Evolution of Performance Attribution Methodologies

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Round-Table "Performance Attribution"
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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

What is Performance Attribution?

- **Definition:**

  Performance attribution is a technique used to quantify the excess returns of a portfolio against it's benchmark into the active decisions of the investment management process.

Why is Attribution Important ?

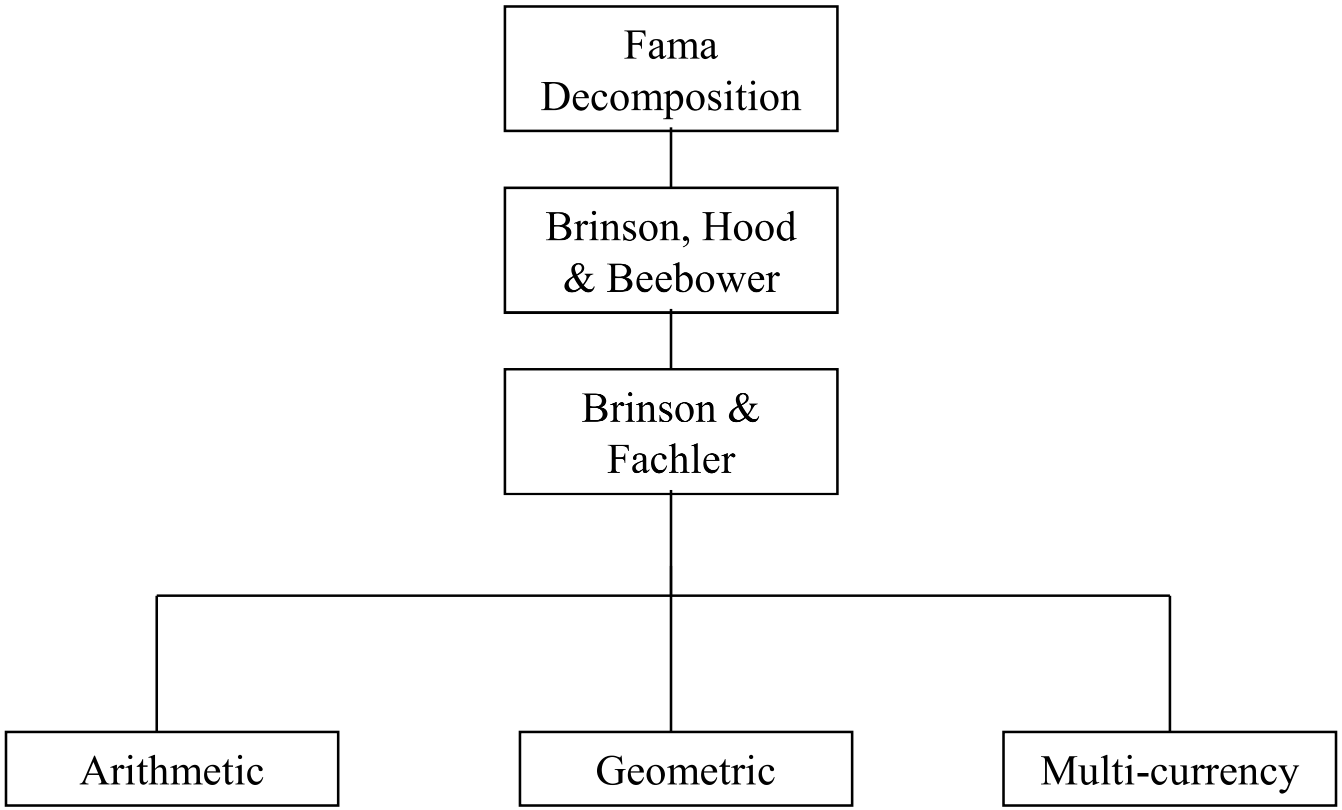
- Key management tool
  - Analysts
  - Portfolio Managers
  - Senior Management
  - Consultants
  - Clients

