loan Loss Modeling," *Moody's Economy.com Regional Financial Review*, March 2009.

Chapter 4

1. Christopher H. Browne, *The Little Book of Value Investing* (Hoboken, NJ: Wiley, 2007), 149.

2. This estimate is based on 10^{25} atoms in a kilogram of matter and the ability to store 1,024 bits of information in the magnetic interactions of the protons of a single molecule containing 19 hydrogen atoms, which has apparently been demonstrated by researchers at the University of Oklahoma. See Ray Kurzweil, *The Singularity Is Near: When Humans Transcend Biology* (London: Penguin Books, 2005), 131.

3. A point made by Nassim Nicholas Taleb in *Fooled by Randomness: The Hidden Role of Chance in the Markets and in Life* (New York: Texere, 2001), 165–66.

4. For example, in one study, researchers found a correlation between public opinion about the problem of illegal drugs and the number of media stories on the subject. See Thomas Kida, *Don't Believe Everything You Think: The 6 Basic Mistakes We Make in Thinking* (Amherst, NY: Prometheus Books, 2006), 178.

5. John Maynard Keynes, *The General Theory of Employment* (New York: Harcourt, Brace, 1912). For a discussion of infinite recursion, also see Didier Sornette, *Why Stock Markets Crash: Critical Events in Complex Financial Systems* (Princeton, NJ: Princeton University Press, 2003), 99–103.

6. The theoretical minimum cost of computing is quite low, especially if you could operate the computer at a temperature close to absolute zero and harness futuristic technologies like reversible and quantum computing. However, even with these technologies, there is in practice a limit to how powerful a computer could become, because transient fluctuations in energy at the subatomic level would introduce occasional mistakes into the calculations. Thus the device would need some kind of routine to check for and correct errors. The amount of energy dissipated in the processing of a single bit of information is kT, where k refers to Boltzman's constant and T to the ambient temperature in degrees Kelvin. See Kurzweil, *Singularity*

Is Near, 130–31, and R. Landauer, "Irreversibility and Heat Generation in the Computing Process," *IBM Journal* (July 1961). The amount of energy required to perform an elementary logical operation in time t is equal to or greater than $\pi h/2t$, where h refers to the quantum scale. See Seth Lloyd, "Ultimate Physical Limits to Computation," *Nature* (August 31, 2000): 1047. For a basic introduction to thermodynamics, see Peter Atkins, *Four Laws That Drive the Universe* (Oxford and New York: Oxford University Press, 2007) or Arieh Ben-Naim, *Entropy Demystified: The Second Law Reduced to Plain Common Sense* (Hackensack, NJ: World Scientific, 2007).

7. John Haugeland, *Artificial Intelligence: The Very Idea* (Cambridge: Massachusetts Institute of Technology Press, hereafter referred to as MIT Press, 1985), 65.

8. Roger Penrose, *The Emperor's New Mind* (New York: Penguin, 1998), 40–97. For a more technical discussion, see Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory*, 2nd ed. (Hoboken, NJ: Wiley-Interscience, 2006), 463–90.

9. The "halting problem" and intractability are some of the problems that lead philosophers to consider minimal rationality as a characteristic of human cognition, rather than the perfect rationality assumed in classic economics. See Christopher Cherniak, *Minimal Rationality* (Cambridge: MIT Press, 1986), 77–81.

10. Penrose, *Emperor's New Mind*, 181–89. For an example of problems that cannot be solved even with an ideal computer, see Cherniak, *Minimal Rationality,* 93–94. The reference to chess is from Herbert A. Simon, *The Sciences of the Artificial*, 3rd ed. (Cambridge: MIT Press, 1996), 118.

11. Michael E. Porter, "What Is Strategy?" *Harvard Business Review* (November–December 1996).

12. The term *critical uncertainty* comes from the literature on scenario analysis in strategic planning. See Peter Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World* (New York: Doubleday, 1996), 115, and Kees Van Der Heijden, *Scenarios: The Art of Strategic Conversation*, 2nd ed. (Hoboken, NJ: Wiley, 2005), 248. Critical uncertainties are called "load-bearing, vulnerable assumptions" in James A. Dewar, *Assumption-Based Planning: A Tool for Reducing Avoidable Surprises* (Cambridge, UK, and New York: Cambridge University Press, 2002), 64–90. Ben Gilad uses an "impact matrix" with one axis for uncertainty and the other for potential impact (which I have borrowed in my exhibit) to quantify the risk associated with "change drivers" in *Early Warning: Using Competitive Intelligence to Anticipate Market Shifts, Control Risk, and Create Powerful Strategies* (New York: AMA COM, 2004), 82.

