HOW TO CALCULATE RETURNS
(and attribution)
ON OPTIONS, FUTURES, AND SWAPS

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Twenty-second Annual

International Performance Measurement, Attribution & Risk Conference (PMAR™)

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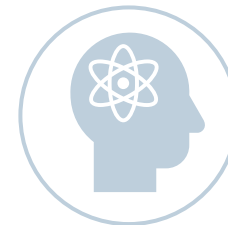# About Robust Technologies
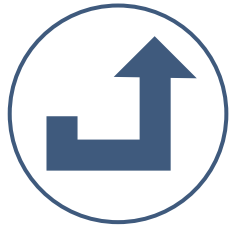
Founded

in 2006

Provide Software

Performance Measurement

Performance Attribution

Benchmark Customization

GIPS® Composites
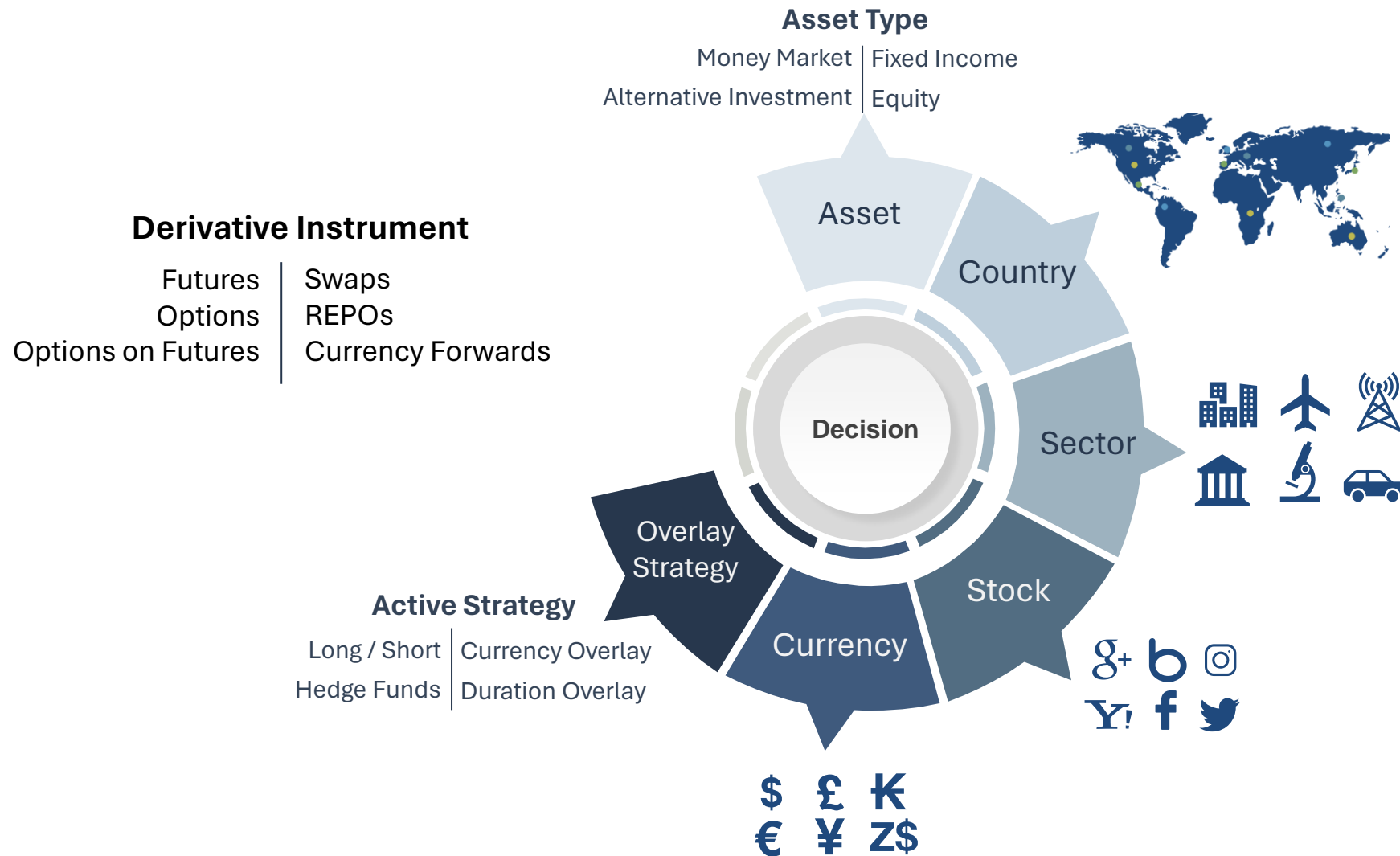
Risk Analytics

Investment Compliance

High End

Investment

Management Firms

Sophisticated

Investment Decision

Process

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Investment Management Decision Process

Asset Type

Money Market | Fixed Income

Alternative Investment | Equity

Derivative Instrument

Futures | Swaps

Options | REPOs

Options on Futures | Currency Forwards

Active Strategy

Long / Short | Currency Overlay

Hedge Funds | Duration Overlay

Asset

Country

Sector

Stock

Currency

Overlay Strategy

Decision

Challenges with Derivative Instruments

Performance

1. Produce meaningful returns that make sense economically

2. Reflect the market exposures offered by the instruments

   - Market exposure: beta (delta), duration

   - Currency exposure

Attribution

- Reflect the intent of the portfolio manager's investment decisions

Manager's decision:

Intent: Increase Equity exposures from 50% to 90%

