What practitioners need to know about uncertainty

By Mark Kritzman, Financial Analysts Journal, March- April 1991

Uncertainty is the result of imperfect knowledge and incomplete data. Many of the laws that explain the behaviour of random variables in nature seem to apply to the behaviour of financial variables.

A random variable is an event whose outcome depends on chance factors. Just because an outcome is influenced by chance, does not imply that we are completely ignorant about its possible values.

We can gain good insights from past data. For example, we can compute the daily returns on an index. We can then use a frequency distribution table to analyse the returns. As we increase the number of observations, this discrete probability distribution becomes a normal distribution.

The normal distribution is continuous and assumes that there is an infinite number of observations covering all possible values on a continuous scale.

The normal distribution is an excellent approximation of the random variations associated with many natural phenomena.

The normal distribution can be completely described with two parameters- the mean and variance.

The normal distribution is symmetric around the mean. So mean, mode and median are equal.

The area enclosed within one standard deviation on either side of the mean of the normal distribution covers 68% of the total area, within 2 standard deviations 95% and within 3 standard deviations, 99.7%.

By using standardized returns, we can work with a standard normal distribution and find out the probability that the return will lie within a given range. To standardize a return, we have to subtract the mean and divide by the standard deviation.

Over extended holding periods, the normal distribution may not be a good approximation of the distribution of returns. This is because short holding period returns are compounded rather than cumulated to derive long holding period returns. We can represent the compound value of an index as a simple accumulation when expressed in terms of logarithms. It is the logarithm of one plus the holding period returns. The actual returns conform to a lognormal distribution. Such a distribution assigns higher probabilities to extremely high values than it does to extremely low values.

We should use a lognormal distribution when trying to estimate outcomes over long investment horizons.

The normal and lognormal distributions are not perfect models of the distribution of asset returns and other financial variables. Stock prices do not change continuously or in small increments. Many investment strategies yield returns that are skewed and not symmetric. Thus, the normal distribution, while being applicable in many situations, is an inexact model of reality.