Performance Analyst

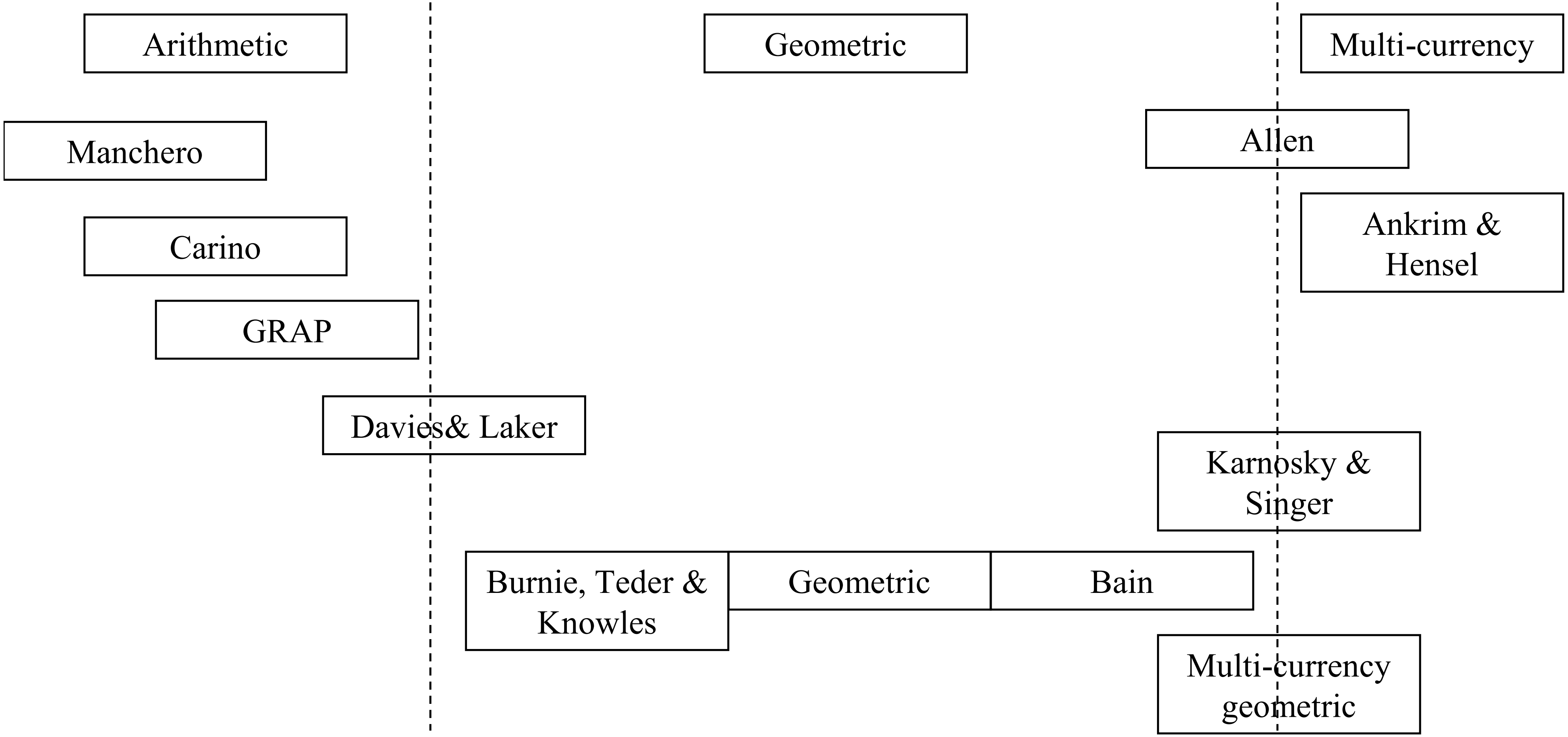
Allows:

- The measurer to add value
- Participate in the Investment process
- Act as a control function
- and raises the profile of the '*Performance Measurement Function*'

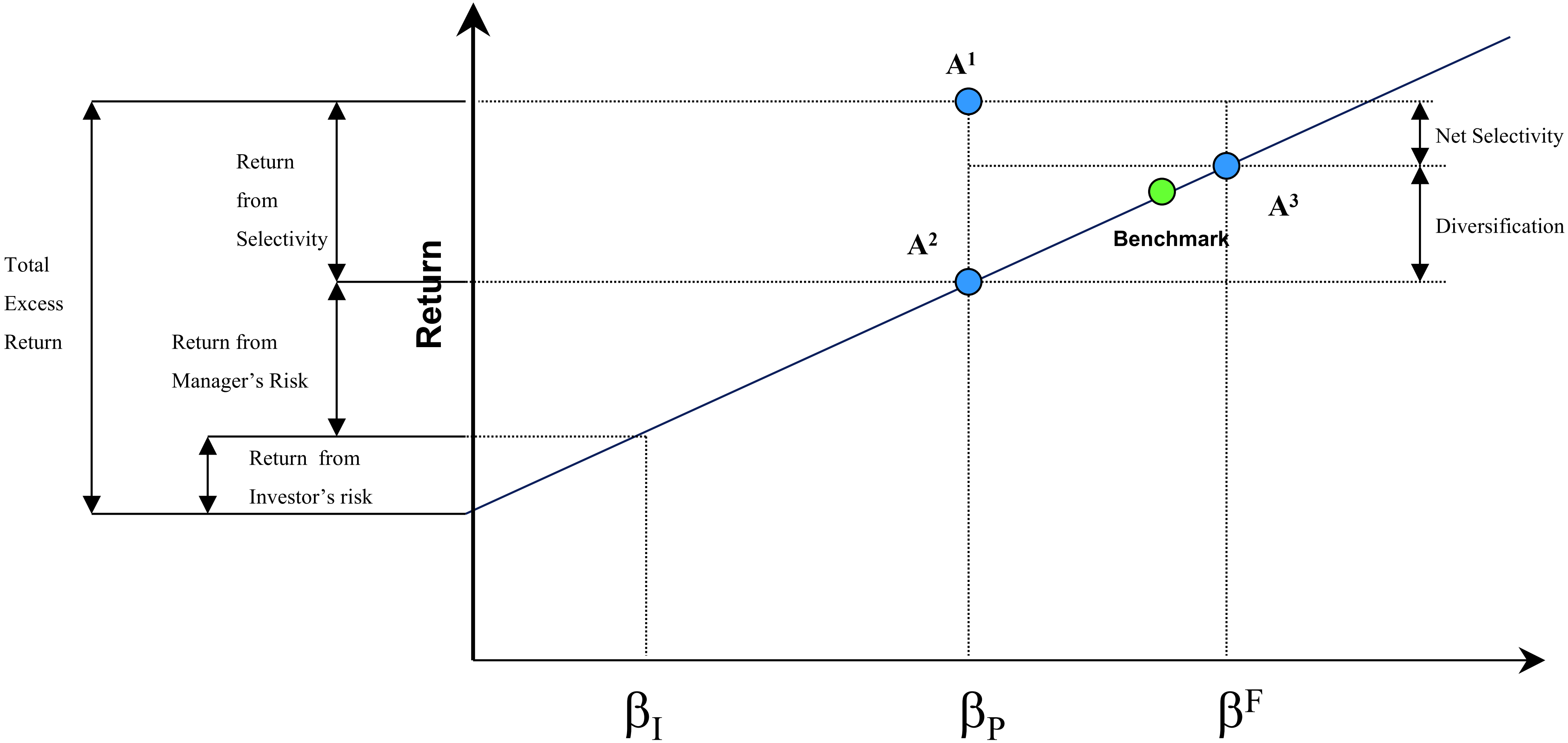
Evolution of Performance Attribution Methodologies



