PART
One

The Challenges of Changes and Crises

CHAPTER **1**

The Discontinuity Challenge

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The twists and tangles of the 2008 credit crunch will long be remembered. While this chapter does not address that specific discontinuity, it does focus on discontinuities in general. From a longer time perspective, we see that discontinuities occur frequently, suggesting that in addition to applying our experience and running our models that work in "normal" times, we need to prepare to face the inevitable discontinuity environments.

THINKING ABOUT DISCONTINUITIES

Q: How's your day going?
A: Same old, same old.

Most days, things go on today as they did yesterday. A very large portion of our behavior is rooted in the *almost always correct* assumption that past experience will guide us through the next day.

Almost always correct? Yes, but what about those occasions when something crosses our path that is new and dangerous, something wholly unlike what we encountered in the past?

Exhibit 1.1 shows how these "unexpected" shocks seem to occur every few years.[1] Looking further back, we can find serious U.S. stock market/ financial panics in 1797, 1812, 1819, 1823, 1825, 1837, 1847, 1857, 1866, 1893, 1907, 1918, 1929 . . . you get the picture. As Rahl shows, these disruptive events are not the outliers we think they are, but rather common events that occur far more frequently than we recall. There are a lot of discontinuities, they always surprise many, they wreak havoc on the financially weak, and, most importantly, once the markets and the economy are sufficiently wrung out, they go away.
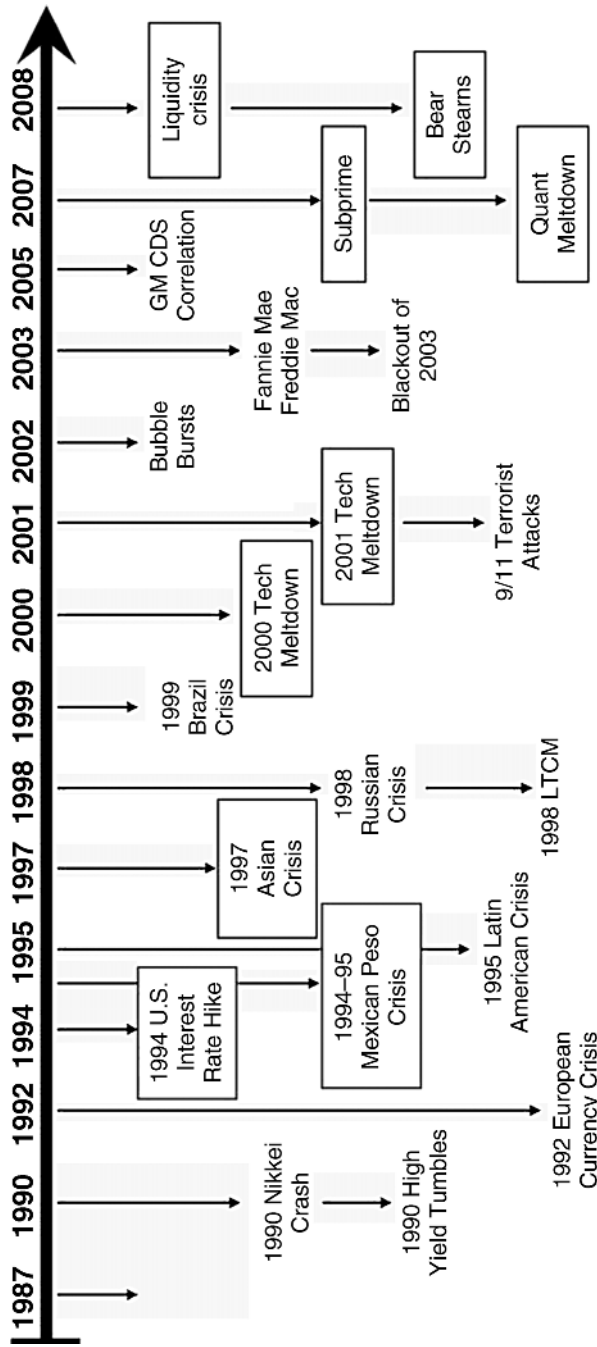
EXHIBIT 1.1 "Unexpected" Financial Shocks—Once-in-a-Lifetime Crises Seem to Occur Every Few Years
Source: Courtesy of Leslie Rahl at Capital Market Risk Advisors (http://www.cmra.com/crises.php).

