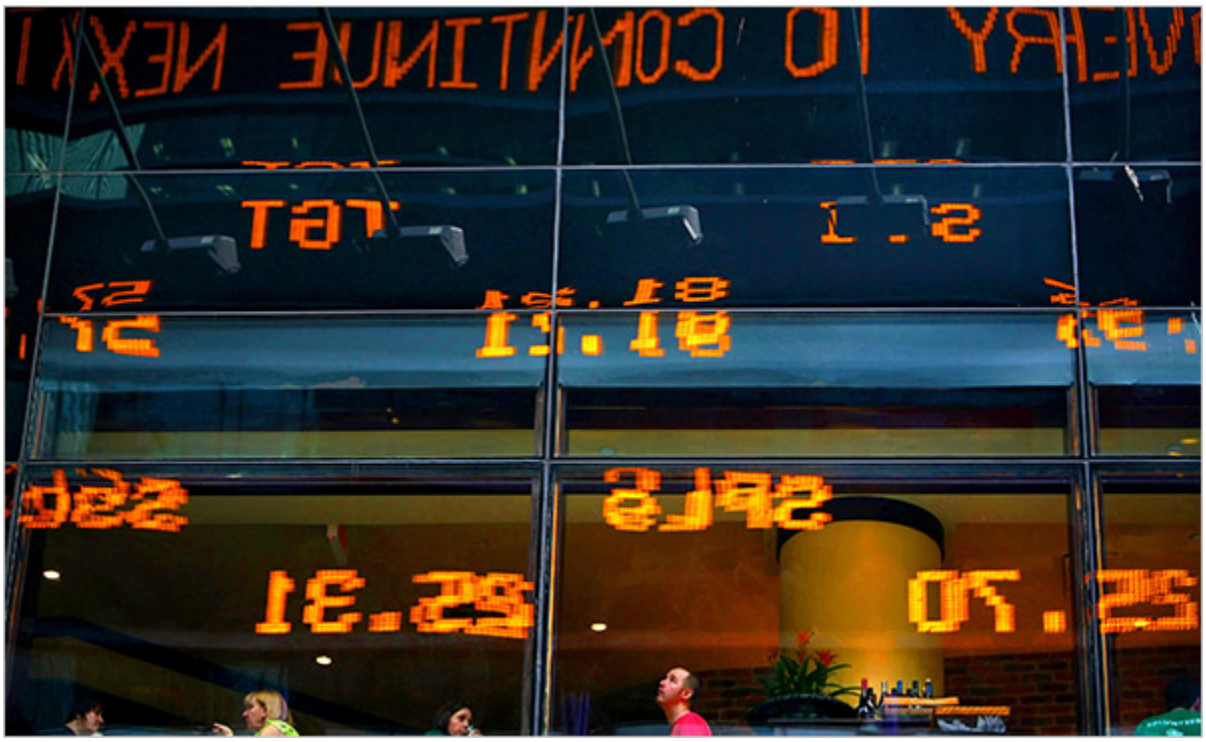
They Tried to Outsmart Wall Street



Nicole Bengiveno/The New York Times

NEW THEORIES After spending 20 years in the study of physics, Emanuel Derman applied his thinking to stock options.

By DENNIS OVERBYE
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Emanuel Derman expected to feel a letdown when he left particle physics for a job on Wall Street in 1985.

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"Nobody ever took these models to be playing chess with God." — Emanuel Derman

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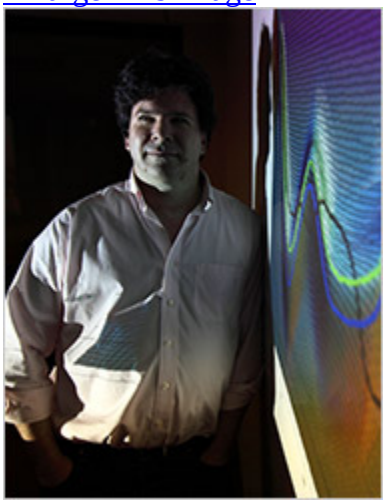

James Estrin/The New York Times

FIGURES "There is a positive role for engineers and scientists. It's not remote pointy-headed wizards plotting the destruction of the world." — Eric Weinstein, a physicist at a hedge fund.