13. Simon, *Sciences of the Artificial*, 51–58. Similarly, "the main reason to focus attention on a select set of target hypotheses is to economize the acquisition of new data . . . [and] to confine inferences to pertinent regions of the network," making propagation of new information through the entire network unnecessary (thus economizing on computational time). See Judea Pearl, *Probabilistic Reasoning in Intelligent*

Systems: Networks of Plausible Inference (San Mateo, CA: Morgan Kaufmann, 1997), 318–19.

14. Neuroscientists view our ability to pay attention as a limited resource that one allocates to an object or a location in order to enhance the speed or accuracy of sensory perception. Experiments with monkeys and humans that involve the monitoring of a random selection of visual cues show that the subjects' ability to systematically focus their attention at locations was consistent with the probability of the cues appearing there. See Paul Glimcher, *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics* (Cambridge: MIT Press, 2003), 323–28.

15. Van Hecke cites one study where researchers observed that law students failed to consider both sides of an issue before writing an essay that required them to do so. In another, a researcher studying Fortune 100 employees identified failure to stop and think as a greater barrier to intelligent behavior than either limited motivation or ability. See Madeleine L. Van Hecke, *Blind Spots: Why Smart People Do Dumb Things* (Amherst, NY: Prometheus Books, 2007), 37–39.

16. Gay Klein, *Power of Intuition* (New York: Currency Books, 2003), 270.

17. Mark Bowden, *Black Hawk Down* (New York: Atlantic Monthly Press, 1999), 175.

18. Quoted in Peter J. Tanous, *Investment Gurus* (New York: Prentice Hall Press, 1997), 353.

19. If 50,000 chunks of knowledge define expert knowledge (of the sort acquired over a decade's study), then it would take about 16 dichotomous tests to identify the relevant information. At about 10 milliseconds per test, the act of identification would take less than 200 milliseconds. Apparently it takes in practice a few hundred milliseconds to 1 or 2 seconds for memory to produce results. See Simon, *Sciences of the Artificial*, 88, 90.

20. See Klein, *Power of Intuition*, 13–29, for his theory of recognition-primed decision making and a case study.

21. William Duggan, *Strategic Intuition: The Creative Spark in Human Achievement* (New York: Columbia Business School Publishing, 2007). Napoleon's *coup d'oeil* is discussed on pp. 55–67.

22. See Simon, *Sciences of the Artificial,* 193–200, for a discussion of the trial-and-error approach to searching and the near decomposability of certain kinds of problems.

23. Pearl, *Probabilistic Reasoning in Intelligent Systems*, 107.

24. Gilad, *Early Warning*, 131.

25. Rob Johnston, *Analytic Culture in the U.S. Intelligence Community: An Ethnographic Study* (Washington, DC: Central Intelligence Agency, 2005), 25–27.

26. David Hirshleifer and Ivo Welch, "An Economic Approach to the Psychology of Change: Amnesia, Inertia, and Impulsiveness," Yale Cowles Foundation Discussion Paper No. 1306, June 2001.

27. Because of the "combinatorial explosion" entailed in trying to search through all branches of a decision tree, searching must be "*selective*, that is, partial and risky" (Haugeland, *Artificial Intelligence*, 178).

28. Kenneth A. Posner, Camron Ghaffari, and David Brown, "Advance America: Initiating with an Underweight-V Rating," Morgan Stanley Research, January 25, 2005.

Chapter 5

1. Quoted in Christopher Cherniak, *Minimal Rationality* (Cambridge: Massachusetts Institute of Technology Press, hereafter referred to as MIT Press, 1986), 108.