Despite the frequency of discontinuities and the major effects they can have on the economy and our accumulated wealth, most investment thinking is based on consideration of data gathered during more normal cause-and-effect economic times. There is a very strong reason for this focus: It isn't really possible to do otherwise. We can paint scenarios of dire conditions, but we cannot usefully judge their likelihood, their timing, or their severity. Faced with our inability to deal with the unknowable, our focus naturally turns to the more intelligible.

Thus, the study of economic value necessarily focuses on the observables (i.e., history), and especially the massive data generated by the continuous unfolding of economic and market history. But out there lay broader possibilities perfectly capable of upsetting our best-laid plans. Surprise is always around the corner. H. L. Mencken put it well when he said, "Penetrating so many secrets, we cease to believe in the unknowable. But there it sits nevertheless, calmly licking its chops."

Where do these discontinuities arise? Actually, very few sources seem to account for the majority: natural disasters; large financial failures, most often arising from overextended leverage and expectations (aka greed); and the unintended consequences of political tinkering. Allan Bloom, in *The Closing of the American Mind*,[2] points out the supremacy of politics over economics:

> *The market presupposes the existence of law and the absence of war. . . . Political science is more comprehensive than economics because it studies both peace and war and their relations . . . the preservation of the polity continuously requires reasoning and deeds which are "uneconomic" or "inefficient." Political action must have primacy over economic action, no matter what the effect on the market.*

DECISION MAKING IN NORMAL TIMES

We can characterize most active investment managers as intuitive thinkers who search for significant facts that stand out from the mass of observation— that is, hidden value. The danger for the intuitive thinker is that discontinuity events overwhelm the economic thinking that must prevail during the everyday course of events. In discontinuous times, everything's an outlier, and hidden value becomes deeply and obscurely hidden.

Quantitative managers, in contrast, are systematic thinkers who focus on "normal" tendencies like orderly effects and small systemic inefficiencies, which are often obscured from the intuitors within the mass of data. But the equations don't work when we encounter the deviant outlier observations. Statisticians recognize that the importance of a data point rises with the square of its distance from the mean observation. Any

statistical analysis using an observation out of the "normal" range will fit a regression line right through that deviant point. It is as though there were only two observations: the deviant point and the blob of the remaining observations, within which all normally significant relationships are insignificant by comparison.

In Exhibit 1.2, the solid line through the blob represents normal relationships, while the dotted line represents the effect of adding an extreme outlier to the regression data.

For this reason, most statistical analyses throw away obviously deviant data. But how can that be justified in the context of portfolio management? It sounds absurd to pretend that these outlier events never happen, yet our primary tools are useful only for investigating economic relationships rather than, as Bloom suggests, the realm of political events.

Well, this is embarrassing! We're damned if we include the deviant data, and damned if we don't. Unless we have some operative model, either intuitive or statistical, of how the world works in normal times, we might as well use astrology to build portfolios. So the correct course of action seems to be to set aside the impenetrable deviants, but by all means not to forget them. The danger, of course, is that once we discard the deviant data, we frequently forget or sublimate that it ever existed. And the more our "normal times" thinking makes us rich, and the longer normal times last, the more inclined we are to forget the unknowable, which is calmly licking its chops.

Keith Ambachtsheer points out in Chapter 2 that it is all too easy to get caught up in the excitement and romance of making truly serious money. It is useful here to reflect on a July 2007 quote from Charles Prince, the ex-chairman and CEO of Citigroup:

When the music stops, in terms of liquidity, things will get complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing. . . .[3]
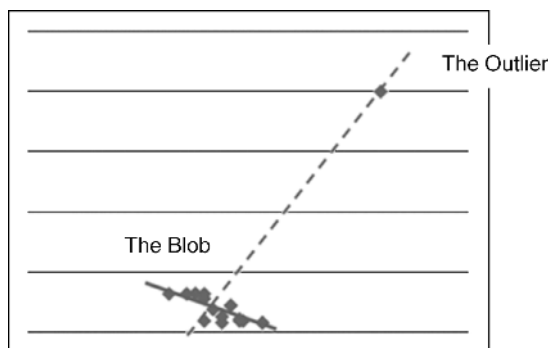
EXHIBIT 1.2   Effect of Adding an Extreme Outlier to the Regression Data

Prince seems supremely confident in his ability to know when to exit, but with everyone planning to stay as late as they can, he clearly underestimated how quickly conditions can change. Four months later, the music stopped and Mr. Prince was unceremoniously ushered out the door.