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CJ Gunther for The New York Times

"In an insane world, the person who is rational has the problem. Money is as addictive as cocaine." — Andrew Lo, a professor of financial engineering.

Enlarge This Image


Thomas Gallane

"If we want to manage risk, we need a model, we need to be able to show we make a lot of money from it." — Satyajit Das, a former trader.

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Carlos Javier Ortiz for The New York Times

"Because the math is really complicated people assume it must be right." — Nigel Goldenfeld, whose company sells derivatives software.

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After all, for almost 20 years, as a graduate student at Columbia and a postdoctoral fellow at institutions like Oxford and the University of Colorado, he had been a spear carrier in the quest to unify the forces of nature and establish the elusive and Einsteinian “theory of everything,” hobnobbing with Nobel laureates and other distinguished thinkers. How could managing money compare?

But the letdown never happened. Instead he fell in love with a corner of finance that dealt with stock options.

“Options theory is kind of deep in some way. It was very elegant; it had the quality of physics,” Dr. Derman explained recently with a tinge of wistfulness, sitting in his office at Columbia, where he is now a professor of finance and a risk management consultant with Prisma Capital Partners.

Dr. Derman, who spent 17 years at Goldman Sachs and became managing director, was a forerunner of the many physicists and other scientists who have flooded Wall Street in recent years, moving from a world in which a discrepancy of a few percentage points in a measurement can mean a Nobel Prize or unending mockery to a world in which a few percent one way can land you in jail and a few percent the other way can win you your own private Caribbean island.

They are known as “quants” because they do quantitative finance. Seduced by a vision of mathematical elegance underlying some of the messiest of human activities, they apply skills they once hoped to use to untangle string theory or the nervous system to making money.

This flood seems to be continuing, unabated by the ongoing economic collapse in this country and abroad. Last fall students filled a giant classroom at M.I.T. to overflowing for an evening workshop called “So You Want to Be a Quant.” Some quants analyze the stock market. Others churn out the computer models that analyze otherwise unmeasurable risks and profits of arcane deals, or run their own hedge funds and sift through vast universes of data for the slight disparities that can give them an edge.

Still others have opened an academic front, using complexity theory or artificial intelligence to better understand the behavior of humans in markets. In December the physics Web site arXiv.org, where physicists post their papers, added a section for papers on finance. Submissions on subjects like “the superstatistics of labor productivity” and “stochastic volatility models” have been streaming in.

Quants occupy a revealing niche in modern capitalism. They make a lot of money but not as much as the traders who tease them and treat them like geeks. Until recently they rarely made partner at places like Goldman Sachs. In some quarters they get blamed for the current breakdown — “All I can say is, beware of geeks bearing formulas,” Warren Buffett said on “The Charlie Rose Show” last fall. Even the quants tend to agree that what they do is not quite science.

As Dr. Derman put it in his book “My Life as a Quant: Reflections on Physics and Finance,” “In physics there may one day be a Theory of Everything; in finance and the social sciences, you’re lucky if there is a useable theory of anything.”

Asked to compare her work to physics, one quant, who requested anonymity because her company had not given her permission to talk to reporters, termed the market “a wild beast” that cannot be controlled, and then added: “It’s not like building a bridge. If you’re right more than half the time you’re winning the game.” There are a thousand physicists on Wall Street, she estimated, and many, she said, talk nostalgically about science. “They sold their souls to the devil,” she said, adding, “I haven’t met many quants who said they were in finance because they were in love with finance.”

The Physics of Money

Physicists began to follow the jobs from academia to Wall Street in the late 1970s, when the post-Sputnik boom in science spending had tapered off and the college teaching ranks had been filled with graduates from the 1960s. The result, as Dr. Derman said, was a pipeline with no jobs at the end. Things got even worse after the cold war ended and Congress canceled the Superconducting Supercollider, which would have been the world’s biggest particle accelerator, in 1993.

