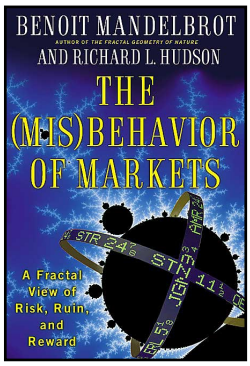

The Misbehavior of Markets

A Fractal View of Risk, Ruin, and Reward

by Benoit Mandelbrot and Richard L. Hudson
Basic Books © 2004
328 pages

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Take-Aways

- Markets are much riskier than most people or most financial professionals realize.
- Modern financial theory rests on weak foundations.
- The weakness of widely accepted financial theories implies a severe vulnerability in the global financial system.
- Modern financial theory assumes that prices move randomly in a “normal” range. But prices are not random, and “normal” does not encompass all price fluctuations.
- Market professionals say that market timing is a fool’s game, but the facts prove otherwise. Many big market moves consist of a series of similar moves clustered in a short period of time.
- Only fractals succeed in capturing the reality of the markets.
- Heretical truths include: markets always roil, always deceive and always bubble.
- More heresy: price movements are not slow and steady; markets everywhere are the same and volatility is more predictable than prices.
- No absolute or bedrock “value” exists in the investment world.
- Technical market “patterns” are meaningless fantasies.

Rating (10 is best)

Overall	Applicability	Innovation	Style
10	**9**	**10**	**10**

Relevance

What You Will Learn

In this Abstract, you will learn: 1) Why generally accepted financial theory is weak; 2) Why a fractal approach to the markets is stronger; and 3) Some interesting lore about the evolution of markets and market analysis.

Recommendation

Finance is a difficult and recondite subject, perhaps second only to mathematics in its inability to inspire excitement in most readers. Yet Benoit Mandelbrot and Richard L. Hudson, co-authors of this book, manage to turn financial math into a great yarn, full of interesting characters and dramatic events. Some of what the book actually says will be old news to market professionals, but it says it quite interestingly. Mandelbrot did his most important financial work in the 1960s, but his ideas about leptokurtosis (which deals with the shape of probability functions), fractals (which deal with repetitive patterns) and such have received quite a bit of subsequent attention in trading rooms and in the finance departments of major universities. So, perhaps, it is merely a dramatic device that this book presents Mandelbrot as a solitary, clear-thinking prophet struggling against a blind and hostile economic orthodoxy. That presentation certainly succeeds as drama — the story races along and the reader keeps rooting harder and harder for Mandelbrot to win. The co-authors have spun an excellent saga that says important things in a new way. *getAbstract.com* thinks every investor, every business journalist and every financial professional ought to read this book.

Abstract

The Maverick

Benoit Mandelbrot likes to relate the story of how his father, a prisoner in WWII France, managed to cheat death. When Resistance fighters attacked the camp and opened the gates, most of the prisoners started down the road toward Limoges. Mandelbrot's father was canny enough to see the stupidity of staying with the group. He peeled off alone and made his way through the thick woods. Not long after, a German Stuka bomber strafed the easy target presented by a group of closely packed escapees on the open highway.

"Price movements do not follow the well-mannered bell curve assumed by modern finance; they follow a more violent curve that makes an investor's ride much bumpier."

Mandelbrot's family had emigrated from Poland to France in 1936 to escape the gathering storm of war and oppression. When the Vichy government made life tough for Jews in France, he hid in Lyons, where sympathetic benefactors provided him with false documents and ration cards. During this period, hiding in a school, he discovered his extraordinary mathematical intuition — an ability to see immediately the truths that others could only reach after long struggle and elaborate proof.

"It is the Hippocratic Oath to 'do no harm.' In finance, I believe the conventional models and their more recent 'fixes' violate that oath. They are not merely wrong; they are dangerously wrong."

Clearly, Mandelbrot's childhood prepared him to accept the possibility of the unthinkable — even, under certain circumstances, its probability. His intuitive genius enabled him to see similarities and connections among phenomena that seemed, to others, utterly unrelated — for example, the floods of the Nile River and the prices of stocks on Wall Street.

He was a maverick. As a young man, Mandelbrot withdrew from the elite Ecole Normale Superiore to enroll in the Ecole Polytechnique. He went on to study at the California

"The simplest fractals scale the same way in all directions, hence are called self-similar … If the fractals scale in many different ways at different points, they are multifracta — and their mathematical properties become intricate and powerful."