Call this temptation the financial dance of death. It's easy to string along while the money's flowing in, *but how do you know when to stop?* Those who leave the dance too early leave money on the table and initially look incompetent. However, a fully committed player like Mr. Prince finds that he can't escape when the building's on fire and everyone wants out at the same time. Envision a whole symphony hall overwhelmed with panic. Now envision the same panic in the trading rooms of Wall Street. As we've seen, hardly anybody knows how to call that timing very well.

"Haven't we been here before?" you might ask. In retrospect, all the dance steps to ruin look familiar. But each time the players are different, the lyrics sound new, and there's money to be made. We've seen junk bonds bring down the S&Ls, we've seen Russian bonds bring down Long Term Capital Management, but we've never experimented with junk mortgages before, so it looks different—at first glance. The leverage gets geared up, the duration of the assets is mismatched to the liabilities, and the comeuppance generates an illiquidity trap. In this game of musical chairs, all the chairs disappear at once while the music is still playing. "Nobody rings a bell when it's time to sell," says the wise old Wall Street adage.

It's easy to scapegoat Charles Prince as a "greedy" Wall Streeter, but all of us can be entranced by the siren's song.

The above excesses can be summed up as a slowly accumulating deficit in adult supervision, common sense, skepticism, ethical concern, and good, old-fashioned prudence. As often happens in booms, the kids, the ones who didn't live through the last debacle, shouldered the adults aside or impressed them too much. It's happened before and it will happen again.

TALEB'S BLACK SWANS

Nicholas Taleb hardly needs introduction to the readers of this book. His work focuses on discontinuities, which he identifies as "black swans." Taleb describes a *black swan* as "a highly improbable event with three principal characteristics: It is unpredictable; it carries a massive impact; and, after the fact, we concoct an explanation that makes it appear less random, and more predictable, than it was."[4]

In a recent Web article,[5] highly recommended to the reader, Taleb focuses on the problem of identifying risks when one cannot rely on conventional statistical methods.

Investment professionals are accustomed to taking risks in order to enhance expected returns. But Taleb points out that we can never correctly identify all the risks. Taleb describes risks that cannot be described by "normal" databases, and that involve higher levels of risks that cannot even be defined by standard methods. They may even involve risks that have never occurred—indeed, that based on our observable data would be considered impossible.

Taleb lays out a 2×2 decision table, where one axis is the decision type and the second axis characterizes two structures of variability:

Where do we get into trouble using Normal distributions?		Variability Structure	
		Quantitative	**Qualitative**
Decision Structure	Simple	Analyzable	Okay
	Complex	Okay	*Danger!*

Source: Taleb (see note 4).

Decisions break into two groups, which Taleb calls *simple* and *complex*. Simple decisions are true/false, win/lose on the flip of a coin or the payoffs from tossing dice. Complex decisions are situations where you care not only about the frequencies, but also the impact.

Variability structures are similarly divided into simple and complex, or very distinctly *quantitative* versus *qualitative*. The quantitative structure corresponds to "random walk"–style randomness found in statistics textbooks. Complex structures embed random jumps as well as random walk elements—the kind of distributions Mandelbrot famously brought to our attention.[6]

Taleb points out that the problems lie in the confluence of complex decisions and random jump elements. It's here that black swans bite most viciously.

Consider the dual meaning of the word *normal*. As a proper noun, capital-*N*, *Normal*, it specifically refers to a body of statistical knowledge developed around the delightful mathematical properties of the Gaussian distribution. But the use of the name "normal" probably comes to the statistical world from general usage, "being approximately average or within certain limits." While there are many places where *normal* experience is Normally distributed, we fool ourselves—and our clients—when we forget that much of economic life is distinctly abnormal.

