risk management

$P(\text{shortfall}) = P[\text{Actual Return} < \text{Benchmark Return}]$
$E(\text{shortfall}) = E[\text{Actual Return} - \text{Benchmark Return}] \text{ where } [\text{Actual} < \text{Benchmark}]$
$\text{Tracking Error}_{\text{Stocks}} = [(\beta_i - 1)^2\sigma^2_m + \sigma^2_e)]^{1/2}$
$\text{Tracking Error}_{\text{Bonds}} = [D^*_I\sigma^2_e + (D^*_I\beta_I - D_I)\sigma^2_{\Delta r}]^{1/2}$
$VAR = (\text{Z-Score})(\sigma)$
$\text{Relative VAR} = VAR_{\text{Portfolio}} / VAR_{\text{Benchmark}}$

Alternative Measures of Risk

flashcard concepts

- The Standard Deviation (σ) and Variance (σ^2) are Symmetrical Measures of Risk. These risk measures may be inadequate when applied to securities or portfolio strategies that exhibit asymmetric (skewed) return distributions
- Standard Deviation, Semi-variance, and other quantifiable measures of risk cannot characterize the behavioral aspects of investment risk
- Most investors are concerned with downside risk. To accurately measure downside risk, you should define a Risk Benchmark
- TRACKING ERROR is defined as the σ of the Difference in return between the investment and a specified benchmark or target position. It measures how closely the investment performs relative to the benchmark.
- Assuming that the deviations on the downside are more serious, tracking error does not give us a complete picture of the risk involved in a particular investment
- For Stock investments, if a β is close to 1, the tracking error is primarily a *f* of UNSYSTEMATIC Risk
- If the Duration f a bond under consideration is similar to that of the market index and the Yield β is equal to 1, then the tracking error will equal the duration-adjusted residual yield volatility
- There are THREE DOWNSIDE RISK Measures:
  - The *Probability of Shortfall* - the total probability of returns falling below the risk benchmark return. The main drawback of this concept is that it does not take into consideration the severity of downside risk
  - The *Expected Shortfall* - the average distance of downside returns relative to the risk benchmark return. The expected shortfall measure neglects to consider the variability of downside returns
  - The *Semivariance* - measure of the squared distance of downside returns relative to the risk benchmark. The semi-variance is the preferred measure of downside risk. The Relative Semi-variance is the semi-variance computed relative to a variable risk benchmark

Problem Set: Alternative Measures of Risk by Clarke

1. DISCUSS reasons why the σ should not be considered the SOLE measure of investment risk. INTRODUCE an Alternative to the σ that corrects some of the standard deviation's drawbacks.

The σ cannot accommodate investment vehicles with asymmetric payoff profiles (such as options strategies and portfolio insurance). The σ assumes a normal probability distribution of returns. Due to its very nature, the standard deviation measures symmetrical risk patterns. In other words, upside risk matters just as much as downside risk. Most of us would agree that downside variability is much more important than upside variability. The standard deviation also cannot quantify the behavioral aspects of investing risk. It does not take into account the mean return of the investment. The probability distributions of asset returns may not be stable over time. The Semi-Variance can be viewed as a viable alternative to the standard deviation in that it corrects for the problems of asymmetry and downside risk.

2. CRITICIZE Shortfall as a measure of risk and DISCUSS how semi-variance is an improvement as a risk measure.

The trouble with expected shortfall is that it does not consider the distribution (or variability) of returns from the benchmark return. Hence, you could have two investments with exactly the same expected shortfalls but one investment could still be considered riskier by some investors if returns are more highly skewed on the downside. We can fix this problem with Semi-Variance

Semi-variance fixes the problem that outliers pose to the expected shortfall by squaring the distance from each observation below the benchmark return. Hence, observations that are farther below the benchmark return are penalized more by this system. Using the semi-variance in lieu of the standard deviation results in more appealing asset allocation decisions since only downside risk is considered

3. DISCUSS tracking error and how its computation is related to other measures of risk (β and σ)

Tracking Error is defined as the standard deviation of the difference in return between the investment and a specified benchmark or target position. It measures how closely the investment performs relative to the benchmark. However, tacking error relies on a normal distribution. As a result, tracking error does not distinguish between deviations above and below the benchmark. Assuming that the deviations on the downside are more serious, tracking error does not give a complete picture of the risk involved in a particular investment. The variance of the total return is a special case of the tracking error when the benchmark return and the expected return of the investment are equal. The formula for the tracking error for stocks looks much like the measurement of total risk. If the β is close to 1, the tracking error is primarily a *f* of Unsystematic Risk. Similarly, if the duration of the bond is similar to that of the market index and the yield beta is equal to 1, then the tracking error will equal the duration-adjusted residual yield volatility

