1 RETURNS AND RISK

Review: Return and Risk

- Financial assets are generally described by their **risk** and **return** characteristics
- Financial assets normally generate two types of return for investor: periodic income (dividends or interest payments) and price change (capital gain/loss)
- Gross and net return
  - A gross return is the return earned by an asset manager prior to deductions for management expenses, custodial fees, taxes, or any other expenses that are not directly related to the generation of returns but rather related to the management and administration of an investment
  - Net return is a measure of what the investment vehicle has earned for the investor. Net return deducts all managerial and administrative expenses that reduce an investor's return
- Pre-tax and after-tax nominal return
- Real return

Holding Period Returns

- Suppose you invest in a stock index fund. The fund currently sells for $100 per share. Suppose your investment horizon is one year. If the price per share at year's end $110 and the cash dividends over the year are $5, what is your holding period return?

$$r = \frac{P_1 - P_0}{P_0} + \frac{D_1}{P_0}$$

Multi-Period Returns

$$r = (1 + r_1)(1 + r_2)\ldots(1 + r_n) - 1$$

- What was your average annual return over the five-year period?
- Annualising returns?

LAB: Basics of Return

- Use the file: lab_101_Prices to Returns.ipynb
- Data file: sample_prices.csv

Notes: These files are provided by EDHEC Business School

Risk

- **Risk** is defined as the **uncertainty** over the amount or timing of future cash flows from an investment, or the **variability** of returns from those that are expected
- The risk of a security can be considered in isolation, or on a portfolio basis; this distinction is critical for portfolio theory
- Some investments are *risk free*, e.g., a default free T-bond.
- Most investments, however, are risky. Consider an investment in a stock, which offers a return in the form of a dividend and capital gain; the return that the investor receives is risky, since both the dividend and the future sale price of the stock is uncertain
- Other risky investments include government bonds to be sold before maturity, corporate bonds, derivatives, commodities, real estate, a firm's physical assets, human capital
- The most common risk measure is the **standard deviation**

Measuring risk

- Variance is the expected value of squared deviations from the mean.
- Standard deviation is the square root of variance.
- The higher the variability or the volatility of the outcomes is, the higher will be the squared deviations.
- Variance and standard deviation provide one measure of uncertainty – or the risk – in outcomes.

Measuring risk

THIS MEASURE IS CALLED STANDARD DEVIATION AND IS COMPUTED AS FOLLOWS

$$\sigma_R = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(R_i - \bar{R})^2}$$

WE **CAN'T COMPARE** THE VOLATILITY FROM DAILY DATA WITH THE VOLATILITY FROM MONTHLY DATA

$$\sigma_{ann} = \sigma_p\sqrt{p}$$

THERE ARE APPROXIMATELY 252 **TRADING DAYS** PER CALENDAR YEAR

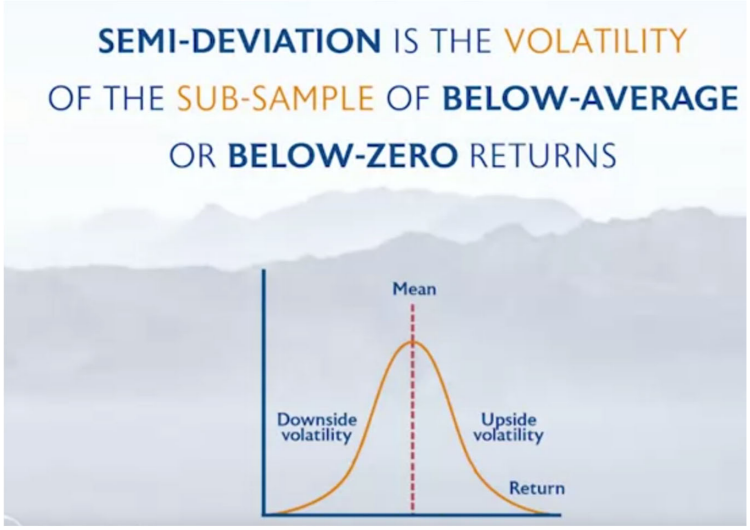
LAB: Volatility and Risk

- Use the file: lab_102_Volatility and Risk.ipynb
- Data files:
  - ind30_m_vw_rets.csv

Alternative measures of risk

- There are alternative ways to measure risk, for example:
  - ✓ Range of returns
  - ✓ Semi-variance: a measure that only considers deviations below the mean
  - ✓ **Maximum drawdown**: the return from the highest price to the lowest price over a period of time (this measure is widely used by traders)

Semi Variance and Semi-Deviation



$$\sigma_{semi} = \sqrt{\frac{1}{N}\sum_{R_t \le \bar{R}} \left(R_t - \bar{R}\right)^2}$$