2. In a report downgrading CIT to neutral on the heels of the announcement, I wrote that the transaction rationale was unclear: "The real issue at CIT, in our view, is the company's high cost of capital and low returns on equity. Until CIT improves its funding costs, we think it will have trouble competing with bank-owned finance companies, not to mention the likes of GE Capital, especially given the thin margins characteristic of vendor finance and other commercial finance businesses. We don't see Tyco's purchase of CIT as providing any benefit to CIT's funding costs. In fact, CIT's corporate debt spreads widened 2 bps yesterday on news of the deal, while TYC's were unchanged. CIT's corporate debt is ranked by the fixed-income rating agencies several notches better than Tyco's (A1/A+ versus Baa1/A-). Moody's has indicated it will review CIT's ratings for possible downgrade, although Standard & Poor's has reaffirmed its current ratings. CIT's recent 5-year bond issuance ('06 maturity) is currently trading at 165 bps over Treasuries, 10 bps lower than Tyco's 10-year debt ('11 maturity) at 175 bps." See Kenneth A. Posner and Athina Meehan, "The CIT Group: Downgrading to Neutral," Morgan Stanley Dean Witter Research, March 14, 2001.

3. Kenneth A. Posner and Athina Meehan, "CIT Group: A Long Way to Go," Morgan Stanley Research, July 5, 2002.

4. Kenneth A. Posner and Athina Meehan, "The CIT Group: Rebalancing Our Ratings," Morgan Stanley Research, September 8, 2003.

5. Carol Tavris and Elliot Aronson, *Mistakes Were Made (but Not by Me): Why We Justify Foolish Beliefs, Bad Decisions, and Hurtful Acts* (New York: Houghton Mifflin Harcourt, 2007), 10. See also Eddie Harmon-Jones and Judson Mills, eds., *Cognitive Dissonance: Progress on a Pivotal Theory in Social Psychology* (Washington, DC: American Psychological Association, 1999).

6. Tavris and Aronson, *Mistakes Were Made*, 19.

7. For examples of studies on this topic, see Max Bazerman, *Judgment in Managerial Decision Making*, 6th ed. (Hoboken, NJ: Wiley, 2006), 35–36.

8. Tavris and Aronson detail many of these bad decisions in *Mistakes Were Made*.

9. Uri Bar-Joseph, "Intelligence Failure and the Need for Cognitive Closure: The Case of Yom Kippur," in *Paradoxes of Strategic Intelligence: Essays in Honor of Michael I. Handel*, ed. Richard K. Betts and Thomas G. Mahnken (Portland, OR: Frank Cass, 2003), 166–89.

10. Ward Edwards, "Conservatism in Human Information Processing," in *Judgment Under Uncertainty: Heuristics and Biases,* ed. Daniel Kahneman, Paul Slovic, and Amos Tversky (Cambridge, UK: Cambridge University Press, 1982), 359–69.

11. The other explanation comes from prospect theory, according to which people are willing to take greater risk to avoid a loss than they are to sustain a gain. See Andrea Frazzini, "The Disposition Effect and Under-Reaction to News," *The Journal of Finance* LXI.4 (August 2006): 2017–46.

12. Richard J. Heuer, Jr., *Psychology of Intelligence Analysis* (New York: Novinka Books, 2006), 28. Tavris and Aronson have a similar thought: "Becoming aware that we are in a state of dissonance can help us make sharper, smarter, conscious choices instead of letting automatic, self-protective mechanisms resolve our discomfort in our favor" (Tavris and Aronson, *Mistakes Were Made*, 226).

13. Bazerman, *Judgment in Managerial Decision Making*, 172–74.

14. Heuer, *Psychology of Intelligence Analysis,* 24–25.

15. The need for "mettle" comes from Christopher H. Browne, *The Little Book of Value Investing* (Hoboken, NJ: Wiley, 2007), 149.

16. Some practitioners have come to the same conclusion. For example, the CIA conducted case studies on how its analysts gauge diagnostic power when they update their subjective probability assessments. In a declassified study conducted in the early 1970s, a group of analysts was polled on their changing views of the odds of hostilities between the Soviet Union and China. The study revealed that the analysts' judgments about probabilities were inconsistent with their assessment of the diagnostic power of new information—a troubling inconsistency. See Charles E. Fisk, "The Sino-Soviet Border Dispute: A Comparison of the Conventional and Bayesian Methods for Intelligence Warning," originally published in *Studies in Intelligence*, 1972, reprinted in *Inside CIA's Private World: Declassified Articles from the Agency's Internal Journal 1955–1992*, ed. H. Bradford Westerfield (New Haven, CT: Yale University Press, 1995).