Action: Buy additional equities worth £400 k

Before

	Portfolio					Benchmark		Attribution (BF)		
	Begin Value	End Value	P&L	Wgt	ROR	Wgt	ROR	Alloc	Selec	Total
Money Market	500,000	515,000	15,000	50%	3.00%	20%	3.00%	-1.68%	0.00%	**-1.68%**
Equities	500,000	550,000	50,000	50%	10.00%	80%	10.00%	-0.42%	0.00%	**-0.42%**
Total	**1,000,000**	**1,065,000**	**65,000**	**100%**	**6.50%**	**100%**	**8.60%**	**-2.10%**	**0.00%**	**-2.10%**

Brinson-Fachler

$$Allocation = \left(W_P^k - W_B^k\right) \times \left(R_B^k - R_B^T\right)$$

Now

Market Exposure ☑

☑

	Portfolio					Benchmark		Attribution (BF)		
	Begin Value	End Value	P&L	Wgt	ROR	Wgt	ROR	Alloc	Selec	Total
Money Market	100,000	103,000	3,000	10%	3.00%	20%	3.00%	0.56%	0.00%	**0.56%**
Equities	900,000	990,000	90,000	90%	10.00%	80%	10.00%	0.14%	0.00%	**0.14%**
Total	**1,000,000**	**1,093,000**	**93,000**	**100%**	**9.30%**	**100%**	**8.60%**	**0.70%**	**0.00%**	**0.70%**

Meaningful Attribution

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What is an Index Futures Contract?

1   Obligation to purchase or sell a given basket of securities at a specified date and price (contract).

2   Exchange traded.

3   Require margin account.

4   Daily P&L are marked-to-market (settled into margin account).

5   **Long** Position is *synthetically* equivalent to : **Borrowing Cash** (**short**) and **Buy Asset** (**Long**).

6   **Short** Position is *synthetically* equivalent to : **Lending Cash** (**Long**) and **Sell Asset** (**Short**).

