Primer on the Misapplication of Statistical Analysis to Investing

[The Reader is Forewarned: I water down the terminology somewhat, but this discussion is technical in nature. If you're not interested in the application of statistical analysis to investments, skip it.]

Problems Understanding Probability: Don't Roll the Dice

Calculating probability to arrive at a level of certainty and risk can be a complex process in investing. Like the weather, many investment opportunities have many inputs, including exogenous events that have nothing to do with the investment itself but can dramatically impact valuation. Faced with that complexity and the daunting qualitative and quantitative analysis it mandates, modern finance and investment theory has generated a number of "shortcuts" for assessing risk and probability, many borrowed from mathematics and statistics, and for the most part consistently misunderstood and misapplied. Consider the following question:

A person flipping a quarter flips "heads" 10 times in a row. What are the odds of flipping heads again?

The answer is 50%. Although most people read some pattern into the unlikely outcome of 10 "heads" in a row, the quarter itself has no memory, and the odds remain unchanged.

That was a warm-up. Here's a much more difficult question. Read every word *very, very carefully*:

> Imagine a die (that is, just one of a pair of dice) that has 20 flat, symmetrical sides numbered 1 through 20. It might look something like a small soccer ball. Each time you roll it, it eventually settles on one number. Here's the question: On a given, normal, typical day, what are the odds of your rolling the die such that it lands on a specific number you have chosen beforehand? (i.e., the odds that it will land on 5, 17, or any other number you choose?)
>
> (By the way, just so you know beforehand, every time you roll anything other than a 16 you make $5. If you roll a 16, you lose $50. And if you lose $100, you're fired.)

If you answered "1 in 20," you're *theoretically right.* But what if you were asked to prove that theoretical assertion? Remember, the question begins with the phrase "On a given, normal, typical day..."

In order for the actual outcome to result in each number occurring 5% of the time - for that to be the actual occurrence *in reality* - that die has to be rolled thousands of times. And you're not going to roll that die thousands of times on *a normal, typical day...* This is why investing based on simple, raw probabilities is foolhardy. Calculating the blind probabilities, making $5 on every roll and only losing on a 16 might seem like a great "investment", but you would have to roll that die thousands of times to be certain you came out ahead, and what if your first roll was a 16? And your second?

What if what you rolled the first time *influenced* what you might roll the second time?

The investment world is full of professionals who fail to recognize this fracture between theory and reality, in the end utilizing a shorthand of probability analysis that simply does not apply to the world of investing. It is because they rely on this theoretical, mathematical outcome to drive their investment strategies that so many portfolio managers experience dramatic losses. In lieu of the investment fundamentals they analyze the minutiae of historical price data, observe the statistical outcomes, invest on that basis, and then, eventually, become statistics themselves. Having misunderstood risk and probability in even the most basic sense, they assess *investment risk* with even greater misplaced confidence, utilizing statistical shorthand such as standard deviation, volatility and variance as substitutes for in-depth analysis and common sense. The point is that one's investment outcome should *never* simply rely on a roll of the dice. The investor wants the dice to be loaded...

As a reminder, for examples of how probability analysis can play a useful, ultimately critical role in investing, revisit Probability Analysis in the Philosophy page.

Misused Metrics

It is accepted gospel in the investment arena that standard deviation, as well as its sister statistic, variance, are reliable metrics for gauging the volatility of a given fund's investment returns. These metrics are embraced because they are understood as measures of volatility, which has come to be accepted as a proxy for risk. The prevailing perception is that standard deviation is a reliable indicator of volatility, and the greater the volatility, the greater the risk. Hence:

Standard Deviation = Investment Volatility
Investment Volatility = Investment Risk

These assumptions are incorrect, for a number of reasons, and the investment world's reliance on them explains in some part why a community of apparently intelligent individuals continues to be "blindsided" by enormous losses on a semi-regular basis.

Standard Deviation - **σ** - is the square root of the **Variance** - **σ^2** - and the most commonly used measure of "spread."