Evolution of Performance Attribution Methodologies



Fama Decomposition 1972



Attribution - Brinson Model (1985, 1986 & 1991)

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:

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

Allocation

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

Selection

Brinson Model

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

Brinson attribution

Excess Return = Quadrant 1 – Quadrant 4

Asset Allocation = Quadrant 2 – Quadrant 4

Stock Selection = Quadrant 3 – Quadrant 4

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

Brinson Fachler

Asset Allocation

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

Brinson Hood Beebower

OR

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

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

Brinson Fachler

Stock Selection

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

Interaction

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

Arithmetic Worked Example (Asset allocation)

	Portfolio Weight	Benchmark Weight	Portfolio Return	Index Return
UK	40%	40%	20.0	10.0
Japan	30%	20%	-5.0	-4.0
US	30%	40%	6.0	8.0
Total	100%	100%	8.3	6.4
Total Excess Return		**8.3 - 6.4 =1.9**		

Asset (or country) Allocation

UK	[40%-40%] x (10.0-6.4) = 0
JAPAN	[30%-20%] x (-4.0-6.4) = -1.04
US	[30%-40%] x (8.0-6.4) = -0.16
TOTAL	0-1.04 - 0.16 = -1.2

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Example (Stock 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**		
Stock 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

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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	30%	40%	6.0	8.0
Total	100%	100%	8.3	6.4

Total Excess Return **8.3 - 6.4 =1.9**

Interaction

UK	[40%-40%] x (20.0-10.0) = 0
JAPAN	[30%-20%] x (-5.0+4.0) = -0.1
US	[30%-40%] x (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

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

Stock Selection including Interaction

Excess Return = Quadrant 1 – Quadrant 4

Asset Allocation = Quadrant 2 – Quadrant 4

Stock Selection = Quadrant 1 – Quadrant 2

Brinson Model

Step I
Benchmark Return

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

Step II
Semi-Notional

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

Step III
Portfolio Return

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

Brinson Fachler

Stock Selection

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

No Interaction

Example (Stock 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	30%	40%	6.0	8.0
Total	100%	100%	8.3	6.4

Total Excess Return **8.3 - 6.4 =1.9**

Stock Selection

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

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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 :

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

- and similarly for benchmark performance

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

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

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

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

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

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

Geometric Attribution (Various 1990's)

- Total Portfolio performance $$r = \sum_{j=1}^{j=n} PW_j \times PR_j$$

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

  Rename semi-notional fund $$b_S = \sum_{j=1}^{j=n} PW_j \times IR_j$$

  (Index returns applied to actual portfolio weights)

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

- Expanding $$(1+g) = \frac{(1+r)}{(1+b_S)} \times \frac{(1+b_S)}{(1+b)}$$

Stock Selection   Market Selection

Geometric Attribution

Asset Allocation

$$(PW_i - IW_i) \times \left(\frac{1 + IR_i}{1 + b} - 1 \right)$$

Stock Selection

$$PW_i \times \left(\frac{1 + PR_i}{1 + IR_i} - 1 \right) \times \left(\frac{1 + IR_i}{1 + b_S} \right)$$

Geometric Worked Example (Asset 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	30%	40%	6.0	8.0	8.0
Total	100%	100%	8.3	6.4	5.2

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

Asset (or country) 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 $$\frac{1.052}{1.064} - 1 = -1.13$$

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Example (Stock 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	30%	40%	6.0	8.0	8.0
Total	100%	100%	8.3	6.4	5.2