Taleb points out that students of statistics approach a problem by assuming a probability structure, typically with a known probability distribution, in all likelihood a Gaussian, Normal distribution. But the critical
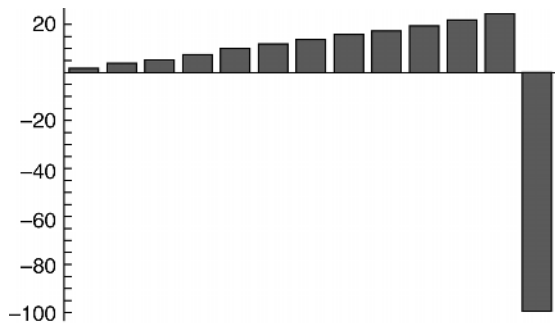
EXHIBIT 1.3   Anatomy of a Blowup
Source: Taleb (see note 4).

problem is not making computations once you know the probabilities, but finding the true distribution.

Low-probability events that carry large impacts may be difficult to compute from past data. Our empirical knowledge about the potential contribution of rare events will not, then, prepare us for black swan events. *Risk* is one word but not one number. Variance, skewness, and kurtosis (fat tails) are important. So is the application of risk-scenario analysis that illuminates survivability, best outcome, and breakeven analysis.

Exhibit 1.3 is Taleb's chart describing a blowup. In the *Edge* article, Taleb calls this his classical metaphor:

> *A turkey is fed for a 1000 days—every day confirms to its statistical department that the human race cares about its welfare ''with increased statistical significance.'' On the 1001st day, the turkey has a surprise.*

A big problem for investors is that we can experience a long sequence of normal events before we run into these fat-tail events. We get lulled into the complacency of ''a new era.'' Furthermore, the more our ''normal times'' experience makes us rich, the more inclined we are to forget that the unknowable is still out there—still calmly licking its chops.

WHERE WE GO WRONG

Lies, Damn Lies, and Statistics

Because they occur so frequently, there is an unfortunate tendency to invoke Normal distributions in situations where they may not be applicable:

"Everybody believes in the exponential law of errors: the experimenters, because they think it can be proved by mathematics; and the mathematicians, because they believe it has been established by observation."[7]

In other words, they assume that someone else is minding the other end of the store. What are we to do? Taleb describes the problem as the greatest epistemological difficulty he knows.

> *In real life we do not observe probability distributions . . . we just observe events. So we do not know the statistical properties—until, of course, after the fact. Given a set of observations, plenty of statistical distributions can correspond to the exact same realizations— each would extrapolate differently outside the set of events on which it was derived. The inverse problem is more acute when more theories, more distributions can fit a set a data.*
>
> *[This] inverse problem is compounded by the small sample properties of rare events as these will be naturally rare in a past sample. It is also acute in the presence of nonlinearities as the families of possible models . . . explode in numbers.*[8]

Let's face it: Economic data is nonnormally distributed, yet in all "normal" times, it will pass all the parametric tests for Normality. Normal thinking is unprepared and inadequate for abnormal times. In the words of Martin Leibowitz of Morgan Stanley, there are "dragon risks" akin to the ancient cartographers' depiction of the unknown as dragons inhabiting the reaches beyond the edge of the map.

Models are built on economic thinking, but noneconomic events lead to the discontinuities. It is difficult to the point of impossibility to assess the risks, gauge the likelihood of occurrence, anticipate the timing, or predict the severity.

Information Overload

Simply stated, the market is too complicated for anyone to fully comprehend. There are just too many moving parts, more than can be simultaneously comprehended by the human mind. Our minds are trained over many generations to identify the steppingstones in front of us, not taking in the whole view as a camera would. We're not built with enough mental hardware. What this means is that we can miss signals, even clear signals, because we can't distinguish them from the background noise.

Herbert Simon identified this phenomenon as bounded rationality.[9] *Bounded rationality*, stated simply, means that there is too much information for any one human being to process. In order to make a decision, we

need to simplify by discarding what we believe is irrelevant or unimportant information and get to the core of the issue.

