



Portfolio Monitoring

Agenda

Introduction

Modern Portfolio Theory and Efficient Markets

Equity Risk Premium

Arbitrage Pricing Theory

Equity Portfolio

Introduction to Asset Allocation

Return Calculations

Advanced Risk Measures and Return Distributions

Principal vs Agent Risk

Benchmarks

Basic Attribution

Deeper Dive into Attribution

Yield Curve Construction



Introduction

What is Performance Measurement?

What

- Calculation of Portfolio Return, Benchmark and Peer Group comparison
- Maintenance of performance track records
- Distribution

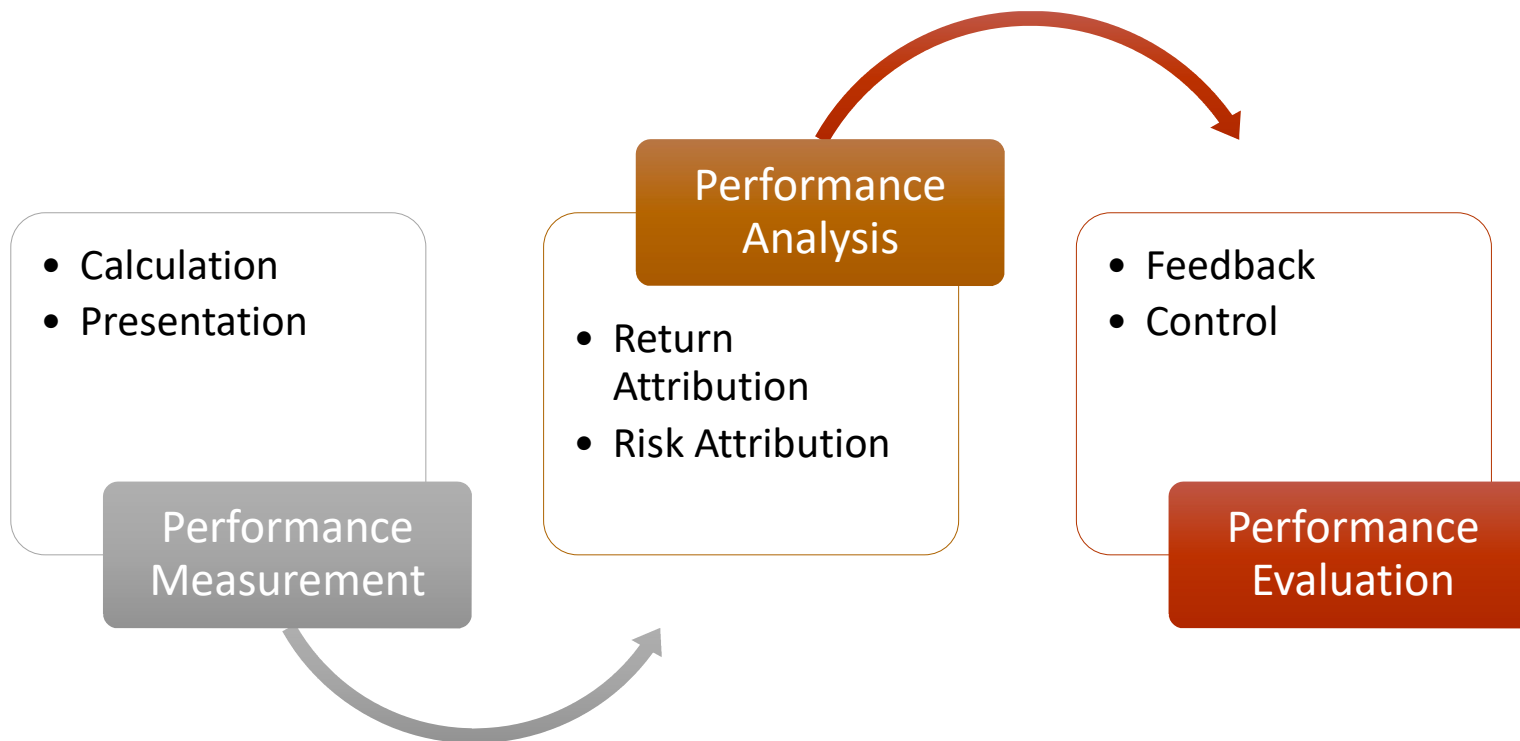
Why

- Performance Attribution
- Risk Analysis
- Forensic Analysis

How

- Feedback into Investment Decision Process
- Structural Issues

Performance Measurement Process





**Modern Portfolio Theory
& Efficient Markets**

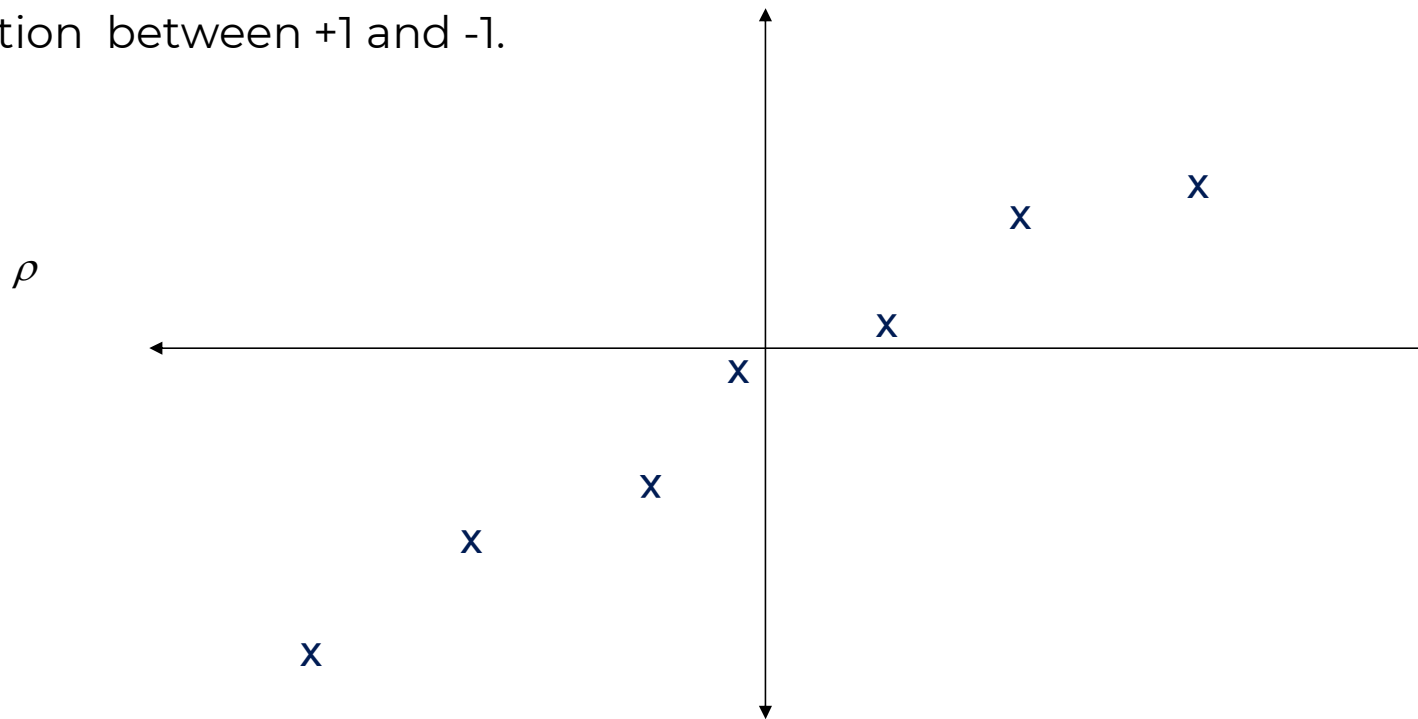
Portfolio Theory

Assumptions:

- Returns normally distributed.
- Variance and mean constant.
- Returns related by constant correlations.

Correlation

Correlation between +1 and -1.



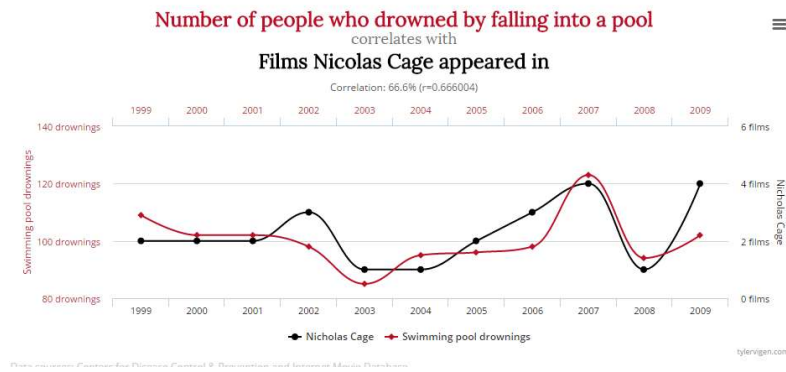
Correlations Between Various Assets (Page: CORR)

Correlation means:

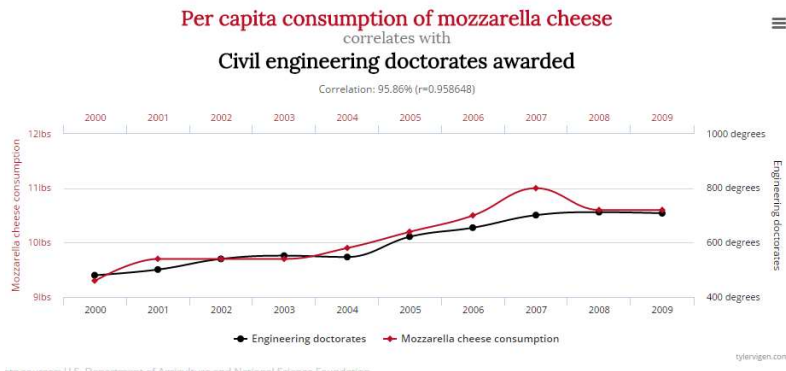
The strength of relationship between 2 data sets, between 0 and |1| (negative → data sets tend to have opposite relationships).

<Filter>		Correlation Matrix (10 Rows x 10 Columns)									
Security	S&P 500 INDEX	DAX INDEX	NIKKEI 225	Euro Spot	USD-JPY X-RATE	Germany Generic Govt 10Y	Generic 1st 'TY' Future	Japan Generic Govt 10Y	Generic 1st 'CL' Future	Gold Spot \$/Oz	
11) S&P 500 INDEX	1.000	0.594	0.249	-0.205	0.420	-0.006	-0.390	-0.010	-0.305	-0.202	
12) DAX INDEX	0.594	1.000	0.371	-0.244	0.444	-0.048	-0.454	0.108	-0.473	-0.336	
13) NIKKEI 225	0.249	0.371	1.000	-0.130	0.438	0.027	-0.154	0.014	-0.228	-0.249	
14) Euro Spot	-0.204	-0.244	-0.130	1.000	-0.444	-0.003	0.198	0.015	0.152	0.375	
15) USD-JPY X-...	0.419	0.444	0.438	-0.444	1.000	-0.010	-0.524	0.013	-0.163	-0.557	
16) Germany Gen...	-0.006	-0.048	0.027	-0.003	-0.010	1.000	0.029	0.011	0.090	-0.025	
17) Generic 1st '...	-0.388	-0.454	-0.154	0.198	-0.524	0.029	1.000	-0.018	0.179	0.410	
18) Japan Generi...	-0.010	0.108	0.014	0.015	0.013	0.011	-0.018	1.000	-0.021	-0.011	
19) Generic 1st '...	-0.305	-0.473	-0.228	0.152	-0.163	0.090	0.179	-0.021	1.000	0.132	
20) Gold Spot ...	-0.200	-0.336	-0.249	0.375	-0.557	-0.025	0.410	-0.011	0.132	1.000	

Beware 'Spurious Correlations'!



Correlation 67%



Correlation 96%

Portfolio Theory

Weighted returns are additive:

$$r_{a+b} = w_a r_a + w_b r_b$$

Where :

r = return, w = weight

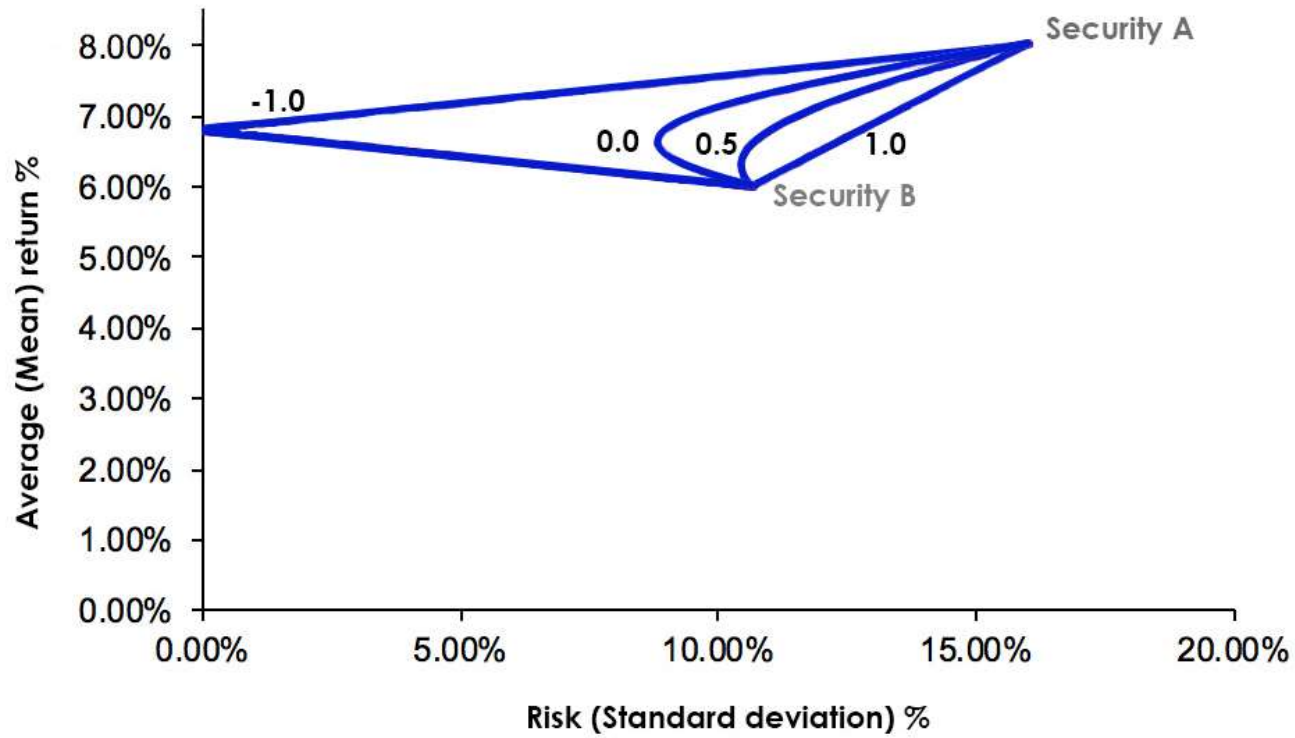
Risk is determined by standard deviation and correlation:

$$\sigma_{a+b} = \sqrt{w_a^2 \sigma_a^2 + w_b^2 \sigma_b^2 + 2w_a w_b \rho_{ab} \sigma_a \sigma_b}$$

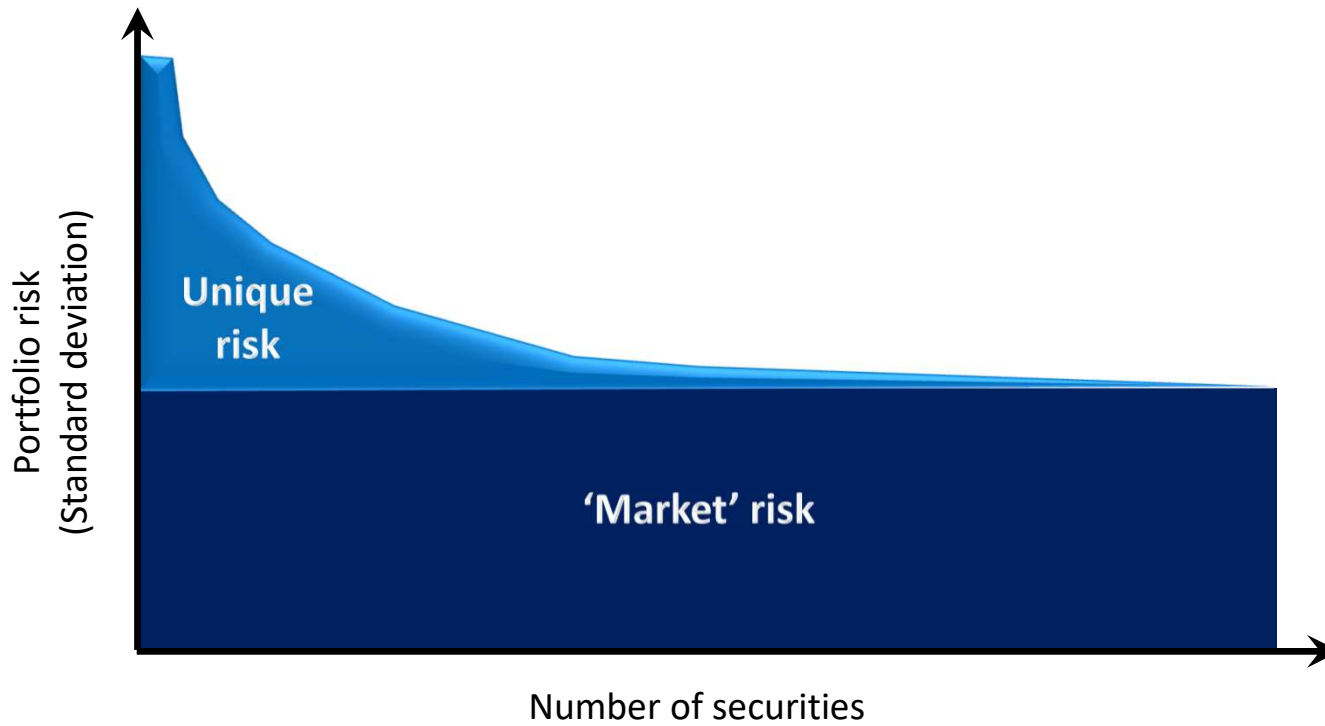
Where:

σ = standard deviation, ρ = correlation

Diversification and the Efficient Frontier



Portfolio Diversification



Efficient Market Hypothesis

Markets fully and accurately incorporate all available information into market prices

Weak form market efficiency	<ul style="list-style-type: none">• Market prices reflect all past price and volume data• Excess returns will not be generated through technical analysis
Semi-strong form market efficiency	<ul style="list-style-type: none">• Market prices reflect all market information that is made publicly available• Excess returns will not be generated through either technical or fundamental analysis
Strong form market efficiency	<ul style="list-style-type: none">• Market prices reflect all market information that is made either publicly or privately available• Excess returns will not be generated even through insider information

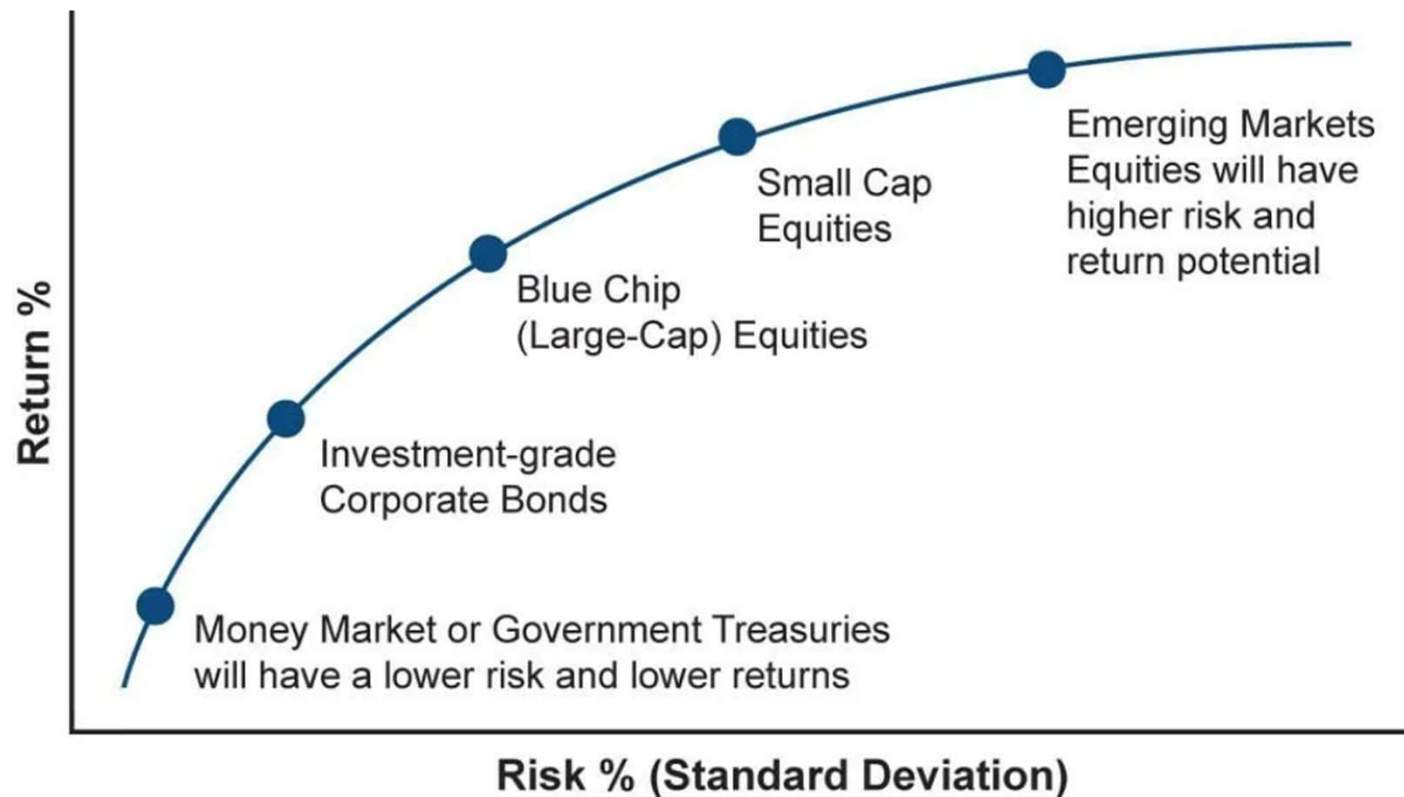


Equity Risk Premium

What is Equity Risk Premium?

- Equity Risk Premium refers to the excess returns from equity or individual stocks over the risk-free return rate.
- The risk-free rate is typically aligned with long-term government bonds, based on the assumption of the government having no default risk.
- This premium represents the additional return a stock provides to its investor beyond the risk-free rate, in exchange for the risk undertaken.
- It serves as a reward for investors who choose to take on greater risks by investing in equities instead of opting for risk-free investment options.

Equity Risk Premium



Equity Risk Premium

- There is a direct relationship between equity risk premium and the level of risk involved; greater risk leads to a wider margin between stock returns and the risk-free rate, resulting in a higher premium.
- Historical data supports the notion of the equity risk premium, demonstrating that over the long term, higher risk-taking is rewarded for investors.
- For an investor making logical decisions, any escalation in investment risk should be matched by an increase in the potential returns to maintain the attractiveness of the investment.
- For example, if government bonds are giving an investor 2% returns, any rational investor would choose the stock of any company only if it gave more than 2% returns, say 8%. Here, $8\% - 2\% = 4\%$ is the **equity risk premium**.

Risk-free Asset

- A Risk-Free Asset is characterized by the certainty of its future returns, stemming from absolute trust in the issuer.
- Typically, government securities are classified as risk-free assets due to the theoretical assurance that the government will not default on interest and principal repayments.
- This assurance is underpinned by the government's ability to self-finance its debt, either through borrowing from the central bank or by printing additional currency.
- Consequently, risk-free assets are considered to have no default risk and minimal risk of inflation.

Calculating Equity Risk Premium

The formula:

Equity Risk Premium (on the Market) = Rate of Return on the Stock Market – Risk-free Rate

Here, the rate of return on the market can be taken as the return on the concerned index of the relevant stock exchange. Often, the risk-free rate can be taken as the current rate on long-term government securities.

CAPM and Equity Risk Premium

- CAPM, is a model for calculating the expected returns of a security based on their systematic risk calculated by the Beta coefficient.
- According to the CAPM, there are two components of returns to an investor.
- The first component is the time value of money that is given by the risk-free rate of return and the second is the compensation for the risk investors take that is represented by the risk premium.

CAPM Calculation

CAPM can be described using the following equation:

$$R_a = R_f + \beta_a (R_m - R_f)$$

Where:

R_a = Expected return on security 'a'

R_f = Risk-free rate of return

R_m = Expected return on the market

β_a = Beta of 'a', and,

β_a = Covariance of Market Return with Stock Return / Variance of Market Return

CAPM and Equity Risk Premium

β_a is the risk coefficient of stock 'a' which is unique to that particular stock. It measures the stock's volatility using measures of dispersion.

$\beta_a = \text{Covariance of Market Return with Stock Return} / \text{Variance of Market Return}$

$$\text{Equity Risk Premium} = R_a - R_f = \beta_a (R_m - R_f)$$



Arbitrage Pricing Theory

What is the Arbitrage Pricing Theory?

- Arbitrage Pricing Theory (APT) theorizes that the returns of an asset are predictable through a linear correlation between the asset's anticipated returns and macroeconomic elements influencing its risk.
- Formulated in 1976 by the economist Stephen Ross from the United States.
- APT presents a framework for a multi-factor pricing model in securities analysis, emphasizing the link between the expected return of a financial asset and associated risks.

Arbitrage Pricing Theory

- APT targets identifying the accurate market value of securities that might be momentarily mispriced due to less-than-perfect market efficiency, leading to overvaluation or undervaluation.
- It expects market dynamics to eventually rectify such mispricings, aligning prices with their true market values.
- This temporary mispricing presents arbitrageurs with short-term, virtually risk-free profit opportunities.
- As an alternative to CAPM, APT is more adaptable and complex, offering investors and analysts a customizable approach to analysis.
- However, its application is challenging and time-consuming, as it requires identifying and analyzing numerous factors affecting an asset's price.