Variance is a measure of how spread out a distribution is, whether it be a distribution of monthly fund returns or the average weekly rainfall over the past 9 years. One calculates the variance by computing the average squared deviation of each number from its mean. For the numbers 5, 6, and 7, the mean is 6 and the variance is:

$$\sigma^2 = \frac{(5-6)^2 + (6-6)^2 + (7-6)^2}{3} = .667$$

In summation notation, the formula for the variance in a population is

$$\sigma^2 = \frac{\Sigma (X - \mu)^2}{N}$$

where μ is the mean and N is the number of scores. When the variance is computed in a sample, the following is utilized (where M is the mean of the sample):

$$S^2 = \frac{\Sigma (X - M)^2}{N}$$

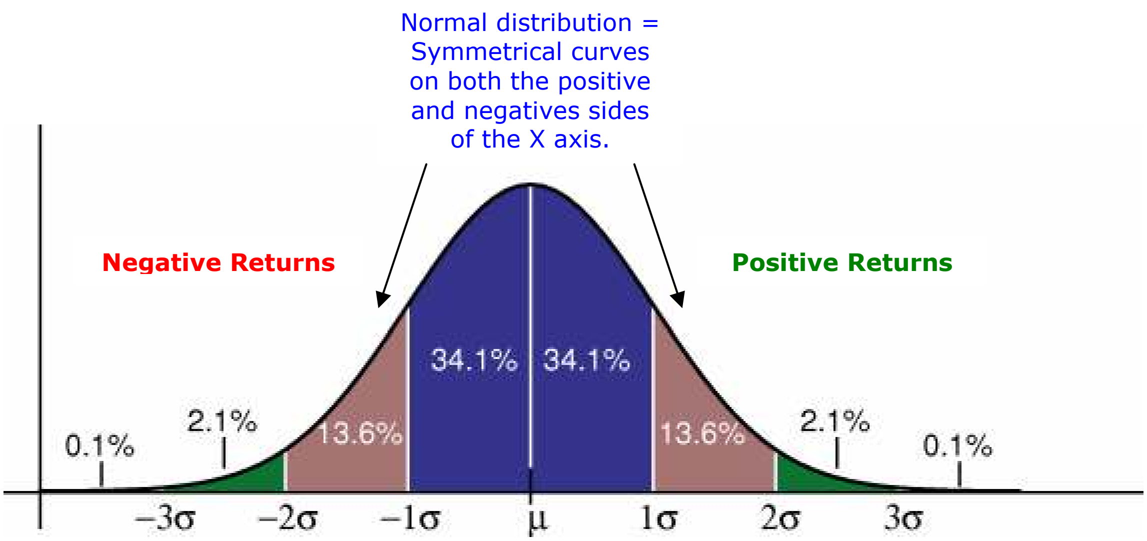
However, S^2 is a biased estimate of σ^2. The most common formula for computing variance in a sample is:

$$s^2 = \frac{\Sigma (X - M)^2}{N-1}$$

which gives an unbiased estimate of σ^2. Since samples are usually used to estimate parameters, s^2 is the most commonly used measure of variance.

Standard deviation is used by investors to measure the risk of a stock or a stock portfolio because they see it as an immediate indicator of volatility; the more returns deviate from the historical average, the more volatile the (stock) investment.

But the adoption of standard deviation as a measure of spread is only possible due to one key attribute: **Normal Distribution**. The normal curve is often called the Gaussian distribution. The term "bell-shaped curve" is often used in everyday usage. *See illustration below.*



The *normal distribution* is the most used statistical distribution. The principal reasons are:

1. Normality arises naturally in many physical, biological, and social measurement situations.

2. Normality is important in statistical inference.

All members of the family of normal curves share the same bell shape, given the X-axis is scaled properly. They're bilaterally symmetrical, i.e., if any normal curve was drawn on a two-dimensional surface (a piece of paper), cut out, and folded through the third dimension, the two sides would be exactly alike. That is, the distribution of events being measured is symmetrical on both sides of the mean. Both sides of the "bell" look exactly the same.

Why is standard deviation, which is predicated on the above normal distribution, so relied upon by the investment world?

Because if the mean and standard deviation of a normal distribution are known, it is possible to compute the percentile rank associated with any given score. In a normal distribution, about 68% of the scores are within one standard deviation of the mean and about 95% of the scores are within two standards deviations of the mean. Thus, using standard deviation as an indicator, investment portfolios and funds can literally be "scored."