17. The suggestion is taken from Heuer's *Psychology of Intelligence Analysis*, which in turn quotes a study by Daniel J. Isenberg, "How Senior Managers Think," in *Decision Making: Descriptive, Normative, and Prescriptive Interactions*, ed. David Bell, Howard Raiffa, and Amos Tversky (Cambridge, UK, and New York: Cambridge University Press, 1988).

18. James A. Dewar *Assumption-Based Planning: A Tool for Reducing Avoidable Surprises* (Cambridge, UK, and New York: Cambridge University Press, 2002),

91–107, and Peter Schwartz, *The Art of the Long View: Planning for the Future in an Uncertain World* (New York: Doubleday, 1996), 198.

19. Kenneth A. Posner, "Discover Financial Services: Market May Be Overlooking Value of Network 'Put' Option," Morgan Stanley Research, August 14, 2007.

20. Kenneth A. Posner, "Discover Financial Services: To Underweight-V on Risk of Consumer Credit Recession," Morgan Stanley Research, October 31, 2007. Betsy Graseck's report calling for a consumer credit recession, "Large Cap Banks: Consumer Contagion Coming," was published on the same day (Morgan Stanley Research).

21. Kenneth A. Posner and Andy Bernard, "Betting on the Tortoise: Upgrading DFS to Overweight-V," Morgan Stanley Research, February 22, 2008.

Chapter 6

1. Peter J. Tanous, *Investment Gurus: A Road Map to Wealth from the World's Best Money Managers* (New York: Prentice Hall Press, 1997), 38.

2. Alice Schroeder, *The Snowball: Warren Buffett and the Business of Life* (New York: Bantam, 2008), 598.

3. For a high-level summary of the development of information economics, as well as a brief discussion of asymmetric information and strategies for overcoming it, see Joseph E. Stiglitz, "Information and the Change in the Paradigm in Economics," *The American Economic Review* (June 2002).

4. Kenneth A. Posner, Camron Ghaffari, and David Brown, "Specialty Finance: Student Lending Survey II: Underweight SLM, Overweight NNI," Morgan Stanley Research, September 13, 2005.

5. Sallie Mae, Q3 2005 Earnings Call Transcript, CallStreet, October 20, 2005.

6. Ben Gilad, *Early Warning: Using Competitive Intelligence to Anticipate Market Shifts, Control Risk, and Create Powerful Strategies* (New York: AMACOM, 2004), 101.

7. Ibid., 7, 8.

8. Sydney Finkelstein, *Why Smart Executives Fail: And What You Can Learn From Their Mistakes* (New York: Penguin, 2003), 165, 169, 214.

9. Wachovia Corp., Q2 2008 Earnings Call, CallStreet (July 22, 2008), 14.

10. For those unfamiliar with the term, a *deferred tax asset* reflects the value of tax deductions that have run through the generally accepted accounting principles (GAAP) income statement but have not yet been taken in the tax returns. Freddie had established reserves against future credit losses in its financial statements under GAAP, even though it would not deduct those reserves for tax purposes until it wrote off the loans. If a company cannot demonstrate that it will have sufficient taxable income in future periods to use those tax deductions, then its auditors may force the

company to write off a portion of the deferred tax asset, a move that would impair its capital. For this reason, regulators limit the size of deferred tax assets that banks can count as capital. The regulatory guidelines for Freddie and Fannie Mae did not address deferred tax assets, but the companies were still vulnerable to their auditors' determination.

11. Federal Home Loan Mortgage Corp., 2008 Q2 Earnings Conference Call, CallStreet (August 6, 2008), 20.

12. Undoubtedly, part of the reason for the deferred tax write-down was the auditors' concern that the government would have the company take actions to benefit public policy, such as reducing its guarantee fees, rather than maximize profits. Whether the company would have been forced to write off its deferred tax asset if it had remained private is an open question.

13. Rakesh Khurana, *Searching for a Corporate Savior: The Irrational Quest for Charismatic CEOs* (Princeton, NJ: Princeton University Press, 2002), 79, 156.

14. Adapted from Judea Pearl, *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference* (San Mateo, CA: Morgan Kaufmann Publishers, 1988), 58–59.

Chapter 7

1. In computational theory, *mapping* is another term for a mathematical function that produces an output for one or more inputs. See Michael Sipser, *Theory of Computation* (London: Springer, 2007), 15.