Arbitrage in the APT

- The APT suggests that the returns on assets follow a linear pattern. An investor can leverage deviations in returns from the linear pattern using the arbitrage strategy.
- Arbitrage is the practice of the simultaneous purchase and sale of an asset on different exchanges, taking advantage of slight pricing discrepancies to lock in a risk-free profit for the trade.
- However, the APT's concept of arbitrage is different from the classic meaning of the term. In the APT, arbitrage is not a risk-free operation – but it does offer a high probability of success.
- What the arbitrage pricing theory offers traders is a model for determining the theoretical fair market value of an asset.
- Having determined that value, traders then look for slight deviations from the fair market price, and trade accordingly.

Mathematical Model of the APT

The Arbitrage Pricing Theory can be expressed as a mathematical model:

$$ER(x) = R_f + \beta_1 RP_1 + \beta_2 RP_2 + \dots + \beta_n RP_n$$

Where:

- $ER(x)$ – Expected return on asset
- R_f – Riskless rate of return
- β_n (Beta) – The asset's price sensitivity to factor
- RP_n – The risk premium associated with factor



Equity Portfolio

Passive equity portfolio management

- Buy-and-hold strategy over a long period of time
- Tends to track performance to an index
- Focused on matching market performance
- Manager is assessed on how effectively they can track the target index

Active equity portfolio management

- Main aim of this strategy is to outperform a passive benchmark portfolio with an element of risk involved

Passive Equity Portfolio Management Strategies

Replicating performance of a target index

- However due to fees and commissions, the portfolio might underperform the target index

A rationale with this approach is that 1-2% active management costs is hard to overcome in risk-adjusted performance

Different market indexes are used in portfolio tracking

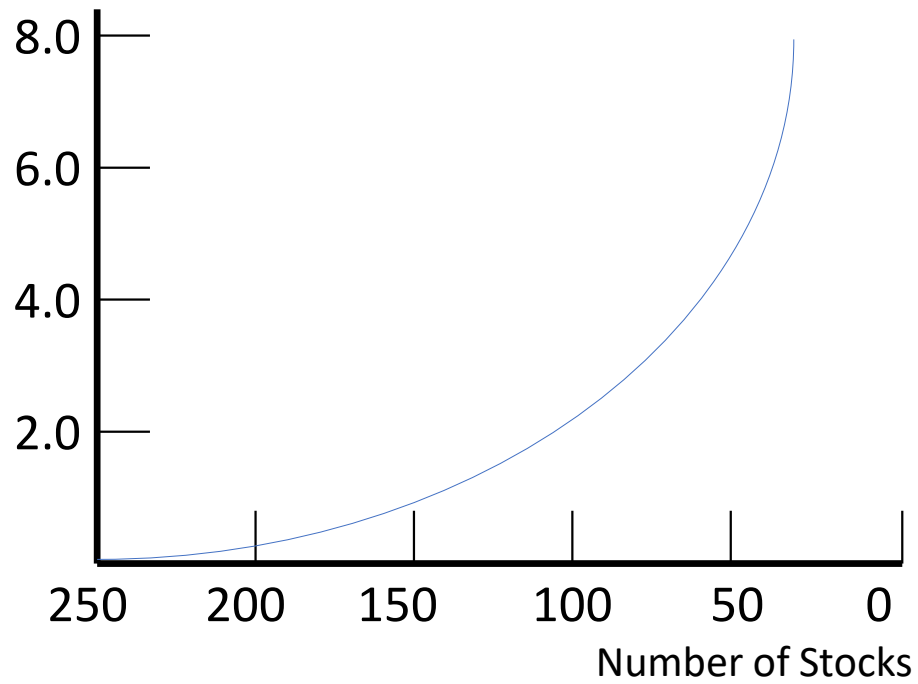
Portfolio Tracking Error

Objective: Reduce tracking error by optimizing over

- Sum of securities in the portfolio
- The securities to add to the portfolio

Expected Tracking Error

Expected Tracking Error
(Percent)



Portfolio Indexation

In choosing the number of securities in a portfolio, investors will need to make a tradeoff between tracking errors and transaction costs

Portfolios with a limited number of securities will have low transaction costs but high tracking errors.

It is unlikely for a portfolio to not have tracking errors

The composition securities and characteristics of the index may change over time

Passive Equity Portfolio Management Strategies

Tracking a market index is not a simple task.

There are three main strategies with building a passive portfolio

- Full replication
- Sampling
- Quadratic optimization



Full Replication

Securities in the index are purchased in proportion to the weights in the index. This approach allows close tracking of the portfolio.

Advantage: Reduces tracking errors

Disadvantages: Transaction fees are high and high adjustment fees are required when reinvesting dividends.



Sampling

- Buy a sample of stocks in the benchmark index based on their specific weights in the index.
- Limited stocks in the index means would lead to lower commissions.
- Reinvesting dividends is challenging.
- There will be some tracking error as this approach will not follow the index closely.

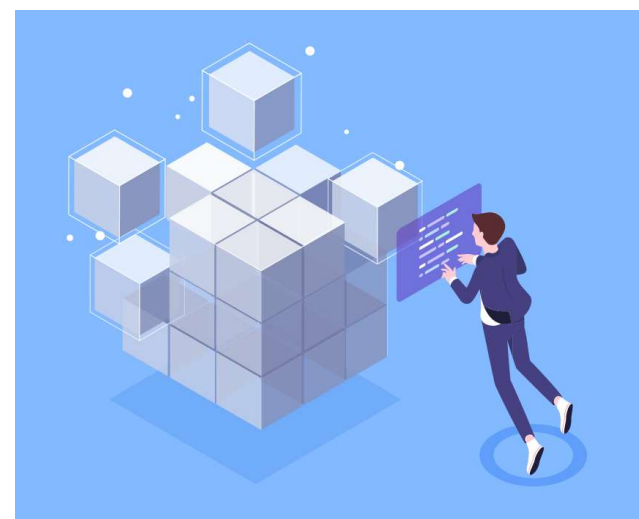


Optimization

Historical information on correlations between securities and price changes are inputted into a computer program.

The computer program then determines the portfolio composition leading to reduced tracking error within the benchmark.

However, this model relies on historical correlations which may change over time leading to failure in tracking the index



Dollar-Cost Averaging



This strategy involves buying purchasing fixed dollar investments in each period over a specific amount of time

Prevents investors from purchasing a lot of shares when prices are high and a small amount of shares when the prices are low

This strategy is often used by fund managers and individuals when building a position in a particular security

Reference Portfolio

When constructing a reference portfolio, investors may choose between the following types:

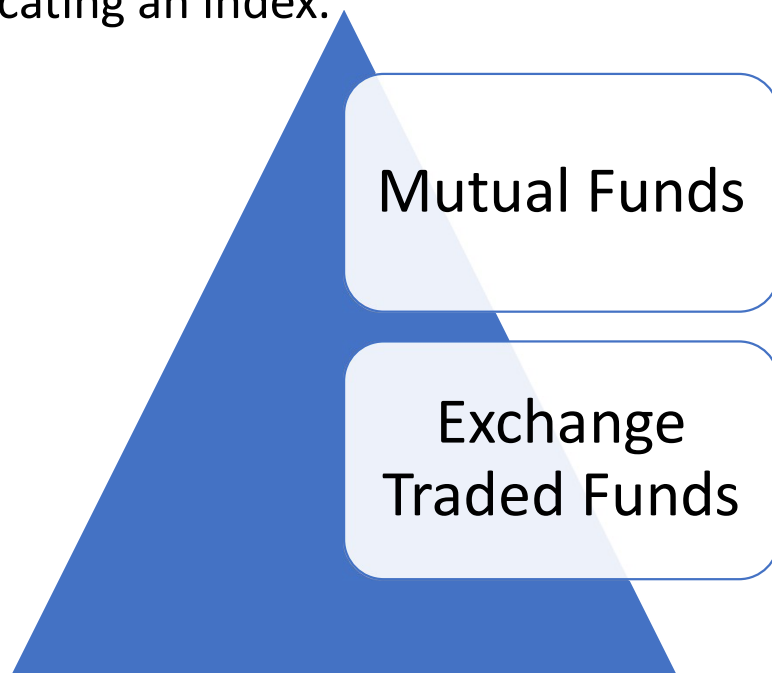
- Value weighted
- Price weighted
- Equal weighted

However, it may be necessary for the portfolio to be rebalanced when:

- Changes to the index composition
- Stock splits, repurchases and dividend payments
- New stock issues

Replicating an Index Portfolio

It may be practical and cost effective for small investors to choose a 'pre-made' fund for the purpose of replicating an index.



Active Equity Portfolio Management Strategies

The overall goal of an active portfolio is to earn a return that exceeds the return on a passive portfolio after considering transaction costs and taking on an element of risk.

An appropriate benchmark must be selected with this strategy

Practical difficulties of active manager

- Transactions costs need to be covered by superior performance of the portfolio in relation to the benchmark
- Taking on higher risk may also add more responsibility to the manager and his goal of beating the benchmark



Broad Overview of Active Investment Strategies

Fundamental Analysis

- 'Top-down' approach
- 'Bottom-up' approach

Technical Analysis

- Momentum
- Contrarian

Other anomalies and attributes

- Effects of the calendar for e.g. weekends or the start of the year i.e. January
- Characteristics of the Security
- Value vs Growth Investment Styles

Fundamental Analysis

Top-down Approach

- Forecasting the future economy
- Proportioning your investments to certain economic regions
- Choosing the right sectors to invest in based on your economic analysis
- Identify the best securities to invest in each sector

Bottom-up Approach

- Does not take the economic cycle into consideration when selecting securities
- Instead, securities are selected based on their quantitative characteristics such as market capitalisation, book-to-market ratio etc.

Active Equity Portfolio Management Strategies

Three strategies

- **Sector rotation:** Moving funds from one industry/sector to another
- **Style investing:** Choosing a particular style when managing the portfolio for e.g. growth/value strategy
- **Stock picking:** Picking individual stocks and buying them when they're low and selling them when they're high

Sector Rotation

Positioning a portfolio in order to benefit from the market's next move. This is based on the following stock characteristics:

Growth

Value

Capitalization

Price/Equity

Style Investing

Style investing involves building a portfolio that takes into account some characteristics of equity securities for e.g. small cap stocks, high P/E stocks etc.

Two of the common characteristics include:

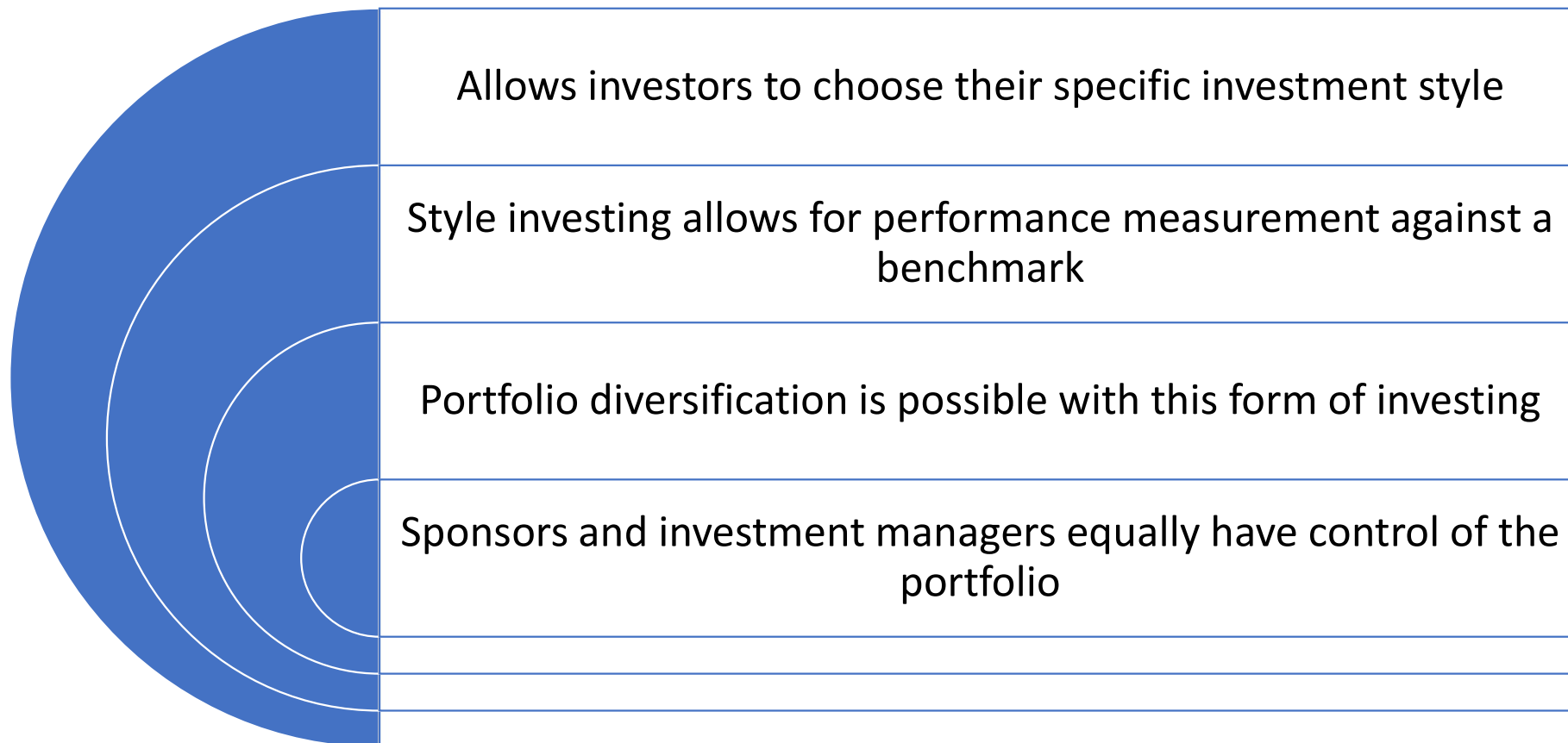
Value stocks

- These stocks are considered to be underpriced and hold some value in the future. They usually have a low P/E ratio

Growth stocks

- These stocks are considered to have high earnings per share and often also have a high P/E ratio

Benefits of Style Investing



Value Vs. Growth

Growth investing

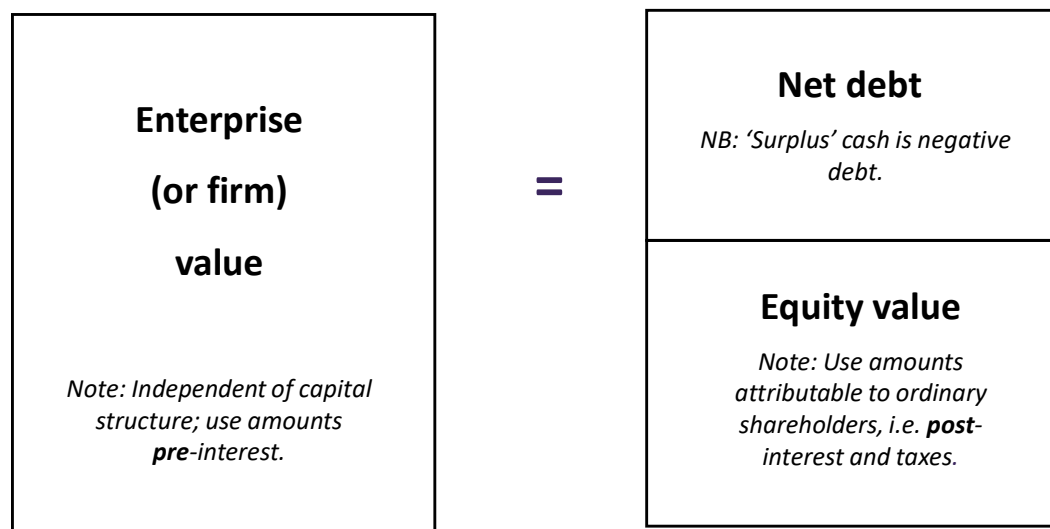
- This form of investing is more concerned with EPS, earnings and changings in fundamentals
- Growth investors are always on the lookout for companies with rapid EPS growth

Value investing

- Not concerned with current earnings of a company
- Focused towards the pricing of stocks

Enterprise vs. Equity Value

- **Basic definition**
- The value of the **enterprise** (or firm) lies in its **net operational assets** (operational assets less operational liabilities).
- This is equal to the value of the financing that supports the operations.





Introduction to Asset Allocation

Characteristics of Asset Classes

- Consist of homogenous investments
- Be mutually exclusive
- Be diversifying (not be highly correlated with other asset classes)
- Together the asset classes should have sufficient market breadth, covering most of the world's investable wealth
- Should have sufficient liquidity to make investment practical

Asset Classes that may be Considered for Inclusion

TIPS

- Homogeneous – strong correlations across maturity
- Mutually exclusive – very different return characteristics to ordinary bonds
- Low correlation with other assets
- Liquid

International assets

- Should consider:
 - Currency risk
 - Increased correlations in times of stress
 - Emerging market concerns

Alternative investments

- Potentially should be regarded as asset classes (e.g. private equity, commodities etc.)
- Present problems re: information and fees

Asset Class Selection

Adding a new asset class can be justified if its addition results in a mean variance improvement. Could be due to correlation impact or better Sharpe ratio.

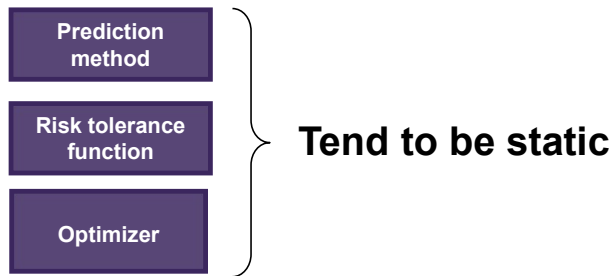
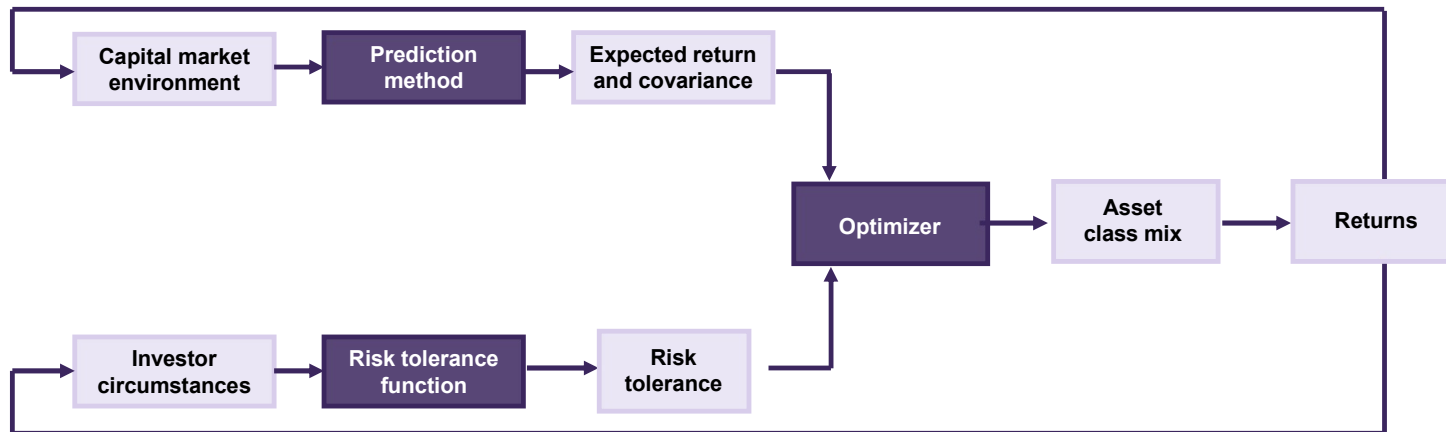
To determine whether it is worthwhile adding an asset class:

- If the Sharpe ratio of the new asset class is greater than the existing Sharpe ratio, multiplied by the correlation between the new asset class and the existing portfolio, it is worthwhile adding the asset class

$$\frac{E(R_{\text{new}}) - R_F}{\sigma_{\text{new}}} > \left[\frac{E(R_P) - R_F}{\sigma_P} \right] \text{Corr}(R_{\text{new}}, R_P)$$

Formula

The Asset Allocation Process



Asset Allocation

Implementing the asset allocation strategy

- Passive
 - Trackers
 - ETF
 - Cash plus long futures
 - Cash plus index-linked swap
 - Mutual funds
- Semi-active
 - Enhanced index funds
- Active

Asset Allocation

Tactical Asset Allocation (TAA)

- TAA is active management at the asset class level
- Based on short-term expectations and perceived disequilibria
- Can be conducted independently from in-class investment by using derivatives as an overlay strategy
- Tends to be based on three principles:
 - Available returns are reflected in market prices
 - We can either directly observe (T-bills) or make educated guesses (equities)
 - Relative expected returns reflect relative risk perceptions
 - Equity risk premiums are generally high relative to bond risk premiums when investors are fearful of the future
 - Equity risk premiums tend to vary with relative stock/bond volatility
 - Short-term divergences may be exploitable
 - Markets are rational and mean-reverting
 - TAA seeks to exploit short-term divergences

The active fund management process

Asset allocation

- Sometimes referred to as strategic asset allocation. It is the broad sketch of the fund in terms of asset classes and their proportions
- For example, a portfolio looking to achieve growth would be mainly invested in equities:

Equities 60%	Property 20%	Bonds 17%	Cash 3%
---------------------	-------------------------	----------------------	--------------------

Tactical asset allocation/market timing

- The ability of the fund manager to select stocks and alter the asset allocation weightings according to short-term market conditions

Equities 54%	Property 20%	Bonds 23%	Cash 3%
---------------------	-------------------------	----------------------	--------------------

Approaches to Investing





Return Calculations

Calculation of Performance Return

Objective - To measure the rate of return between two points in time:

Simple Return

$$\frac{\text{Market End Value}}{\text{Market Start Value}} = \text{Wealth Ratio}$$

The market valuation should reflect the
 "correct economic" value

$$\text{Wealth Ratio} - 1 = \text{Rate of Return}$$

$$= \frac{\text{MEV} - \text{MSV}}{\text{MSV}}$$

$$= \frac{\text{Gain (or loss)}}{\text{MSV}}$$

Example

Start Market Value £100m

End Market Value £112m

No cash flow

$$\text{Wealth Ratio} = \frac{112}{100} = 1.12$$

$$\text{Rate of Return} = \frac{112 - 100}{100} = 1.12 - 1 = 12\%$$

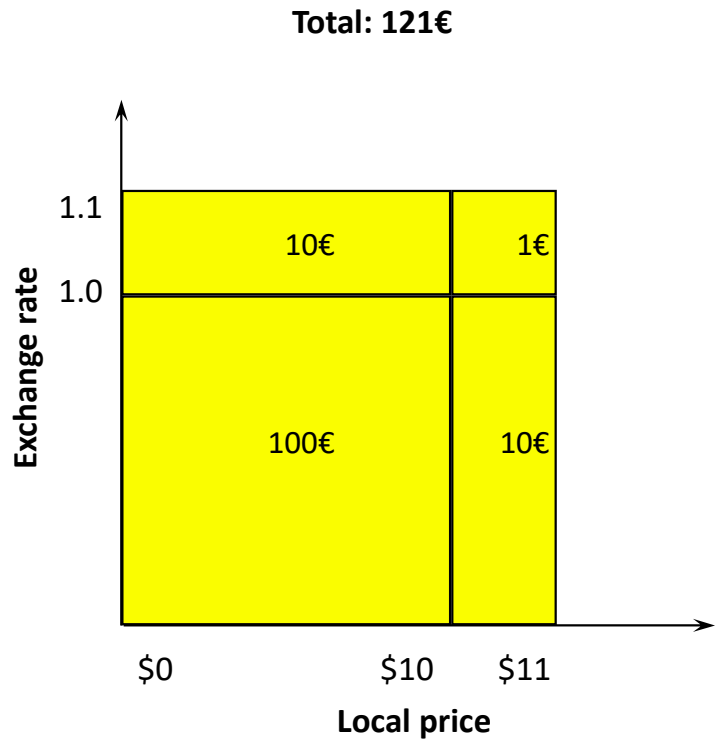
Currency

Local Return 10.0%
 Currency Return 10.0%
 Total Return $1.1 \times 1.1 - 1 = 21\%$

Example

10 units of stock priced at \$10
 Base currency of Portfolio €
 Exchange Rate \$1 = €1
 Market Start Value $10 \times 10 \times 1 = €100$
 Price at end of period \$11
 Exchange rate \$1 = €1.1
 Market End Value $10 \times 11 \times 1.1 = €121$

Return $= \frac{121}{100} - 1 = 21\%$



Calculation Methodology with Cash Flows

- | Money-weighted
- | Time-weighted
- | Hybrid

Money (or dollar) Weighted

- Each dollar invested is assumed to have achieved the same “rate” of return irrespective of when it was invested

- Simple Dietz

$$r = \frac{MEV - MSV - C}{MSV + \frac{C}{2}}$$

Note: C = external cashflow

- Modified Dietz

$$r = \frac{MEV - MSV - C}{MSV + \sum W_i \times C_i}$$

$$W_i = \frac{TD - D_i}{TD}$$

TD = total days in period

D_i = day of external cashflow

C_i = external cashflow on day i

Internal Rate of Return (IRR)

Find the value of r that satisfies:

$$MEV = \sum MSV \times (1+r) + c_i \times (1+r)^{W_i}$$

- The original method
- Dietz methods are 1st order approximations of IRR

Internal Rate of Return (IRR)

- Old methodology (Boulding 1935, Keynes 1936)
 - Initially used by Actuaries for pensions and insurance funds
- Requires a constant force of return assumption
- Described as “Internal” because the external environment ignored
- Requires iterative methods
 - Newton-Raphson
- Used throughout finance
 - Project appraisal (forward-looking)
 - Redemption yield
- Investment returns are not interest rates
 - Ex-post
 - Volatile
 - Positive and Negative

Time-Weighted

Each time period is given equal weight irrespective of the amount invested

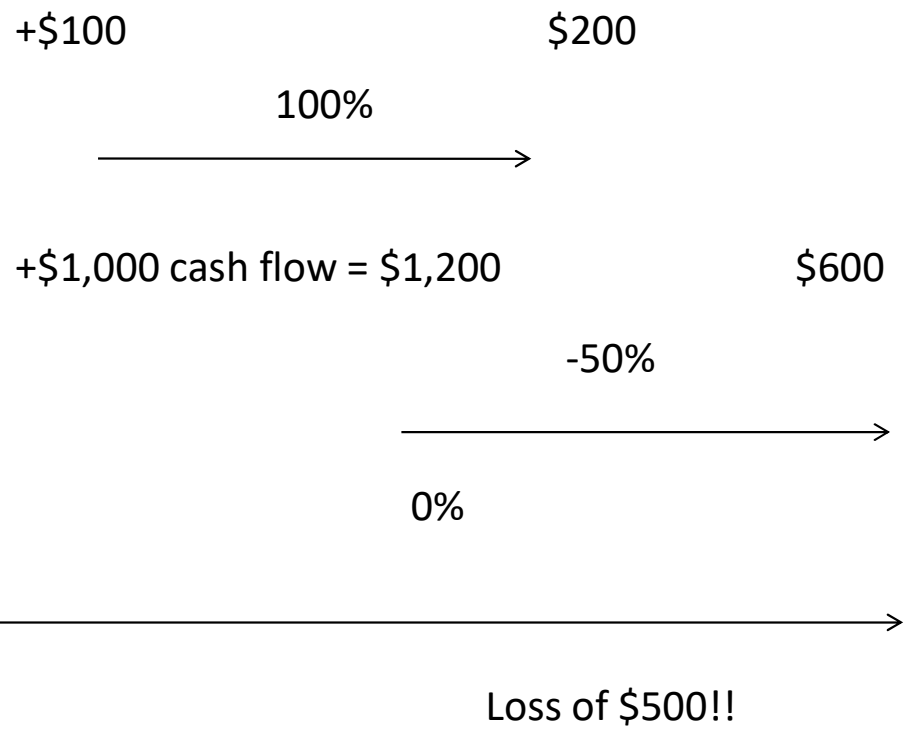
- True-time Weighted - Portfolio is valued at each cash flow.