However, for standard deviation to be an accurate measure of *any* distribution of events whether they be investment returns or meteorological phenomena those events must be *normally distributed.*

Problem #1: Normal distribution can't be assumed.

For standard deviation to be an accurate measure of *any* distribution of events whether they be investment returns or meteorological phenomena those events must be *normally distributed.* Normal distribution is assumed because, given a large enough sample, normality arises naturally in many physical, biological, and social measurement situations.

Most people are familiar with a normal distribution through the common term "bell curve". All members of the family of normal curves share the same bell shape, given the X-axis is scaled properly. They're bilaterally symmetrical, i.e., the distribution of events being measured is symmetrical on both sides of the mean.

As much as normality of distribution may be witnessed in nature and also be helpful as a premise in drawing statistical inferences, normality cannot be assumed with respect to investment returns.

One reason for this is the investor's time horizon; if returns are calculated monthly, it's possible that, over enough months, returns will assume a normal distribution. However, how often will it occur that the average investor is invested for such an extended period that he can rely on the normal distribution that is the critical assumption behind standard deviation?

Few investors today are likely to be invested long enough, perhaps even *live long enough*, to experience the benefits of a normal distribution.

If the investment period is too short for a normal distribution to be assumed, standard deviation is a patently unreliable indicator… of anything.

Problem #2: Even if normal distribution *could* be assumed, it's only the positive half of that distribution that the investor is interested in, and standard deviation measures *both.*

The symmetry that makes a curve bell-shaped and thus a normal distribution is also not helpful with respect to investing because exactly half of that distribution the returns that are at or above the mean is variance that the investor *wants*: positive returns. Returns below the mean, represented by the portion of the bell curve to the left of the mean, are what the investor seeks to avoid. Thus, one half of the dispersion is attractive, and one half is to be avoided, but standard deviation measures *both*.

Thus, standard deviation, variance, their use in calculating volatility and application in assessing investment risk are entirely useless because half of what they describe is *positive volatility* the investor wants: The price of the security going up...

False Choices: Quantitative vs. Qualitative Measures of Portfolio Risk

Based on the above analysis, it's certainly clear that the statistical metrics utilized to measure portfolio risk provide very little by way of useful information. Given that the above is hardly a complicated analysis, why do investors continue to look to these numbers when attempting to gauge risk?

Excluding the fundamentally uninformed, it appears to come down to convenience. Utilizing these statistical tools reduces all strategies, regardless of their inherent differences, to one common mathematical point of comparison. This means that one theoretically has a common basis for choosing which fund to invest in, despite the fact that they employ dramatically different strategies. Although it's entirely misleading, it does appear to translate the qualitative into the quantitative. And given that few investors are capable of in-depth qualitative analysis, this quantitative approach prevails.

The other reason often proffered for utilizing these statistical metrics in evaluating portfolio risk is the assertion that *there's no alternative*. This is, of course, entirely fatuous.

Utilizing standard deviation to gauge investment risk because "there's nothing better" is the equivalent of using the butt of a loaded and cocked revolver to drive nails into a wall because there's no hammer nearby.

A qualitative analysis of the portfolio and manager, including a close review of the actual positions, is far superior to any other means of evaluation. Unfortunately, it also requires that the investor understand the underlying strategies and is capable of a qualitative analysis of the strategy, the manager, etc. Very few individuals appear to possess these competencies.

There are laws in place that are meant to protect less educated investors from being taken advantage of. Investing in hedge funds is by law limited to what the regulations define as "sophisticated investors." And every year, those sophisticated investors lose billions because they have no idea what they own or how truly risky it is. Ignorance is pervasive, even among putative professionals whose business it is to invest in hedge funds.

A survey of funds of funds (FOF) conducted in 2003 found that most of the 1,700 FOF surveyed relied on "inappropriate quantitative analysis of hedge fund data." According to the study, "only 13% of the 61 alternative management groups surveyed 'combine a quantitative approach with a qualitative portfolio construction approach' even though that's the only appropriate way to assess the fund's exposure to extreme market situations." As one FOF manager who appears to understand put it, "The quantitative approach is important but it has to constantly be overseen by qualitative analysis..."[1]

[1] "Funds of Funds Are Falling Short," WSJ, 3/3/04