Institute of Technology, at the Massachusetts Institute of Technology and at the Institute for Advanced Study in Princeton. He wound up working at IBM Research, an industrial laboratory, which was an unconventional posting indeed for a scholar of Mandelbrot's pedigree. Also unconventionally, he took a scientific interest in the study of markets, cotton prices, the distribution of wealth, risk, stock market bubbles and other economic phenomena. A notation that the economic profession did not always welcome Mandelbrot's contributions to the field would be an understatement. Indeed, at times his insights seemed to threaten the foundations of the discipline.

Mandelbrot's Heresies

The conventionally accepted orthodoxy about finance presents a more or less rational, more or less clear, more or less stable body of thought and practice. Mandelbrot's work defies that orthodoxy by propounding what he calls his "Ten Heresies of Finance:"

"The very heart of finance is fractal."

1. Markets are like roiling seas — Like seas, they have turbulence. Turbulence is a complicated phenomenon, with currents, eddies, streams, channels, flows and backflows all mingling and affecting each other. Markets are like that. There is scaling in turbulence and in markets. Some days, prices don't move at all, or move only in tiny increments. Other days, they leap and plunge. Moreover there is long-term dependence in markets. For example, the decision in the early 1980s by IBM to use Bill Gates's DOS as the PC's operating system certainly has consequences today.
2. Financial theories fall short — Standard financial theories don't even begin to capture the full range of market risk. Think of the so-called Equity Premium Puzzle. Economists have noted with some bewilderment that a long-term investment in stocks would have returned much more than a long-term investment in bonds. This puzzles economists because the average risk of stocks isn't nearly as great as the premium would imply. But, in fact, the phenomena of scaling and long-term dependence make markets much riskier than conventional models assume. Thus, the so-called Equity Premium is merely fair compensation for much higher risk levels.
3. Market timing clearly makes good, sound sense — Brokers and financial advisors almost unanimously recommend that clients (especially retail clients) eschew market timing. But Mandelbrot's analysis leaves little doubt that market moves tend to cluster, and that a few big up or down moves are responsible for most gains and losses.

"Human nature yearns to see order and hierarchy in the world. It will invent it where it cannot find it."

4. Prices do not move slowly and steadily — They often move discontinuously, with a big jump. This discontinuity is one of the main reasons why markets are so much riskier than many people, even many financial professionals, presume.
5. Market time expands and contracts — Financial orthodoxy implicitly assumes that the clock runs at the same speed for everyone in the market. But prices scale with time. A trading chart for a day of activity looks like a chart of a week or a month or a decade. Fractal analysis provides a means of dealing with flexible time.
6. Markets are the same always and everywhere — Markets have a life of their own. Fractal geometry provides the math to study patterns that stay the same even though the scale of space or time changes. Mathematicians call such patterns "invariances." Economists contend that economics has no invariances and they try to cope with changes in volatility by using forms of analysis that add or modify parameters. It is probably more productive to find the invariances and analyze them using a multifractal model.

"In building a model, start simple."

7. Bubbles will happen; you can count on it — Financial prices scale. This means that the odds of a really big price movement, given an initial large price movement, are about the same as those of a moderate movement given a middling movement. In other

words, if a stock has gone from one to ten, it is equally probable that it will go from ten to one hundred. Under these circumstances, why shouldn't bubbles happen?

8. Markets deceive — People like to see patterns. So market pundits oblige them by identifying and interpreting patterns. Because of long-term price dependence, data may show that price changes occur in particular increments or particular directions. But these changes are merely products of chance. Reading "meaning" into them, as technical analysts do, is fatuous.
9. Volatility is easier to predict than prices — Conventional financial theory suggests that price movements are random and unpredictable, independent of each other and distributed in a normal, bell-shaped curve. Yet, while it may be true that price moves are unpredictable, it is not true that they are mutually independent and randomly distributed. In fact, big price moves seem to beget other big moves, and little moves to beget other little moves. Volatility clusters. Options traders make money by correctly predicting and protecting against volatility. Most do not use conventional financial models without extensive modification. Efforts are underway to forecast volatility the way meteorologists predict the weather.
10. Value is not worth much in financial markets — Financial analysts like to think that companies, countries or currencies have a basic economic value. They try to get at this value by examining assets, or cash flow, or national income accounts, or inflation, or other factors. Their *modus operandi* implies that some relationship among these factors determines the value to which rational buyers and sellers will inevitably assent. Perhaps such a value exists, but it is elusive, protean and extremely difficult to calculate. What matters in markets is not absolute value but rather differences in price from place to place or from time to time.

"Since the world is not black and white, the study of multifractals comes closer to the way many aspects of nature really work."