Simple wealth ratios are calculated between each external cash flow

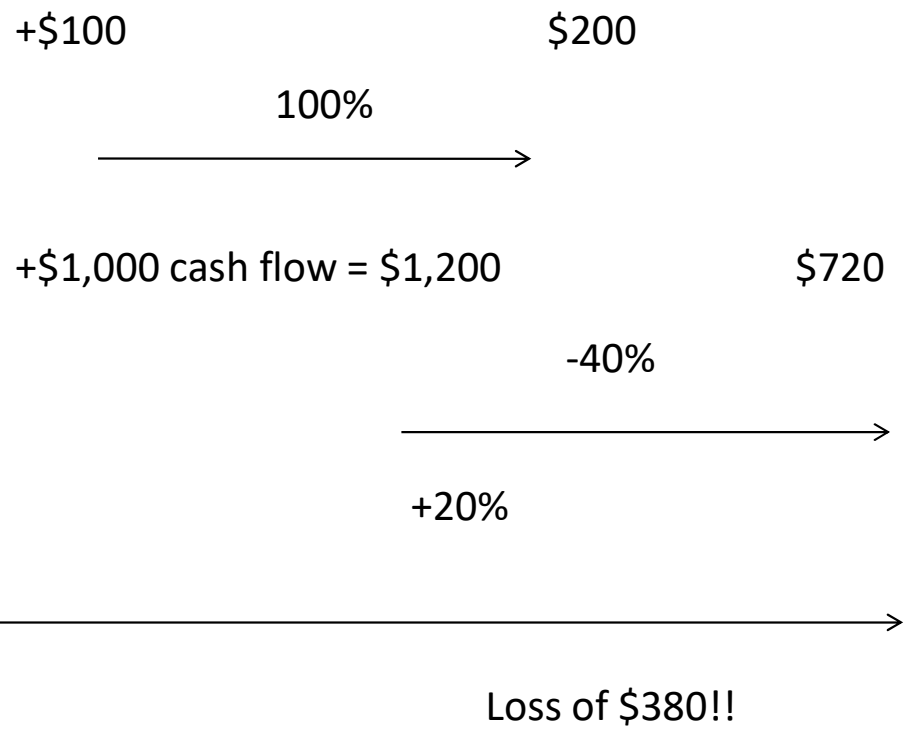
Returns for each finite period are “chain-linked” as follows:

$$(1+r_1) \times (1+r_2) \times (1+r_3) \dots \dots (1+r_n) = (1+R)$$

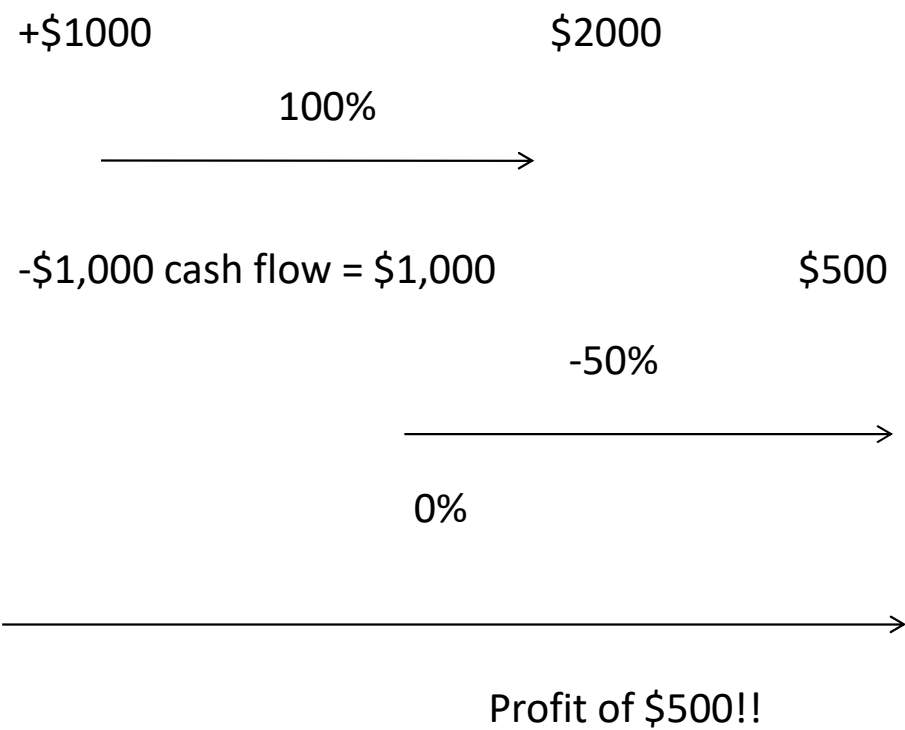
Time Weighted Return (Example 1)



Time Weighted Return (Example 2)



Time Weighted Return (Example 3)



Unitised Method (NAV Performance)

All Collective Funds with multiple stakeholders

Unit Trusts and mutual funds

Hedge Funds

Pooled Pension Funds (Retail & Institutional)

Unit price or “NAV” (*Net asset value price*) is calculated regularly (*by definition at the time of each cash flow*). The ratio of unit prices provides a return.

$$\frac{NAV_1}{NAV_S} \times \frac{NAV_2}{NAV_1} \times \frac{NAV_3}{NAV_2} \times \dots \times \frac{NAV_{n-1}}{NAV_{n-2}} \times \frac{NAV_E}{NAV_{n-1}} = \frac{NAV_E}{NAV_S} = (1 + R)$$

NAV Performance (Distributions)

- If income is distributed, then the return calculation must allow for the assumption of reinvested distributions using an adjusted NAV unit price:

$$NAV'_n = NAV_n \times \prod_{i=1}^{i=n} \left(1 + \frac{D_i}{NAV_i} \right)$$

NAV Performance (Distributions)

Date	Distribution	Unit price	Adjustment factor	Cumulative adjustment factor	Adjusted Unit price
30/06/2017		100.00			
31/03/2018	3.98	120.73	1.033	1.033	124.71
31/03/2019	4.34	117.27	1.037	1.071	125.62
31/03/2020	4.55	130.07	1.035	1.109	144.20
31/03/2021	4.69	134.13	1.035	1.147	153.91
31/03/2022	4.94	137.18	1.036	1.189	163.07
31/03/2023	5.04	126	1.040	1.236	155.77
31/07/2023		134.25			

Hybrids

Chain-linked money-weighted returns over finite short periods

- Standard
 - Chain-linked Modified Dietz
- BAI
 - Chain-linked simple IRRs

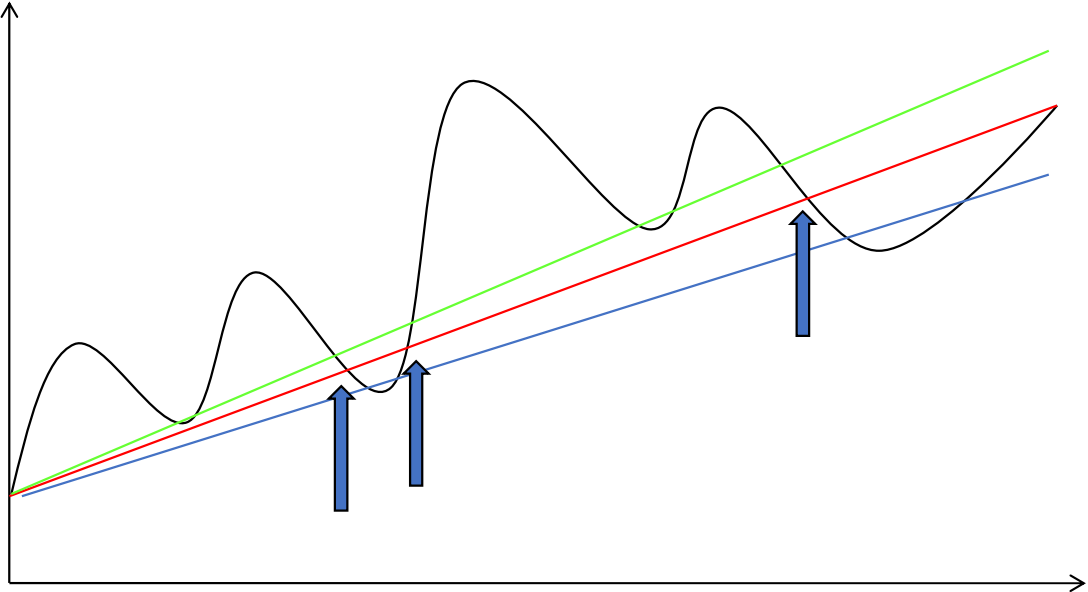
Time Weighted Returns or Money Weighted Returns

- Most analysts would prefer TWR
 - The portfolio manager is typically not in control of cash flows
 - Eases comparison (with other managers & benchmarks)
- Venture Capital/Private Equity/Infrastructure prefer IRR
 - Accurate valuations are not available
 - Closer to the investment decision process
 - Some control of the amount invested.
- Some argue MWR's are more closely linked to underlying profit and loss.
- Modified Dietz and TWRs can be disaggregated within a finite performance period. IRR cannot.

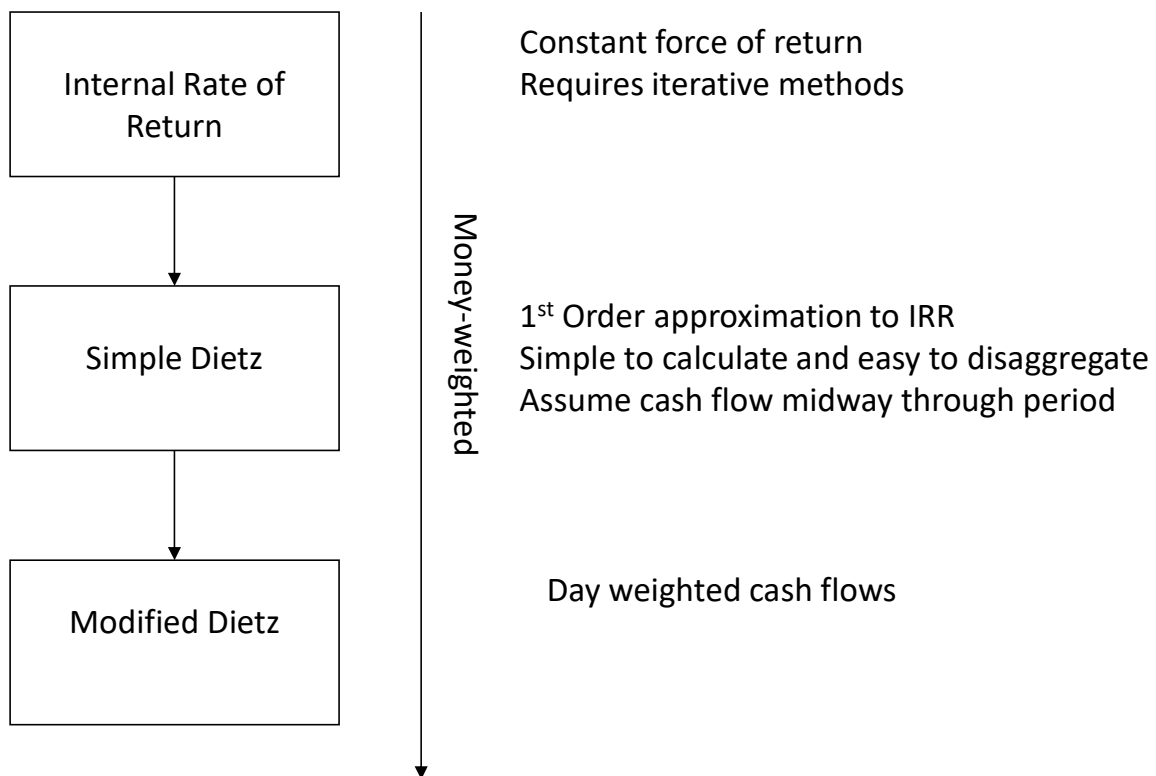
$$r = \sum_{j=1}^{j=n} PW_j \times PR_j$$

- TWR
 - Sensitive to error
 - Greater data requirements
 - More information required from benchmarks (*expensive?*)

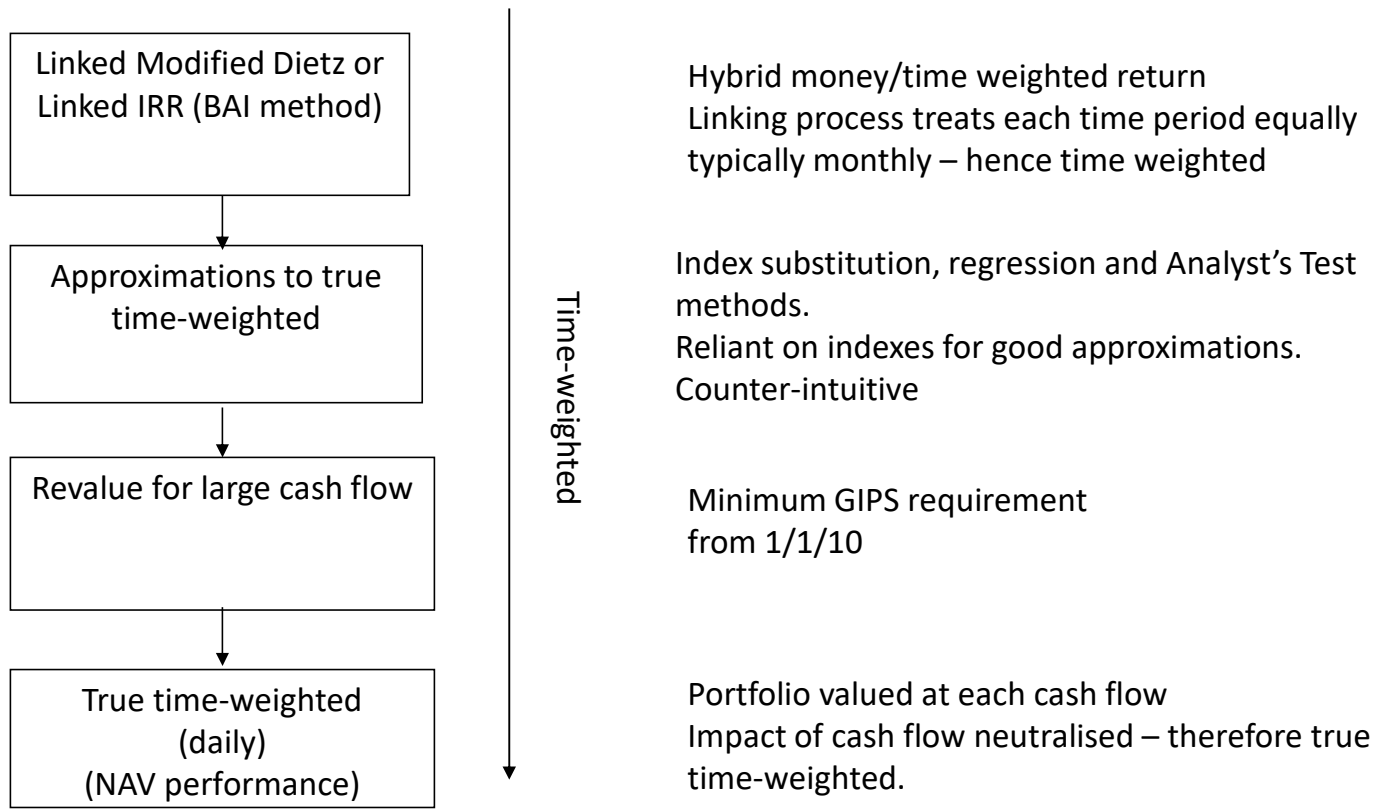
Time Weighted Returns or Money Weighted Returns



Evolution of Return Methodologies



Evolution of Return Methodologies



Speed of Evolution

- Depends on the availability of accurate valuations

| Mutual Funds

| Pension Funds

| Real Estate

| Private Equity

IRR Disadvantages

- Constant force of return assumption
 - Invalid (OK for ex-ante IRR but not ex-post IRR)
- Iterative methods required & multiple solutions
 - Actually not a big problem
- Cannot be disaggregated
 - Required for attribution
- Inefficient
 - not linkable
- Not comparable
 - With benchmarks
 - Other managers with different cash flow experience

Why Should IRR be Used?

“Received Wisdom”

Either:

- Manager Performance
- Client Performance

or

- No control of the timing of cash flow
- Control of the timing of cash flow

-Time-weighted

- Money-weighted

- Time-weighted

- Money-weighted

Received Wisdom is not Correct?

- Why do we calculate rates of return?
 - For comparison with:
 - Benchmarks
 - Other portfolio managers
 - Expectations
 - History
- Profit and loss alone does not allow a fair comparison with different amounts of capital – which leads to a rate of return calculations.
- Money-weighted rates of return damage comparability
- Time-weighted rates of return should be used if possible.

When is Time-Weighted not Appropriate?

- Possibly for illiquid assets:
 - Private Equity, Real Estate & Infrastructure
 - Accurate valuations not available
 - Time-weighted return not accurate
 - Benchmarks probably not available
 - Less value in the time-weighted return
 - More likely to have control of the timing of cash flow
 - Equal weighting each time period more of an issue
 - Particularly for isolated assets or for fixed life investments (*issue even for liquid assets*)
 - Not necessarily an issue for attribution analysis within a larger portfolio

Why not use IRR for Asset Owner Performance?

- Damages comparability
- Profit and loss is an alternative measure
- Clients are not necessarily in control of cash flow
- Attribution and risk analysis difficult
- Regulation drives up costs

Arithmetic & Geometric Means

Arithmetic Mean (average return) $t = \text{frequency of data i.e. monthly} = 12, n = \text{number of periods}$

$$\bar{r} = \frac{t}{n} \times \sum_{i=1}^n r_i$$

Geometric Mean (annualized return)

$$\tilde{r} = \left(\prod_{i=1}^n (1 + r_i) \right)^{1/n} - 1$$

For monthly observations:

$$(1 + R)^{12/n} - 1$$

$R = \text{cumulative return}$

DO NOT annualize for periods less than one **year**

Arithmetic & Geometric Means

- Cumulative return over 5 years = 75%

$$\frac{75\%}{5} = 15\%$$

- Average return

$$(1.15 \times 1.15 \times 1.15 \times 1.15 \times 1.15 - 1 = 101.1\%)$$

- Annualised return $1.75^{1/5} - 1 = 11.84\%$

$$(1.1184 \times 1.1184 \times 1.1184 \times 1.1184 \times 1.1184 - 1 = 75\%)$$

Practical Session

Global Emerging Markets Equity Fund

31/12/97	Valuation	\$74,180,620
14/01/98	Cash flow	\$37,136,058
31/01/98	Valuation	\$104,410,909
14/01/98	Valuation immediately before cash flow. \$66,014,931	

MSCI EMF \$	January	-7.92%
MSCI EMF \$	31/12/97 to 14/01/98	-10.68%
MSCI EMF \$	14/01/98 to 31/01/98	+3.09%

Calculation Examples

Calculate:

i) Simple Dietz

ii) Modified Dietz *Assume Cashflow* *a) End of Day*
b) Start of Day

iii) True-time Weighted Return

Timing of Time-Weighted Cash Flows

- End of day (net cash flow)
- Beginning of day (net cash flow)
- Midday (50% weighted cash flow modified Dietz within the day)
- Beginning of day (Cash inflow, purchases), End of day (Cash outflow, sales)
- Beginning of day (Cash outflow, sales), End of day (Cash inflow, purchases)
- Actual Time (i.e. 11am)

Timings of Cash Flows - Issues

- End of day – Zero Denominator with inflows
- Beginning of day – Zero Denominator with outflows
- Midday – Hybrid approach
- Bod-Eod – Higher capital employed
- Eod-Bod – Lower capital employed
- Actual – Difficult to establish the exact time let alone accurate valuation at that time

Timing of Cash Flow - Example

	Day 1	Day 2
BMV	\$100	\$111
Cash Flow	+\$10	-\$10
Actual Value	\$100.5	\$111.5
EMV	\$111	\$102

Timing of Cash Flow - Example

- End of day $\frac{101}{100} \times \frac{112}{111} - 1 = 1.910\%$
- Beginning of day $\frac{111}{110} \times \frac{102}{101} - 1 = 1.908\%$
- Midday $\left(1 + \frac{111 - 100 - 10}{100 + 10/2}\right) \times \left(1 + \frac{102 - 111 + 10}{111 - 10/2}\right) - 1 = 1.905\%$
- Inflow – Bod
 Outflow – Eod $\frac{111}{110} \times \frac{112}{111} - 1 = 1.818\%$
- Inflow – Eod
 Outflow – Bod $\frac{101}{100} \times \frac{102}{101} - 1 = 2.0\%$
- Actual $\frac{100.5}{100} \times \frac{111.5}{110.5} \times \frac{102}{101.5} - 1 = 1.909\%$

Timing Methodologies

- End of day
- Beginning of day
- Intra-day weighted (weighted by the hour)
- Differentiated
- Actual
- Rule based

Timing of Cash Flows

- A timing policy must be established
- Applied consistently
- Policy must have some economic relevance
- Sector methodology must be consistent with total return methodology
- Applied to cash flows in individual securities



**Portfolio Risk & Return
Assessment**

Risk

- Dictionary Definition:
 - Latin word from a Greek navigation term rhiza a metaphor for “difficulty to avoid in the sea”
 - The potential impact of an event determined by combining the likelihood of the event occurring with the impact should it occur
 - The uncertainty of expected outcomes

Risk

- Compliance Risk

- Operational Risk



Liquidity Risk

- Counterparty Risk

- Portfolio Risk

Compliance Risk

- Broader than Regulatory Risk
- Compliance is not Risk Control
- Mandate Risk
 - Client Limits
 - Regulatory Limits
 - Internal Limits

Mandate Risk

- The Investment Management Agreement
 - Duties imposed
 - Investment guidelines
 - Performance fees
 - Exclusion of liability
 - Risk limits (ex-post , ex-ante)

Operational Risk

- Operations
 - Efficient processes (STP)
 - Settlement
 - Management Information
- Error monitoring
- Internal Audit

Liquidity Risk

- Assets cannot be traded quickly enough
 - Asset allocation
 - Risk allocation
 - Realise profits
 - Prevent losses

Counterparty Risk

- | Outstanding Trades
- | Derivatives Exposure
- | Stock Lending
- | Not credit risk

Portfolio Risk

Are the portfolio of assets managed to client *expectations*?



Unilever - Merrill

Merrill faces payout to avoid court action

Possible compromise with pension fund could cost £75m

By Simon Targett,
 Investment Correspondent

Merrill Lynch Investment Managers may have to pay as much as £75m if it wants to stave off an embarrassing High Court action with the £4bn Unilever Superannuation Fund, one of the largest pension schemes in the UK.

The fund – run for employees of Unilever, the Anglo-Dutch group – has brought a £130m lawsuit against the US bank's asset management arm for allegedly mismanaging £1bn of its investments about four years ago.

MLIM, one of the world's biggest fund managers, is understood to be keen to reach a compromise before the case reaches the High Court next week. Bob Doll, MLIM's new president, told the Financial Times last week: "We want [the court case] out of the way, and the sooner the better."

But USF's trustees are pre-

paring to drive a hard bargain. They are understood to have turned down earlier efforts by MLIM to strike a compromise, including an offer of a £20m payment.

"The trustees need to see a big enough number to show that Merrill Lynch have clearly conceded the point that they were in the wrong here," said one person close to Unilever. "The trustees, having got this far and having dared to take on the City establishment, are keen to prove that there was negligence here, and that they were not just sore losers."

USF is unhappy that MLIM's fund managers underperformed an agreed benchmark index by 10.5 per cent in 1997, even though a contract specified that they should not fall more than 3 per cent below the index.

MLIM says this downside threshold was no more than a target and it was not a guaran-

tee. But USF insists it was the product of serious negotiation towards the end of 1996, and MLIM entered into the agreement in the full knowledge of its importance as a "tram line" within which it could invest money in the stock market.