WHERE N IS THE NUMBER OF RETURNS
THAT FALL BELOW THE MEAN

Maximum Drawdown

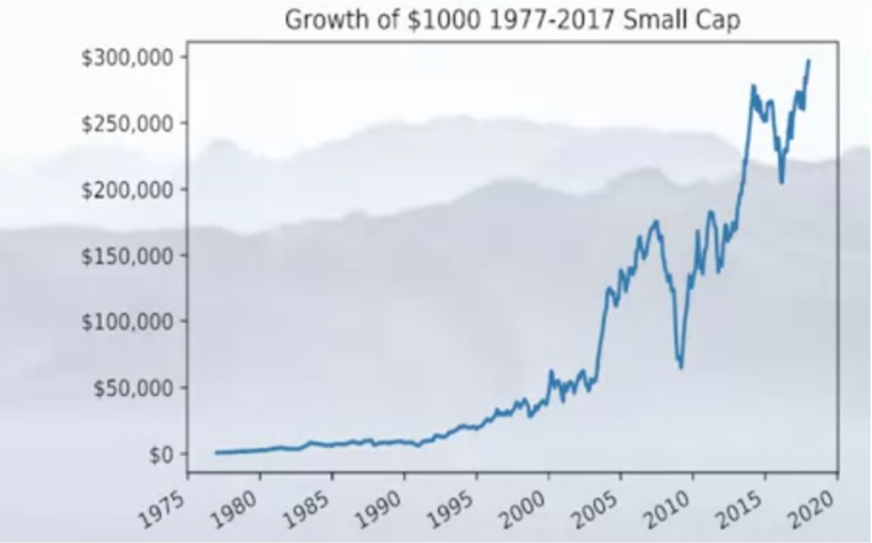
THE **MAX DRAWDOWN** IS THE MAXIMUM LOSS FROM
THE PREVIOUS HIGH TO A SUBSEQUENT LOW

BUY AT ITS HIGHEST VALUE - **SOLD** AT THE BOTTOM

THE **WORST POSSIBLE RETURN** YOU COULD HAVE
SEEN IF YOU "BOUGHT HIGH, SOLD LOW"

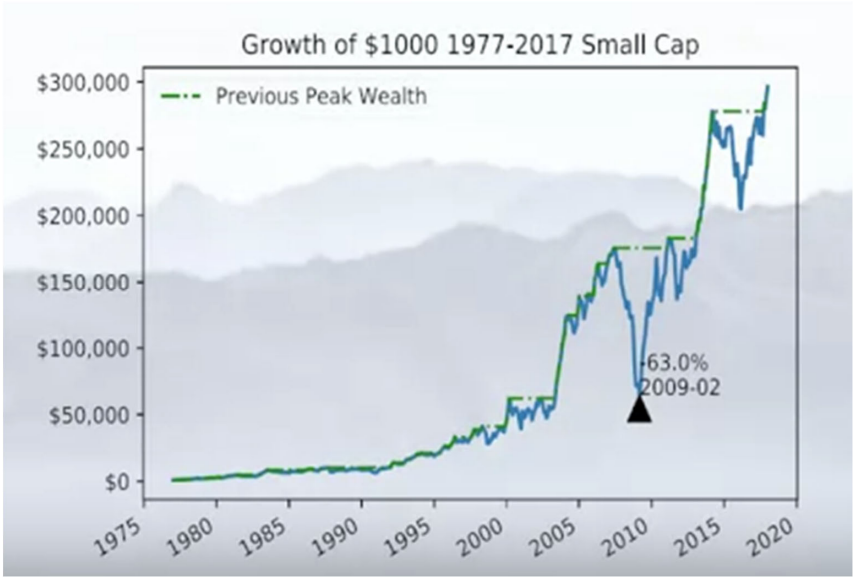
Maximum Drawdown

Step 1: Computing a drawdown is to construct **a wealth index** (hypothetical buy-and-hold investment in the asset)



Maximum Drawdown

Step 2: Look at **the prior peak** at **any point in time**



Step 3: Compute the **Drawdown** as the difference between the previous peak and the current value

Maximum Drawdown

YOU MIGHT WONDER IF THE **DRAWDOWN RISK** CAN BE USED AS THE DENOMINATOR IN A MANNER SIMILAR TO **USING THE VOLATILITY OF THE ASSET** IN THE SHARPE RATIO

THE **CALMAR RATIO** IS DEFINED AS THE RATIO OF THE ANNUALIZED RETURN OVER THE TRAILING 36 MONTHS TO THE **MAXIMUM DRAWDOWN** OVER THOSE TRAILING 36 MONTHS

