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## Don't risk using normal distribution

by **Lisa Goldberg**

It feels as though financial extremes have become everyday occurrences. Oil prices have doubled in the past year and there is disagreement about whether they will revert to previous levels.

US mortgage giants Freddie Mac and Fannie Mae are under severe strain. The value of the euro relative to the dollar is at a record high. Damaged financial markets attempting to recover from the subprime mortgage crisis may be destined for more turbulence.

There is reason to believe that extreme losses may occur more frequently than they once did. The size, complexity and interconnectivity of financial markets are greater than ever before. A minor mishap can propagate through counterparty relationships, generating an impact of unprecedented proportion. Complicated securities engineered to specific risk profiles have unintended exposures that come to light only after they have generated substantial losses.

Nevertheless management of extreme risk remains outside the scope of current investment practice, which relies on volatility to measure risk.

Volatility is the average dispersion of future portfolio returns and, to an investor, greater volatility means

greater risk. But volatility also determines a normal distribution that is used implicitly in many financial models to price exotic securities. Is this advantageous, harmless or dangerous?

The normal distribution plays an important role in the physical and social sciences. However, it is not the right forecasting model for every situation and it is a severe mismatch to financial markets: it substantially underestimates the likelihood of extreme market moves. This can translate into a severe mismatch between the model price of a derivative security and its market price.

Furthermore, the portfolio with the greatest volatility need not be the portfolio most likely to experience a large loss. There are many facets to risk and it is impossible for a single number to address them all.

To manage extreme risk, an investor has to measure the magnitude and likelihood of a crisis.

At first, this might seem impracticable. A crisis is a singular event and does not provide any information about when the next crisis is coming or how to avoid it.

Yet, there is a well-established quantitative theory of extremes and it is not too different from the volatility-based normal theory that is current-

ly used by financial practitioners. It is just a little more flexible.

The key to measuring extreme risk is to ignore the everyday ups and downs and to concentrate on large losses. A useful measure of financial risk called expected shortfall is the typical loss to a portfolio in a turbulent market.

To illustrate, suppose that you have \$1bn invested in an index fund that closely tracks the MSCI USA Index. It is a terrible day in the market - the worst in 100 - and your manager asks for your best estimate of how bad your losses will be. Using expected shortfall as your measure, based on historical data back till 1972, you estimate your expected loss is about \$35m.

Had you used normal distribution as a measure, you would have forecast an estimated loss of just \$26m, potentially leaving you with a huge gap to explain. Normal distribution forecasts are too low to guide allocation to capital reserves and rainy-day accounts. The historical estimate of expected shortfall is better at reflecting events since 1972, a period during which there have been several extreme losses.

For example, since January 1972, there have been eight one-day losses exceeding 5 per cent for the MSCI USA Index, 12 for the MSCI UK Index and

13 for the MSCI Japan Index. For the USA, four of these occurred in the first half period (before April 1990), mostly connected to Black Monday in 1987. The other four occurred in the recent half period.

In other words, there is at least one reason to believe that extreme risk has been present all along and recent turbulence in the market has opened our eyes to it. This suggests that a very long history may be a relevant and stabilising ingredient to forecasts of extreme risk.

Expected shortfall is not part of the investment process for most financial practitioners. Data constraints, obscure mathematical formalism and the spectre of new technology prevent many from benefiting from insights that a broader risk management paradigm can provide.

However, a fast-growing group of early adopters from hedge funds to investment banks and pension funds rely on non-normal estimates of extreme risk to allocate funds, to select securities and to measure performance.

A new generation of risk management tools is on the horizon and it can provide reliable economic forecasts - even in the throes of market turmoil.

*Lisa Goldberg is executive director of MSCI Barra*