USF – advised by Frank Russell, the US-based pension consultancy – had originally proposed a downside threshold of 2 per cent. It changed this after protests from MLIM, which had, by then, run money for Unilever for nine years.

Talks between Slaughter & May, USF's lawyers, and Simmonds & Simmonds, acting for MLIM, are not expected to be delayed by the collapse of Richard Greenhalgh, chairman of USF's trustees and a senior Unilever executive. Last night, Mr Greenhalgh was still reported to be in hospital, with a suspected heart attack.

www.ft.com/banking

Financial Times

1st October 2001

Risk Management

Risk Managers

- Front Office
- Paid to take risk
- Risk is good

Risk Controllers

- Middle office
- Paid to monitor/reduce risk
- Risk is bad

Risk Measures (Performance Appraisal)

Ex-Post

- Risk after the event
- Historical

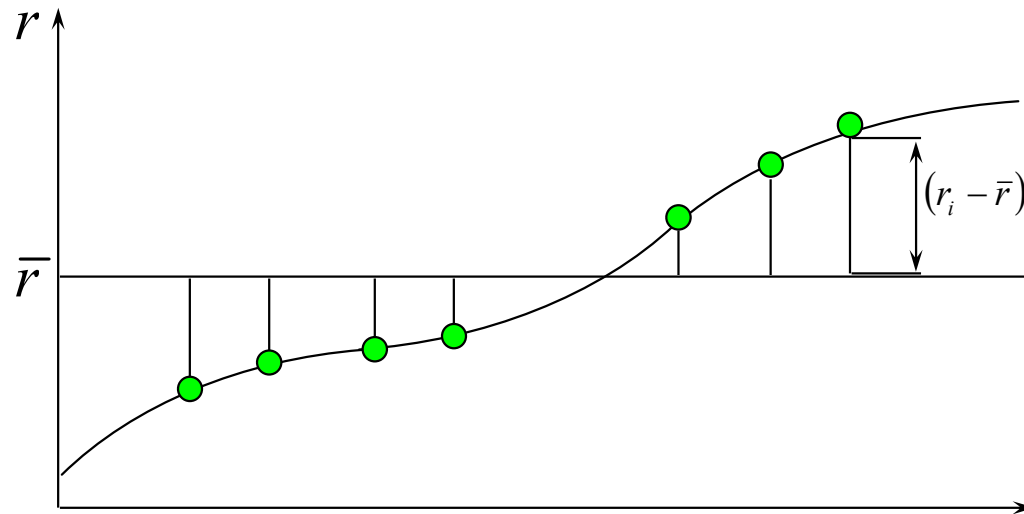
Ex-Ante

- Risk before the event
- Prospective

Simple Risk Measures

- Absolute
 - Variability, Sharpe Ratio
- Relative
 - Tracking Error, Information Ratio
- Regression
 - α , β , ρ

Variability (Volatility)



$$MAD = \frac{\sum_{i=1}^{i=n} |r_i - \bar{r}|}{n}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{i=n} (r_i - \bar{r})^2}{n}}$$

Standard Deviation

- Variance

$$\sigma^2 = \frac{\sum (r_i - \bar{r})^2}{n}$$

- Bessel's Correction

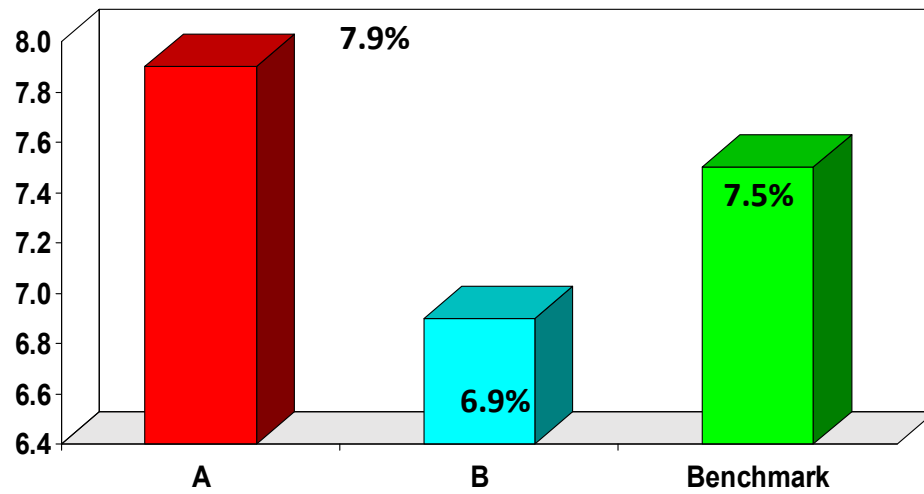
- n or n-1
- population or sample
- Used because sample mean leads to underestimation of variance
- Neither required or standard practice

- Annualized Standard Deviation

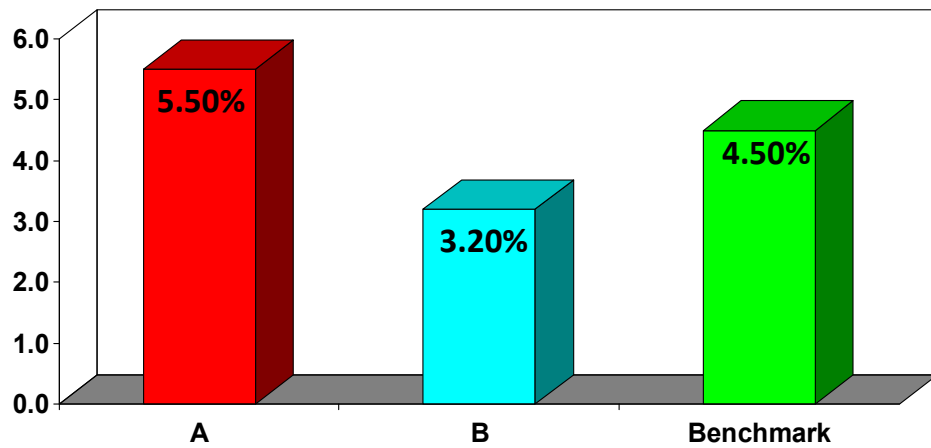
$$\tilde{\sigma} = \sqrt{t} \times \sigma$$

- Returns are independent and uncorrelated (Central Limit Theorem)

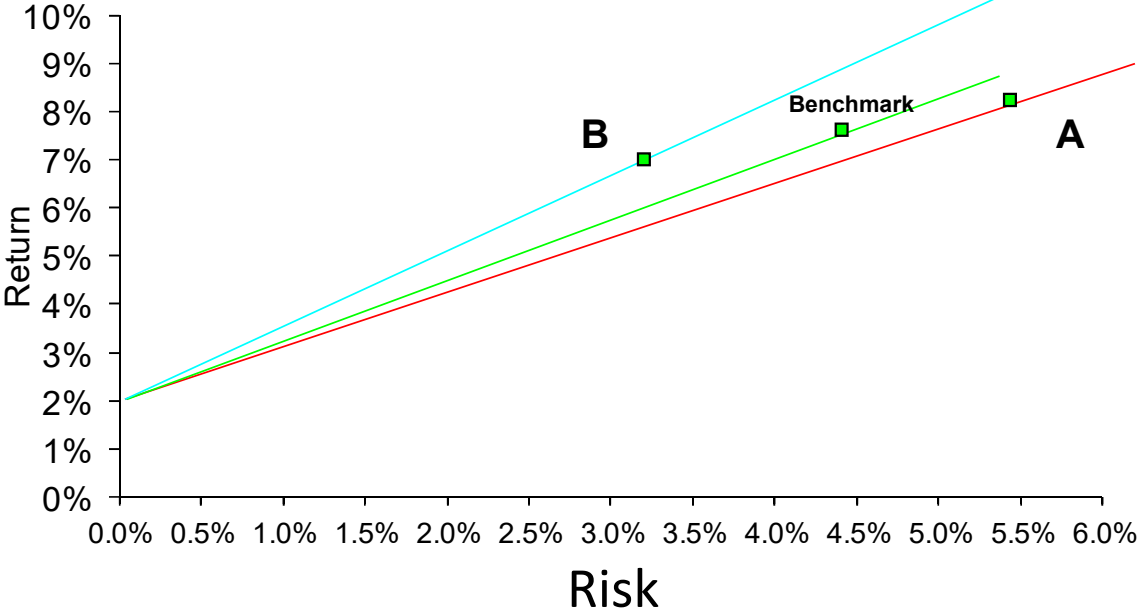
Portfolio Returns



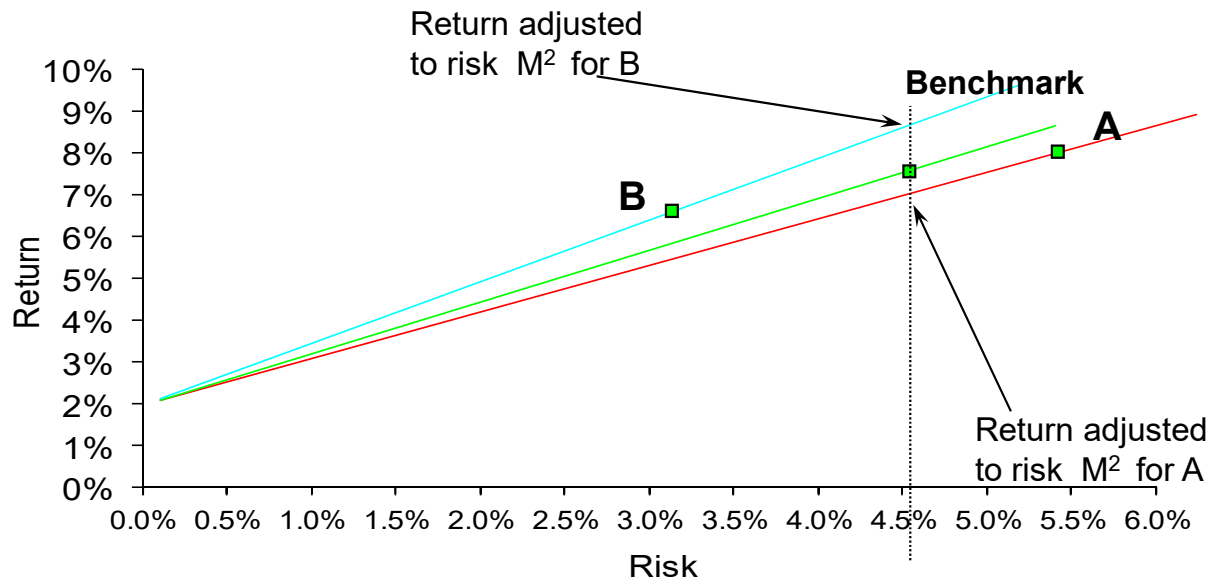
Portfolio Risk



Sharpe Ratio



M²



Risk-Adjusted Returns

Sharpe Ratio $SR = \frac{\tilde{r} - \tilde{r}_F}{\tilde{\sigma}}$

$$M^2 = \tilde{r} + SR \times (\tilde{\sigma}_b - \tilde{\sigma})$$

or

$$M^2 = (\tilde{r} - \tilde{r}_F) \times \frac{\tilde{\sigma}_b}{\tilde{\sigma}} + \tilde{r}_F$$

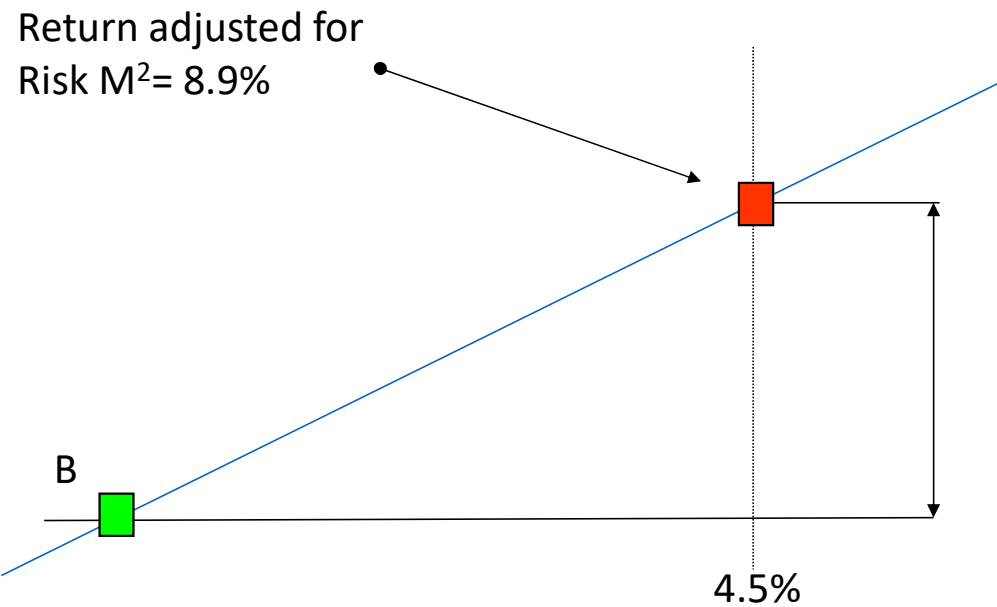
$\tilde{\sigma}$ = Annualised Portfolio Risk

$\tilde{\sigma}_b$ = Annualised Benchmark Risk
 (Market risk)

\tilde{r} = Annualised Portfolio return

\tilde{r}_F = Annualised Risk free rate

Modigliani Excess Return



$$M^2 (\text{Excess}) = 8.9\% - 7.5\% = 1.4\%$$

Risk-adjusted excess return (arithmetic)

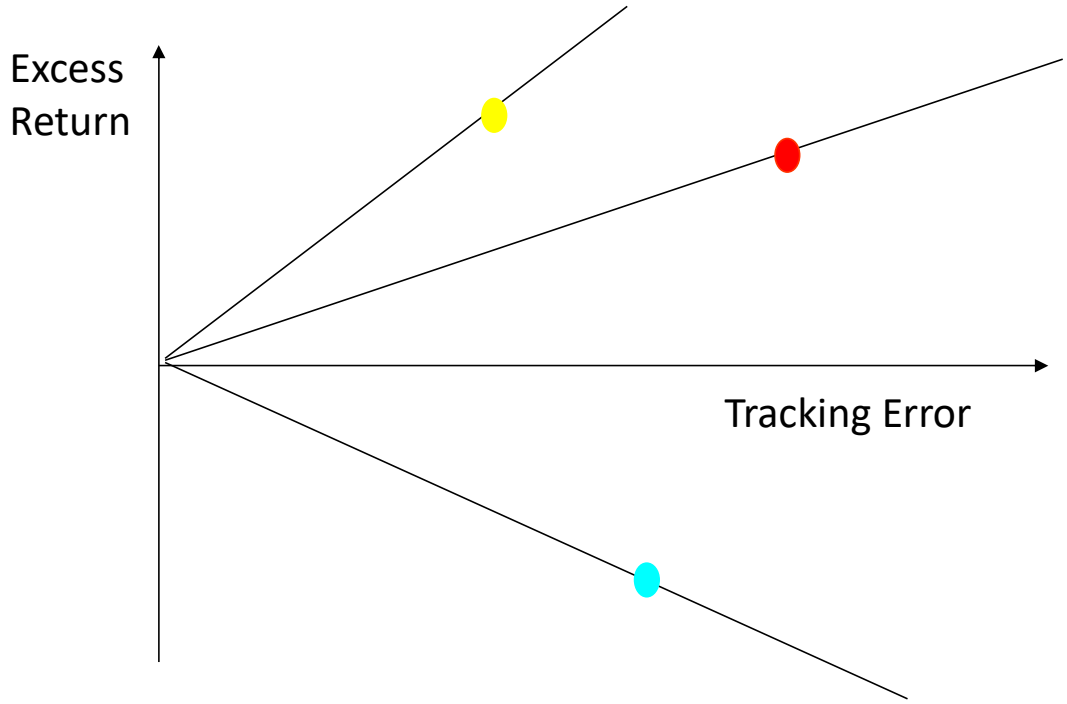
Tracking Error (Tracking Risk, Relative Risk, Active Risk)

- Tracking Error
 - Standard Deviation of excess return
- Measures consistency of excess return
 - Ex-Post or Ex-ante
 - Normally annualized

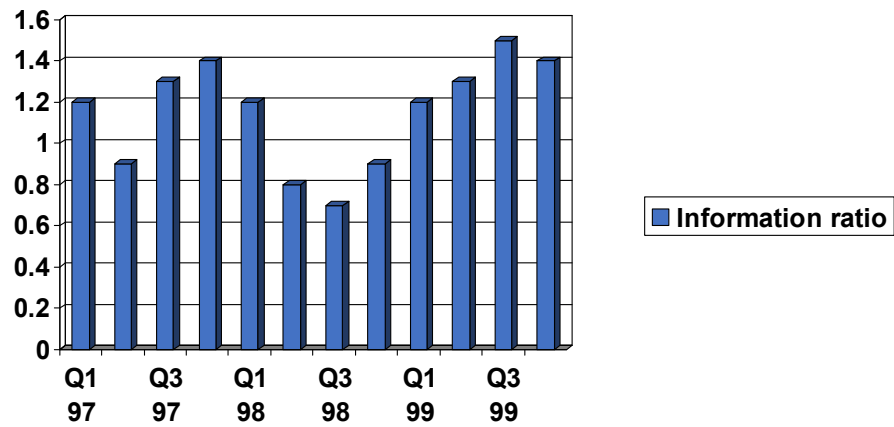
- Information Ratio

$$= \frac{\text{Annualised Excess Return}}{\text{Annualised Tracking Error}}$$

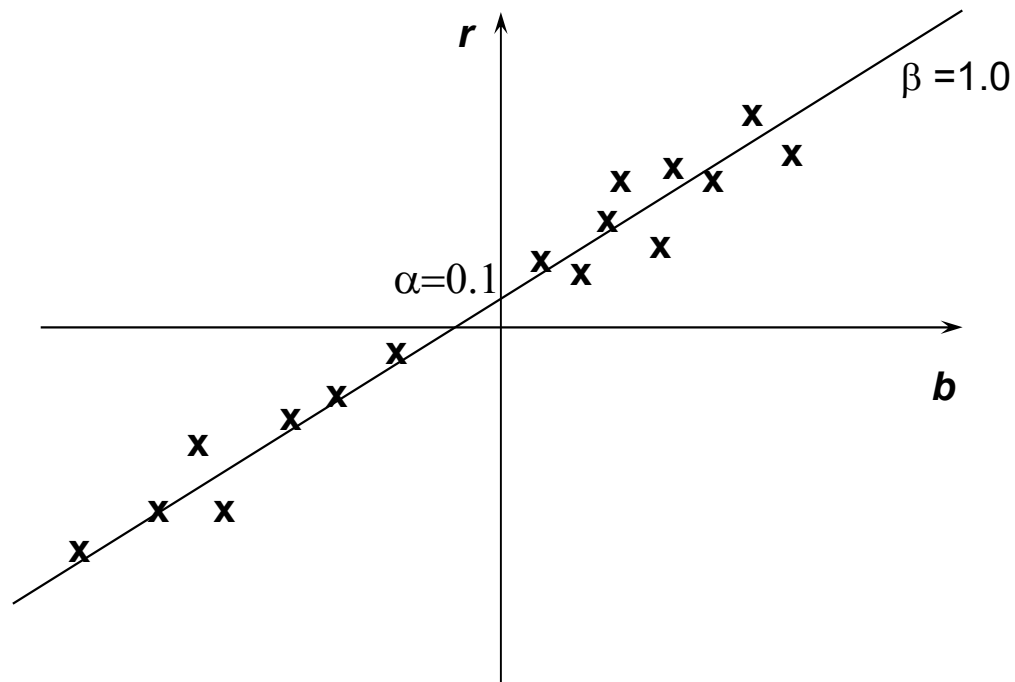
Information Ratio



Information Ratio

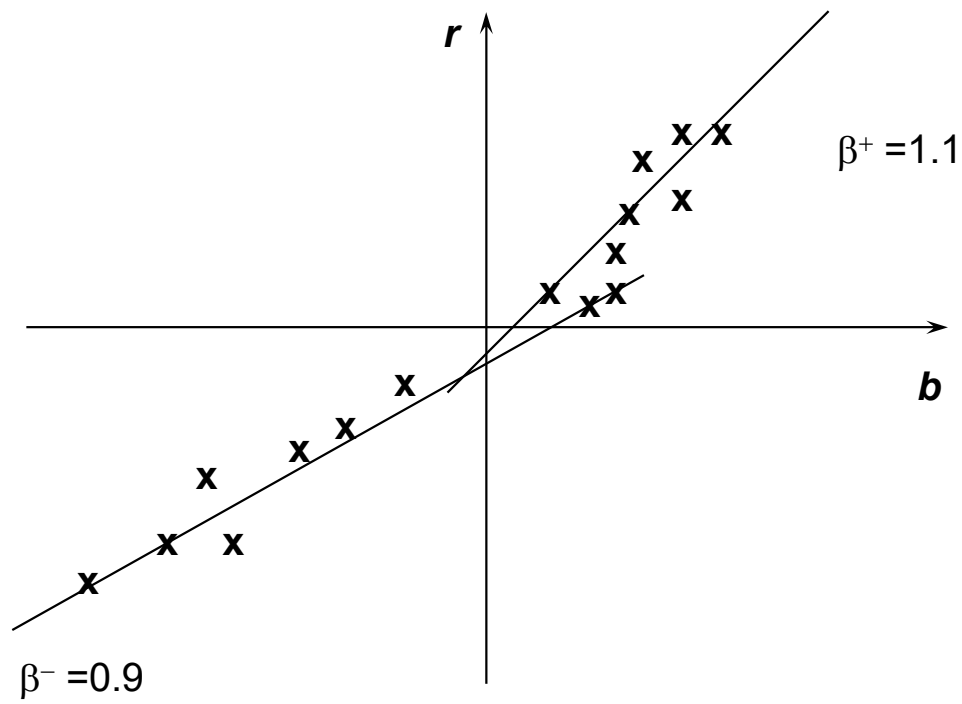


Regression Equation



$$R = \alpha + \beta (b - r_F) + \varepsilon$$

Bull & Bear Betas



Regression Equation

Regression Equation $r - r_F = \alpha + \beta \times (b - r_F) + \varepsilon$

Beta (β)

Gradient of the regression equation

Jensen's Alpha (α)

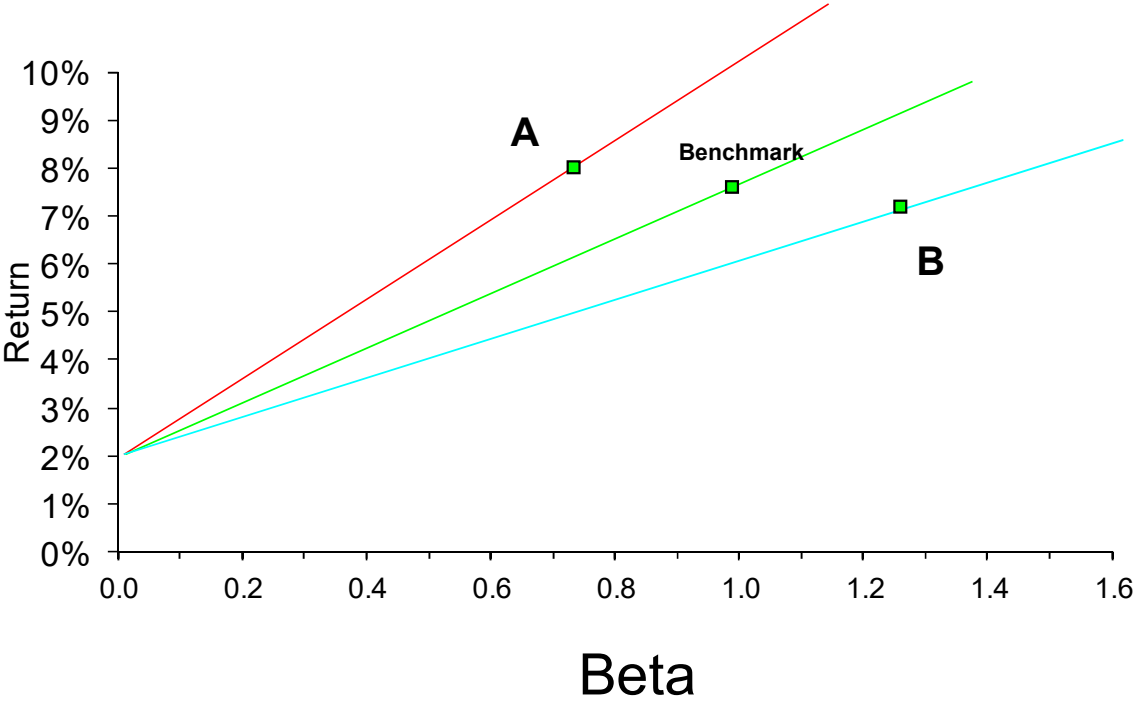
Intercept of the Regression Equation

Regression Statistics

• Correlation (r or r) = $\frac{\text{Systematic Risk}}{\text{Portfolio Risk}}$

• Coefficient of Determination (R^2) = $\frac{\text{Systematic Variance}}{\text{Portfolio Variance}}$

Treynor Ratio



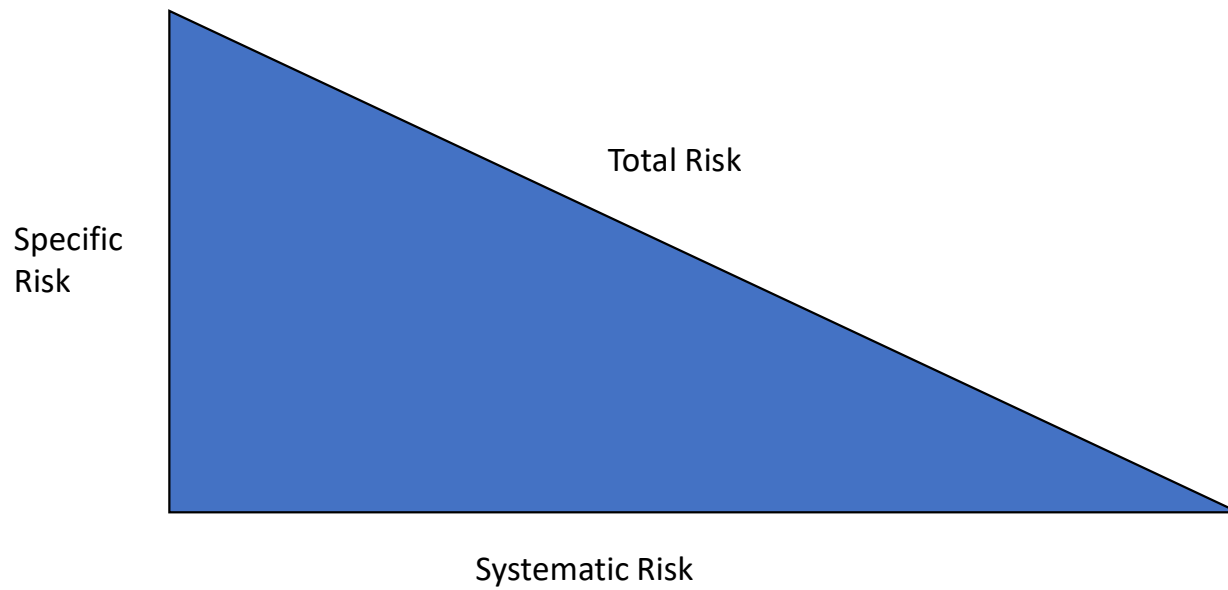
Risk Measures

Treynor Ratio $TR = \frac{\tilde{r} - \tilde{r}_F}{\beta}$

Systematic Risk $\tilde{\sigma}_s = \beta \times \tilde{\sigma}_b$

Appraisal Ratio $\frac{\text{Jensen's Alpha}}{\text{Specific Risk}} = \frac{\tilde{\alpha}}{\tilde{\sigma}_\varepsilon}$

Total Risk



$$\text{Total Risk}^2 = \text{Systematic Risk}^2 + \text{Specific Risk}^2$$

Risk-adjusted Performance – Exercise

Using the information provided below, calculate the Treynor measures, ex-post alphas, Sharpe measures and for the three funds and for the market.