VAR for the Asset Manager

flashcard concepts

- The Variance/Covariance VAR method uses a process where complex portfolio risks are MAPPED to individual risk factors and then the portfolio σ is computed using the individual standard deviations of these risk factors and their relative portfolio weights. Once the standard deviation is computed, VAR can be computed by finding the Maximum dollar (or return) loss for a given probability level and time period
- The Strengths of Variance/Covariance VAR are that:
  - It is Relatively Straight-forward
  - Market Data Used to Compute VAR is Readily Available
  - the RiskMetrics system can even model some non-linear positions
- Weaknesses of Variance/Covariance VAR:
  - Assume Stable Variance/Covariance matrix through time (may not be true)
  - Assume Normally Distributed Returns (may not be true)
  - Variance/Covariance Matrix becomes larger and more complex as the number of risk factors grows
- With HISTORICAL VAR, you simply line up returns from low to high and pick the return level that corresponds to the probability level you are interested in.
- Strengths of Historical VAR are:
  - Easy to Use and Understand
  - Makes no assumptions re: return normality or linearity
  - Variance/Covariance matrices are not necessary
- Weaknesses of Historical VAR are:
  - Large Data Requirements
  - Assuming that the future will be like the past
  - Valuation models may be necessary for assets without frequent return statistics
- MONTE CARLO Simulation utilizes asset pricing models to generate many future portfolio price paths. The distribution of asset returns is then generated from the results of this path determination process. Once the distribution of asset returns is determined, VAR is easily derived by looking at the appropriate probability level. The strengths of Monte Carlo VAR are that
  - it is more flexible relative to parametric or historical VAR
  - no assumptions re: linearity or normality of returns are required
- Weaknesses of Monte Carlo VAR include
  - Portfolio complexity and the number of scenarios needed
  - the path generation process requires asset pricing models which may or may not be reflective or reality
- STRESS TESTING is “what if” analysis applied to a particular VAR computation. Stress testing allows you to determine the validity and reliability of a VAR estimate
- The practical applications of VAR for portfolio managers are
  - Comparable risk evaluation across asset classes
  - Identification of Key Portfolio risks
  - Portfolio construction
  - Setting portfolio risk limits

- Absolute performance evaluation using VAR should be performed with the problems of VAR in mind
- Peer group risk evaluation using VAR is not a good idea due to the fact that VAR differs significantly depending on the methodology and assumptions employed
- Relative risk evaluation v. a benchmark portfolio is more effective than relative peer evaluation because the same methodologies and assumptions can be applied to both the portfolio under evaluation and the benchmark. Hence, comparability problems are minimized.

Problem Set: VAR for the Asset Manager by Stocks & Ito

1. DISCUSS the strengths and weaknesses of using variance/covariance VAR computation

Strengths:

- Using RiskMetrics, the computation of VAR is relatively easy
- In most cases, the market data necessary to compute VAR is available
- The RiskMetrics system can even model the risk of some non-linear positions

Weaknesses:

- System assumes that the variance/covariance matrix is Stable through time. We know now from the Clarke article that the σ and Correlations may not be stable through time
- Some assets may have non-normal return distributions. Variance/Covariance VAR has limited success in handling non-normal distributions
- The VAR computation becomes more difficult as the complexity of the portfolio increases. As portfolio complexity increases, the number of required risk factors grows, and the variance/covariance matrix rises proportionately

2. CONTRAST the use of VAR for relative risk evaluation v. a competitor's portfolio relative to a similar evaluation relative to a benchmark portfolio.

Relative evaluation v. a Market Index is more Viable than Peer Group Evaluation because a particular individual will be making the VAR computation for both the underlying portfolio and the market index. Hence, you don't have the large comparability problems that are inherent in peer comparisons. Also, the characteristics of the market index are better known than the characteristics of the competitor's portfolio.

3. Briefly OUTLINE the uses of VAR for portfolio managers

Uses of VAR for portfolio managers include:

- *Comparability* - VAR measures risk comparably across asset classes. The result is that with VAR, the risk of a bond portfolio can be compared against the risk of an equity portfolio
- *Risk Identification* - Recall that the key to the parametric VAR computation is the dis-aggregation of complex risks into isolated risk factors. A portfolio manager can use this process to identify the macroeconomic factors that have the mot impact on the overall portfolio manager.
- *Portfolio Construction* - The parametric method relies on the determination of the variance/covariance matrix of these individual risk factors. The portfolio manager can use this variance/covariance matrix to develop optimal portfolio allocations - similar to standard modern portfolio theory

- *Risk Limits* - Portfolio manager can use VAR to set risk limits for a portfolio - either on an absolute level or on a relative basis v. a benchmark.