7   Cost effective **surrogate** to buying or selling shares. Offer great liquidity and minimal transaction fees.

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Futures: Cost Effective Surrogate to Buying and Selling Assets

Great Liquidity and Low Transaction fees

FTSE 100 - Index Future

Contract Size	£10 x FTSE 100 Index Price
Minimum price movement (tick size and value)	0.5 (£5.00)

Size	Price		Notional Value	# Contracts		Notional Value
10	8,000	=	80,000 x	5	=	400,000
	8,560	=	85,600		=	428,000
Return	**7%**			**Gain**		**28,000**

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Manager's decision:

Intent: Increase Equity exposures to 90%

Action: Engage in futures contracts Notionally equivalent to £400K

How does attribution results look like?
What is the story?

	Portfolio					Benchmark		Attribution (BF)		
	Begin Value	End Value	P&L	Wgt	ROR	Wgt	ROR	Alloc	Selec	Total
Money Market	500,000	515,000	15,000	50%	3.00%	20%	3.00%	-1.68%	0.00%	**-1.68%**
Equities	500,000	578,000	78,000	50%	15.60%	80%	10.00%	-0.42%	2.80%	**2.38%**
Stocks	500,000	550,000	50,000	50%	10.00%					
Future	0	28,000	28,000	0%	#DIV/0!					
Total	**1,000,000**	**1,093,000**	**93,000**	**100%**	**9.30%**	**100%**	**8.60%**	**-2.10%**	**2.80%**	**0.70%**

Market Exposure ⚠️   Return ⚠️

⚠️ Misleading Attribution

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How do we fix that?

Notional Exposure and Margin

Market Exposure ☑   Return ⚠️

Portfolio

	Begin Value	End Value	CF	No CoC	P&L	Wgt	ROR
Cash & Equival	**100,000**	**115,000**	-	-	**15,000**	**10%**	**15.00%**
Money Market	400,000	412,000	-		12,000	40%	3.00%
Future Offset	(400,000)	(428,000)	(28,000)	-	-	-40%	0.00%
Margin	100,000	131,000	28,000		3,000	10%	3.00%
Equities	**900,000**	**978,000**	-	-	**78,000**	**90%**	**8.67%**
Stocks	500,000	550,000	-		50,000	50%	10.00%
Future	400,000	428,000	-		28,000	40%	7.00%
Total	**1,000,000**	**1,093,000**	-	-	**93,000**	**100%**	**9.30%**

3.Offset
1.Interest
1.Margin
2.Notional
4.Future P&L
Cost of carry

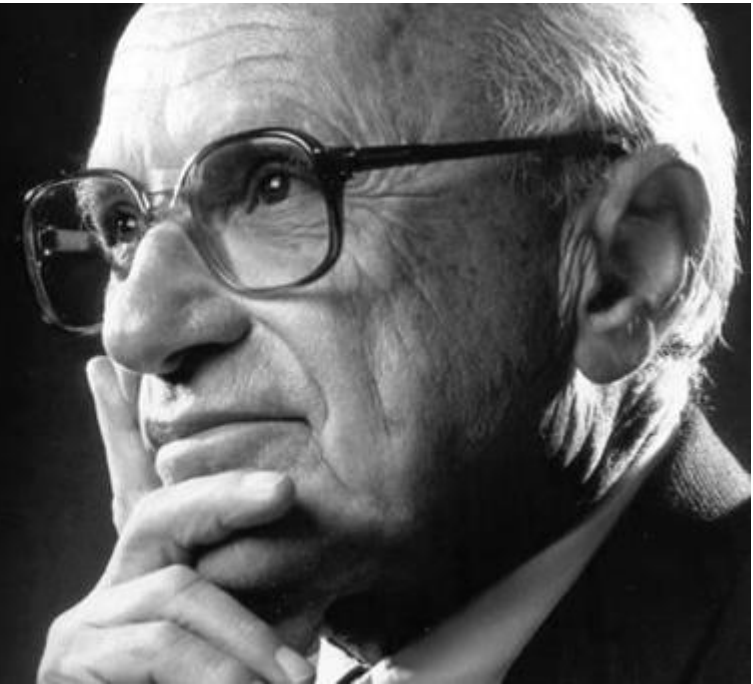|	
Initial Margin Deposit :	100,000
3% Interest on Variation Margin :	3,000
Future P&L :	28,000
Ending Margin Balance :	131,000

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Cost-of-Carry
=
No Free Lunch

Arbitrage Free Theory

"There's no such thing as a free lunch."