Stock Selection

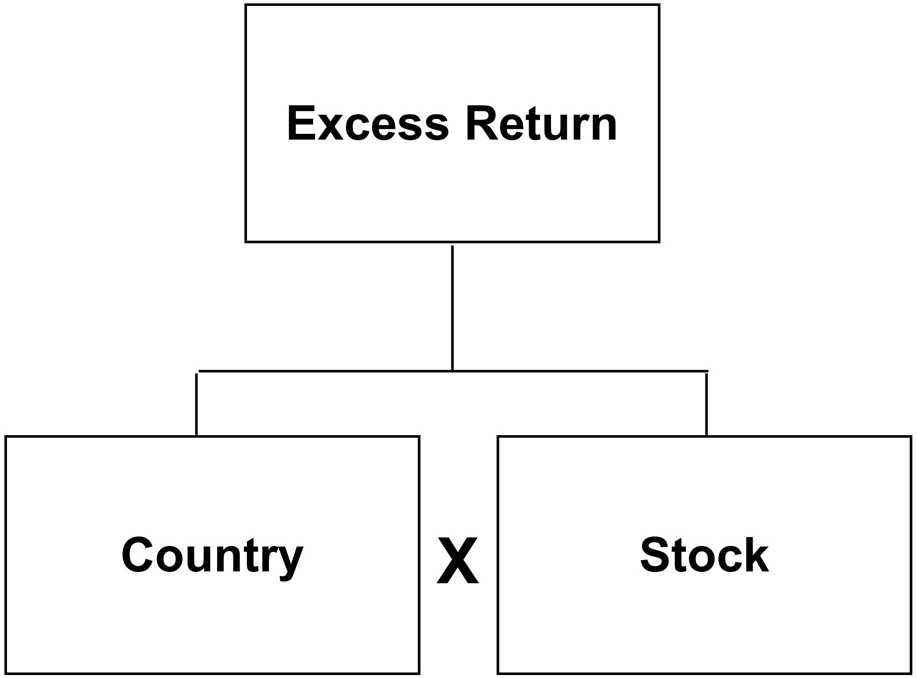
UK $$[40\%]\times\left(\frac{1.20}{1.10}-1\right)\times\left(\frac{1.10}{1.052}\right)=3.80$$

JAPAN $$[30\%]\times\left(\frac{0.95}{0.96}-1\right)\times\left(\frac{0.96}{1.052}\right)=-0.285$$

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

TOTAL 3.80 - 0.28 - 0.57 = 2.95 **or alternatively** $\frac{1.083}{1.052}-1=2.95$

Geometric Performance Attribution



Excess Return Attribution ?

Preferences:

Arithmetic Excess Return =
Arithmetic Attribution Methodology

Geometric Excess Return =
Geometric Attribution Methodology

Smoothing Algorithms

Natural consequence of using arithmetic excess returns!

- Two approaches:
  - Genuine Smoothing algorithms
    - "Square pegs into round holes"
  - Excess return reinvestment
    - Arithmetic factors restated

Carino Smoothing (1999)

Using logs (or continuous compounding)

$$\ln\left(1+R\right) = \ln(1+R_1) + \ln(1+R_2) + \ldots\ldots\ldots + \ln(1+R_T)$$

Excess Return:

$$\ln\left(1+R\right) - \ln(1+B) = \ln(1+R_1) - \ln(1+B_1) + \ldots\ldots\ldots + \ln(1+R_T) - \ln(1+B_T)$$

Carino Smoothing

Introduce the term k_t

$$k_t = \frac{\ln(1 + R_t) - \ln(1 + B_t)}{R_t - B_t}$$

Then

$$\ln(1 + R) - \ln(1 + B) = \sum_{t=1}^{T} k_t \times (R_t - B_t)$$

Carino Smoothing

Divide by *K*

$$K = \left[\ln(1+R) - \ln(1+B)\right] \Big/ (R - B)$$

New Multi-period arithmetic Factor

= Old Single period Arithmetic Factor $\times \dfrac{K_t}{K}$

Manchero Smoothing (2000)

Clearly: $R - B \neq \sum (R_t - B_t)$

Need factor A that satisfies: $R - B \approx A \sum_{t=1}^{T} (R_t - B_t)$

A = Average Arithmetic Difference or
Geometric Mean Difference

$$A = \frac{(R - B)/T}{\left[(1 + R)^{1/T} - (I + B)^{1/T}\right]}$$

Manchero Smoothing

- A still leaves a residual
- Create Corrective term α_t so that:

$$R - B = \sum_{t=1}^{T} \left(A + \alpha_t\right) \times \left(R_t - B_t\right)$$

$$\alpha_t = \left[\left(R - B - A \times \sum_{j=1}^{T} (R_j - B_j)\right) \Big/ \sum_{j=1}^{T} \left(R_j - B_j\right)^2\right] \times \left(R_t - B_t\right)$$

Manchero Smoothing

New Multi-period arithmetic Factor

= Old Single period Arithmetic Factor $\times\ (A + \alpha_t)$

$$A = (1/T) \times \left[(R - B)\big/\left((1+R)^{1/T} - (1+B)^{1/T}\right)\right] \qquad (R \neq B)$$

$$A = (1+R)^{((T-1)/T)} \qquad (R = B)$$

$$\alpha_t = \left[\left(R - B - A \times \sum_{j=1}^{T} (R_j - B_j)\right)\Big/\sum_{j=1}^{T} (R_j - B_j)^2\right] \times (R_t - B_t)$$