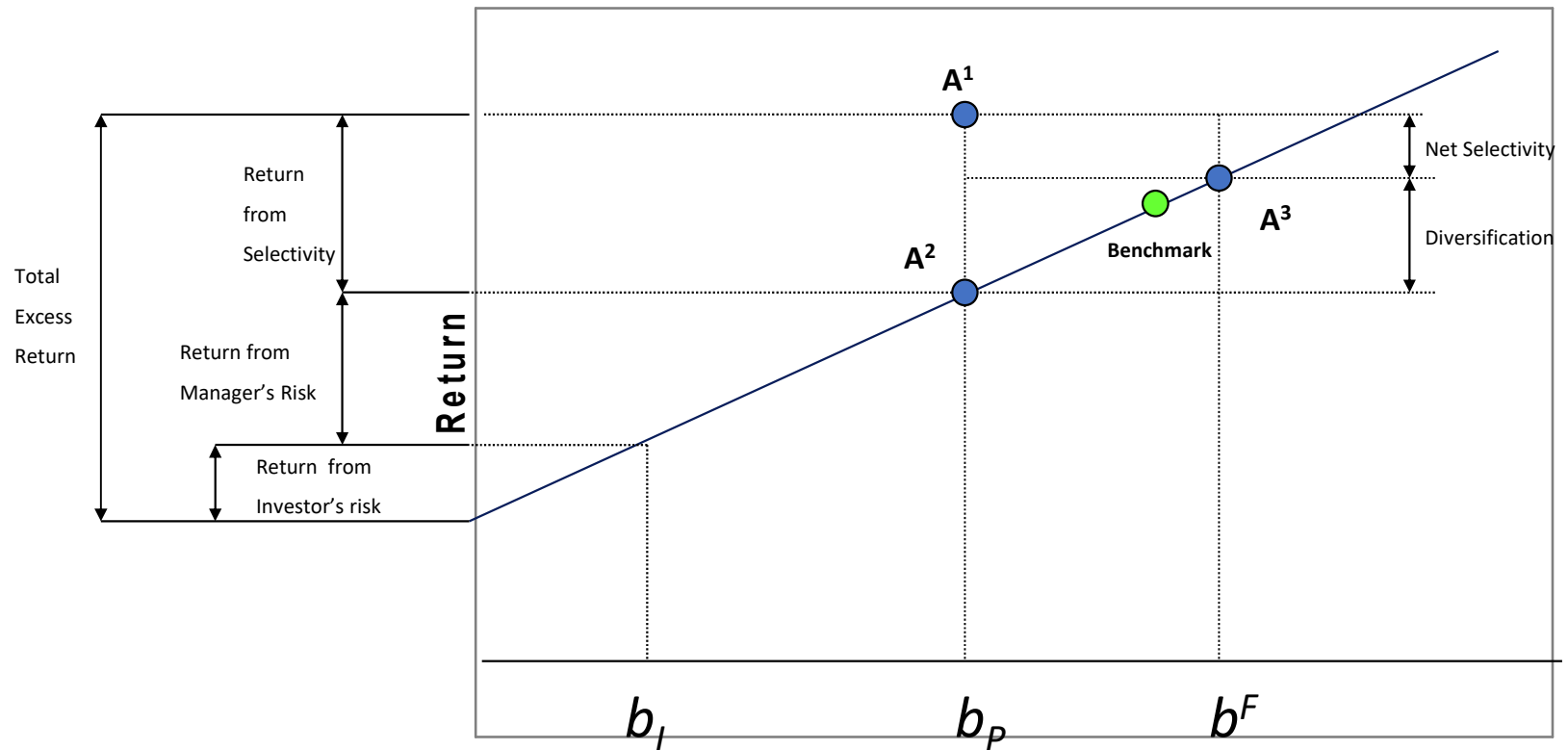
Rank the three funds, and comment on their relative performance

Risk-free return	4.5%			
	Market			
	portfolio	Fund X	Fund Y	Fund Z
Average return	11.0%	10.7%	12.5%	13.6%
Standard deviation	12.0%	10.1%	17.8%	19.2%
Beta	1.00	0.80	1.10	1.45

Fama Decomposition

- Early form of performance attribution
- Return above risk-free rate decomposed into two components:
 - Systematic Risk
 - Investor's risk
 - Manager's risk
 - Selectivity (Jensen's alpha)
 - Diversification
 - Net selectivity

Fama Decomposition



Fama Decomposition: Systematic Risk

Return due to systematic risk

$$r_{\beta_P} = \beta_P \times (b - r_F)$$

Return due to investor's systematic risk

$$r_{\beta_I} = \beta_I \times (b - r_F)$$

Return due to manager's systematic risk

$$r_{\beta_M} = (\beta_P - \beta_I) \times (b - r_F)$$

Fama Decomposition

Fama Equivalent b^F

$$\beta^F = \frac{\sigma}{\sigma_b}$$

Diversification (d)

(Return required to justified specific risk taken)

$$d = (\beta^F - \beta_P) \times (b - r_F)$$

Net Selectivity (s)

$$s = \alpha - d$$



Advanced Risk Measures and Return Distributions

Descriptive Statistics (Skewness & Kurtosis)

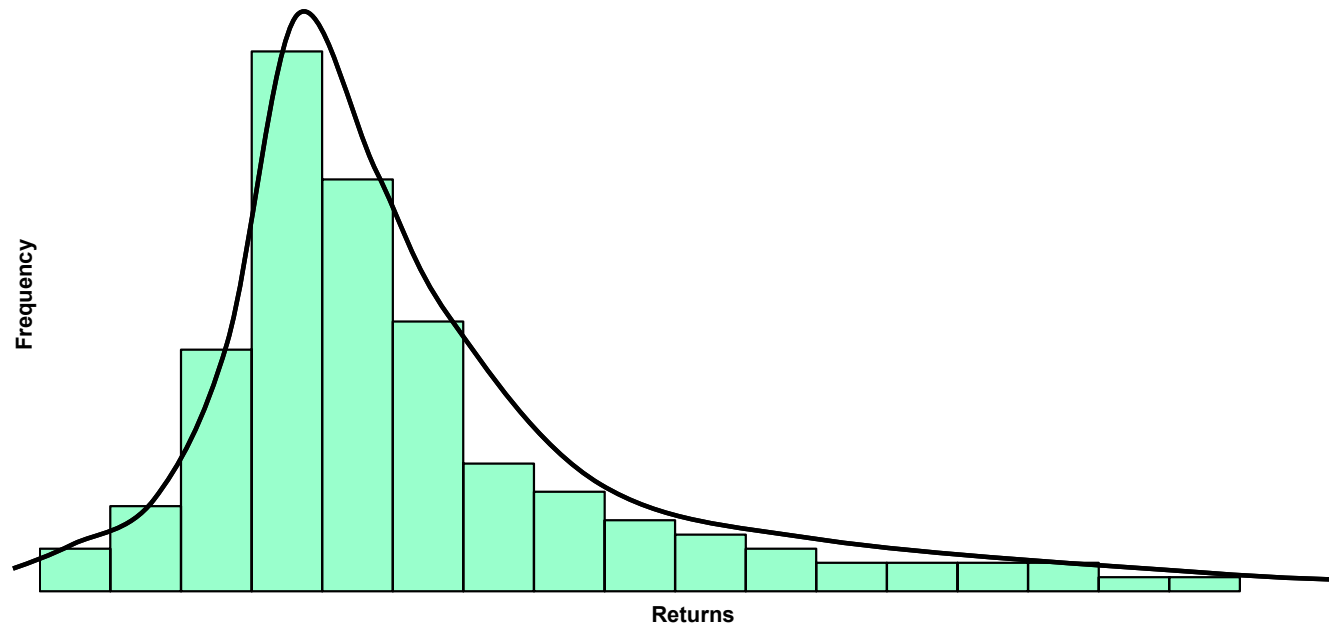
- Investment returns are not normal
 - Particularly hedge funds

- Skewness
$$S = \sum \left(\frac{r_i - \bar{r}}{\sigma} \right)^3 \times \frac{1}{n}$$

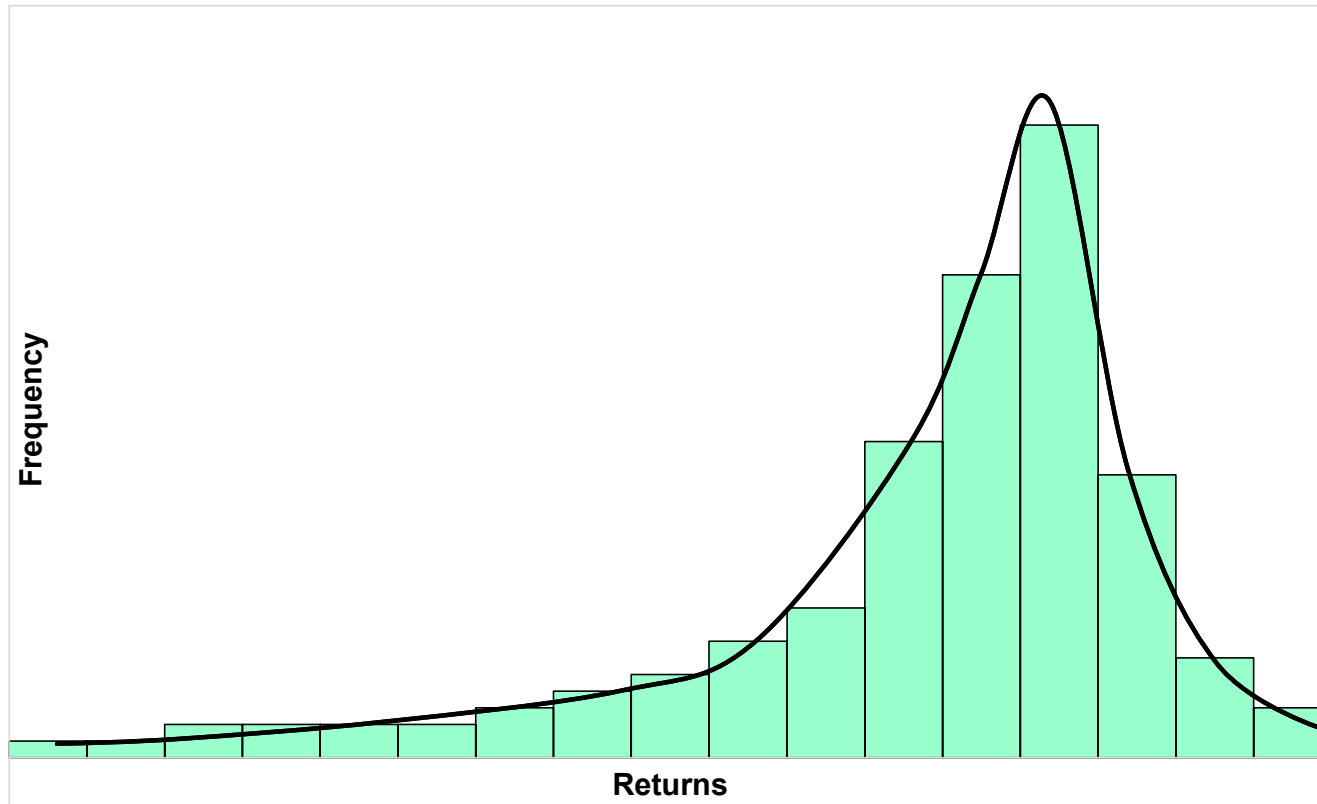
- Kurtosis
$$K = \sum \left(\frac{r_i - \bar{r}}{\sigma} \right)^4 \times \frac{1}{n}$$

- Excess Kurtosis
$$K_E = \sum \left(\frac{r_i - \bar{r}}{\sigma} \right)^4 \times \frac{1}{n} - 3$$

Positive Skew



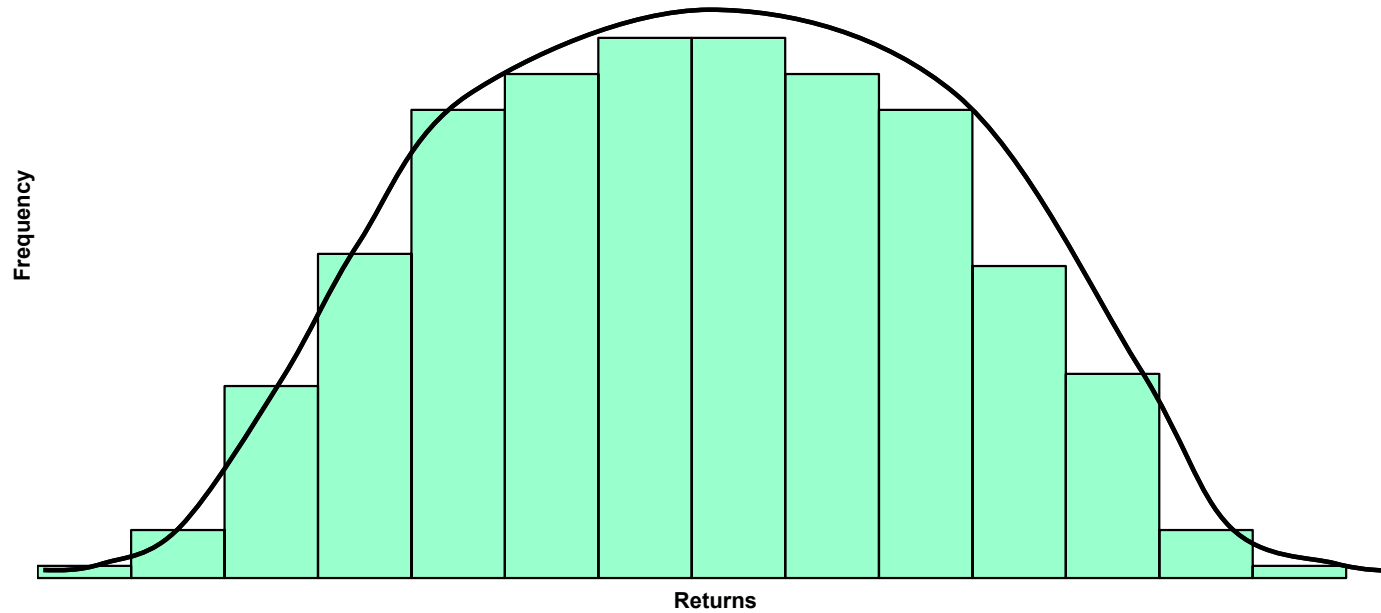
Negative Skew



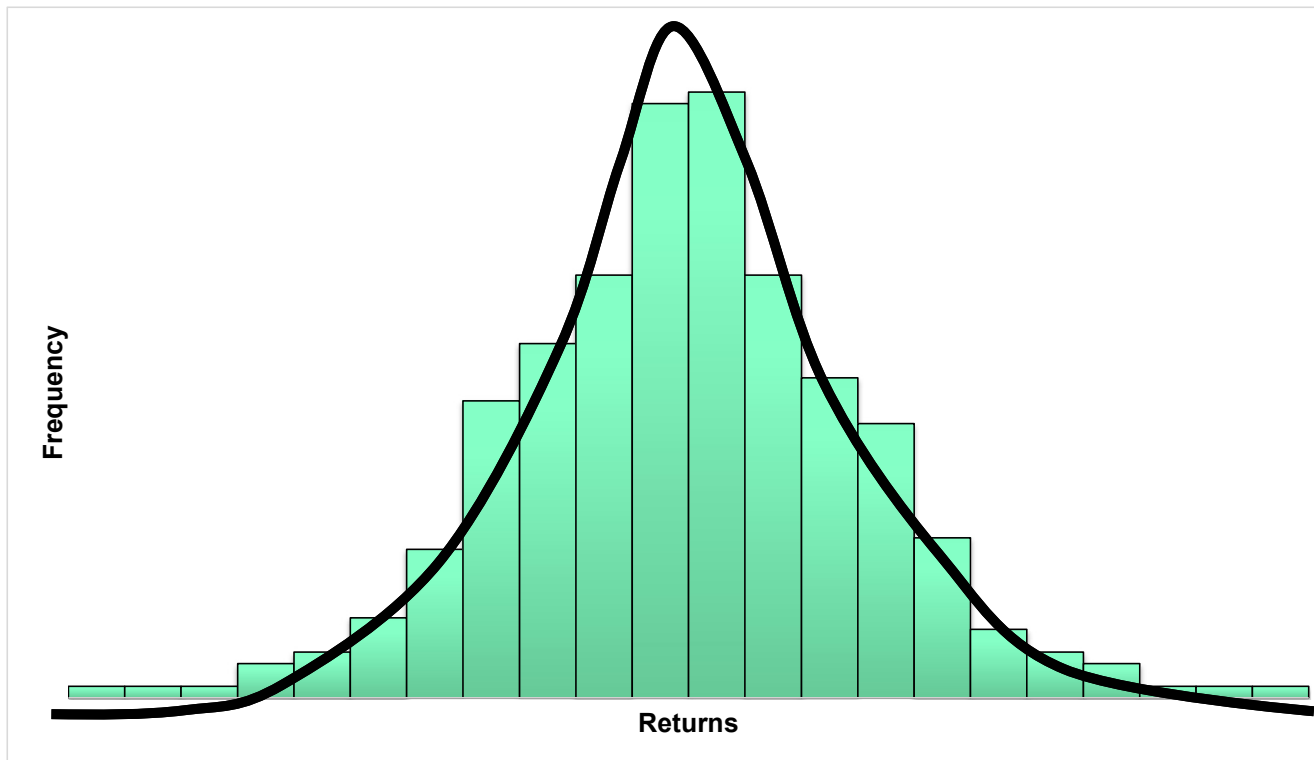
Kurtosis

- From the Greek for bulge
- Leptokurtic distribution
 - Greater than 3
 - Thin peak, fat tails
- Platykurtic distribution
 - Less than 3
 - Fat broad peak, thin tails

Platykurtic (kurtosis < 3)



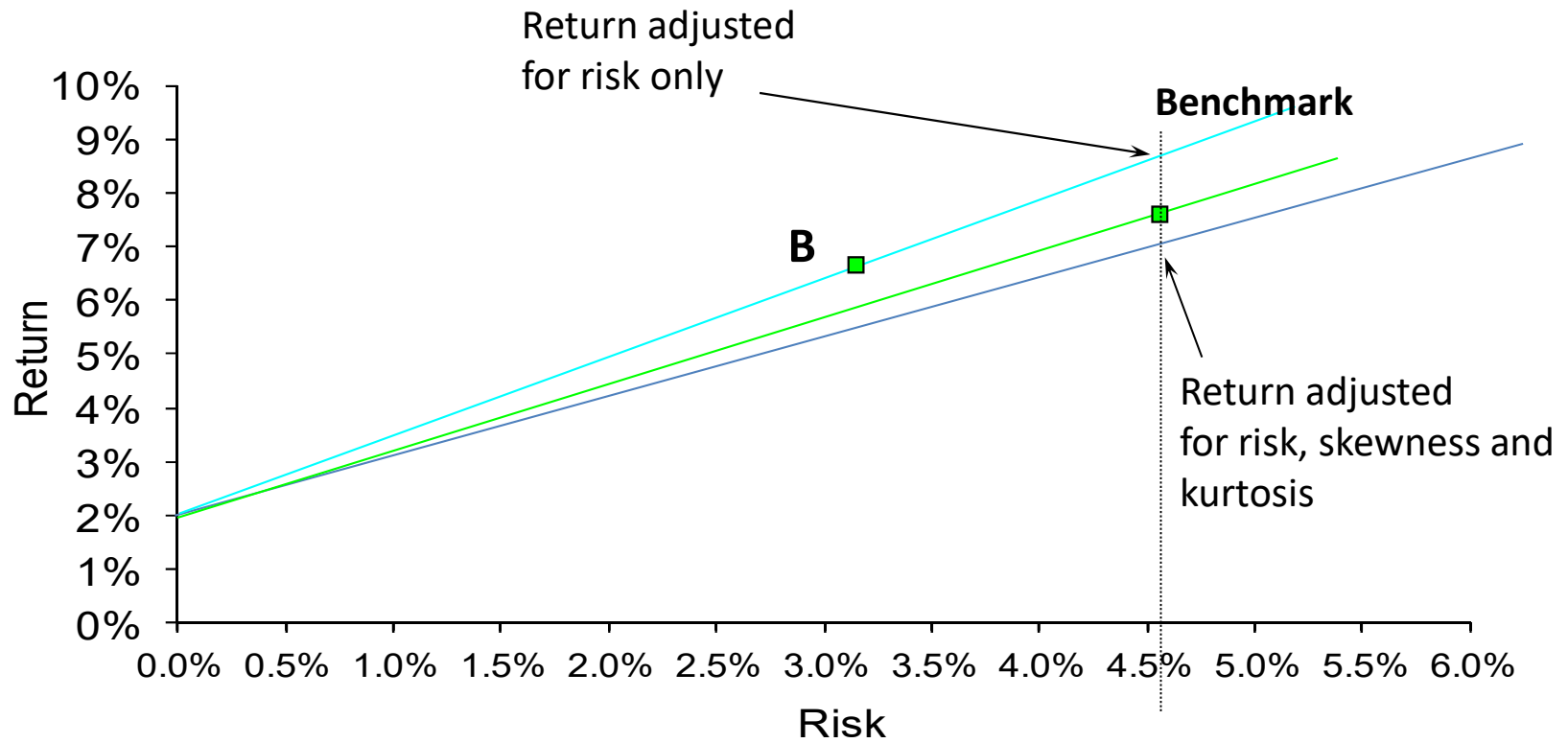
Leptokurtic (kurtosis > 3)



Adjusted Sharpe Ratio

$$ASR = SR \times \left[1 + \left(\frac{S}{6} \right) \times SR - \left(\frac{K-3}{24} \right) \times SR^2 \right]$$

Adjusted M²



Hedge Funds

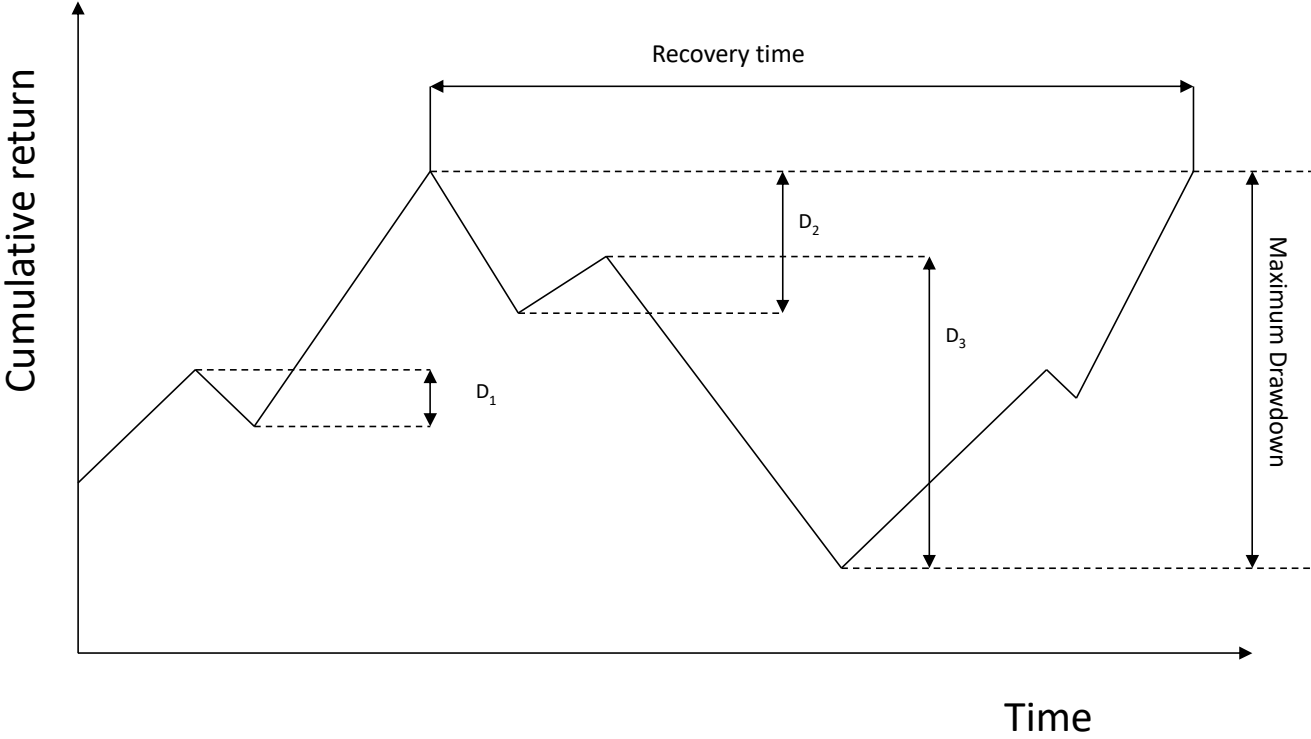
“A hedge fund constitutes an investment program whereby the managers or partners seek absolute returns by exploiting investment opportunities while protecting principal from potential financial loss”

Ineichen (2003)

Ex-post Risk Measures

- Simple
 - Sharpe Ratio, Information Ratio, M2
 - Regression analysis (a , b, r , R²) Treynor
- Drawdown
- Lower & Higher Partial moments
 - Sortino, Omega, Upside Potential, Prospect
- VaR & Conditional VaR
 - Conditional & Modified Sharpe Ratios
 - Tail Risk
 - Rachev Ratio

Drawdown



Partial Moments (Downside Risk)

$$\text{Sortino Ratio} = \frac{\tilde{r} - \tilde{r}_T}{\tilde{\sigma}_D}$$

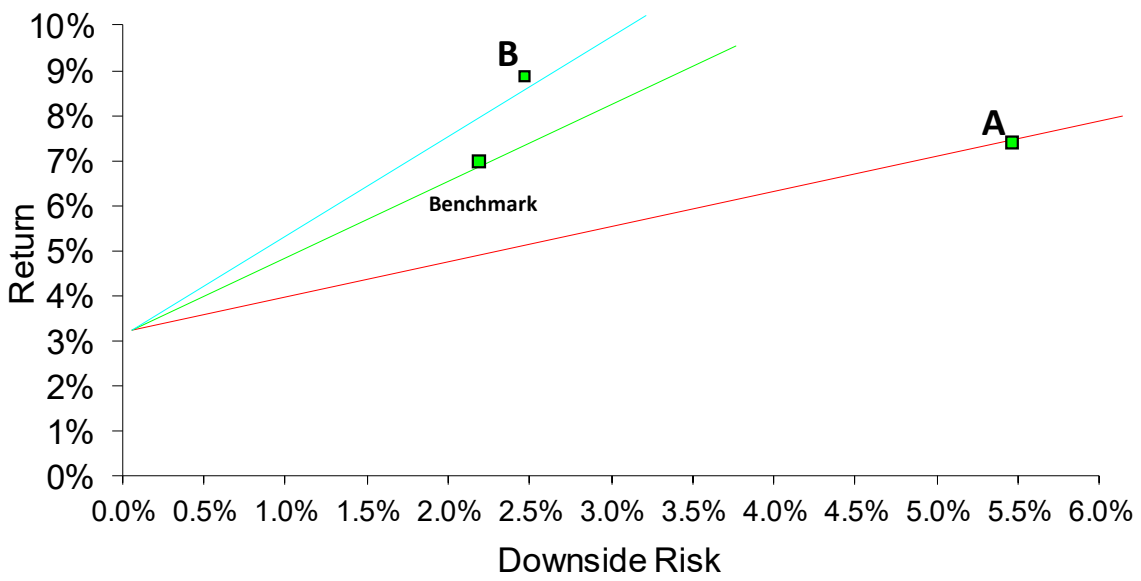
s_D = Downside semi-standard deviation

r_T = Mimimum acceptable (or Target) return

$$\sigma_D = \sqrt{\sum_{i=1}^n \frac{\min[(r_i - r_T), 0]^2}{n}}$$

- Fewer data points
- Less information
 - Does upside dispersion matter?