Global Risk Management: Are We Missing the Point

flashcard concepts

- The point of this article is to show that the main problem facing a risk manager is to uncover and analyze risks that are not readily apparent in the current market environment. e.g., if you use VAR to measure risk, you should look at what VAR is NOT telling you. You should look at what can happen the other 5% of the time
- A Hedge that appears quantifiably riskless based on a pricing model or other hedging framework may still contain some risk. Risks that may remain include (a) Model Risk, and (b) Inventory Risks - such as operational, legal, and liquidity risks.
- The implication of fat-tailed distributions is that there are actual market events that cannot be readily explained or predicted by using a standard normal distribution to measure risk. The risk manager should carefully evaluate the tails of an asset's distribution. You are attempting to guard against the portfolio damage that would be caused by severe market moves.
- Asset correlations tend to rise during 'market events'. As correlations increase, the benefits of global diversification falls. Also, VAR risk estimates become unreliable due to a shift in the variance/covariance matrix. As correlations rise, you can lose more for a given probability level and time due to the loss of diversification benefits. Hence, diversification is reduced at the time when you need it most.
- Non-linear risks are called Negative Φ Risks and are represented by losses that rise at an increasing rate as a particular risk factor moves against you
- Most catastrophic risks in global asset management are of an organizational nature, rather than of risk management structure
- An effective organizations structure is contingent upon appropriately structured incentives, access to information with respect to strategy and revenue, open interaction within the organization, and the knowledge to seize issues directly

Problem Set: Global Risk Mangement: Are we missing the point by bookstaber

1. INTRODUCE Two reasons why a 'hedged' position may still contain some risk

There are TWO main factors that can have an impact on the risk of a Hedge:

- *Model Risk* - Suppose a hedge was created relative to a model like VAR. This hedge is only as good as the model that was used to construct it. If there are problems with the model or the assumptions underlying the model, the hedge will suffer
- *Inventory Risk* - Most trading desks will have net long or short inventory positions that will need to be hedged on a daily basis. What is meant by Inventory Risk are all of those non-quantifiable risk factors that are not considered in VAR or other risk models. Examples include legal risks, operational risks, liquidity risks, etc.

2. COMMENT on the normality of return distributions and the implication of that normality for asset managers

Many academic studies have shown that asset returns are NOT normally distributed. Many asset distributions exhibit 'fat tails'. The key here is a discussion of OUTLIERS. As risk managers we are interested in what may consider the other 5% of the time in a VAR computation. Bookstaber is telling us that we should throw out the 95% of the distribution that everyone else is looking at

and concentrate on the improbable, yet possible, lower 5% of the distribution. If the lower tail of the distribution is not normal, then you will want to analyze the behavior of the lower tail through Stress Testing and the computation of other downside risk measures

3. DISCUSS differentials in market correlations during periods of financial distress v. 'normal' market periods

Bookstaber indicates that during ADVERSE market events (i.e., severe volatility, a market crash, a global currency crisis, etc.) the correlation between global markets increases. This increase in global market correlations is bad news for the benefits of diversification. It is also bad news for VAR computations. As correlations increase, your estimate of VAR will deteriorate. Hence, as correlation between assets rises, the maximum amount you can lose for a given probability over a certain time period increases (you can lose more). Why? Because your assets move together - if one goes down, they are all apt to go down. In other works, your diversification benefits fall as correlations rise.

4. DEFINE NEGATIVE GAMMA Risk and provide ONE example of such a risk

In a non-linear process, the risk of the position 'looks' benign under current conditions but if the risk factor moves against you, your position can blow up. In other words, if the risk factor moves, your risk rises proportionately. This is also called negative gamma exposure.
Example: suppose that you have written some out-of-the-money naked calls. At the current level of stock prices, the exposure looks minimal. But, if stock prices rise rapidly, the risk of your position rises proportionately.

5. EVALUATE how addressing organization questions related to each of the following areas can improve the risk management process

i. Incentives - Structuring an appropriate incentive structure encourages traders to look beyond their own books and staff to consider carefully the positions of the desks
ii. Information - Appropriate peer discussion and reviews with respect to revenue and positions as well as a breakdown of revenue by strategy (and the strategies themselves) should enhance the risk management process and help reduce the risk of catastrophic events
iii. Interaction - The risk management process can be made more effective with opportunities for interaction within the organizational structure. This process may include promoting interactions between traders and staff across desks and business lines and between senior officers and junior traders, without the approval of supervisors
iv. Initiative - Assessing the talents of senior management with respect to trading knowledge can enhance the risk management process by determining if senior management should address issues directly or delegate decision-making to the trading floor

