

Is it True, as *60 Minutes* Confidently Argues, Physicists Are to Blame for Derivatives Debacles?

Derivatives trading bankrupted one of the richest counties in the US, destroyed the oldest merchant bank in England and ravaged the finances of such established institutions as Procter & Gamble, Nippon Steel, Metallgesellschaft and the Minneapolis Symphony. So who's responsible for these financial casualties? Mathematicians and physicists, according to the nation's most widely watched TV news magazine, CBS's *60 Minutes*.

"When Wall Street fell in love with the computer 15 years ago, it hired a lot of smart people with PhDs in mathematics and physics and not much background in finance and told them to design ever more sophisticated and creative investments," Steve Kroft, a *60 Minutes* reporter explained in the show's opening segment on 5 March. Kroft claimed that derivatives "became the financial equivalent of genetic engineering—splicing together all kinds of different commodities and markets and indexes."

Derivatives, in fact, are investment options whose value depends on some variable asset—for instance, interest rates, currency values, stock prices or commodity futures on such deliverables as gold, coffee or pork bellies. Esoteric and volatile, the derivatives market, Kroft asserted, is based on complicated formulas with a lot of variables. Presumably just the kind of exercise that mathematicians and physicists familiar with Monte Carlo techniques, stochastic calculus and game theory are accustomed to using. "The scientists sit before their computers concocting these complex formulas no one can understand," Kroft declared.

Kroft then turned to Jim Grant, a well-known Wall Street investment analyst, who also identified the culprits in the highly publicized derivatives debacles as physicists who "have never worked with human beings before in just this way." Physicists, Grant observed, "do very well with billiard balls; they do well with atoms; they do passively well with protons and electrons. They don't do well with people whose behavior they can't anticipate."

Investment brokers contend that derivatives have become so fashionable in banking, insurance and investment circles that there are some 1200 varieties. Now that derivatives make up a \$35 trillion worldwide annual market, said Kroft, "some say [these financial agreements] could bring down the entire global banking sys-

Who Invented Derivatives Anyway?

Wholly independent of Einstein, the French mathematician Louis Bachelier, in his PhD thesis in 1900 on the theory of speculation, analyzed Brownian motion—only Bachelier worked it out in the context of calculating the value of a stock option. In Bachelier's formulation the value of an option was ultimately governed by an equation that physicists would recognize as the diffusion equation, or Fick's second law. Then, in 1973, Fisher Black, at the time a mathematician at MIT, and Myron S. Scholes, then an economist at the University of Chicago, established the modern context for analysis of option prices, which usually varied randomly but were related by a partial differential equation:

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} - rV = 0$$

where $V(S,t)$ is the value of the derivative, t is the time, σ is the volatility and S the price of the underlying asset, and r is the risk-free interest rate. The boundary conditions to be satisfied when solving the equation depend on the type of derivative.

The so-called Black-Scholes equation bridged the gap between theory and practice in options trading and, indirectly at least, provided the entrée for mathematical physicists into derivatives trading. (See PHYSICS TODAY, June 1994, page 55.)

tem." When Kroft asserted that derivatives account for about 20% of the annual profits of banks and investment houses, Grant added: "I cannot believe how much margin and profits exist in derivatives."

The implication is that it's in Wall Street's self-interest to sell derivatives and that physicists and mathematicians are the hired guns who invented the products that have sent shock waves through the banking system.

But does the fault rest with the physicists and mathematicians who work for banks, insurance companies and investment brokerages to bring the abstract reasoning and conceptual thinking of their fields to bear on derivatives and other financial products? No, says David E. Shaw, an investment broker in New York City and a member of President Clinton's advisory committee on science and technology. "*60*

Minutes accuses the wrong people. Derivatives are one of many ways to leverage a financial trade. There are considerable risks for anyone dealing in derivatives because of the ease and speed of the transaction and the difficulty in understanding all the variables. But the guy who calculates the deal is not to blame. It's those who peddle the derivatives and those who dabble in them."

To Irwin Sheer, a theoretical physicist who left the Superconducting Super Collider after Congress scuttled the project in 1993 and joined an investment house in upstate New York, "Once again we have been portrayed as mad scientists. Derivatives have been around for years, and many investors profited. It was the uncertainties of stocks, bonds and currencies in 1994, not the uncertainties of the derivatives contracts that caused the high fliers to fall."

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WASHINGTON INS & OUTS

Resignations at OSTP, New Roles in Congress and a New Head at the NRC

Since coming to the White House Office of Science and Technology Policy in November 1993 as associate director for science, **M. R. C. Greenwood** has been an untiring advocate for basic research in an Administration more dedicated to technology. Her seemingly nonstop schedule included talks before university facul-

ties, Congressional committees and science conferences on the virtues of maintaining the country's world leadership in science and mathematics education and research. Greenwood organized OSTP's first outreach to the research community with a forum at the National Academy of Sciences, and she animated the Administra-