Sortino Ratio



Extreme Risk – Value at Risk (VaR)

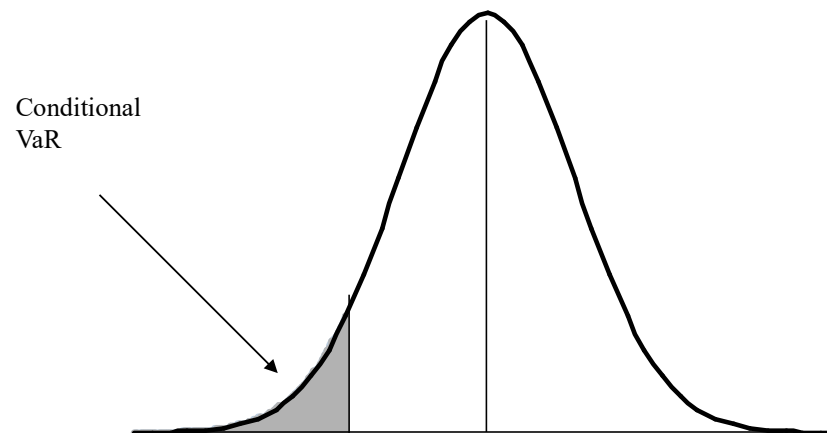
- **Maximum loss in cash terms over a finite period given a certain level of confidence (say 95%)**
- Typically ex-ante
- Easy for lay trustees to understand
- Return at Risk
- Potential upside (*Extreme gains*)

VaR

- Historical Simulation (*Non-parametric*)
 - Re-organises actual historical returns
- Monte Carlo Simulation
 - Multiple hypothetical trials
- Parametric
 - Variance-covariance

Condition VaR (*Expected Shortfall or Tail Loss*)

Conditional VaR is the average return conditional on the return exceeding (more negative than) the value at risk



Duration

- Duration is a Fixed Income Risk Measure
 - Macaulay Duration
 - Macaulay-Weil Duration
 - Modified Duration
 - Effective Duration
- It measures price sensitivity to changes in interest rates

$$\text{Duration} \quad \beta = \frac{D_P}{D_B}$$

Risk Efficiency Ratio

Risk Efficiency Ratio

$$\frac{\text{Observed Tracking Error}}{\text{Forecast Tracking Error}}$$

or

$$\frac{\text{Ex-Post Tracking Error}}{\text{Ex-Ante Tracking Error}}$$

Measures the quality of the tracking error forecast

Practical Issues

- Smoothed Valuations
- Outliers
- Monthly Data
- Annualization
- Continuously compound (log) or simple returns

Why Measure Risk Ex-Post?

- Performance appraisal
 - Performance is two dimensional
- Understanding and articulating investor preferences
 - Investors need to know what they want
- Risk efficiency
 - Comparing ex-ante to ex-post

Periodic Table of Risk Measures							
		Partial Moments					
Descriptive Statistics		Absolute	Relative	Downside	Gain-loss	Prospect	Drawdown
1 st moment	Average	MAD Ratio	Relative Batting Average	Omega-Sharpe Ratio	Omega	Omega –Prospect Ratio	Sterling Ratio
2 nd moment	Variability	Sharpe Ratio	Information Ratio	Sortino Ratio	Variability skewness	Prospect Ratio	Burke Ratio
3 rd moment	Skewness	Skew-adjusted Sharpe Ratio	Skew-adjusted Information Ratio	Skew-adjusted Sortino Ratio	Gain-Loss skewness	Skew-adjusted Prospect Ratio	Calmar Ratio
4 th moment	Kurtosis	Adjusted Sharpe ratio	Adjusted Information Ratio	Kappa	Farnelli-Tibiletti Ratio	New Prospect Ratio	Pain Ratio
Systematic risk	Beta	Treynor Ratio	Appraisal Ratio	Return to Duration	Timing Ratio	Generalised Z Ratio	Ulcer Ratio
Extreme risk	VaR	Reward to VaR	Reward to relative VaR	Conditional Sharpe Ratio	Rachev Ratio	Generalised Rachev Ratio	Reward to Conditional Drawdown
Miscellaneous Risk measures		K Ratio	Upside Capture	Downside Capture	Capture Ratio	R ²	Bias Ratio
		Absolute Batting Average	Risk Efficiency Ratio	Tail Ratio	Convexity	Bera-Jacque Statistic	Active Share

Risk -adjusted Returns
Excess Return
M ²
Skew-adjusted M ²
Adjusted M ²
Alpha
M ² for Var
Factor Alpha
Omega Excess

Choice of Measures

- “Which is the Best”
- All measures are highly correlated
 - Eling & Schuhmacher Journal of Banking & Finance Sept 2007
- Both miss the point

Concluding Remarks

- **“Risk like beauty is in the eye of the beholder”**
- The basic structure of all composite risk measures is the same:

$$\frac{\text{Reward}}{\text{Risk}}$$

- Get it wrong and you're in trouble

Guiding Principles for Efficient Risk Control

Senior Manager Awareness

- Reporting
- Committee Structure

Assertive Attitude

- Self-assessment & risk ownership
- Active use of risk methodology as a marketing argument
- Anticipating client expectations
- Challenging & reviewing practices

Guiding Principles for Efficient Risk Control

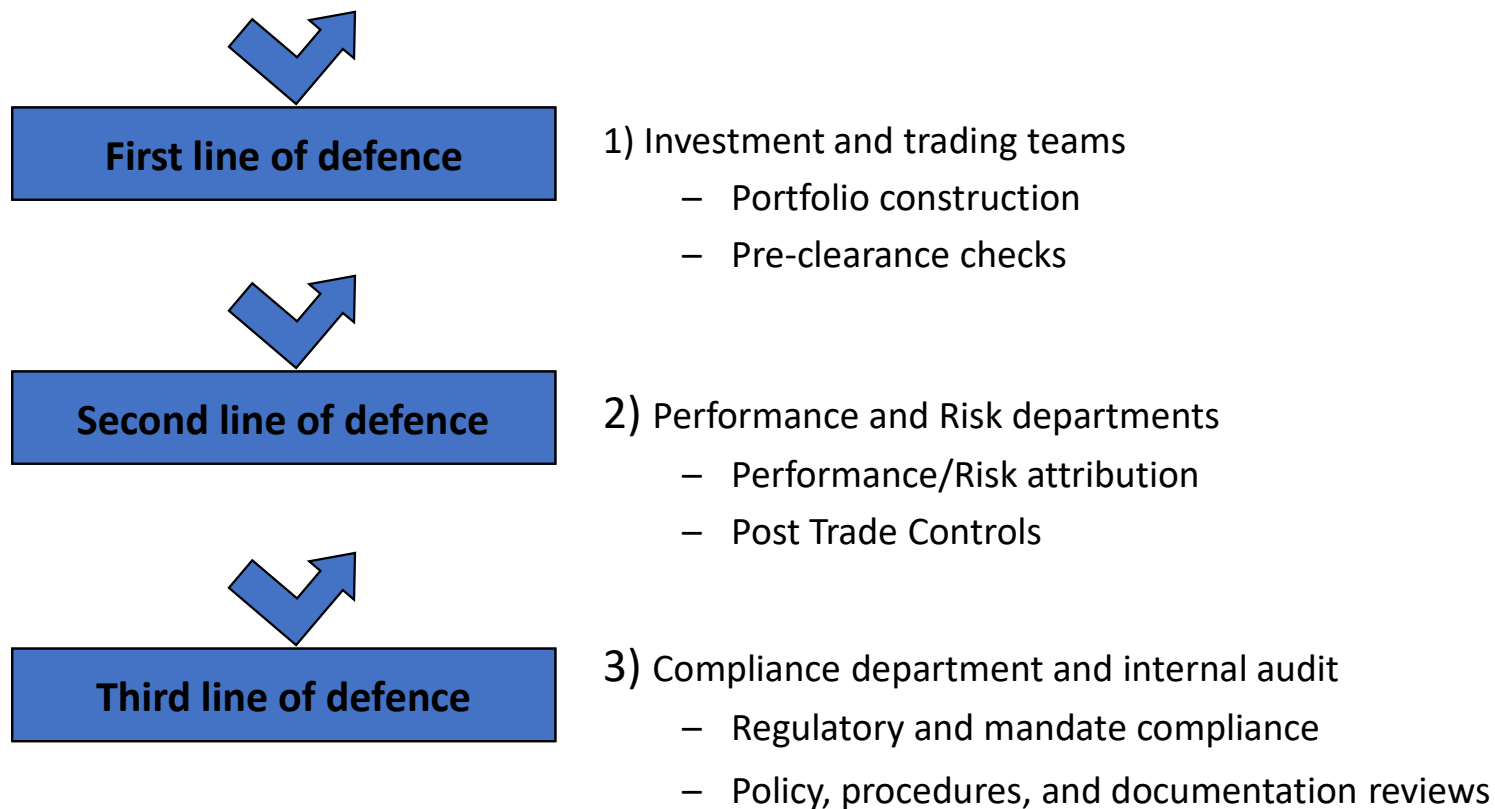
Integration

- Organisation
- Systems: integrated
- Consistent Controls

Confidence in Data

- Data dissemination (pushing data to the business)
- In house indicators, value added data

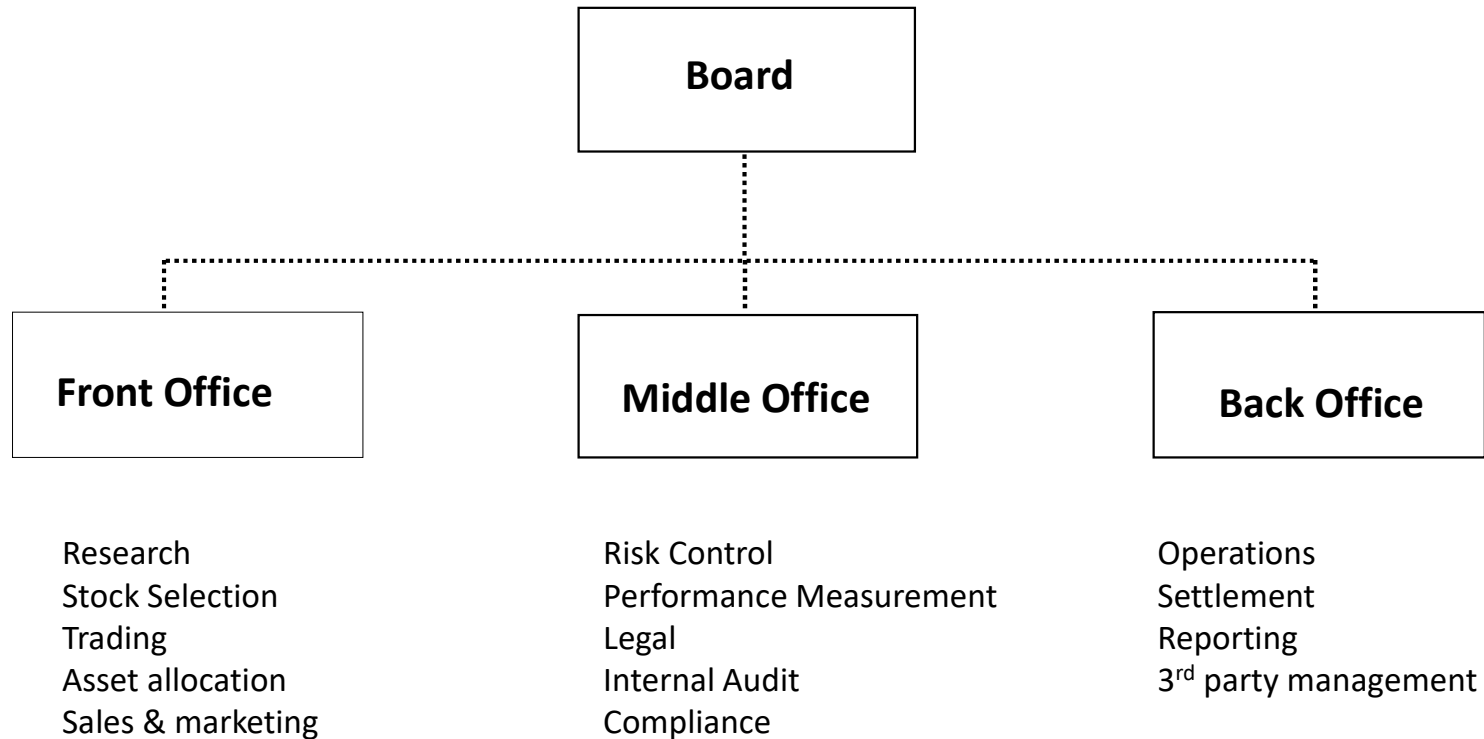
Three Lines of Defence



Risk Control Actions

- Review Mandates
- Establish Risk Awareness
- Risk ownership
- Build Risk Infrastructure
- Identify Risks
 - Accept
 - Eliminate
 - Mitigate (Insurance)
 - Measure (Risk limits and reporting)

Risk Management



Risk Infrastructure

- Risk Management Committee
 - All parts of Firm included
 - Compliance
 - CIO
 - COO
 - Head of Risk
 - Direct report to board
 - Establish Risk Policy
 - New Product/Strategy control
- Portfolio Risk Committee
- Counterparty approval
- Operational Risk Committee

Effective Risk Management

- Documented risk management process
- Independence
- Risk awareness
- Clear risk limits
- Risk and performance attribution
- Appropriate risk measures
- Stress and scenario tests
- Review process (New products, strategies, instruments)
- Monitor risk efficiency



Principal Vs Agent Risk

Understanding 'Principal Vs Agent Risk' in Portfolio Monitoring

Principal: The asset owner (investor) who delegates portfolio management.

Agent: The entity (portfolio manager or financial advisor) managing the assets.

In portfolio management, this relationship is pivotal as the agent makes decisions on behalf of the principal.

The risk arises from potential misalignment of interests, lack transparency, and varying levels of expertise and ethics in agents.

The Agency Problem in Portfolio Management

Occurs when the agent's interests diverge from those of the principal.

Examples:

- Agents choosing highly volatile assets to make up for poor prior returns
- Underperformance due to lack of effort or skill.

Conflicts of Interest: Potential for self-serving actions at the principal's expense.

Risks to the Principal in the Agency Relationship

Misaligned Interests: Risk of agents prioritizing their gains (commissions, fees) over principals' portfolio performance.

Inadequate Information: Principals might not receive full transparency about investment strategies or risks.

Performance Risk: Possibility of suboptimal portfolio performance due to agent's incompetency or negligence.

Mitigating Agent Risks in Portfolio Monitoring

Communication: Regular, clear discussions about goals, strategies, and performance.

Performance-Based Incentives: Aligning compensation with the principal's investment performance.

Auditing: Routine checks and balances, including third-party audits, to ensure compliance and performance.

Third-Party Asset Manager Due Diligence

Operational Review

- Examination of the third-party manager's operational infrastructure including systems, processes, and controls.

Investment Process Evaluation

- Understanding the manager's investment strategy, process, and philosophy. This includes looking at the selection criteria for investments, the research process, portfolio construction, and risk management practices.

Performance Analysis

- Assessing the historical performance data to determine how they have added value to the investments. Also involves separating skill from luck by analyzing performance over different time periods and market conditions.

Compliance and Regulatory Review

- Ensuring the asset manager complies with relevant regulatory requirements and best practice standards.

Reputation and Background Checks

- Investigating the track record, reputation, and background of the third-party managers, including key personnel and their history.

Performance Fees – Good or Bad?

Those in favour suggest:

- The interests of the asset manager are **aligned** with the interests of the asset owner

Those against suggest:

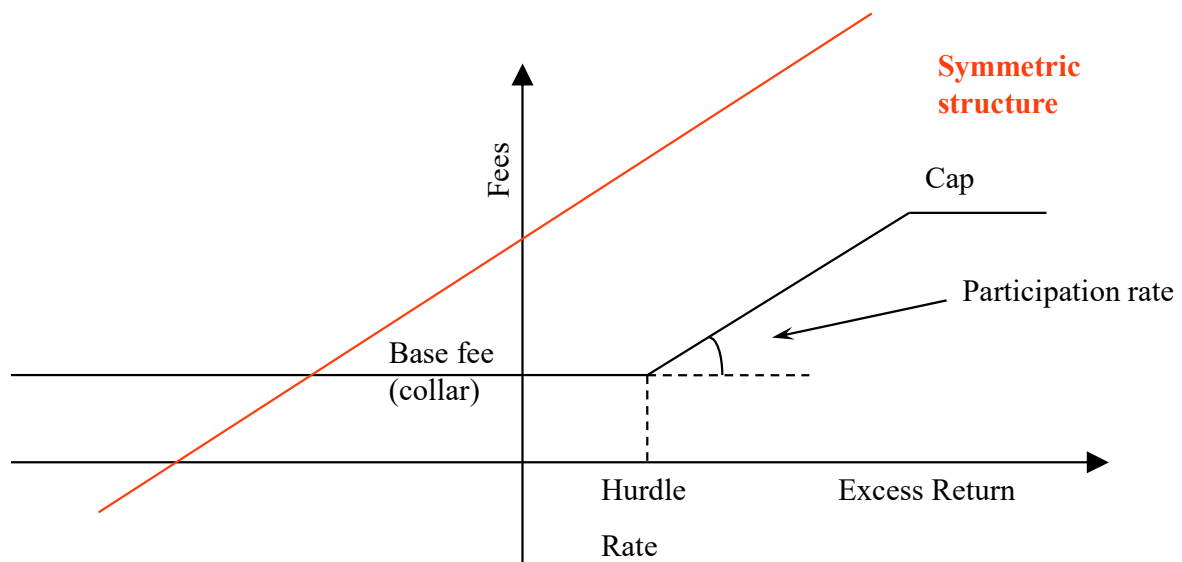
- Conflicts of interest are created and are typically biased in favour of the asset manager

Of course it depends on the how the performance fee is structured

Performance Fee Structures

- Asymmetrical
 - Normal Structure
 - Lower base fee
 - Performance fee for positive performance
- Symmetrical (*Fulcrum*)
 - Performance fee for positive performance
 - Fee rebate for negative performance

Performance Fee Structures



Asymmetrical Fee Structure

- Statement/assumption
“The existence of the performance fee structure does not alter the performance achieved”
- Sufficient constraints/ incentives already
 - Establish and maintain track record
 - Treat asset owners equally
 - Own money invested

Asymmetrical Performance Fee

- Normally favour asset managers
 - Free long call option
 - Higher variability = option more valuable
- If so why?
 - Penalise the right choice (higher fee)
 - Reward the wrong choice (lower fee)

Asymmetrical Performance Fee

- Are asset owners accepting their inability to choose active managers?
- Typically
 - Fees will increase for skilful asset owners
 - Fees will decrease for asset owners lacking skill
 - Fees will increase for average performance
- Asset owners lacking skill should choose passive managers
 - Reduce fees and improve relative performance

Symmetric Performance Fees

- May align interests of asset owners and asset managers
- Volatility of income stream is bad for asset managers
 - Implies a higher base or neutral fee
- When performance is bad – revenue might be required to:
 - Improve the decision process
 - Retain key staff
- Transfer costs are extremely high

Performance Fees

- Increase asset manager's revenue expectation
- Inevitably not good for asset owners
 - Necessary Evil (Access to good asset managers)
- Change asset managers' attitudes to risk
 - Asset manager and asset owner interests are not aligned
 - Must ensure reward is appropriate to the risk taken
 - Should use risk-adjusted performance

Alternative Structures

- Cap & collar
- Hurdle Rates (Hard & Soft)
- High water marks & claw back
- Time periods
 - Shorter time periods favour the asset manager.
- Difficult to ensure client and manager interests are aligned throughout the entire period

Equalization

- Equalization is designed to be fair to all investors who inevitably invest at different times and are therefore subject to different performance returns.
- An investor who invested in the middle of a good period may be charged a full performance fee even if they only participated for part of a period.
- An investor may enjoy a free ride if they invest at a low point after a high-water mark and avoid paying a performance fee as the fund recovers.