Which of these elements are the most important? Since our impressions derive from our personal life experiences, the answers differ from person to person. Thus we walk backwards into the future, with our minds anchored by the imprinted lessons of the past. And we have inadequate tools to process complex, qualitative events that extend beyond past experience.

Irrational Exuberance

The net result is that we don't play the real market; we hum along with the song the market sings in our individual heads. During Normal times the individual mental models fit well enough—at discontinuous times everyone is out of tune. However, while each participant reflects a different set of life's experiences, the market effectively processes *all* the information and choices—those that are in synch and those that are not.

Thus the market delivers its own truth. In *The Wisdom of Crowds*,[10] James Surowiecki puts it this way: ''. . . a crowd's 'collective intelligence' will produce better outcomes than a small group of experts, even if members of the crowd don't know all the facts or choose, individually, to act irrationally. . . . People's errors balance each other out; and including all opinions guarantees that the results are 'smarter' than if a single expert had been in charge.'' The market is smarter than any participant in it. Without the collective intelligence, an index fund could not work.

The markets are good at sorting out rational thoughts, and are equally good at responding to emotional factors, which leads to a sleepwalking herd instinct. At some point, markets need to punish overexuberance. Markets find the price that balances supplying sellers with demanding buyers. If either group is wildly overrepresented, markets cannot find clearing prices. The transaction mechanism staggers and fails. Like the unusual sight that overturns the ferryboat, the black swans stampede the crowd in the same direction at the same time.

Thus fear, or its extreme, panic, is a necessary factor in the operation of any market. Remove fear and the markets cannot restrain rampant greed and exuberance. The only way to right the imbalance was for the unsupportable guarantees to default, thus creating an unforgettable psychological experience for many supposedly sophisticated investors.

The stock market is among the most uncertain and anxiety-producing areas of human endeavor. Nothing is assured; nothing works at all times. Not even the best of intellect, research, ardor, and our most motivated and intensive efforts can guarantee the desired results. We need to apply the best

of both our science and art, but a few strokes of serendipity always come in handy.[11]

Hubris

Hubris? In this industry? Among the Masters of the Universe?

Remember the scene in *History of the World Part I*, where Caesar enters the city in a triumphal procession, while a slave whispers in his ear "Remember, thou art mortal"? Caesar's response, unprintable here, echoes the sentiments of a portfolio manager who just turned in a top-decile performance, or the pension manager who reduced the unfunded liability by 25 percent.

Oh, yes, hubris grows very well in this industry. Indeed, a financial manager who doesn't display great confidence in his own ability is not likely to attract many customers. He must play guru to those who are unsure of their own competence. To them, he must appear to be able to foresee the future. The danger for the guru is that sooner or later he will start believing it himself. Guru-ing is a tough business.

Fortunately, going through the wringer is a good curative for hubris, as many seasoned veterans know. Until it's happened to you, well, it's hard to develop a true appreciation for how swift and devastating the experience can be. As Fred Schwed said in *Where Are the Customers' Yachts?*,[12] "There are certain things that cannot be adequately explained to a virgin, either by words or pictures. Like all of life's rich emotional experiences, the full flavor of losing important money cannot be conveyed by literature."

"More things can happen than will happen." This statement from Elroy Dimson about risk captures the essence of the problem: Rather than worry about the myriad possibilities, we desensitize to possible outcomes with low probabilities. Yet, as Rahl's chart shows, low-probability events occur with surprising regularity. I propose an inversion of Dimson's statement: *More things that can't happen do happen*. Surprise, it seems, is always around the corner.

Here's where Charles Prince went wrong. He—and many others like him—thought his group was smart enough to know when to run for the exits. So did everyone else.

Overexuberance

So you've thought and experimented and labored to come up with a new wrinkle in your investment strategy, and it's working well. Hey, when you're hot, you're hot! Once you've found an edge, the natural desire is to double down and maximize the benefit. If *Tickle Me Elmo* dolls are the hot

Christmas gift fad in 1996, we crank up production so we don't run short before December 25 of that year. Guess wrong, and we own a warehouse full of the stupid dolls.