GRAP Institute Method (1997)

Let E_i be the arithmetic excess return in period *i* then:

$$R_1 = B_1 + E_1 \qquad \text{and} \qquad R_2 = B_2 + E_2$$

Thus the total excess return is:

$$\begin{aligned} 1 + R &= (1 + B_1 + E_1)(1 + B_2 + E_2) \\ &= (1 + B_1 + E_1)(1 + B_2) + (1 + B_1 + E_1)E_2 \\ &= (1 + B_1)(1 + B_2) + E_1(1 + B_2) + (1 + R_1)E_2 \\ &= (1 + B) + E_1(1 + B_2) + (1 + R_1)E_2 \end{aligned}$$

$$E = E_1(1 + B_2) + (1 + R_1)E_2$$

GRAP Institute Method

We can generalised for n periods:

$$E = \sum_{T=1}^{n} E_T \times \prod_{t=1}^{T-1}\left(1 + R_t\right) \times \prod_{t=T+1}^{n}(1 + B_t)$$

Frongello Linking Algorithm (2002)

$$F_{it} = A_{it} \times \left(\prod_{t=1}^{t-1} (1 + R_t) \right) + B_t \times \sum_{t=1}^{t-1} F_{it}$$

Geometric Linking

- Geometric Excess Return $$\left(1+G\right)=\frac{\left(1+R\right)}{\left(1+B\right)}$$
- Stock selection $$\left(1+S\right)=\frac{\left(1+R\right)}{\left(1+B_{SN}\right)}$$
- Market allocation $$\left(1+M\right)=\frac{\left(1+B_{SN}\right)}{\left(1+B\right)}$$
- it follows: $$\left(1+G\right)=\left(1+S\right)\times\left(1+M\right)$$
- By definition no residuals

$$\left(1+G\right)=\left(1+S_1\right)\times\left(1+S_2\right)\ldots\left(1+S_n\right)\times\left(1+M_1\right)\times\left(1+M_2\right)\ldots\times\left(1+M_n\right)$$

Main Differences in Approach

- Interaction
- Arithmetic or Geometric
- Interest rate differentials
- Transactions
- Residuals
- Smoothing algorithms
- Daily v's monthly

Other Forms of Attribution

- Stock level attribution
- Multi-currency attribution
- Trading attribution
- Risk adjusted attribution
- Risk attribution (ex-ante)
- Fixed income attribution
- Style analysis:
  - growth value
  - large cap - small cap

Transaction Analysis

- Part of the Investment Decision Process
  - Dealing function
  - Transaction Costs
  - Market Impact
- Standard Attribution
  - All transaction cost in Stock Selection
  - Notional transfer
- Buy/hold analysis

Buy/Hold – Attribution

- **Holdings Based Attribution:**
  - Performance return attribution calculated with reference to holdings data only – Monthly, weekly or daily
- **Transaction Based Attribution**
  - Performance return attribution calculated from holdings and transaction data.

Holdings based

- **Advantages:**
  - Easy to implement
  - Can use alternative pricing sources
- **Disadvantages**
  - Will not reconcile to performance return
  - Can't be used as an operational tool
  - Residual might overwhelm over factors
  - Errors won't be spotted

Transaction based

- **Advantages:**
  - Reconciles to performance return
  - Identifies all sources of excess return
  - Can be used as a operational tool
- **Disadvantages**
  - More difficult to implement
  - Data must be complete & accurate
  - Back office inefficiencies highlighted

Does Accuracy Matter?

- Internal Controls – no residuals
- Complete Picture
- Confidence in data
- Operational improvements
  - (Investment data is poor)
- Daily calculation – not analysis

Is the error term a problem?

- **Depends:**
  – Manager Activity
  – Asset Category (Liquidity)
  – IPOs
  – Price Sources
  – Cashflow
- **Residuals**
  - Commonly single largest factor
  - Can invalidate entire analysis

Buy/hold concerns

- We are ignoring the active decision in the investment process
- Holding based attribution is least useful when we need it most – I.e. when we have a problem
- Are we letting the back office off the hook?

Currency Attribution

- Market returns compound with currency returns
- Assets denominated in currencies other than country of origin
- Forward contracts generate unrealised gains and losses
- Local returns cannot be achieved

Karnosky & Singer (1994)

$$r = \sum_{i=1}^{i=n} PW_i \times PR_{Li} + \sum_{i=1}^{i=n} PW_i \times c_i$$

$$b = \sum_{i=1}^{i=n} IW_i \times IR_{Li} + \sum_{i=1}^{i=n} IW_i \times c_i$$

Continuously compounded returns

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Karnosky & Singer

$$r = \sum_{i=1}^{i=n} PW_i \times \left(PR_{Li} - x_i\right) + \sum_{i=1}^{i=n} PW_i \times \left(c_i + x_i\right)$$

$$b = \sum_{i=1}^{i=n} IW_i \times \left(IR_{Li} - x_i\right) + \sum_{i=1}^{i=n} IW_i \times \left(c_i + x_i\right)$$