"It is the way gold ore clusters here and there on the surface of the earth; the way oil reserves appear to concentrate in certain strife-prone parts of the world; the way the velocity of the wind on a stormy day comes 'intermittently,' in clusters of high gusts, interspersed with gentler breezes."

"Remember: fractals are not about the 'things' themselves but about their common property of roughness."

"Bubbles are dramatic — but the tendency of markets to deceive and confuse is an everyday affair."

Holes in the Safety Nets

The study of risk emerged as a priority for financial economists in the 1960s. But the edifice they constructed has its foundations in the work of a French mathematician named Louis Bachelier. He analyzed prices on the Paris Bourse during the early twentieth century and concluded that prices changed at random and unpredictably, but that they were susceptible to analysis using the mathematics of probability.

Building on Bachelier's work, the economist Eugene F. Fama propounded the Efficient Markets Hypothesis. This hypothesis says that prices incorporate all the information that matters and change only in response to new information. Therefore, Fama said, it is almost impossible to "beat" the market. The Efficient Markets Hypothesis is one leg of a three-legged stool that supports contemporary financial orthodoxy.

The second leg came from the work of Harry Markowitz, an economist who applied statistical mathematics to the task of designing efficient portfolios that would deliver the highest return for a given level of risk. The third leg came from William F. Sharpe, whose Capital Asset Pricing Model simplified Markowitz's calculations by offering a single variable (beta) to express a stock's level of risk. Markowitz and Sharpe received Nobel Prizes for their work. Other pioneers of securities market risk were Myron S. Scholes and Fischer Black, who collaborated in the development of the Black-Scholes option pricing formula. Options are a kind of insurance that traders and investors use to control the level of risk they will take.

The work of these scholars is not without value, but it has some serious weaknesses. However, when critics such as Mandelbrot pointed at these weaknesses, defenders

of orthodoxy merely invented various patches. For example, long-term dependence causes volatility to cluster and the distribution of risk does not follow a bell curve. Acknowledging long-term dependence would threaten the foundations of financial orthodoxy — randomness wouldn't be what it has been assumed to be.

"Each company relays, distorts, and attenuates the economic signals as they flash around the globe. The signals fade in time. But it can take months, years or decades for a signal to become so weak and remote as to be unremarkable. Such is long-term dependence in an economy. Every event, no matter how remote or long ago, echoes across all other events."

Instead of letting the facts guide them toward multifractal market analysis, theorists and practitioners patched their older, inadequate orthodoxy with a set of statistical techniques called Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH). GARCH essentially changes parameters to retain a normal probability curve; the curve grows or shrinks to deal with increases or decreases in volatility. Such patches may seem to work after a fashion, but they are inferior science. As a result of financial experts' reliance upon obsolete and deficient theories and patches, the world has come close to financial disaster on numerous occasions in recent decades.

The best science finds the simplest explanation for the widest range of phenomena. What the financial world needs is not new patches, but a new model — the multifractal model.

Fractals and Multifractals

A fractal is a pattern that repeats itself in larger or smaller scale. Consider a fern frond, for example, or a coastline, or a stock market price chart. A fern leaf looks like a fern frond. A hundred yards of coastline looks like a hundred miles of coastline. A chart of stock prices for one day looks like a chart of stock prices for ten years. Fractal mathematics offers the promise of devising:

- Better tools for investment analysis — Individual stocks may manifest unique fractal patterns in their price charts — as distinctive as fingerprints.
- Superior portfolios — Portfolios can be developed that are better than those derived through modern portfolio theory. As noted above, conventional thinking about finance assumes that stock prices incorporate all relevant information. It assumes that prices move randomly. It assumes other things that are clearly at variance with facts. A new approach would involve, for example, much more extensive stress tests over a much wider range of possible outcomes.
- Better option valuation models — The "holes" in Black-Scholes, the most widely accepted option-pricing model, have been the subject of much debate. The holes have been patched repeatedly, but the patches are wearing thin.
- Risk management models — Assumptions of randomness, normal probability distributions and so forth underlie many of the risk management models used by international bankers and regulators. Extensive reliance upon such inadequate models actually makes the financial world a much more dangerous place.

"Finance is a black box covered by a veil."

About The Authors

Benoit Mandelbrot, the inventor of fractal geometry, is Sterling Professor of Mathematical Sciences at Yale University and a Fellow Emeritus at IBM's Thomas J. Watson Laboratory. Richard L. Hudson is former managing editor of *The Wall Street Journal's* European edition.