Maximum Drawdown

IT IS IMPORTANT TO NOTE THAT THEY ARE A FAR FROM PERFECT MEASURE

FOR INSTANCE, THEY ARE **ENTIRELY DEFINED** BY TWO POINTS AND HENCE ARE VERY **SENSITIVE TO OUTLIERS**

SECOND, THEY DEPEND ON THE **FREQUENCY OF OBSERVATIONS** IN GENERAL, A VERY DEEP DRAWDOWN ON A DAILY OR WEEKLY BASIS MIGHT ALMOST **COMPLETELY DISAPPER** OR **MOVE TO VERY DIFFERENT LOCATION** BASED ON MONTHLY DATA

IN SPITE OF THESE SHORTCOMINGS, **DRAWDOWNS** ARE CLOSELY MONITORED AND POPULAR AMONGST PRACTITIONERS EVEN THOUGH OTHER MEASURES LIKE **VAR** AND **CVAR** ARE MORE ROBUST MEASURES OF EXTREME RISK

LAB: Drawdown

- Use the file: lab_103_Maximum Drawdown.ipynb
- Data files:
  - Portfolios_Formed_on_ME_monthly_EW.csv

LAB: Building a Module

- Use the file: lab_104_Building a Module.ipynb

LAB: Deviations from Normality (Self – Study)

- Use the file:

  lab_105_ Deviations from Normality.ipynb

Value at Risk

- **Value at risk** is the minimum loss that would be expected a certain percentage of the time over a certain period of time given the assumed market conditions.
- The following three points are important in understanding the concept of VaR:
  - VaR can be measured in either currency units or in percentage terms.
  - VaR is a minimum loss. This point cannot be emphasized enough. VaR is often mistakenly assumed to represent how much one can lose.
  - A VaR statement references a time horizon

The 5% VaR of a portfolio is €2.2 million over a one-day period

Value at Risk

The 5% VaR of a portfolio is €2.2 million over a one-day period

Using the example given, it is correct to say any of the following:

- €2.2 million is the minimum loss we would expect 5% of the time.
- 5% of the time, losses would be at least €2.2 million.
- We would expect a loss of no more than €2.2 million 95% of the time.

Value at Risk

1. Given a VaR of $12.5 million at 5% for one month, which of the following statements is correct?

   A. There is a 5% chance of losing $12.5 million over one month.

   B. There is a 95% chance that the expected loss over the next month is less than $12.5 million.

   C. The minimum loss that would be expected to occur over one month 5% of the time is $12.5 million.

Solution:

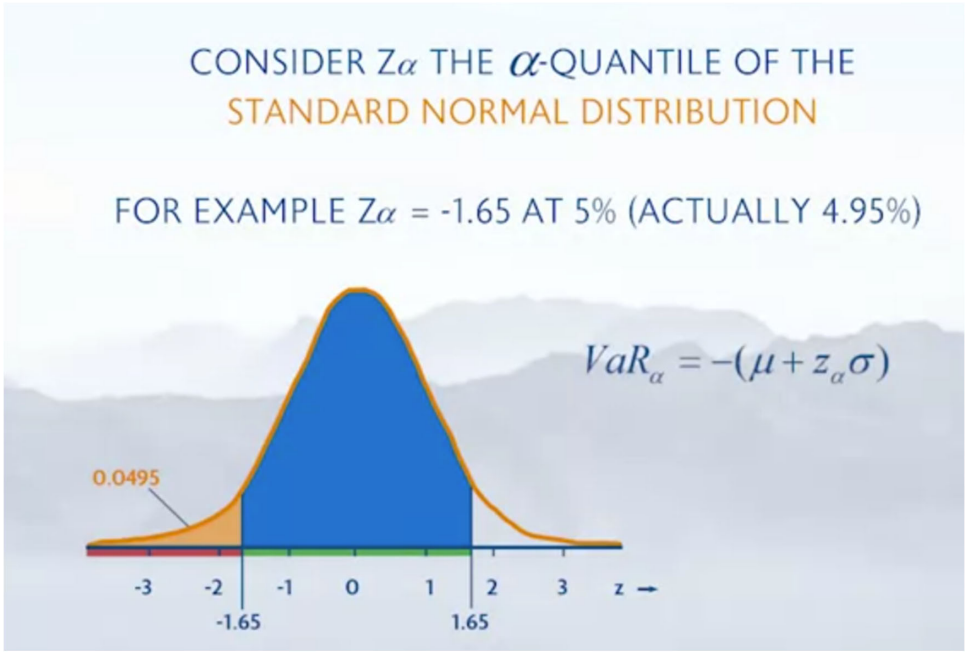
C is correct because it is the only statement that accurately expresses the VaR. A is incorrect because VaR does not give the likelihood of losing a specific amount. B is incorrect because VaR is not an expected loss; rather, it is a minimum loss.