2. According to Metcalfe's Law (named after Bob Metcalfe, the coinventor of the Ethernet), the value of a network increases with the square of the number of connected users. For a discussion of network economics, see Carl Shapiro and Hal R. Varian, *Information Rules: A Strategic Guide to the Network Economy* (Boston: Harvard Business School Press, 1999), 173–225.

3. Kenneth A. Posner and Athina Meehan, "Attacking the Death Star," Morgan Stanley Research, April 15, 2004.

4. Marcia Vickers, "Plastic Under Attack," *Fortune* (May 17, 2006).

5. Gary Klein, *Source of Power: How People Make Decisions* (Cambridge: Massachusetts Institute of Technology Press, hereafter referred to as MIT Press, 1998), 45–74. Keith E. Stanovich and Richard F. West draw a similar distinction between what they call "system 1" (or heuristic-based reasoning) and "system 2" (or conscious, analytic reasoning). See Stanovich and West, "Individual Differences in Reasoning: Implications for the Rationality Debate," in *Heuristics and Biases: The Psychology of Intuitive Judgment*, ed. T. Gilovich, D. Griffin, and D. Kahneman (New York: Cambridge University Press, 2002), 421–40.

6. Robert T. Clemen, *Making Hard Decisions: An Introduction to Decision Analysis* (Pacific Grove, CA: Duxbury/Thomson Learning, 1996), 285–94.

7. John Haugeland, *Artificial Intelligence: The Very Idea* (Cambridge: MIT Press, 1985), 178.

8. Kenneth A. Posner, "MasterCard: Litigation and Other Risks May Be Less Severe Than Market Expects; Initiate with Overweight-V," Morgan Stanley Research, June 22, 2002.

9. Kenneth A. Posner and Andrew Chen, "MasterCard: Market Responding Accurately to Upside Surprise; Downgrade to Equal-weight-V," Morgan Stanley Research, November 2, 2006.

10. Kenneth A. Posner and Betsy Graseck, "The Coming Battle for the Affluent Cardholder," Morgan Stanley Research, August 11, 2006.

11. Kenneth Posner and Camron Ghaffari, "American Express: Giving More Credit to Operating Leverage: Upgrade," Morgan Stanley Research, August 10, 2005.

12. Kenneth A. Posner and Charles Murphy, "Long MA, Short AXP—A Strategy Levered to Payments Pricing That Hedges US Consumer Risk," Morgan Stanley Research, November 21, 2007.

13. Charlie Murphy, "MasterCard: Quick Comment: MA Raising Cross-Border Fees in 2008, Industry Source Suggests; Confirming Data Point for Our Pricing Power Thesis," Morgan Stanley Research, December 10, 2007.

14. Kenneth A. Posner and Andy Bernard, "American Express: Cutting 2008 EPS by $0.16 on Higher Funding Costs, Lowering Price Target to $39—Remain Underweight," Morgan Stanley Research, March 17, 2008.

Chapter 8

1. N. Metropolis, "The Beginning of the Monte Carlo Method," *Los Alamos Science*, Special Issue 1987.

2. Judea Pearl, *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference* (San Mateo, CA: Morgan Kaufmann Publishers, 1988), 211.

3. Gary Kinder, *Ship of Gold in the Deep Blue Sea* (New York: Atlantic Monthly Press, 1998), 215–18, 228–29.

4. Kenneth A. Posner and Camron Ghaffari, "American Express Co.: Legal Risk to Partnership Strategy," Morgan Stanley Research, July 11, 2005.

5. Kenneth A. Posner and Camron Ghaffari, "American Express Co.: Risk Factors Limit Upside; Consider Selling Volatility," Morgan Stanley Research, March 14, 2006.

6. Kenneth A. Posner and Camron Ghaffari, "American Express Co.: Repurchase Calls," Morgan Stanley Research, April 11, 2006.

7. Philippe Jorion, "Risk Management Lessons from Long-Term Capital Management," *European Financial Management* 6 (September 2000): 277–300. For a more general background, see Roger Lowenstein, *When Genius Failed: The Rise and Fall of Long-Term Capital Management* (New York: Random House, 2000).

8. Atish Kakodkar, Barnaby Martin, and Stefano Galiani, "Correlation Trading: A New Asset Class Emerges," Merrill Lynch, November 26, 2003.

9. "Who's the More Foolish? The Fool, or the Fool Who Follows Him?" June 28, 2007, at www.accruedint.blogspot.com.