In finance, the obvious double-down is to apply leverage to the strategy. If the mechanism produces small but consistent outperformance, perhaps with leverage we can significantly enhance the rewards—and the risks. Nothing exceeds like excess. They don't ring a bell when it's time to sell. Just ask Nick Leeson, the rogue trader whose unchecked risk-taking single-handedly caused the overnight collapse of the 223-year-old Barings Bank.

Self-Delusional Raptures

There are many investment strategies that trade off small but highly likely payoffs against a remote but catastrophic loss. Many option-writing strategies have that property, as do market making and insurance policy underwriting. My friend Chris Keith says, "The hard part of trading is not making money on most trades, it is keeping from being killed on the remainder."

When we experience one of these low-probability/highly adverse consequences, the losses mount quickly and inexorably. When a player of games of chance runs out of money, it's called *gambler's ruin*. When a financial institution runs out of capital, it's called *bankruptcy*. Again, just ask Nick Leeson.

Willful Blindness

Saul Hansell published an article in the *New York Times* describing how bankers worked their way around the regulators' requirement to monitor their risk positions. They lied to their computers, says Hansell:[13]

> *The people who ran the financial firms chose to program their risk-management systems with overly optimistic assumptions and to feed them oversimplified data.*[14] *This kept them from sounding the alarm early enough.*
>
> *Top bankers couldn't simply ignore the computer models, because after the last round of big financial losses, regulators now require them to monitor their risk positions. Indeed, if the models say a firm's risk has increased, the firm must either reduce its bets or set aside more capital as a cushion in case things go wrong.*
>
> *In other words, the computer is supposed to monitor the temperature of the party and drain the punch bowl as things get hot. And just as drunken revelers may want to put the thermostat in the freezer, Wall Street executives had lots of incentives to make sure their risk systems didn't see much risk.*

"There was a willful designing of the systems to measure the risks in a certain way that would not necessarily pick up all the right risks," said Gregg Berman, the co-head of the risk-management group at RiskMetrics. "They wanted to keep their capital base as stable as possible so that the limits they imposed on their trading desks and portfolio managers would be stable."

This is using statistics like a drunk uses a lamppost—more for support than illumination. It's junk science, pure and simple. How do you reconcile that behavior with "putting shareholder interests first" or "prudent ethical concerns"?

STAYING AHEAD OF THE GAME: A POTPOURRI OF IDEAS

Throughout this chapter, we have hinted at some of the ideas that might help to avoid destruction by discontinuous market events. There are no easy answers here—in many cases, there are no satisfactory answers at all. The following is a list of thoughts about possible methods to address the challenges that discontinuities bring.

Idea #1: The *Thrive and Survive* Strategy

Set in place a thrive/survive strategy: Thrive in Normal times and survive the discontinuities when they occur.

Think of Normal times as the typical sunny days in Southern California, and discontinuities as the earthquakes. We need to be systematic about how to thrive in normal times; we need to heed the overwhelming likelihood and prepare for it. But complement that skill by preparing for the inevitable discontinuities. Understand that:

- Such episodes *will* occur.
- They will come at unexpected times.
- They will throw our Normal thought processes off-kilter.
- They will affect our expectations and well-laid plans in unpredictable and unpleasant ways.

Learn from the current discontinuities and prepare to survive the next discontinuity. As Ralph Waldo Emerson said, "Bad times have a scientific value. They are occasions a good learner should not miss." We have an opportunity to prepare ourselves to behave in a different way than we might have in the past.

Idea #2: Rethink Risk

Develop a better understanding of risk. Risk is not a number, as Bill Sharpe has pointed out. Risk needs to be thought of as an emotional response— something felt in the gut because it throws us into a world of great uncertainty and potentially irreparable harm. Risk is probabilities multiplied by consequences, and consequences are what matter to pension executives and mutual fund shareholders. Pay attention to the old-fashioned standards of prudence and ethical concern. Isn't avoiding the consequences of the discontinuities what our clients value more than anything else?

That's easier said than done. No one believed Cassandra, and no one will pay more than bemused attention to the doomsayer who's been wrong year after year.

Idea #3: Widen the View

Rethink the knowledge base: Resist the rapid, preprogrammed automatic sifting and winnowing of information. Step back at times and try to see more like a camera, taking in the whole view before the bounded rationality kicks in and throws useful but abnormal information away. Isn't avoiding the consequences of the discontinuities what our clients value more than anything else?

