WHY MODELS SHOULD HAVE FAT TAILS

A statistical model that appears to better describe historical price data could silence the bell-shaped curve.

JUMPING TO conclusions is fine – until you land in a hole. Using the normal distribution as the basis for financial models is just as risky. In a recent paper, UTS academic Austin Gerig makes the point that if price data really did fit the normal distribution, then analogously you could assume there is someone in Australia who is 50 metres tall, and someone on the planet who is, hey, probably, more than 300 metres tall. The danger is in the thin tails, and any quant would agree that if successive events occur 25 standard deviations from the mean, as happened during the GFC, then your model's stuffed.

Gerig has crunched historical price data for US T-notes, gold, the S&P 500 index, oil and the British pound to construct distributions that when overlaid look very much to fans of statistics like a Student's T plot sprinkled with confetti. "If it isn't exactly a Student's T then it's very close to it," says Gerig, a postdoctoral research fellow at the UTS School of Finance and Economics. "The Gaussian [normal] distribution decreases exponentially in the tails and a Student's T distribution has a power law decay," he says. "If you look at extreme values of x – very large percent returns or largely negative percent returns – and you look to see how the probability distribution decays as a function of that value x for a Student's T distribution, it decays as a power law, which means it has a very slow decay. Exponential decay happens much more rapidly."

The parameters for a normal distribution are mean and standard deviation (interpreted as risk), whereas for Student's T the single parameter is degrees of freedom. As degrees of freedom approaches infinity, a Student's T plot approaches standard normal. As it gets small, however, the tails fatten. "So degrees of freedom is a type of measure of risk," Gerig says.

"A lot of people have looked at Student Ts in those terms but we're showing this seems to be working in a lot of different things, in addition to just stocks," he says. "It's like a law. In physics, 150 to 200 years ago, empiricists were looking for all these regularities and trying to develop models. To some extent that's where we are now in economics. This is one of those things that needs an explanation, and we're trying to come up with that explanation. Before you can do that, you have to know what the data says." **– Jeremy Chunn**