Estimating VaR

- **Historical Approach**

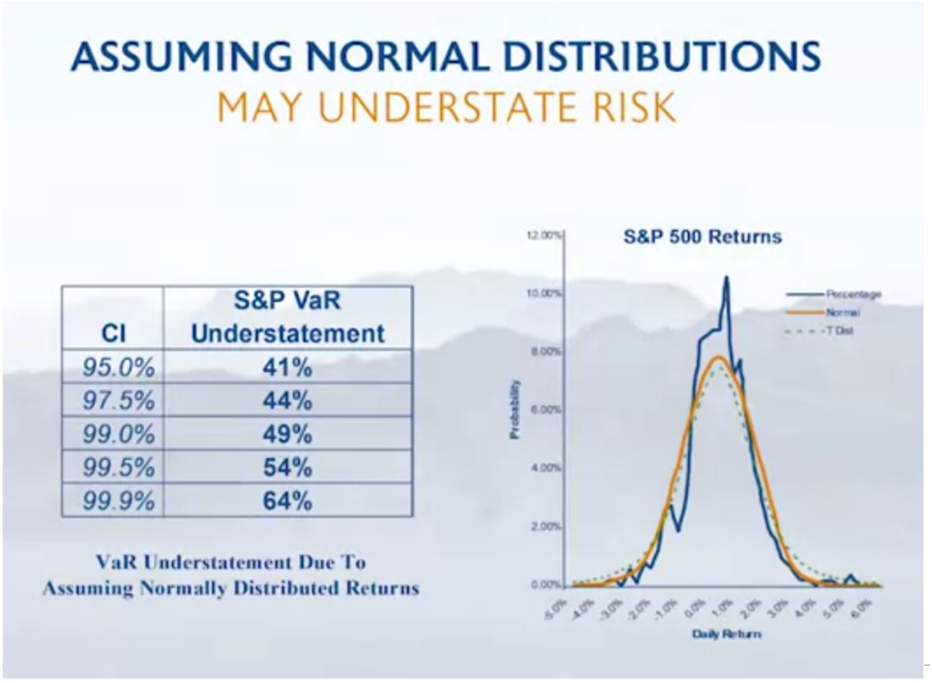
Estimating VaR

- **Variance – Covariance Approach**



Estimating VaR

- **Variance – Covariance Approach**



Estimating VaR

- **Monte Carlo Simulation:**

Monte Carlo simulation is a method of estimating VaR in which the user develops his own assumptions about the statistical characteristics of the distribution and uses those characteristics to generate random outcomes that represent hypothetical returns to a portfolio with the specified characteristics

Advantages of VaR

- Simple concept: VaR is relatively easy to understand.
- Easily communicated concept.
- Provides a basis for risk comparison
- Facilitates capital allocation decisions.
- Can be used for performance evaluation.
- Reliability can be verified.
- Widely accepted by regulators.

Limitations of VaR

- Subjectivity
- Underestimating the frequency of extreme events
- Failure to take into account liquidity
- Sensitivity to correlation risk.
- Vulnerability to trending or volatility regimes
- Misunderstanding the meaning of VaR
- Oversimplification.
- Disregard of right-tail events.

Extensions of VaR

- **Conditional Value at Risk** (CVaR) attempts to address the shortcomings of the VaR. CVaR is the expected loss if that worst-case threshold is ever crossed. CVaR, in other words, quantifies the expected losses that occur beyond the VaR breakpoint.
- Beyond assessing tail loss, a risk manager often wants to know how the portfolio VaR will change if a position size is changed relative to the remaining positions. This effect can be captured by a concept called **incremental VaR (IVaR)**

Extensions of VaR

- A related concept is called **marginal VaR (MVaR**). It is conceptually similar to incremental VaR in that it reflects the effect of an anticipated change in the portfolio, but it uses formulas derived from calculus to reflect the effect of a very small change in the position. Some people interpret MVaR as a change in the VaR for a $1 or 1% change in the position, although that is not strictly correct. Nonetheless, this interpretation is a reasonable approximation of the concept behind marginal VaR, which is to reflect the impact of a small change

LAB: Estimating VaR

- Use the file: lab_106_Downside Measures.ipynb
- Data files:
  - edhec-hedgefundindices.csv

Other key risk measures

- Sensitivity Risk Measures:
  - Equity Exposure Measures: Beta
  - Fixed-Income Exposure Measures: Duration and Convexity
  - Options Risk Measures: Delta, Gamma, Vega
- Scenario Risk Measures
  - Historical Scenarios
  - Hypothetical Scenarios