Not that this is easy—no one believed the boy who cried wolf, and no one will pay attention to a gloom-and-doom manager when he's been wrong year after year.

Idea #4: Define the *Thrive* Strategy

Clarify your understanding of what works in Normal times; pay special attention to where the self-delusional blindspots might lie.

Do *not* throw away the past knowledge and science that worked in normal times. Jason Lanier notes that in normal times, the collective isn't stupid.[15]

> *In some special cases the collective can be brilliant. For instance, there's a demonstrative ritual often presented to incoming students at business schools. In one version of the ritual, a large jar of jelly-beans is placed in the front of a classroom. Each student guesses how many beans there are. While the guesses vary widely, the average is usually accurate to an uncanny degree.*
>
> *This is an example of the special kind of intelligence offered by a collective. It is that peculiar trait that has been celebrated as the "Wisdom of Crowds," though I think the word "wisdom" is*

misleading. It is part of what makes Adam Smith's Invisible Hand clever, and is connected to the reasons Google's page rank algorithms work. It was long ago adapted to futurism, where it was known as the Delphi technique. The phenomenon is real, and immensely useful.

Lanier points out that the collective is not infinitely useful. The collective can be stupid, too. Witness tulip crazes and stock bubbles and subprime mortgages. These are the times when intelligent thought really matters.

Stay in control. Be decisive, even when the best option appears to be to do nothing.

Idea #5: Do Not Underestimate Liquidity Risk

As the next discontinuity hits, most managers will miss the signals and find themselves locked into riding the discontinuity downward. Once the panic starts, the exit doors will be jammed. There may be no way out. Consider the thoughts of Howard Marks of Oaktree Capital:

We have no choice but to assume that this isn't the end, but just another cycle to take advantage of. I must admit it: I say that primarily because it is the only viable position.

Here are my reasons:

- *It's impossible to assign a high enough probability to the meltdown scenario to justify acting on it.*
- *Even if you did, there isn't much you could do about it.*
- *The things you might do if convinced of a meltdown would turn out to be disastrous if the meltdown didn't occur.*
- *Most of the time, the end of the world doesn't happen. The rumored collapses due to Black Monday in 1987 and Long-Term Capital Management in 1998 turned out to be just that.*
- *Money has to be someplace; where would you put yours?*

Idea #6: Define a *Survive* Strategy

Know that you will be unlikely to avoid the damage when the discontinuity hits; but there are steps that can be taken to reduce the potential damage. Think "earthquake preparedness."

One of the easiest remedies is to set up some guardrails around your normal process. Establish some diversification targets, and enforce a calendared discipline to reduce the overexposures and rebalance the overexposures back to target.

Beware the overly complicated hedging devices. If you don't understand them, stay away. Watch out for the rare events, the whiplash of the tail of the distribution of events. Remember, the financial world is fundamentally different at the tails—new regimes, new modes of interactions, different codependencies come into play. The hedges may not protect you when you need it the most—when counterparties fail, liquidity disappears, and all the correlations go to 1.0.

Don't give up on trying new things and new ideas. Consequences stemming from the discontinuity will require new solutions. But don't try to compensate for a low-return environment by upping the risk. Do not confuse the absence of volatility with the absence of risk: When the market needs volatility to find the clearing price, the volatility will appear.

Idea #7: Refine Quantitative Thinking

Quants need to get in touch with how data inaccuracy, statistical misuse, and misspecified probability distributions lead to errors. Watch out for GIGO. Question whether standard deviations can be accepted as risk numbers. Think about skewed outcome possibilities and fat distribution tails—how might they affect results? None of this stuff is easy, and the best we can probably hope for is an awareness and sensitivity, not a mathematical solution.

Do not passively assume that the computer and the equations possess some mystical insight. Make sure you understand the mechanisms and apply common sense. Think beyond the numbers to the pitfalls and the consequences. Consider putting under retainer a mathematical statistician and an epistemologist as consultants to backstop your eager young financial engineers and economists.