10. Gary B. Gorton, *The Panic of 2007* (Hoboken, NJ: Wiley, 2007), 190.

11. Kenneth Posner, Melini Jesudason, Armando Lopez, Robert Stevenson, "Housing Market Downside," Morgan Stanley Research, February 5, 2003, 8.

12. Christopher Mayer and R. Glenn Hubbard, "House Prices, Interest Rates, and the Mortgage Market Meltdown," draft Working Paper, Columbia Business School, October, 2008.

13. Reid Hastie and Robyn M. Dawes, *Rational Choice in an Uncertain World* (Thousand Oaks, CA: Sage, 2001), 156–62.

14. Bennett W. Golub and Leo M. Tilman, *Risk Management Approaches for Fixed Income Markets* (Hoboken, NJ: Wiley, 2000), 56–62 for key rate durations, 95–123 for principal components analysis.

15. For the classic critique of the GSE model (albeit a bit early), see Thomas H. Stanton, *A State of Risk: Will Government-Sponsored Enterprises Be the Next Financial Crisis?* (New York: HarperBusiness, 1991), and Stanton's updated *Government-Sponsored Enterprises: Mercantilist Companies in the Modern World* (Washington, DC: AEI Press, 2002).

16. Kenneth A. Posner, "Fannie Mae, Freddie Mac, and Interest Rate Risk," Morgan Stanley Research, September 9, 2002, and Kenneth A. Posner and David Brown, "Fannie Mae, Freddie Mac & the Road to Redemption," Morgan Stanley Research, July 6, 2005.

17. Diana Hancock, Andreas Lehnert, Wayne Passmore, and Shane M. Sherlund, "An Analysis of the Potential Competitive Impacts of Basel II Capital Standards on U.S. Mortgage Rates and Mortgage Securitization," Federal Reserve Board, April 2005, Figure 5.1. See also "Retail Credit Economic Capital Estimation—Best Practices," The Risk Management Association, February 2003, 54.

18. Kenneth A. Posner, Tony Kim, David Brown, and Drew Uher, "Fannie Mae Cross-Asset Insights: Equity Discounting Too Much Risk, While Sub-Debt Appears Complacent," Morgan Stanley Research, February 2, 2006.

19. Kenneth A. Posner and Tony Kim, "Fannie Mae: Restatement Shows Strong Balance Sheet," Morgan Stanley Research, December 6, 2006.

20. Statement by Secretary Henry M. Paulson, Jr. on Treasury and Federal Housing Finance Agency Action to Protect Financial Markets and Taxpayers, September 7, 2008, at www.treas.gov/press/releases/hp1129.htm.

21. Golub and Tilman, *Risk Management Approaches*, 203.

22. Deborah Lucas and Robert L. McDonald, "An Options-Based Approach to Evaluating the Risk of Fannie Mae and Freddie Mac," *Journal of Monetary Economics* 53 (2006): 155–76.

23. CBO's Estimate of Cost of the Administration's Proposal to Authorize Federal Financial Assistance for the Government-Sponsored Enterprises for Housing, Letter to the Honorable John M. Spratt Jr., July 22, 2008.

24. Charles Duhigg, Stephen Labaton, and Andrew Ross Sorkin, "As Crisis Grew, a Few Options Shrank to One," *New York Times* (September 8, 2008): A1.

Chapter 9

1. Marvin Minsky, *The Emotion Machine: Commonsense Thinking, Artificial Intelligence, and the Future of the Human Mind* (New York: Simon & Schuster, 2006).

2. Kenneth A. Posner and Athina Meehan, "SLM Corporation: Great Expectations," Morgan Stanley Research, September 8, 2003.

3. Kenneth A. Posner, "SLM Corporation: Increasing PT to $54.50, Upgrading to Equal-Weight," Morgan Stanley Research, May 8, 2006.

4. Kenneth A. Posner and Andrew Chen, "SLM Corporation: Stock Now Discounts Political, Balance Sheet Risk; Potential for Rebound," Morgan Stanley Research, January 23, 2007.

5. Quotation referenced in Richard J. Heuer, Jr., *Psychology of Intelligence Analysis* (New York: Novinka Books, 2006), 82.

6. For a general discussion, see Reid Hastie and Robyn M. Dawes, *Rational Choice in an Uncertain World* (Thousand Oaks, CA: Sage Publications, 2001), 47–98.