They arrived on Wall Street in the midst of a financial revolution. Among other things, galloping inflation had made finances more complicated and risky, and it required increasingly

sophisticated mathematical expertise to parse even simple investments like bonds. Enter the quant.

“Bonds have a price and a stream of payments — a lot of numbers,” said Dr. Derman, whose first job was to write a computer program to calculate the prices of bond options. The first time he tried to show it off, the screen froze, but his boss was fascinated anyway by the graphical user interface, a novelty on Wall Street at the time.

Stock options, however, were where this revolution was to have its greatest, and paradigmatic, success. In the 1970s the late Fischer Black, then at the University of Chicago, and Myron S. Scholes and Robert C. Merton, both then at M.I.T., had figured out how to price and hedge these options in a way that seemed to guarantee profits. The so-called Black-Scholes model has been the quants’ gold standard ever since.

In the old days, Dr. Derman explained, if you thought a stock was going to go up, an option was a good deal. But with Black-Scholes, it doesn’t matter where the stock is going. Assuming that the price of the stock fluctuates randomly from day to day, the model provides a prescription for you to still win by buying and selling the underlying stock and its bonds.

“If you’re a trading desk,” Dr. Derman explained, “you don’t care if it goes up or down; you still have a recipe.”

The Black-Scholes equation resembles the kinds of differential equations physicists use to represent heat diffusion and other random processes in nature. Except, instead of molecules or atoms bouncing around randomly, it is the price of the underlying stock.

The price of a stock option, Dr. Derman explained, can be interpreted as a prediction by the market about how much bounce, or volatility, stock prices will have in the future.

But it gets more complicated than that. For example, markets are not perfectly efficient — prices do not always adjust to right level and people are not perfectly rational. Indeed, Dr. Derman said, the idea of a “right level” is “a bit of a fiction.” As a result, prices do not fluctuate according to Brownian motion. Rather, he said: “Markets tend to drift upward or cascade down. You get slow rises and dramatic falls.”

One consequence of this is something called the “volatility smile,” in which options that benefit from market drops cost more than options that benefit from market rises.

Another consequence is that when you need financial models the most — on days like Black Monday in 1987 when the Dow dropped 20 percent — they might break down. The risks of relying on simple models are heightened by investors’ desire to increase their leverage by playing with borrowed money. In that case one bad bet can doom a hedge fund. Dr. Merton and Dr. Scholes won the Nobel in economic science in 1997 for the stock options model. Only a year later Long Term Capital Management, a highly leveraged hedge fund whose directors included the two Nobelists, collapsed and had to be bailed out to the tune of $3.65 billion by a group of banks.

Afterward, a Merrill Lynch memorandum noted that the financial models "may provide a greater sense of security than warranted; therefore reliance on these models should be limited."

That was a lesson apparently not learned.

Respect for Nerds

Given the state of the world, you might ask whether quants have any idea at all what they are doing.

Comparing quants to the scientists who had built the atomic bomb and therefore had a duty to warn the world of its dangers, a group of Wall Streeters and academics, led by Mike Brown, a former chairman of Nasdaq and chief financial officer of Microsoft, published a critique of modern finance on the Web site Edge.org last fall calling on scientists to reinvent economics.

Lee Smolin, a physicist at the Perimeter Institute for Theoretical Physics in Waterloo, Ontario, who was one of the authors, said, "What is amazing to me as I learn about this is how flimsy was the theoretical basis of the claims that derivatives and other complex financial instruments reduced risk, when their use in fact brought on instabilities."

But it is not so easy to get new ideas into the economic literature, many quants complain. J. Doyne Farmer, a physicist and professor at the Santa Fe Institute, and the founder and former chief scientist of the Prediction Company, said he was shocked when he started reading finance literature at how backward it was, comparing it to Middle-Ages theories of fire. "They were talking about phlogiston — not the right metaphor," Dr. Farmer said.

One of the most outspoken critics is Nassim Nicholas Taleb, a former trader and now a professor at New York University. He got a rock-star reception at the World Economic Forum in Davos this winter. In his best-selling book "The Black Swan" (Random House, 2007), Dr. Taleb, who made a fortune trading currency on Black Monday, argues that finance and history are dominated by rare and unpredictable events.