Idea #8: Reassess Quantitative Education

We need to broaden the process that educates quantitative analysts. It's easy to fault the Master of Financial Engineering (MFE) curricula. These programs need to develop a required course entitled something like, "Do You Really Know What You Think You Know?" Taleb's books would be the reading assignment for such a course.[16] Furthermore, *The Black Swan* should be required reading for the CFA exams!

Idea #9: Beware the Consequences of Political Solutions

Don't assume that governmental leaders know how to fix the problem. They will tinker and they will regulate, but they must accommodate widely divergent demands, many of them political rather than economic in nature.

Remember that these solons have no more experience with this discontinuity than you do.

Once the discontinuity has run its course, expect to be subjected to remedies, particularly politically laudable but economically reckless remedies, purportedly designed to prevent a reoccurrence of the disaster. Markets are very good at wringing out the excesses, but, as Bloom said, political actions must have primacy over economic actions.

CONCLUSION

Chaos can be avoided in the same way it has always been, albeit imperfectly, through the slower processes of deliberation and lengthened horizons in investment management, and by elections and court proceedings in the political world. Take a deep breath.

We can *never* gather enough data. Therefore, we need to supplant our normal decision processes based on statistics with nonstatistical, intuitive, consequence-aware, carbon-based logic systems overseen by prudent experts.

In short, the way to survive is through heightened enlightenment, integrity-reasoned, rational, and skeptical expectations, and above all, *parsimony*, in the multiple senses of the word: (1) frugality, (2) economy, and, (3) Occam's Razor—the simplest explanation is most likely to be insightful.

"Once burned, twice shy" behavior will protect those who've been through the experience, but the corollary is "Never burned, not the least bit shy." How are we to help the virgins, the new kids on the block? Guardrails, fatherly advice, or what? At the end of this path lies Fred Schwed's admonition: ". . . the full flavor of losing important money cannot be conveyed by literature." Unfortunately, that includes this chapter.

There is an old Chinese curse that says, "May you live in interesting times." Stay prepared: An interesting time may be just around the corner— licking its chops.

NOTES

1. http://www.cmra.com/crises.php.
2. Allan Bloom, *The Closing of the American Mind* (New York: Simon & Schuster, 1987).
3. http://dealbook.blogs.nytimes.com/2007/07/10/citi-chief-on-buyout-loans-were-still-dancing/.
4. Nassim N. Taleb, *The Black Swan* (New York: Random House, 2007).
5. http://www.edge.org/3rd_culture/taleb08/taleb08_index.html.

6. Benoit Mandelbrot, *The (Mis)behavior of Markets* (New York: Basic Books, 2004).
7. http://mathworld.wolfram.com/NormalDistribution.html.
8. Taleb, op cit.
9. Herbert Simon, *Models of Man* (New York: John Wiley & Sons, 1957).
10. James Surowiecki, *The Wisdom of Crowds* (New York: Random House, 2004).
11. Wayne H. Wagner, "A Curious Dilemma," *CFA*, May/June 2007, pp. 6–7.
12. Fred Schwed and Peter Arno, *Where Are the Customers' Yachts? Or, A Good Hard Look at Wall Street*, (New York: John Wiley & Sons, 1991).
13. http://bits.blogs.nytimes.com/2008/09/18/how-wall-streets-quants-lied-to-their-computers/.
14. Did I just hear a pension fund administrator say, "actuarial assumption of expected rates of return on plan assets?"
15. http://www.edge.org/3rd_culture/lanier06/lanier06_index.html.
16. A personal footnote: As a graduate student in Statistics/Management Science, I was required to take a "real-world applications" course. A team of students was assigned to the United Airlines maintenance facility at San Francisco Airport, and our assignment was to try to improve maintenance scheduling. We had all the theories in hand but the data we were able to gather was spotty, clearly incorrect—and unclearly incorrect—and self-contradictory. The final study report was, as a result, a botch of evasions and mumbles. At the time, I thought the course was a waste of time; but I soon learned that this was likely the most important course of all: that the data rarely conforms to the statistical model. The learned (and caustic) Sir Josiah Stamp said it well: "The government are very keen on amassing statistics. They collect them, add them, raise them to the nth power, take the cube root and prepare wonderful diagrams. But you must never forget that every one of these figures comes in the first instance from the village watchman who puts down what he damn pleases."