Karnosky & Singer

Excess Return

$$r - b$$

Local Attribution

$$\sum_{i=1}^{i=n} PW_i \times (PR_{Li} - x_i) - \sum_{i=1}^{i=n} IW_i \times (IR_{Li} - x_i)$$

Quadrant 1	**Quadrant 2**
Quadrant 3	**Quadrant 4**

Currency Attribution

$$\sum_{i=1}^{i=n} PW_i \times (c_i + x_i) - \sum_{i=1}^{i=n} IW_i \times (c_i + x_i)$$

Quadrant 1	**Quadrant 2**
Quadrant 3	**Quadrant 4**

Currency Returns - Definitions

- Base Return – Return in base currency of portfolio
- Local Return – Weighted average local return
- Currency return

$$\frac{S_{t+1}}{S_t} - 1$$

- Currency Forward return

$$\frac{S_{t+1}}{F_t} - 1$$

- Forward Premium

$$\frac{F_t}{S_t} - 1$$

S_t= Spot rate at time t

F_t= Forward rate at time t for conversion at time t+1

Currency - Portfolio

	Portfolio Weight	Local Return	Portfolio Return (£)	Currency Return
UK	40%	20.0	20.0	0.0
Japan	30%	-5.0	4.6	10.1
US	30%	6.0	28.0	20.8
Total	100%	8.3	17.78	9.26

Currency Return $\frac{1.1778}{1.083} - 1 = 8.75\%$

Currency Benchmark

	Benchmark Weight	Local Return	Benchmark Return (£)	Currency Return
UK	40%	10.0	10.0	0.0
Japan	20%	-4.0	5.6	10.0
US	40%	8.0	29.6	20.0
Total	100%	6.4	16.96	10.0

Currency Return $\frac{1.1696}{1.064} - 1 = 9.92\%$

“Naïve” Currency Attribution

$$\frac{\text{Portfolio Currency Return}}{\text{Benchmark Currency Return}} - 1$$

$$\frac{1.0875}{1.0992} - 1 = -1.06\%$$

Currency Attribution

- Assume currency allocation is independent
- Must be achieved by forward currency contracts
- Therefore exposed to interest rate differentials
  - Forward Premium
  - Karnosky & Singer

Currency Allocation

	Portfolio Weight	Benchmark Weight	Semi-Notional Currency	Benchmark Currency
UK	40%	40%	0.0	0.0
Japan	30%	20%	8.9	10.0
US	30%	40%	17.8	20.0
Total	100%	100%	9.1	10.0

Sterling $$[40\% - 40\%]\times\left(\frac{1.0}{1.1}-1\right)=0$$

Yen $$[30\% - 20\%]\times\left(\frac{1.089}{1.10}-1\right)=-0.1$$

Dollar $$[30\% - 40\%]\times\left(\frac{1.178}{1.10}-1\right)=-0.71$$

TOTAL $$0-0.1-0.71=-0.81$$

or alternatively $$\frac{1.091}{1.10}-1=-0.81$$

Currency Timing

	Portfolio Weight	Portfolio Return	Index Return	Currency Return	Semi Notional
UK	40%	20.0	10.0	0.0	0.0
Japan	30%	4.6	5.6	10.1	10.0
US	30%	28.0	29.6	20.8	20.0
Total	100%	17.78	16.96	9.26	9.00

Sterling $[40\%]\times\left(\frac{1.00}{1.00}-1\right)\times\left(\frac{1.00}{1.09}\right)=0.0\%$

Yen $[30\%]\times\left(\frac{1.101}{1.100}-1\right)\times\left(\frac{1.10}{1.09}\right)=0.03\%$

Dollar $[30\%]\times\left(\frac{1.208}{1.200}-1\right)\times\left(\frac{1.20}{1.09}\right)=0.21\%$

TOTAL $0+0.03+0.21=0.24$

or alternatively $\frac{1.0926}{1.09}-1=0.24\%$

Cost of Hedging (asset allocator's perspective)

	Portfolio Weight	Benchmark Weight	Semi Notional	Hedged to Neutral
UK	40%	40%	10.0	10.0
Japan	30%	20%	-4.0	-3.0
US	30%	40%	8.0	10.0
Total	100%	100%	5.2	5.1

Semi-Notional Hedged to Neutral 5.1

Sterling $$[40\% - 40\%] \times \left(\frac{1.10}{1.10} - 1\right) \times \left(\frac{1.10}{1.052}\right) = 0.0\%$$

Yen $$[30\% - 20\%] \times \left(\frac{0.97}{0.96} - 1\right) \times \left(\frac{0.96}{1.052}\right) = 0.10\%$$

Dollar $$[30\% - 40\%] \times \left(\frac{1.1}{1.08} - 1\right) \times \left(\frac{1.08}{1.052}\right) = -0.19\%$$

TOTAL $0 + 0.10 - 0.19 = -0.10\%$ **or alternatively** $\frac{1.051}{1.052} - 1 = -0.10\%$