"Every trader will tell you that every risk manager is a fraud," he said, and options traders used to get along fine before Black-Scholes. "We never had any respect for nerds."

Dr. Taleb has waged war against one element of modern economics in particular: the assumption that price fluctuations follow the familiar bell curve that describes, say, IQ scores or heights in a population, with a mean change and increasingly rare chances of larger or smaller ones, according to so-called Gaussian statistics named for the German mathematician Friedrich Gauss.

But many systems in nature, and finance, appear to be better described by the fractal statistics popularized by Benoit Mandelbrot of IBM, which look the same at every scale. An example is the 80-20 rule that 20 percent of the people do 80 percent of the work, or have 80 percent of the money. Within the blessed 20 percent the same rule applies, and so on. As a result the odds of game-changing outliers like Bill Gates's fortune or a Black Monday are actually much greater than the quant models predict, rendering quants useless or even dangerous, Dr. Taleb said.

“I think physicists should go back to the physics department and leave Wall Street alone,” he said.

When Dr. Taleb asked someone to come up and debate him at a meeting of risk managers in Boston not too long ago, all he got was silence. Recalling the moment, Dr. Taleb grumbled, “Nobody will argue with me.”

Dr. Derman, who likes to say it is the models that are simple, not the world, maintains they can be a useful guide to thinking as long as you do not confuse them with real science — an approach Dr. Taleb scorned as “schizophrenic.”

Dr. Derman said, “Nobody ever took these models as playing chess with God.”

Do some people take the models too seriously? “Not the smart people,” he said.

Quants say that they should not be blamed for the actions of traders. They say they have been in the forefront of pointing out the shortcomings OF modern economics.

“I regard quants to be the good guys,” said Eric R. Weinstein, a mathematical physicist who runs the Natron Group, a hedge fund in Manhattan. “We did try to warn people,” he said. “This is a crisis caused by business decisions. This isn’t the result of pointy-headed guys from fancy schools who didn’t understand volatility or correlation.”

Nigel Goldenfeld, a physics professor at the University of Illinois and founder of NumeriX, which sells investment software, compared the financial meltdown to the Challenger space shuttle explosion, saying it was a failure of management and communication.

Prisoners of Wall Street

By their activities, quants admit that despite their misgivings they have at least given cover to some of the wilder schemes of their bosses, allowing traders to conduct business in a quasi-scientific language and take risks they did not understand.

Dr. Goldenfeld of Illinois said that when he posted scholarly articles, some of which were critical of financial models, on his company’s Web site, salespeople told him to take them down. The argument, he explained, was that “it made our company look bad to be associating with Jeremiahs saying that the models were all wrong.”

Dr. Goldenfeld took them down. In business, he explained, unlike in science, the customers are always right.

Quants, in short, are part of the system. “They get paid, a Faustian bargain everybody makes,” said Satyajit Das, a former trader and financial consultant in Australia, who likes to refer to them as “prisoners of Wall Street.”

“What do we use models for?” Mr. Das asked rhetorically. “Making money,” he answered. “That’s not what science is about.”

The recent debacle has only increased the hunger for scientists on Wall Street, according to Andrew Lo, an M.I.T. professor of financial engineering who organized the workshop there, with a panel of veteran quants.

The problem is not that there are too many physicists on Wall Street, he said, but that there are not enough. A graduate, he told the young recruits, can make $75,000 to $250,000 a year as a quant but can also be fired if things go sour. He said an investment banker had told him that Wall Street was not looking for Ph.D.’s, but what he called “P.S.D.s — poor, smart and a deep desire to get rich.”

He ended his presentation with a joke that has been told around M.I.T. for a long time, but seemed newly relevant; “What do you call a nerd in 10 years? Boss.”

An earlier version of this article misspelled the given name of Satyajit Das. The article also misstated the affiliations of Fischer Black, Myron S. Scholes and Robert C. Merton when they published their papers in the 1970s on pricing stock options.

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