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Stress for Success

Stress manifests itself in many ways; a receding hairline, insomnia or even a complete corporate collapse ...

Though he fall seven times, he will get up again, for only the wicked fail under stress.

Proverbs 24:16

December, 1980 was the end of my first semester as a graduate student at the University of Chicago. I was working for a professor, Craig Ainsley, who wanted to fit financial time series assuming that volatility followed a random walk. Robert Engle had just visited and given a seminar in the statistics department, after which Craig was very excited. He wanted me to stay in Chicago for the Christmas break to help work out the equations and process some data. I declined, and I've always believed that three weeks we lost could have been the reason Engle has one more Nobel prize than I do. Or maybe he's just smarter than me.

Ski stress

Instead of working for intellectual immortality, I visited John in Boulder, Colorado to do some cross-country skiing. He first drove me to Aspen, where they wanted \$25 to ski on their (admittedly very nice) trails. I understand paying for downhill skiing, after all someone has to build and run the lifts. I don't understand wanting to be on steep icy trails, but if that's what you want it makes sense that you have to pay for it. Cross-country skiing is different. It's for independent spirits who go wherever they choose and pay no one. Moreover the Aspen trails were not crowded,



but not empty either. I wanted virgin powder and complete solitude.

John said he understood and knew just the place. After a short drive we came to a beautiful spot without the slightest sign that anyone else had ever been there. The snow was untouched, the ground flat or gently sloping, the woods sparse enough for wonderful light and easy skiing. After enjoying the exercise for half an hour or so, I chortled about the foolishness of people paying \$25 to fight the crowds on Aspen's less perfect trails. "Why don't other people come

here?" I asked John.

"Well, there're a lot of old mineshafts around," John replied, then added in response to my expression, "... but don't worry, I know where they all are."

I don't recall what I said to that, if I managed any sound at all. But what I would say today is, "Can I see your stress test on that?" Stress testing is the discipline that measures how confident or unconfident risk managers should be. The field suffers from some confusion, because the term can be used for two different ideas.

The two faces of stress

The first might be called micro-stress testing. If you're worried that there are mineshafts under the snow, take a pole and jab it into the snow in several places. You hope it goes down easily for a few feet, then hits something solid like rock or dirt. If anything else happens, if there is rock a millimeter below the snow surface, if the pole keeps going into a mineshaft, if there is water beneath the snow, if there is ice on the surface; you know to be careful. For stress testing purposes, you don't try to characterize the precise nature of the danger or quantify its probability. All you want to know is whether your basic risk management strategy of looking at the snow and being alert for visible dangers like drop-offs, rocks and trees, is sufficient, or if you need to enhance your sensing capabilities.

An entirely different kind of stress test requires a bird's-eye view of the skiing region, say from a fire tower sixty feet above the ground. That might reveal you are skiing in an old river bed that will gently encourage you toward what was once a dramatic waterfall, and is now a steadily steepening slope to cliff that by the time you see, you will be unable to avoid. Without this second kind of stress test, you may make decisions that are individually safe, but collectively lead to disaster, because you cannot see the big picture. This could be called a macro-stress test, but I prefer the term "scenario analysis." A micro stress tests looks for deep information within your normal risk management horizon, scenario analysis looks for superficial information beyond the normal risk management horizon.

In scenario analysis, the emphasis is not on finding out whether a danger exists; we already knew there are such things as cliffs. What we care about is how close they are to us, and how likely it is we will fall off of them. In my terminology, scenario analysis considers realistic situations far from current conditions while stress testing considers simple nearby stresses which need not be realistic. Scenario analysis is a path, with reactions along the way, stress testing is a sudden shift in a few variables with everything else held constant. The output of scenario analysis is quantitative, like a temperature gauge on your car's

dashboard, while the output of stress testing can be binary, like an "idiot light" that comes on when your engine overheats. Both are essential complements to a risk management system.

Scenario analysis grew out of a regulator's mindset. Could an exogenous stress like a stock market crash or liquidity crisis cause my institution or the financial system as a whole to fail? Stress testing came naturally to engineers and applied mathematicians. If you design anything, whether a bridge or a risk management system, before you trust it, you stress it to make sure it is safe and performs as expected. It is the models and assumptions that are stressed, not the financial system. The basic question is could a small change in our risk management framework, or a small movement in market prices, cause a large change in our outputs?

Confused stress

One unfortunate consequence of using the term "stress testing" for both is that people concentrate far too much on bad scenarios. Every institution that follows best risk management practices can tell you exactly how a repeat of the 1987 stock market crash, 1994 interest rate shock, 1997 Asian financial crisis, 1998 Russian default or 2000 Nasdive would affect them. But there is danger in good times as well.

Suppose the stock market zoomed upward and a penny in quarterly earnings could translate to billions in market capitalization, and hundreds of millions in top management option grants. Would your institution have the strength to avoid accounting trickery, analyst puffery and foolish mergers? The damage from these failings in the recent past, in terms of criminal convictions, destroyed companies and billion-dollar fines, far exceeds the damage from bad economic news. Natural disasters and financial crashes may destroy more total economic value, but financial institutions suffer far more from uncontrolled behavior in good times.

What if a hedge fund produced extraordinary returns and social cachet, would your senior managers invest heavily and extend preferential trading terms and leverage? What if some region of the world expanded economically and paid premium rates for short term funds, would your

institution extend excessive credit and yank it away at the first sign of instability? What if interest rates fell three years in a row, would your traders and salespeople accommodate customers who wanted to make crazy double-up bets that they would continue to fall, and hide those bets from their shareholders?

For micro stress tests, there is a different confusion. Some people think they need large movements in market conditions or long time horizons. That is one way to stress your models, but not the only or most important one. Moreover, if you forget you're stressing your models, you may just compare the output to itself.

Consider, for a simple example, a portfolio consisting of a short vanilla call and a long down-and-out call with the exact same terms. If you look at extreme moves of the underlying, this portfolio will have small risk. If the underlying goes up a lot, the down-and-out feature is negligible, so the two options offset. If the underlying goes down, neither option is worth much so the difference is small.

To catch the risk in a stress test, you have to notice that a small change in underlying price or volatility assumption can cause a disproportionate movement in net portfolio value. That move is still small, but it should alert you that there is a dangerous path (the price falls to knock out the long option, then rises to create a large loss from the short option). Of course, in this case you could figure out the danger without any quantitative analysis at all, but in complicated portfolios it's often the case the dangers show up as disproportionate responses to small movements rather than large responses to large movements. In this case a simulation of future paths would also catch the problem, but in realistic cases it's impossible to generate enough scenarios to catch all the holes in your P&L distribution.

Home for Christmas

Back to Colorado in 1980. One nice thing about cross-country skiing in lonely places is it's never any trouble to retrace your steps. You can get back to the car without danger by following your own tracks (unless it's snowing). But if you want to get anywhere, and you need to control risk, you need two types of stress test.