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Revised Country Allocation

	Portfolio Weight	Benchmark Weight	Index Return	Hedged Index
UK	40%	40%	10.0	10.0
Japan	30%	20%	-4.0	-3.0
US	30%	40%	8.0	10.0
Total	100%	100%	6.4	5.1

Revised Asset (or country) Selection

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

Yen $$[30\% - 20\%] \times \left(\frac{0.97}{1.064} - 1 \right) = -0.88$$

Dollar $$[30\% - 40\%] \times \left(\frac{1.10}{1.064} - 1 \right) = -0.34$$

TOTAL $$0 - 0.88 - 0.34 = -1.22$$

or alternatively $$\frac{1.051}{1.064} - 1 = -1.22$$

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Currency Benchmark

	Benchmark Weight	Local Return	Benchmark Return (£)	Currency Return
UK	40%	10.0	10.0	0.0
Japan	20%	-4.0	5.6	10.0
US	40%	8.0	29.6	20.0
Total	100%	6.4	16.96	10.0

Currency Return $$\frac{1.1696}{1.064} - 1 = 9.92\ \%$$

Sterling 40% X 0.0% = 0.0%

Yen 20% X 10.0% = 2.0%

Dollar 40% X 20% = 8.0%

Total = 10.0% currency return

Currency Compounding (Benchmark)

	Benchmark Weight	Local Return	Benchmark Return (£)	Currency Return
UK	40%	10.0	10.0	0.0
Japan	20%	-4.0	5.6	10.0
US	40%	8.0	29.6	20.0
Total	100%	6.4	16.96	10.0

Currency Return $$\frac{1.1696}{1.064} - 1 = 9.92\%$$

Sterling $$[40\%] \times 0.0\% \times \left(\frac{1.10}{1.064}\right) = 0.0\%$$

Yen $$[20\%] \times 10.0\% \times \left(\frac{0.96}{1.064}\right) = 1.80\%$$

Dollar $$[40\%] \times 20.0\% \times \left(\frac{1.08}{1.064}\right) = 8.12\%$$

TOTAL $$= 9.92\%$$

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Benchmark Compounding

	Benchmark Weight	Benchmark Currency	Adjusted Currency
UK	40%	0.0	0.0
Japan	20%	10.0	9.0
US	40%	20.0	20.3
Total	100%	10.0	9.92

Benchmark compounding

Sterling $[40\%]\times\left(\frac{1.00}{1.00}-1\right)\times\left(\frac{1.00}{1.0992}\right)=0.0\%$

Yen $[20\%]\times\left(\frac{1.10}{1.09}-1\right)\times\left(\frac{1.09}{1.0992}\right)=0.18\%$

Dollar $[40\%]\times\left(\frac{1.20}{1.203}-1\right)\times\left(\frac{1.203}{1.0992}\right)=-0.11\%$

TOTAL $0+0.18-0.11=0.07$

or alternatively $\frac{1.10}{1.0992}-1=0.07\%$

Currency Compounding (Portfolio)

	Portfolio Weight	Local Return	Portfolio Return (£)	Currency Return
UK	40%	20.0	20.0	0.0
Japan	30%	-5.0	4.6	10.1
US	30%	6.0	28.0	20.8
Total	100%	8.3	17.78	9.26

Currency Return $\frac{1.1778}{1.083} - 1 = 8.75\%$

Sterling $[40\%] \times 0.0\% \times \left(\frac{1.20}{1.083}\right) = 0.0\%$

Yen $[30\%] \times 10.1\% \times \left(\frac{0.95}{1.083}\right) = 2.66\%$

Dollar $[30\%] \times 20.8\% \times \left(\frac{1.06}{1.083}\right) = 6.09\%$

TOTAL $= 8.75\%$

Portfolio Compounding

	Portfolio Weight	Portfolio Currency	Adjusted Currency
UK	40%	0.0	0.0
Japan	30%	10.1	8.9
US	30%	20.8	20.3
Total	100%	8.75	9.26

Portfolio compounding

Sterling $[40\%]\times\left(\frac{1.00}{1.00}-1\right)\times\left(\frac{1.00}{1.0926}\right)=0.0\%$

Yen $[30\%]\times\left(\frac{1.089}{1.101}-1\right)\times\left(\frac{1.101}{1.0926}\right)=-0.34\%$

Dollar $[30\%]\times\left(\frac{1.203}{1.208}-1\right)\times\left(\frac{1.208}{1.0926}\right)=-0.12\%$

TOTAL $0-0.34-0.12=-0.46$

or alternatively $\frac{1.0875}{1.0926}-1=-0.46\%$

Currency Attribution

$$\frac{1.0926}{1.090} \times \frac{1.090}{1.091} \times \frac{1.091}{1.100} \times \frac{1.052}{1.051} \times \frac{1.0875}{1.0926} \times \frac{1.100}{1.0992}$$

Currency Timing	Cost of Hedging Currency perspective	Currency Allocation	Cost of Hedging Country perspective	Portfolio Compounding	Benchmark Compounding

$$= \frac{1.052}{1.051} \times \frac{1.0875}{1.0992} = \text{Cost of Hedging} \times \frac{\text{Portfolio Currency}}{\text{Benchmark Currency}}$$