Milton Friedman

July 31, 1912 – November 16, 2006

Benefit from the price appreciation of some assets

+

Without buying the assets (keep cash)

→

There must be a cost

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2.3 The price relationship between index and its futures price

The best-known model for pricing stock index futures is undoubtedly the cost of carry model, developed by Cornell and French (1983a). The derivation of this model is based on a simple no-arbitrage argument that two different assets, or combinations of assets, that yield the same return should sell for the same price. Otherwise, arbitrage profit is

Reference

Cornell, Bradford and French, Kenneth R., (1983), The pricing of stock index futures, Journal of Futures Markets, 3, issue 1, p. 1-14.

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Arbitrage Free Theory

Investor should be indifferent between

Buy			Future		
400,000			**400,000**		
Dividend		Return	Interest		Return
1%		9%	3%		7%
4,000		36,000	12,000		28,000
40,000			40,000		
Profit			**Profit**		

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Cost-of-Carry
Transfer Cash return(risk free rate) to Future

Long Positions

Short Positions

Synthetically Equivalent

Borrowing Cash (Short)
Buying Assets (Long)

Lending Cash (Long)
Selling Assets (Short)

	Begin Value	End Value	CF	CoC	P&L	Wgt	ROR
						Market Exposure ☑	Return ☑
Portfolio							
Cash & Equival	**100,000**	**115,000**	-	(12,000)	15,000	10%	3.00%
Money Market	400,000	412,000	-		12,000	40%	3.00%
Future Offset	(400,000)	(428,000)	(28,000)	(12,000)	-	-40%	0.03
Margin	100,000	131,000	28,000		3,000	10%	3.00%
Equities	**900,000**	**978,000**	-	12,000	78,000	90%	10.00%
Stocks	500,000	550,000	-		50,000	50%	10.00%
Future	400,000	428,000	**3% CoC**	12,000	28,000	40%	10.00%
Total	**1,000,000**	**1,093,000**	-	-	**93,000**	**100%**	**9.30%**

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Attribution Story

Before

	Begin Value	End Value		Portfolio			Benchmark		Attribution (BF)		
				P&L	Wgt ⚠️	ROR ⚠️	Wgt	ROR	Alloc	Selec	Total
Money Market	500,000	515,000		15,000	50%	3.00%	20%	3.00%	-1.68%	0.00%	**-1.68%**
Equities	500,000	578,000		78,000	**50%**	15.60%	80%	10.00%	-0.42%	2.80%	**2.38%**
Stocks	500,000	550,000		50,000	50%	10.00%					
Future	0	28,000		28,000	0%	#DIV/0!				⚠️	
Total	**1,000,000**	**1,093,000**		**93,000**	**100%**	**9.30%**	**100%**	**8.60%**	**-2.10%**	**2.80%**	**0.70%**

Misleading Attribution

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Attribution Story

Now	Portfolio				Market Exposure ☑	Return ☑		Benchmark		Attribution (BF)		
	Begin Value	End Value	CF	CoC	P&L	Wgt	ROR	Wgt	ROR	Alloc	Selec	Total
Cash & Equival	**100,000**	**115,000**	**-**	**(12,000)**	**15,000**	**10%**	**3.00%**	**20%**	**3.00%**	**0.56%**	**0.00%**	**0.56%**
Money Market	400,000	412,000	-		12,000	40%	3.00%					
Future Offset	(400,000)	(428,000)	(28,000)	(12,000)	-	-40%	3.00%					
Margin	100,000	131,000	28,000		3,000	10%	3.00%					
Equities	**900,000**	**978,000**	**-**	**12,000**	**78,000**	**90%**	**10.00%**	**80%**	**10.00%**	**0.14%**	**0.00%**	**0.14%**
Stocks	500,000	550,000	-		50,000	50%	10.00%				☑	
Future	400,000	428,000	-	12,000	28,000	40%	10.00%					
Total	**1,000,000**	**1,093,000**	**-**	**-**	**93,000**	**100%**	**9.30%**	**100%**	**8.60%**	**0.70%**	**0.00%**	**0.70%**