Equalization - Example

Date	Gross assets	Net assets	Performance fee accrual
31/12/2021	100	100	0
31/03/2022	90	90	0
30/06/2022	120	115	5
30/09/2022	140	130	10
31/12/2022	130	122.5	7.5

Assume a performance fee of 25%

1st Investor – invests 31/12/2021 Performance return $130-100=30$ Performance fee $30 \times 25\%=7.5$

2nd Investor – invests 31/03/2022 Performance return $130-90=40$ Performance fee $40 \times 25\%=10$

Paid for by the standard performance fee of 7.5 and a depreciation deposit of $100-90=10 \times 0.25\%=2.5$

Equalization - Example

Date	Gross assets	Net assets	Performance fee accrual
31/12/2021	100	100	0
31/03/2022	90	90	0
30/06/2022	120	115	5
30/09/2022	140	130	10
31/12/2022	130	122.5	7.5

3rd Investor – invests 30/06/2022 Performance return $130-120= 10$ Performance fee $10 \times 25\%=2.5$

Paid for by the standard performance fee and a rebate or equalisation credit of $120-100=20 \times 0.25\%=5$

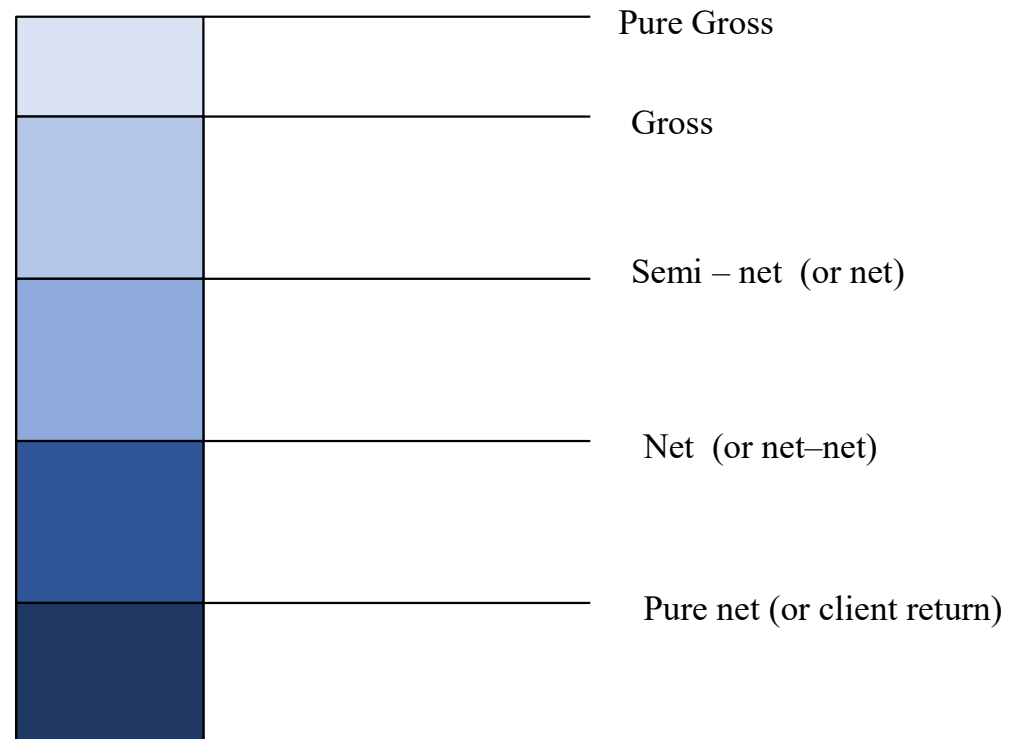
4th Investor – invests 30/09/2022 Performance return $130-140= -10$ Performance fee=0

Standard performance fee of 7.5 paid but also a 7.5 rebate from an equalisation credit of $140-100=40 \times 0.25\%=10$
 2.5 Equalisation credit retained

Conclusions

- Most performance Fee structures favour asset managers
- If used they should be:
 - Unambiguous & fair
 - Risk-adjusted
 - Symmetrical
 - But simple

Fees & Expenses



Fees & Expenses

- Pure Gross
 - Theoretical return excluding transaction costs
 - Indexes are Pure Gross
- Gross
 - Underlying performance of portfolio manager
- Semi-net
 - Net of base fee (unethical?)
- Net
 - Net of base fee plus performance fee
- Pure Net
 - Asset owner return
 - Includes custody fees and other expenses not in the control of the manager



Benchmarks

Benchmarks

- Dictionary Definition:

“A standard by which something is evaluated or measured”

“A surveyor’s mark made on some stationary object”

Role of Benchmarks

- Asset allocation strategy
 - Past performance
 - Correlation
 - Liabilities
- Measure the manager's added value
 - IMA
 - Monitoring
 - Relative return
 - Relative risk
- Passive management
 - Alternative or smart beta

Benchmark Relationships

- Passive
 - Replicate
- Relative
 - Investment decision explicitly linked
- Aware
 - Benchmark choice articulates the broad strategy
- Agnostic
 - Background information, market barometer

Attributes of a Good Benchmark

- | Appropriate
- | Investable
- | Accessible & Transparent
- | Independent

Best Benchmark Practice

- | Unambiguous
- | Set in advance
- | Never retrospectively changed

Types of Benchmarks

- Commercial Indexes
 - FTSE, S&P, MSCI, JP Morgan, Freedom, Bloomberg etc.
- Customised indexes
- Peer Groups
 - Typically country specific
- Random portfolios
 - Rarely used
- ETFs
 - Genuine alternative (including fees and charges)
- Target returns
 - Risk free rate, Inflation plus, Funding requirement

Types of Benchmarks

- Blended
 - Special type of customized indexes
 - Blends of multiple indexes from different index providers
 - Balanced
- Spliced
 - Changes in index chained-linked over time.
 - Bad performance practice to change indexes retrospectively
- Money-weighted
 - Sometimes called public market equivalents
 - Replicate the errors of the money-weighted return
- Normal portfolios
 - Recommended list of securities

Benchmarks

	Indexes	Peer Groups
Accessible	✓(?)	x
Investible	✓ (most)	x
Independent	✓	✓
Relevant	✓	✓

Peer Groups – Advantages & Disadvantages

- Active Managers
- Transactions included

Advantages

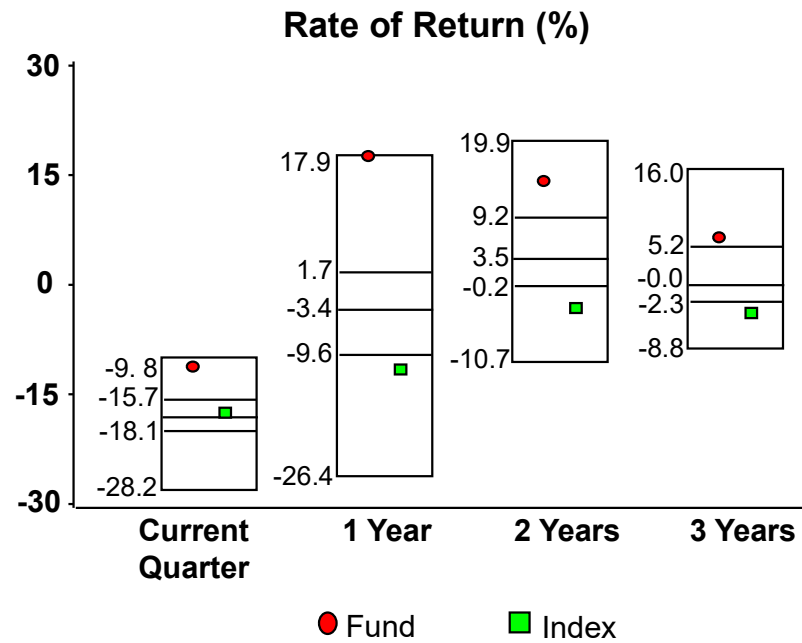


- Not achievable
- Survivorship bias
- Constituent quality & consistency

Disadvantages



Floating Bar Chart



Index Construction

- Index Providers
 - Transparency, methodology, categorization
 - Construction rules
 - Weights & returns
 - Characteristic data
 - Distribution
- Customised indexes
- Indexes can be disaggregated

$$b = \sum_{j=1}^{j=n} IW_j \times IR_j$$

for j=n asset categories or securities.

Evaluating Indexes

- | Weighting Method
- | Coverage
- | Concentration
- | Turnover
- | Construction Rules

Index Providers

- Index providers differentiate their indices through rules
- Intellectual property is created
- Generate revenue (or sell other services)
- Variations
 - Stock Selection (Sampling, filtering & buffering)
 - Float weights
 - Calculation methodology (Corporate Actions, suspensions)

Free Float Factors

Company	FTSE	MSCI	Difference
CAMECO CORP ORD	0.2	1	-0.8
PETROCHINA CO	0.1	0.8	-0.7
POHANG IRON & STEEL	0.3	1	-0.7
BROADCOM CORP	0.3	1	-0.7
JOHN FAIRFAX HOLDING	0.4	1	-0.6
CHINA SOUTHERN AIRLI	0.4	1	-0.6
GUANGSHEN RAILWAY H	0.4	1	-0.6
ZHEJIANG SOUTHEAST B	0.4	1	-0.6
ZHEJIANG EXPRESSWAY	0.4	1	-0.6
ABS-CBN HOLDINGS	0.4	1	-0.6
TELECOM ITALIA SVGS	0.5	1	-0.5
ALUMINUM CORP OF CHI	0.2	0.7	-0.5
SIMON PROPERTY GROUP	0.5	0.9	-0.4
CANTV TELEFONOS 'D'	0.4	0.8	-0.4
BEIJING DATANG POWER	0.3	0.7	-0.4

Company	FTSE	MSCI	Difference
MALAYAN UTD INDS	0.75	0.2	0.55
COMPAREX HOLDINGS	1	0.45	0.55
COMPEQ MANUFACTURING	1	0.45	0.55
INVENTEC CORP	1	0.45	0.55
LITE-ON TECH CORP	1	0.45	0.55
TAISHIN FINANCIAL	1	0.45	0.55
GRUPO FINANCIERO BBV	1	0.4	0.6
PREMIER IMAGE TECHNO	1	0.4	0.6
LG ELECTRONICS INV	0.75	0.1	0.65
MALAYSIA MINING	1	0.35	0.65
PUNCAK NIAGA HLDGS	1	0.3	0.7
GRUPO CARSO	1	0.25	0.75
GRUPO MEXICO 'B'	1	0.25	0.75
ELKEM A	1	0.25	0.75
SOUTHWEST AIRLINES	1	0.25	0.75

Source: FT Interactive Data, 16/9/02

Weighting Methods

- | Price – Higher price, larger weight
- | Equal
- | Market Cap – Weighted by size
- | Fundamental – Book value, free cash flow, sales or dividends
- | Minimum variance
- | GDP Country weights adjusted to economic output

Fixed Income Indexes

- Pricing sources
- Liquidity
- No. of instruments
- Duration
 - Issuers preference
- Weighting
 - Debt-weighted

Impact of Weighting Schemes

	Weighting Scheme				
	Price	Market Cap	Equal	Price	Market Cap
Allianz	252.55	\$45.9b	20%	78.74%	9.34%
Marconi	0.11	\$0.4b	20%	0.03%	0.09%
Vodafone	1.03	\$102.2b	20%	0.32%	20.78%
AOL Time Warner	16.98	\$72.1b	20%	5.29%	14.67%
Microsoft	50.05	\$271.1b	20%	15.61%	55.12%

Concentration

MSCI Finland – April 2002

Nokia 61%

20 Others 39%

Equity Index Turnover

12 Month periods

		Add	Delete
Russell 3000	June 2010	2%	2%
Russell 2000	June 2010	10%	8%
MSCI EAFE	Dec 2000	3%	5%
MSCI EMF	Dec 2000	30%	7%

Source : MSCI, Russell

Customised Indexes

- More specialization implies more customized indexes
- Index providers will charge heavily
- Calculate internally
 - No stamp of independence
 - Need constituent data

Fixed or Floating Weights

- Monthly, quarterly or annual
- Differences can be large
- Trading costs
 - Sell raising indexes
 - Buy falling indexes
 - Bad if returns are persistent

Currency Effects

- Most international indexes use WM/Reuters* rates
- Currency returns can therefore be derived from from base and local returns

$$\text{Currency return} = \frac{1 + B_B}{1 + B_L} - 1$$

- Hedged returns can also be similarly derived

*WM/Refinitiv from November 2020

Typical Index Data

	Weight	Local Return	Dollar Return	Dollar hedged return
Australia	8.46%	0.81	6.28	0.56
France	23.31%	-3.03	0.53	-3.17
Japan	48.46%	2.68	6.23	2.84
Singapore	2.16%	-3.22	-1.88	-3.19
Switzerland	17.61%	0.47	3.89	0.57

Excess Return

- **Arithmetic**

Arithmetic excess return is the profit in excess of a notional or benchmark fund expressed as a percentage of the initial amount invested

- **Geometric**

Geometric Excess return is the profit in excess of the benchmark fund expressed as a percentage of the final value of the benchmark fund.

Excess Return - Example

Arithmetic Market Start Value £1,000,000
 Market End Value £1,070,000
 Hence Profit £70,000 and a return of 7%

Benchmark return 5%

Hence value of notional fund £1,050,000 and profit of £50,000

Added value £70,000 - £50,000 = £20,000

or 7% - 5% = 2% or 20,000/1,000,000

Geometric Added value £20,000/ 1,050,000 = 1.9%

or

$$\frac{1.07}{1.05} - 1 = 1.9\%$$

Arithmetic or Geometric?

Arithmetic

- Easier to understand
- Larger absolute values in rising markets
- More widely and traditionally used

Geometric

- Compoundable
- Convertible
- Proportionate

Compoundable

- Since actual performance is chain-linked and expressed as :

$$(1 + r_1) \times (1 + r_2) \times (1 + r_3) \dots \dots \dots (1 + r_n) = (1 + R)$$

- and similarly for benchmark performance

$$(1 + b_1) \times (1 + b_2) \times (1 + b_3) \dots \dots \dots (1 + b_n) = (1 + B)$$

- then the geometric outperformance over the total period can be expressed as:

$$(1 + G) = \frac{(1 + R)}{(1 + B)} = \frac{(1 + r_1)}{(1 + b_1)} \times \frac{(1 + r_2)}{(1 + b_2)} \times \frac{(1 + r_3)}{(1 + b_3)} \dots \dots \dots \frac{(1 + r_n)}{(1 + b_n)}$$

$$(1 + G) = \frac{(1 + R)}{(1 + B)} = (1 + g_1) \times (1 + g_2) \times (1 + g_3) \dots \dots \dots (1 + g_n)$$

Convertible

	1998	1997	1996	1995
In US Dollars				
Portfolio	-33.1	15.9	10.0	-7.2
Benchmark	-25.3	-11.6	6.0	-5.2
Arithmetic Difference	-7.8	27.5	4.0	-2.0
In Sterling				
Portfolio	-33.9	20.6	0.2	-6.5
Benchmark	-26.2	-8.0	-3.8	-4.5
Arithmetic Difference	-7.6	28.6	4.0	-2.0
in Deutschemarks				
Portfolio	-38.0	35.3	18.4	-14.3
Benchmark	-30.8	3.2	14.2	-12.5
Arithmetic Difference	-7.2	32.1	4.2	-1.8
Geometric Difference	-10.4	31.1	3.7	-2.1

Proportionate

- Which is the better excess return ?

51% v 50%

or 11% v 10%

- Arithmetically both +1%
- Geometrically:

$$\frac{1.11}{1.1} - 1 = 0.9\%$$

$$\frac{1.51}{1.50} - 1 = 0.67\%$$

Excess Return

Geometric Excess return:

$$\frac{1 + r}{1 + b} - 1 = \frac{1 + r}{1 + b} - \frac{1 + b}{1 + b} = \frac{r - b}{1 + b}$$

Hence Geometric Excess return is simply the Arithmetic Excess return divided by the wealth ratio of the benchmark

$$\frac{1.07}{1.05} - 1 = \frac{1.07}{1.05} - \frac{1.05}{1.05} = \frac{0.07 - 0.05}{1.05} = \frac{2\%}{1.05} = 1.9\%$$



Basic Attribution

What is Return Attribution

- **Definition:**

Return attribution is a technique used to quantify the excess returns of a portfolio against its benchmark into the active decisions of the investment management process.

What is Return Attribution

- **Return Attribution**
 - Excess, relative, or active return
 - Absolute return or contribution analysis
- **Performance Attribution**
 - Return attribution, performance attribution, and attribution are interchangeable terms
 - Performance is two dimensions (risk & return)
- **Risk Attribution**
 - Ex-post, ex-ante

Why is Attribution Important?

- Key management tool
 - Performance Analysts
 - Operations
 - Portfolio Managers
 - Senior Management
 - External Consultants

Attribution – Brinson Model

Portfolio Performance

$$r = \sum_{j=1}^{j=n} PW_j \times PR_j$$

Benchmark Performance

$$b = \sum_{j=1}^{j=n} IW_j \times IR_j$$

Intermediate Notional Funds:

$$b_S = \sum_{j=1}^{j=n} PW_j \times IR_j \quad \text{Allocation}$$

$$r_S = \sum_{j=1}^{j=n} IW_j \times PR_j \quad \text{Selection}$$

Brinson Model

<p>Quadrant 4</p> <p>Portfolio Return</p> $r = \sum_{j=1}^{j=n} PW_j \times PR_j$	<p>Quadrant 2</p> <p>Allocation Return</p> $b_S = \sum_{j=1}^{j=n} PW_j \times IR_j$
<p>Quadrant 3</p> <p>Selection Return</p> $r_S = \sum_{j=1}^{j=n} IW_j \times PR_j$	<p>Quadrant 1</p> <p>Benchmark Return</p> $b = \sum_{j=1}^{j=n} IW_j \times IR_j$

Brinson Attribution

Excess Return = Quadrant 4 – Quadrant 1

Allocation = Quadrant 2 – Quadrant 1

Selection = Quadrant 3 – Quadrant 1

Interaction = Quadrant 4 – Quadrant 3
– Quadrant 2 + Quadrant 1

Asset Allocation

Brinson, Hood & Beebower

$$\sum_{j=1}^{j=n} PW_j \times IR_j - \sum_{j=1}^{j=n} IW_j \times IR_j = \sum_{j=1}^{j=n} (PW_j - IW_j) \times IR_j$$

OR

Brinson & Fachler

$$= \sum_{j=1}^{j=n} (PW_j - IW_j) \times (IR_j - b)$$

Since $\sum_{j=1}^{j=n} PW_j = \sum_{j=1}^{j=n} IW_j = 1$

Stock Selection & Interaction

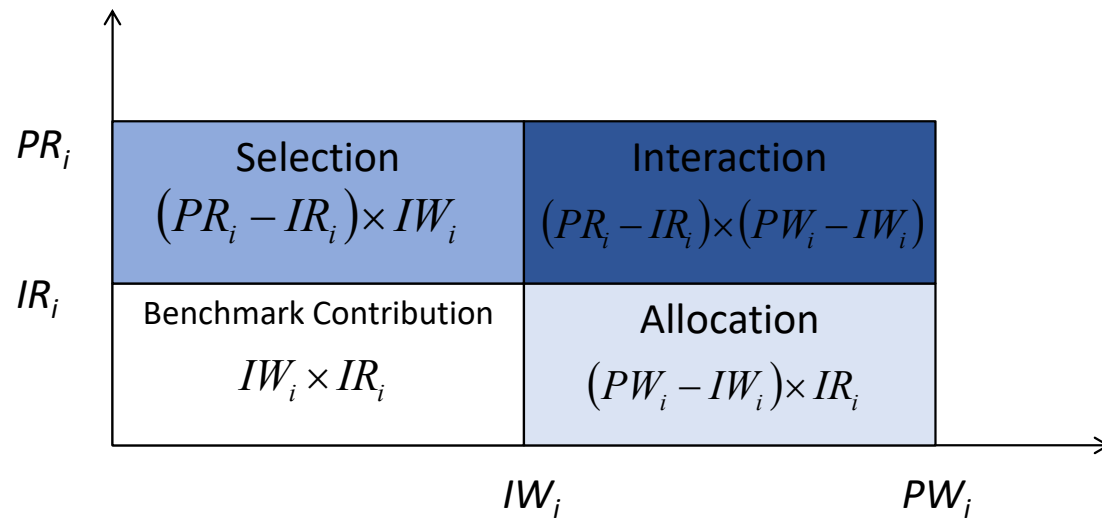
Stock Selection

$$\sum_{j=1}^{j=n} IW_j \times PR_j - \sum_{j=1}^{j=n} IW_j \times IR_j = \sum_{j=1}^{j=n} IW_j \times (PR_j - IR_j)$$

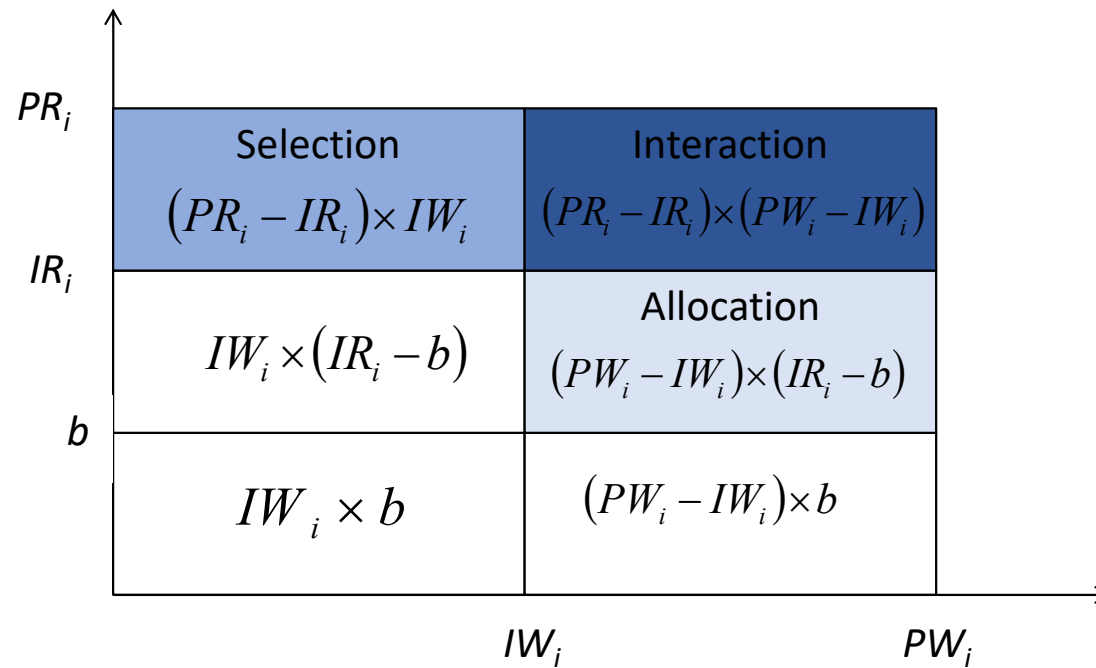
Interaction

$$\sum_{j=1}^{j=n} PW_j \times PR_j - \sum_{j=1}^{j=n} PW_j \times IR_j - \sum_{j=1}^{j=n} IW_j \times PR_j + \sum_{j=1}^{j=n} IW_j \times IR_j = \sum_{j=1}^{j=n} (PW_j - IW_j) \times (PR_j - IR_j)$$

Attribution Effects (Brinson, Hood & Beebower)



Attribution Effects (Brinson& Fachler)



Attribution Formula

- Allocation
 - Allocation effects between asset categories
 - Overweight, underweight
- Selection
 - Selection effect within asset categories
- Interaction
 - Combination of asset allocation and selection effects

Example (Brinson, Hood & Beebower – Allocation)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return
UK	40%	40%	20.0	10.0
Japan	30%	20%	-5.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4

Total Excess Return

8.3 - 6.4 = 1.9

Allocation

UK $[40\% - 40\%] \times 10.0 = 0.0$

JAPAN $[30\% - 20\%] \times -4.0 = -0.4$

US $[30\% - 40\%] \times 8.0 = -0.8$

TOTAL $0.0 - 0.4 - 0.8 = -1.2$

Example (Brinson Fachler – Allocation)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return
UK	40%	40%	20.0	10.0
Japan	30%	20%	-5.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4

Total Excess Return

$$8.3 - 6.4 = 1.9$$

Allocation

UK $[40\% - 40\%] \times (10.0 - 6.4) = 0$

JAPAN $[30\% - 20\%] \times (-4.0 - 6.4) = -1.04$

US $[30\% - 40\%] \times (8.0 - 6.4) = -0.16$

TOTAL $0 - 1.04 - 0.16 = -1.2$

Example (Selection)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return
UK	40%	40%	20.0	10.0
Japan	30%	20%	-5.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4
Total Excess Return			8.3 - 6.4 = 1.9	
Selection				
UK			[40%] x (20.0-10.0) = 4.0	
JAPAN			[20%] x (-5.0+4.0) = -0.2	
US			[40%] x (6.0-8.0) = -0.8	
TOTAL			4.0 - 0.2 - 0.8 = 3.0	

Example (Interaction)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return
UK	40%	40%	20.0	10.0
Japan	30%	20%	-5.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4
Total Excess Return			8.3 - 6.4 = 1.9	
Interaction				
UK			$[40\% - 40\%] \times (20.0 - 10.0) = 0$	
JAPAN			$[30\% - 20\%] \times (-5.0 + 4.0) = -0.1$	
US			$[30\% - 40\%] \times (6.0 - 8.0) = 0.2$	
TOTAL			$0 - 0.1 + 0.2 = 0.1$	
TOTAL			-1.2 + 3.0 + 0.1 = 1.9	

Brinson Model

<p>Quadrant 4</p> <p>Portfolio Return</p> $r = \sum_{j=1}^{j=n} PW_j \times PR_j$	<p>Quadrant 2</p> <p>Allocation Return</p> $b_S = \sum_{j=1}^{j=n} PW_j \times IR_j$
	<p>Quadrant 1</p> <p>Benchmark Return</p> $b = \sum_{j=1}^{j=n} IW_j \times IR_j$