7. Martin Leibowitz and Anthony Bova, "Portfolio Analysis: Beyond Diversification: 'Dragon Risk'," Morgan Stanley Research, July 21, 2004. Leibowitz attributes the term "dragon risk" to Cliff Asness.

8. Kate Kelly, "How Goldman Won Big on Mortgage Meltdown," *Dow Jones Financial News Online* (December 17, 2007).

9. Joel Greenblatt, *The Little Book That Beats the Market* (Hoboken, NJ: Wiley, 2006). For an analysis critical of Greenblatt's back-testing claims, see Bill Alpert, "The Little Book's Little Flaw," *Barron's Online*, Wednesday, March 27, 2006, at http://online.barrons.com/article/SB114325090789508133.html.

10. www.buffettsystem.com/.

11. Brian T. Hayes, PhD, "August 2007 Quantitative Equity Turbulence: An Unknown Unknown Becomes a Known Unknown," Lehman Brothers, November 2007.

12. Richard Bookstaber, *A Demon of Our Own Design* (Hoboken, NJ: Wiley, 2007), 182–90.

13. Graham's image of Mr. Market is "probably the most brilliant metaphor ever created for explaining how stocks can become mispriced" (Jason Zweig, commentary to chapter 8 of Benjamin Dodd's *The Intelligent Investor* [New York: HarperBusiness, 2005], 213).

14. Hayes, "August 2007 Quant Equity Turbulence," Presentation to New York Academy of Sciences, April 17, 2008. See also Amir E. Khandani and Andrew W. Lo, "What Happened to the Quants in August 2007? Evidence from Factors and Transactions Data," Working Paper, October 23, 2008.

15. Khandani and Lo, "What Happened to the Quants in August 2007? Evidence from Factors and Transactions Data," 3. The Lehman analyst quoted was M. Rothman, "Turbulent Times in Quant Land," U.S. Equity Quantitative Strategies, Lehman Brothers Research, 2007.

16. *The Intelligent Investor*, 191–92, 194.

17. George J. Benston, *An Analysis of the Causes of Savings and Loan Association Failures*, Salomon Brothers Center for the Study of Financial Institutions, 1985.

18. MBNA Corp., Q4 2004 Earnings Call Corrected Transcript, CallStreet (January 21, 2005), 8.

19. It was thought that MBNA's largest investors were interested in monetizing their stakes, so perhaps management had to push for growth as aggressively as possible if it wanted a chance to maintain the company's independence.

20. For example, see Laurence H. Meyer, "Supervising Large Complex Banking Organizations: Adapting to Change," in *Prudential Supervision: What Works and What Doesn't*, ed. Frederic S. Mishkin (Chicago: University of Chicago Press, 2001), 97–98.

21. Oliver Wyman, "Payback Time for Basel II," 2007.

22. "The growing fashion in risk management, supported by the Basel Committee on Banking Supervision, is a move away from discretionary judgments about risk and a move to more quantitative and market-sensitive approaches" (Avinash Persaud, "Sending the Herd off the Cliff Edge: The Disturbing Interaction Between Herding and Market-Sensitive Risk Management Practices," Bank for International Settlements Papers, No 2 [2000]).

23. Claudio Borio, "The Macroprudential Approach to Regulation and Supervision," VOX—Research-Based Policy Analysis and Commentary from Leading Economists, April 14, 2009, at www.voxeu.org/index.php?q=node/3445.

24. Avinash Persaud, "Macro-Prudential Regulation: Fixing Market (and Regulatory) Failures," Policy Brief, undated.

25. For a quick summary, see Sam Peltzman, "Regulation and the Natural Progress of Opulence," 2004 Distinguished Lecture, AEI-Brookings Joint Center for Regulatory Studies, American Enterprise Institute for Public Policy Research,

Washington, DC. For a discussion of how risk management systems encourage financial institutions to take on more risk, see Kent Osband, *Iceberg Risk: An Adventure in Portfolio Theory* (New York: Texere, 2003).

26. L. William Seidman, *Full Faith and Credit: The Great S&L Debacle and Other Washington Sagas* (New York: Times Books, 1993), 133–34.

27. Kenneth A. Posner and Andrew Chen, "SLM Corporation: Seeking Relative Value," in *North American Financials US Financials Model Portfolio*, Morgan Stanley Research, February 15, 2007.