Currency Attribution

Currency

$$\frac{1+r_L}{1+b_{SNL}} * \frac{1+b_{SNH}}{1+b_L} * \frac{1+b_{SNL}}{1+b_{SNH}} * \frac{1+r}{1+r_L} * \frac{1+b_L}{1+b}$$

Stock

Country

Cost of Hedging

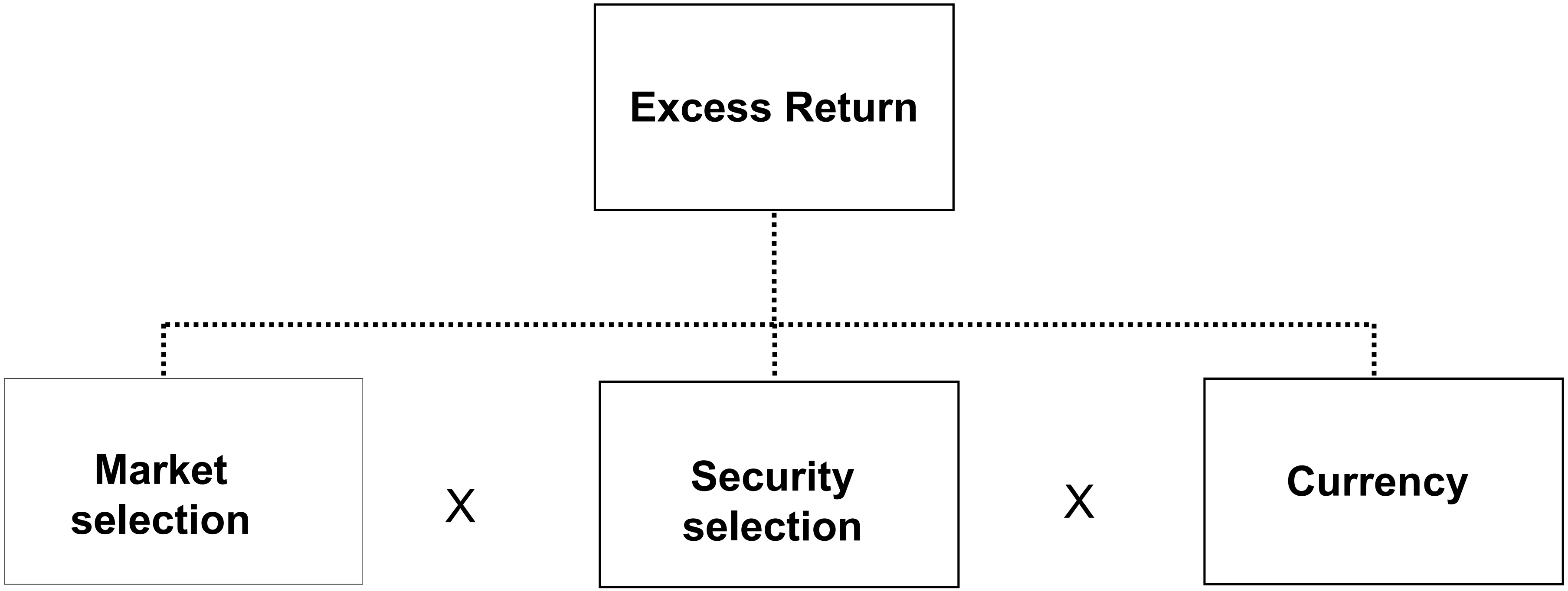
Currency Attribution

Currency

$$\frac{1.083}{1.052} \times \frac{1.051}{1.064} \times \frac{1.052}{1.051} \times \frac{1.1778}{1.083} \times \frac{1.064}{1.1696}$$

Stock | **Country** | **Cost of Hedging** | **Portfolio Currency** | **Benchmark Currency (Inverted)**

Geometric Attribution



Fixed Interest Attribution

- **Very different to Equity attribution!**
  - Fixed Income managers are more concerns about yield curve effects
  - Parallel shift, steepening or flattening yield curve
  - Credit spreads
- Daily attribution
  - Essential for active managers
- Hedged to Neutral
  - Critical for Global Bond portfolios
- Emerging debt

Fixed Income Attribution

Three Types

- Yield Curve Decomposition
- Aggregated Decomposition
- Regression Method

Single Currency – Yield Curve Attribution

- Attribute
  - Time Effect
  - Parallel Shift
  - Slope (or twist) (between two maturities)
  - Other Curve reshape (Yield curve must be input)
  - Spread effects
- Pricing

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Where next?

- Integrated Performance Attribution & Risk
- Integrated Balanced Attribution
- Complete Investment Process
  - Transactions
  - Research
- Attribution Standards

Attribution Standards

- No generic attribution methodology
- Fit the Investment Process
- Purpose?
  - Performance tool
  - Operational tool
  - Portfolio Management tool
  - Risk control tool
- Geometric v Arithmetic
- Multiple smoothing algorithms

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