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## A Mountain, Overlooked

How Risk Models Failed Wall St. and Washington

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Crooked mortgage brokers, greedy investment bankers, oblivious rating agencies and gullible investors have all been faulted in the financial crisis, and there is bipartisan agreement that regulators were asleep at the switch. It's all well and good to call for substantial new oversight. But if regulators were oblivious to the danger, the question is why.

In the case of Fannie Mae and Freddie Mac, the answer seems easy: Their massive lobbying machines thwarted every legislative attempt at reform. But what about the Fed, the Treasury and the Securities and Exchange Commission, agencies that are not above politics but are known for their professionalism and expertise? Surely they had the capability and motivation to avoid a calamity of the type that is occurring. Why did they fail?

The problem is that Wall Street and regulators relied on complex mathematical models that told financial institutions how much risk they were taking at any given time. Since the 1990s, risk management on Wall Street has been dominated by a model called "value at risk" (VaR). VaR attributes risk factors to every security and aggregates these factors across an entire portfolio, identifying those risks that cancel out. What's left is "net" risk that is then considered in light of historical patterns. The model predicts with 99 percent probability that institutions cannot lose more than a certain amount of money. Institutions compare this "worst case" with their actual capital and, if the amount of capital is greater, sleep soundly at night. Regulators, knowing that the institutions used these models, also slept soundly. As long as capital was greater than the value at risk, institutions were considered sound -- and there was no need for hands-on regulation.

Lurking behind the models, however, was a colossal conceptual error: the belief that risk is randomly distributed and that each event has no bearing on the next event in a sequence. This is typically explained with a coin-toss analogy. If you flip a coin and get "heads" and then do it again, the first heads has no bearing on whether the second toss will be heads or tails. It's a common fallacy that if you get three heads in a row, there's a better-than-even chance that the next toss will be tails. That's simply not true. Each toss has a 50-50 chance of being heads or tails. Such systems are represented in the bell curve, which makes clear that events of the type we have witnessed lately are so statistically improbable as to be practically impossible. This is why markets are taken by surprise when they occur.

But what if markets are not like coin tosses? What if risk is not shaped like a bell curve? What if new events are profoundly affected by what went before?

Both natural and man-made systems are full of the kind of complexity in which minute changes at the start

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result in divergent and unpredictable outcomes. These systems are sometimes referred to as "chaotic," but that's a misnomer; chaos theory permits an understanding of dynamic processes. Chaotic systems can be steered toward more regular behavior by affecting a small number of variables. But beyond chaos lies complexity that truly is unpredictable and cannot be modeled with even the most powerful computers. Capital markets are an example of such complex dynamic systems.

Think of a mountainside full of snow. A snowflake falls, an avalanche begins and a village is buried. What caused the catastrophe? The value-at-risk crowd focuses on each snowflake and resulting cause and effect. The complexity theorist studies the mountain. The arrangement of snow is a good example of a highly complex set of interdependent relationships; so complex it is impossible to model. If one snowflake did not set off the avalanche, the next one could, or the one after that. But it's not about the snowflakes; it's about the instability of the system. This is why ski patrols throw dynamite down the slopes each day before skiers arrive. They are "regulating" the system so that it does not become unstable.

The more enlightened among the value-at-risk practitioners understand that extreme events occur more frequently than their models predict. So they embellish their models with "fat tails" (upward bends on the wings of the bell curve) and model these tails on historical extremes such as the post-Sept. 11 market reaction. But complex systems are not confined to historical experience. Events of any size are possible, and limited only by the scale of the system itself. Since we have scaled the system to unprecedented size, we should expect catastrophes of unprecedented size as well. We're in the middle of one such catastrophe, and complexity theory says it will get much worse.

Financial systems overall have emergent properties that are not conspicuous in their individual components and that traditional risk management does not account for. When it comes to the markets, the aggregate risk is far greater than the sum of the individual risks; this is something that Long-Term Capital Management did not understand in the 1990s and that Wall Street seems not to comprehend now. As long as Wall Street and regulators keep using the wrong paradigm, there's no hope they will appreciate just how bad things can become. And the new paradigm of risk must be understood if we are to avoid lurching from one bank failure to the next.

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