## DEFINITIONS

In the domain of finance, volatility denoted by is the extent with which financial values such as asset prices vary over time. In statistical terms, standard deviation denoted by measures the variation of a series of financial values over a predefined period of time about its mean . Similarly, variance denoted by or measures the spread or dispersion between the values in the series, ie to what extent each value is away from the mean .

The relationships between , and are:

where is a value in the series, is the mean of all values in the series, is the number of values in the series

and where is the number of time intervals over which the is measured or observed.

A special form of variance or that only consider either the upside or downside risk is called semivariance, given by the following

or

Correlation is another statistic that measures the extent with which two series of values are linearly related or moving together or otherwise over the period observed.

where:

x,y = two series of values

n = number of observations

Given the above relationships, and risk defined as the likelihood of loss, value at risk statistically measures the potential loss in dollar amount at a given level of confidence or threshold for a given period of time. In particular, conditional value of risk measures the total potential loss from the threshold to negative infinity. It is also known as expected shortfall for this reason.

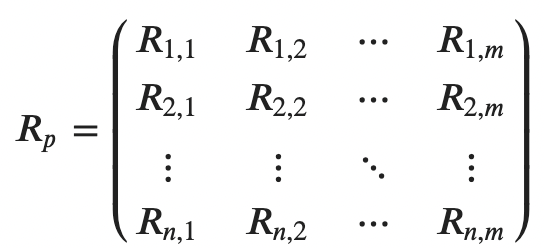
Other commonly used measurements of risk are standard deviation, R-squared, alpha, beta, Sharpe ratio, value at risk (VaR), and conditional value at risk (CVaR).

Tail risk (TR): A measure of the likelihood of extreme losses in the portfolio (this is similar to the concept of value-at-risk or VaR; we will also introduce the concept of conditional VaR or CVaR, which is sometimes referred to as expected shortfall). Tail risk corresponds to the area of the portfolio loss distribution from which we typically calculate economic capital.

See <https://drive.google.com/drive/u/2/folders/1Pkly9RjGvqbcMJmWXFl5o6tFaOY1d5CS>

We complete this section on the definitions of statistical risks with their application to asset allocation in a portfolio.

If a portfolio consists of stock and returns, the return matrix for this portfolio is calculated as follows.



As a result, the expected return of the stock is given by

is the weight or proportion of the portfolio that is made up of stock . Thus,

Therefore, the weighted expected return of the portfolio is given by

Similarly, the variance of the same portfolio is given by

where correlation coefficient defined above = 1 for the same stock, ie

If the covariance of stock and is defined as

then

where is the vector of weights

Definitions:

* https://www.investopedia.com/terms/v/volatility.asp
* https://www.investopedia.com/terms/s/standarddeviation.asp
* https://www.investopedia.com/terms/v/variance.asp
* https://www.investopedia.com/terms/c/correlation.asp
* https://www.investopedia.com/terms/r/risk.asp
* https://www.investopedia.com/terms/r/riskmeasures.asp
* https://www.investopedia.com/ask/answers/041415/what-are-some-common-measures-risk-used-risk-management.asp
* https://www.investopedia.com/terms/m/modernportfoliotheory.asp
* https://www.investopedia.com/terms/p/pmpt.asp
* https://www.investopedia.com/terms/s/semideviation.asp
* https://www.investopedia.com/terms/d/derivative.asp

## ILLUSTRATIONS WITH DATA

Assets chosen for the illustration:

1. West Texas Intermediate (WTI) — Cushing, Oklahoma (DCOILWTICO)

2. S&P 500 index

3. US 10 year Bond

Timeline considered for the analysis: 10 years.

### Visualising the time series data of the 3 securities:

Crude Oil Prices: Brent - West Texas Intermediate