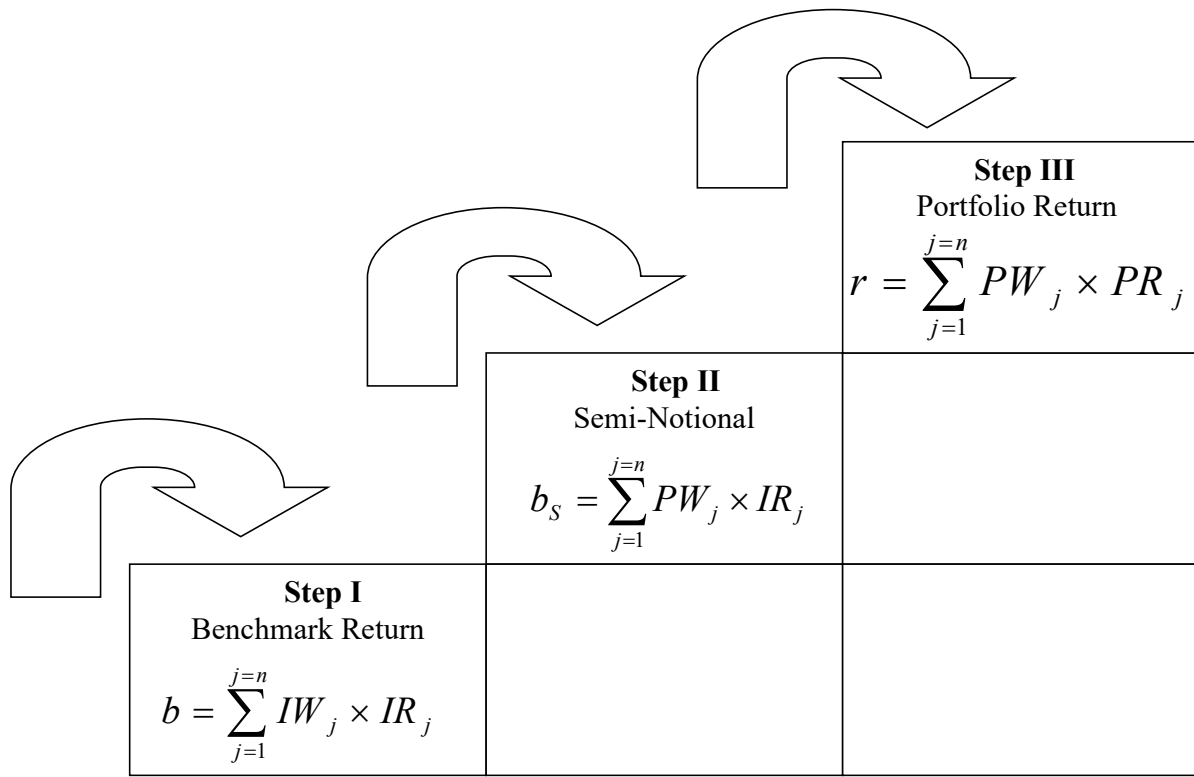
Stock Selection Including Interaction

Excess Return = Quadrant 4 – Quadrant 1

Allocation = Quadrant 2 – Quadrant 1

Selection = Quadrant 4 – Quadrant 2

Brinson Model



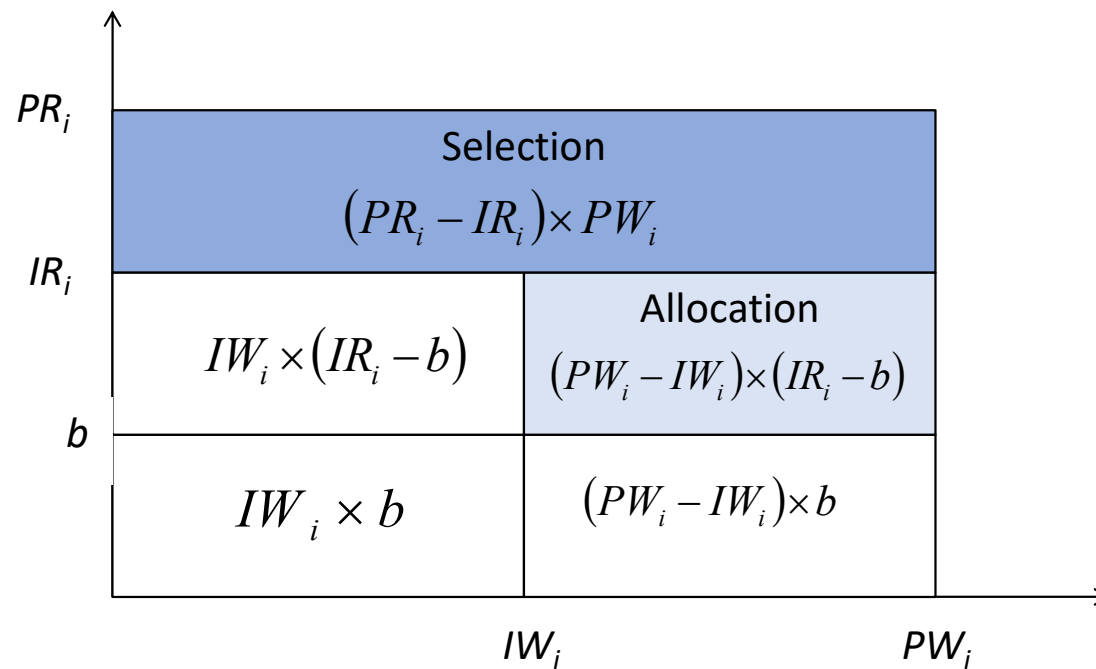
Selection Including Interaction

Selection

$$\sum_{j=1}^{j=n} PW_j \times PR_j - \sum_{j=1}^{j=n} PW_j \times IR_j = \sum_{j=1}^{j=n} PW_j \times (PR_j - IR_j)$$

No Interaction

Attribution Effects



Attribution Formula

- Only two types of attribution formula
 - Allocation
 - Selection
- Repeated at different levels of analysis
 - Managers
 - Assets
 - Countries/regions
 - Sectors
 - Securities

Asset Classes

- An investment asset class should:
 - have distinct risk-return properties
 - homogeneous
 - mutually exclusive
 - diversifying

Asset Classes

01 Public

- Equities
- Bonds

02 Private

- Equities
- Debt
- Real Estate
- Infrastructure
- Natural Resources

03 Commodities

04 Cash, Currency, Derivatives and Alternatives

05 Overlay

06 Balanced Strategies

- Two or more asset classes (not counting cash)

Example (Selection with Interaction)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return
UK	40%	40%	20.0	10.0
Japan	30%	20%	-5.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4

Total Excess Return

$$8.3 - 6.4 = 1.9$$

Stock Selection

UK	$[40\%] \times (20.0 - 10.0) = 4.0$
JAPAN	$[30\%] \times (-5.0 + 4.0) = -0.3$
US	$[30\%] \times (6.0 - 8.0) = -0.6$
TOTAL	$4.0 - 0.3 - 0.6 = 3.1$

Geometric Attribution

- Total Portfolio performance

$$r = \sum_{j=1}^{j=n} PW_j \times PR_j$$

Semi-notional fund

$$b_s = \sum_{j=1}^{j=n} PW_j \times IR_j$$

Benchmark

$$b = \sum_{j=1}^{j=n} IW_j \times IR_j$$

- Geometric Excess Return

$$(1 + g) = \frac{(1 + r)}{(1 + b)}$$

- Expanding

$$(1 + g) = \frac{(1 + r)}{(1 + b_s)} \times \frac{(1 + b_s)}{(1 + b)}$$

Geometric Attribution

Allocation
$$\sum_{j=1}^{j=n} (PW_j - IW_j) \times \left(\frac{1 + IR_j}{1 + b} - 1 \right)$$

Selection
$$\sum_{j=1}^{j=n} PW_j \times \left(\frac{1 + PR_j}{1 + IR_j} - 1 \right) \times \left(\frac{1 + IR_j}{1 + b_S} \right)$$

Geometric Worked Example (Allocation)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return	Semi-Notional
UK	40%	40%	20.0	10.0	10.0
Japan	30%	20%	-5.0	-4.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4	5.2

Total Excess Return $\frac{1.083}{1.064} - 1 = 1.79$

Allocation

UK $[40\% - 40\%] \times \left(\frac{1.10}{1.064} - 1 \right) = 0$

JAPAN $[30\% - 20\%] \times \left(\frac{0.96}{1.064} - 1 \right) = -0.97$

US $[30\% - 40\%] \times \left(\frac{1.08}{1.064} - 1 \right) = -0.15$

TOTAL $0 - 0.97 - 0.15 = -1.13$

or alternatively

$\frac{1.052}{1.064} - 1 = -1.13$

Example (Selection)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return	Semi-Notional
UK	40%	40%	20.0	10.0	10.0
Japan	30%	20%	-5.0	-4.0	-4.0
US	<u>30%</u>	<u>40%</u>	<u>6.0</u>	<u>8.0</u>	<u>8.0</u>
Total	100%	100%	8.3	6.4	5.2

Selection

$$\text{UK} \quad [40\%] \times \left(\frac{1.20}{1.10} - 1 \right) \times \left(\frac{1.10}{1.052} \right) = 3.80$$

$$\text{JAPAN} \quad [30\%] \times \left(\frac{0.95}{0.96} - 1 \right) \times \left(\frac{0.96}{1.052} \right) = -0.28$$

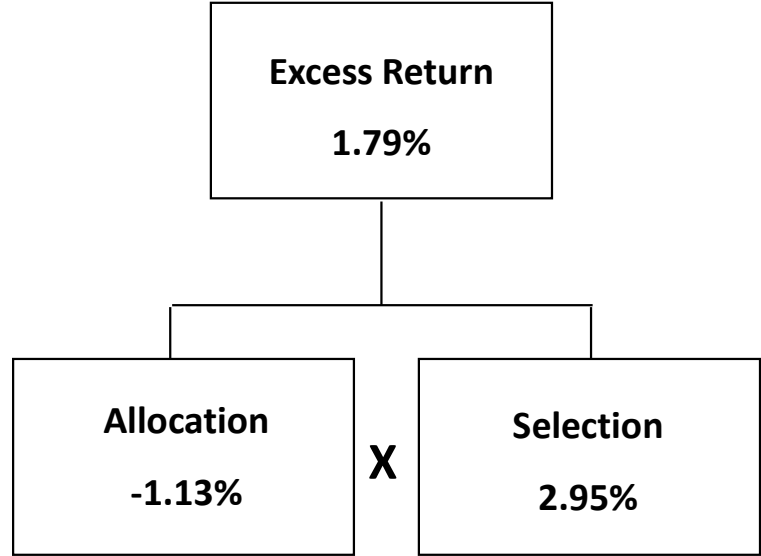
$$\text{US} \quad [30\%] \times \left(\frac{1.06}{1.08} - 1 \right) \times \left(\frac{1.08}{1.052} \right) = -0.57$$

$$\text{TOTAL} \quad 3.80 - 0.28 - 0.57 = 2.95$$

or alternatively

$$\frac{1.083}{1.052} - 1 = 2.95$$

Geometric Return Attribution



$$\frac{1.083}{1.064} - 1 = \frac{1.052}{1.064} \times \frac{1.083}{1.052} - 1 = (1 - 1.13\%) \times (1 + 2.95\%) - 1 = 1.79\%$$



Deeper Dive into Attribution

Main Types of Attribution

- Returns-based
 - factor analysis
- Holdings-based
 - calculated with reference to holdings data only
 - Monthly, weekly or daily

—————→
Increasing accuracy

- Transactions-based
 - calculated from holdings and transaction data

↑
Increasing accuracy
↓

Returns - Based

- Easy to implement
- Consistent with a factor-based investment process
- Complements traditional attribution

Advantages:



- Residuals
- Relies on appropriate factors
- Assumes constant exposure
- Errors won't be spotted

Disadvantages



Holdings - Based

- Easy to implement
- Can use alternative pricing sources

Advantages:



- Will not reconcile to performance return
- Can't be used as an operational tool
- Residual might overwhelm over factors
- Errors won't be spotted

Disadvantages



Transactions - Based

- Reconciles to performance return
- Identifies all sources of excess return
- Can be used as a diagnostic tool

Advantages:



- More difficult to implement
- Data must be complete & accurate
- Back-office inefficiencies highlighted

Disadvantages



What are the Demands?

- More detailed
 - Stock-level attribution
- More frequent
 - Demand for daily
 - Quicker delivery
- More complex strategies
 - Customized indexes
 - Futures, Swaps & options
 - Absolute return, market neutral, extended short
- Risk Attribution
 - Ex-post & ex-ante

Return Attribution

- Frequently against the benchmark
 - Classic relative attribution
- Another Portfolio
 - Identify unexpected return differences in the same strategy
- Composite or peer group
 - Assuming underlying data available
- Beginning of period
 - Measures the portfolio manager's active decisions

Security Level Attribution (Bottom Up)

- Lots of data needed
- Index data is expensive and difficult to manage
- Stock returns are often meaningless
 - Investment Gaps
 - Problems of Dietz formula
 - Extremely large cash flows
- Quality of back-office data
- Perishable

Security Level Attribution

- Bottom-up strategies
- Selection within sectors
- Communication and dialogue
- Diagnostic tool
 - Performance analyst
 - Operations
- Oversight
 - Independent directors
 - Compliance & risk control

Security Level Attribution

	Portfolio	Benchmark	Portfolio	Benchmark	Timing & Stock	
	Weight	Weight	Return	Return	Trading	Allocation
Allianz	10.2%	9.34%	15%	15%	0%	0.08%
Marconi	5.2%	0.03%	-25%	-25%	0%	-1.48%
Vodafone	15%	20.78%	3.4%	3.4%	0%	0.11%
AOL Time Warner	22%	14.67%	-5.2%	-5.2%	0%	-0.74%
Microsoft	47.6%	55.12%	6.9%	7.5%	-0.28%	-0.15%
Total	100%	100%	2.88%	5.46%	-0.28%	-2.17%

Security Level Reporting

- Time period
 - Security weights
- Stock-picking effect
- Stock additions
 - Cash
- Stock exclusions
 - Missed opportunities
 - Dodged bullets
- Overweight
- Underweight

Levels of Attribution

- Allocation
 - Manager
 - Asset (Equities, Bonds, Private Equity, Real Estate, Alternatives)
 - Country/ region
 - Industrial sector
 - Securities (Bottom-up strategies)
- Selection
 - Manager performance
 - Selection (within, assets countries and sectors)
 - Timing with securities

Off-Benchmark Attribution (Selection Only)

	Portfolio	Benchmark	Portfolio	Benchmark	Selection	Allocation
	Weight	Weight	Return	Return		
UK	40%	40%	20%	10%	3.89%	0%
Japan	30%	20%	-5%	-4%	-0.29%	-0.98%
US	20%	40%	6%	8%	-0.38%	-0.30%
Emerging Markets	10%	0%	8%	6.4%	0.15%	0%
Total	100%	100%	8.5%	6.4%	3.29%	-1.28%

Use overall benchmark for Emerging Market segment

Off-Benchmark Attribution (Allocation Only)

	Portfolio	Benchmark	Portfolio	Benchmark	Selection	Allocation
	Weight	Weight	Return	Return		
UK	40%	40%	20%	10%	3.81%	0%
Japan	30%	20%	-5%	-4%	-0.29%	-0.98%
US	20%	40%	6%	8%	-0.38%	-0.30%
Emerging Markets	10%	0%	8%	8%	0.15%	0.15%
Total	100%	100%	8.5%	6.4%	3.14%	-1.13%

Use portfolio return as proxy for Emerging Market benchmark return

Off-Benchmark (Selection and Allocation Only)

	Portfolio	Benchmark	Portfolio	Benchmark	Selection	Allocation
	Weight	Weight	Return	Return		
UK	40%	40%	20%	10%	3.80%	0%
Japan	30%	20%	-5%	-4%	-0.28%	-0.98%
US	20%	40%	6%	8%	-0.38%	-0.30%
Emerging Markets	10%	0%	8%	9.4%	-0.13%	0.28%
Total	100%	100%	8.5%	6.4%	3.00%	-1.00%

Identify an appropriate Emerging Market benchmark return (ex-ante)

Off-Benchmark (0% Benchmark)

	Portfolio	Benchmark	Portfolio	Benchmark	Selection	Allocation
	Weight	Weight	Return	Return		
UK	40%	40%	20%	10%	3.80%	0%
Japan	30%	20%	-5%	-4%	-0.28%	-0.98%
US	20%	40%	6%	8%	-0.38%	-0.30%
Emerging Markets	10%	0%	8%	0%	0.77%	-0.60%
Total	100%	100%	8.5%	6.4%	3.93%	-1.88%

Zero % benchmark replacing no benchmark - misleading

Other Attribution Issues

- Transaction costs
- Residuals
- Division by zero (Methodology)
- Abnormal returns (Methodology)
- Cash included?

Fixed Income Attribution

- **Very different from Equity attribution!**
 - Different Investment Process
 - Fixed Income managers are more concerned about yield curve effects
 - Parallel shift, steepening, or flattening yield curve
 - Credit spreads
- Unadjusted Brinson model not suitable for most strategies



Yield Curve Construction

Spot, par, and forward curves

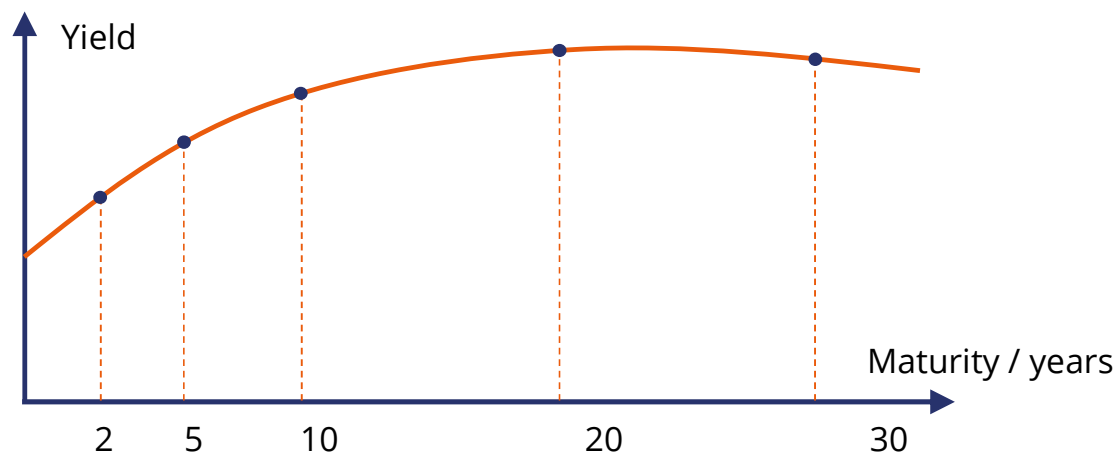
A yield curve shows the yields on various bonds plotted against their maturities. The description of such rates is the term structure of interest rates.

The spot rate yield curve (a.k.a. zero or strip curve) shows the spot rates (as defined earlier), a par bond yield curve shows the YTM of bonds trading at par.

A forward yield curve shows the implied rates for bonds of the same maturity (typically one year) for starting dates in the future.

A typical yield curve may look like the diagram, though without extensive data it is convention to use linear interpolation between the observed points.

Note that upward-sloping = **normal**, downward-sloping = **inverted**.



Calculating the par yield curve

- Given a series of spot rates, the par yield curve can be computed, as shown in the following example.
- If spot rates of 3%, 3.5% and 4% are given for 1, 2, and 3-year maturities, calculate the equivalent par yields.

Solution

$$1 \text{ year: } 100 = \frac{C + P}{(1 + Z_1)^1} = \frac{C + 100}{1.03} \Rightarrow C = 0.03 = 3\%$$

$$2 \text{ year: } 100 = \frac{C}{(1 + Z_1)^1} + \frac{C + P}{(1 + Z_2)^2} = \frac{C}{1.03} + \frac{C + 100}{1.035^2} \Rightarrow C = 3.4914$$

$$3 \text{ year: } 100 = \frac{C}{(1 + Z_1)^1} + \frac{C}{(1 + Z_2)^2} + \frac{C + P}{(1 + Z_3)^3} = \frac{C}{1.03} + \frac{C}{1.035^2} + \frac{C + 100}{1.04^3} \Rightarrow C = 3.9738$$

Yield spread measures

A yield spread is the difference between the yields-to-maturity of two fixed income securities, typically a bond being analyzed and a benchmark bond (benchmark spread).

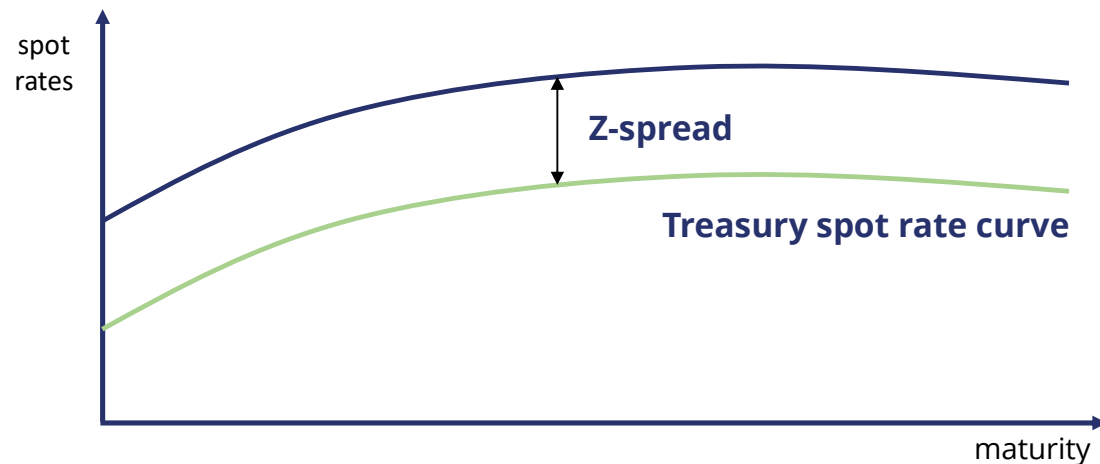
- Example: A 10-year, 5% Treasury bond is trading at par, while a 10-year, 8% corporate bond has a YTM of 7.40% and is priced at 104.19. Calculate the benchmark spread.
- Solution: YTM of Treasury bond = 5%, since it is trading at par.

Hence benchmark spread = $YTM_{\text{corporate}} - YTM_{\text{Treasury}} = 7.40\% - 5\% = 2.40\% = 240 \text{ bps}$.

- If a government bond is being used as benchmark (actual or interpolated), the spread is known as the G-spread. The most appropriate benchmark would be the on-the-run bond of closest maturity to the subject bond.
- An alternative MRR-based benchmark is the interest rate swap rate (see Derivatives), with the same currency and similar tenor: such a spread is the interpolated spread, or I-spread.

Yield spread measures

- Zero-volatility spread (or Z-spread or static spread): This is a measure of the spread that is added to each spot rate on the benchmark yield curve for the sum of the discounted cash flows to equal the bond's trading price.



The Z-spread avoids the assumption in the G/I-spreads that the yield curve is flat. Note that the Z-spread represents a parallel shift of the entire spot rate curve.

Factors Influencing Yield Curves - Level & Slope

Level Factor:

- Represents the most significant and persistent influence on the yield curve.
- Directly related to long-term expectations about inflation and economic growth.
- A higher level generally indicates expectations of higher inflation and stronger growth.

Slope Factor:

- Less persistent but highly indicative of the business cycle phases.
- Reflects changes in short-term monetary policy and broader economic conditions.
- A steeper slope often signifies tighter monetary policy and an expanding economy.

Factors Influencing Yield Curves - Curvature

Curvature Factor:

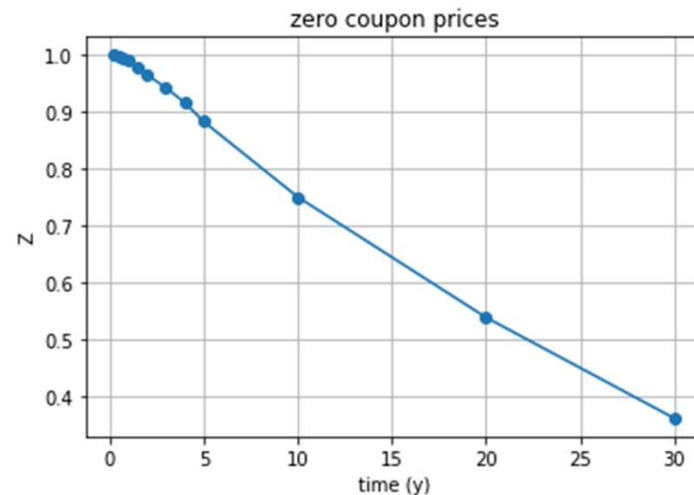
- The most complex and least predictable component of yield curve behavior.
- Influenced by market sentiment and varying degrees of risk aversion among investors.
- It reflects short-term fluctuations and anomalies in the bond market.

Orthogonality of Factors:

- Each factor (level, slope, curvature) operates independently (orthogonally).
- Different macroeconomic determinants drive these factors, affecting the yield curve in distinct ways.

Zero Coupon Yield Curves

- Yield curves are used to estimate the future yields of bonds with different maturities.
- They are the yields of bonds that do not pay any periodic interest payments, but instead pay a single lump sum at maturity.
- Also known as spot rates or spot yields.
- Can be estimated by using the prices of bonds with different maturities and solving for the discount rate that equates the present value of the bond's cash flows to its current market price.
- Can be used to estimate forward rates, which are the expected yields of bonds with different maturities at some future point in time.
- They are interchangeable with bond prices and forward rates, meaning that knowledge of any one of these variables implies knowledge of the other two



Understanding The Zero Rate And Forward Rate Dynamics

- Zero rates are the yields of bonds that do not pay any periodic interest payments, but instead pay a single lump sum at maturity. They represent the discount rates that equate the present value of a bond's cash flows to its current market price.
- Forward rates are the expected yields of bonds with different maturities at some future point in time. They can be estimated from the yield curve and represent the market's expectations for future interest rates.

Understanding The Zero Rate And Forward Rate Dynamics

- The relationship between zero rates and forward rates is given by the formula:

$$(1 + z(n))^n = (1 + f(n, n+1))^n * (1 + z(n+1))^{(n+1)}$$

- where $z(n)$ is the zero rate for a bond with maturity n , $f(n, n+1)$ is the forward rate for the period between n and $n+1$, and $z(n+1)$ is the zero rate for a bond with maturity $n+1$.
- This formula shows that the zero rate for a bond with maturity n is a function of the forward rates for the period between n and $n+1$, as well as the zero rate for a bond with maturity $n+1$. In other words, the zero rate for a longer-term bond depends on the expected yields of shorter-term bonds.

Understanding The Zero Rate And Forward Rate Dynamics

- The dynamics of zero rates and forward rates are influenced by a variety of factors, including inflation expectations, economic growth, monetary policy, and market sentiment. Changes in these factors can cause shifts in the yield curve, which in turn affect the level and slope of zero rates and forward rates.
- Understanding the dynamics of zero rates and forward rates is important for bond investors, as it can help them to make informed decisions about the timing and duration of their investments

Program: Associate Training Program | Portfolio Monitoring





Appendix

Appendix A – Calculation Examples

i) Simple Dietz

$$\frac{MEV - MSV - C}{MSV + C / 2} = \frac{104,410,909 - 74,180,620 - 37,136,058}{74,180,620 + 37,136,058 / 2} = -7.45\%$$

ii) a) Modified Dietz (End of Day)

$$\frac{MEV - MSV - C}{ACE} = \frac{104,410,909 - 74,180,620 - 37,136,058}{74,180,620 + (37,136,058 * 17 / 31)} = -7.30\%$$

ii) b) Modified Dietz (Start of Day)

$$\frac{MEV - MSV - C}{ACE} = \frac{104,410,909 - 74,180,620 - 37,136,058}{74,180,620 + (37,136,058 * 18 / 31)} = -7.21\%$$

Appendix A – Calculation Examples

iii) True Time Weighted

$$\frac{66,014,931}{74,180,620} \times \frac{104,410,909}{66,014,931 + 37,136,058} - 1 = 0.8899 \times 1.0122 - 1 = -9.92\%$$

Valuation error

$$\frac{66,258,130}{74,180,620} \times \frac{104,410,909}{66,258,130 + 37,136,058} - 1 = 0.8932 \times 1.0098 - 1 = -9.80\%$$

Large valuation error

$$\frac{68,320,351}{74,180,620} \times \frac{104,410,909}{68,320,351 + 37,136,058} - 1 = 0.921 \times 0.99 - 1 = -8.82\%$$