Meaningful Attribution

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Currency Exposure
Underlying Assets

Currency Exposure
Futures

P&L

$ -

£ -

Currency Exposure

Interaction

P&L
$ 5,000

1.375

Currency

I

1.250

$ 555,000
£ 440,000

Local

Asset Exposure

P&L
$ 50,000
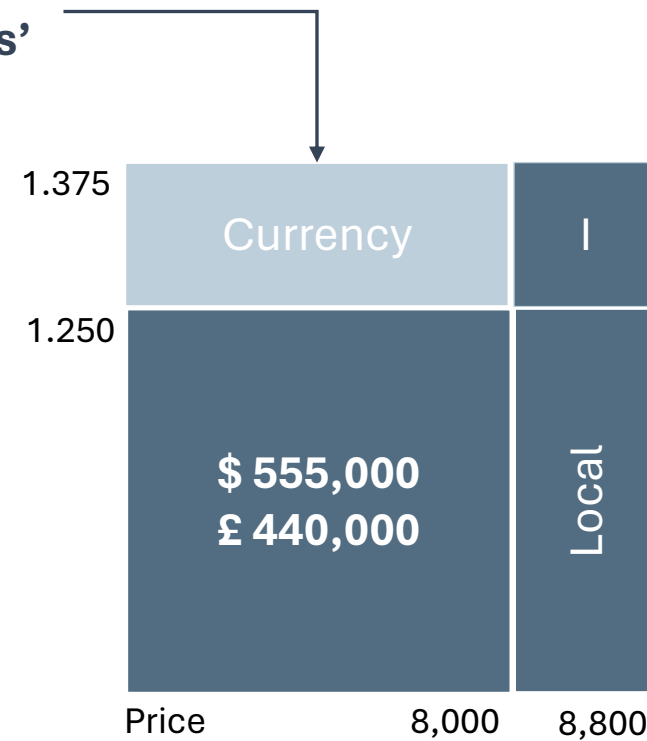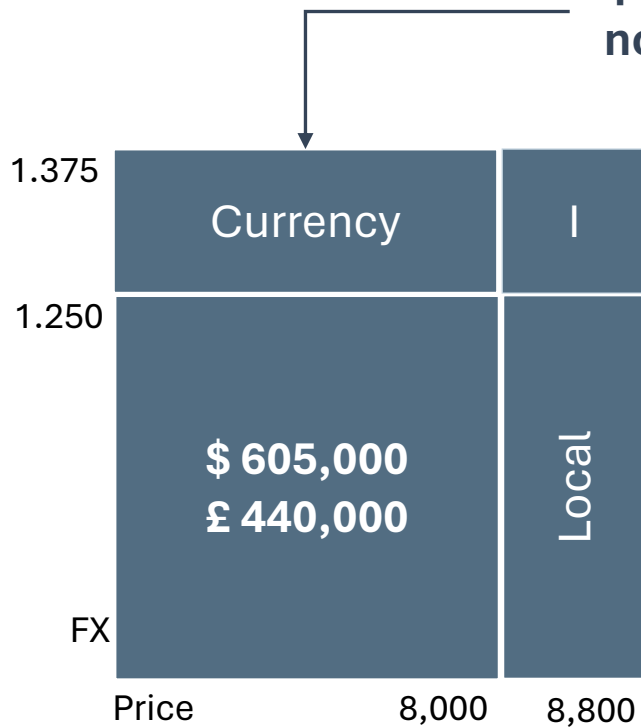**£ 40,000**

FX

Price   8,000   8,800

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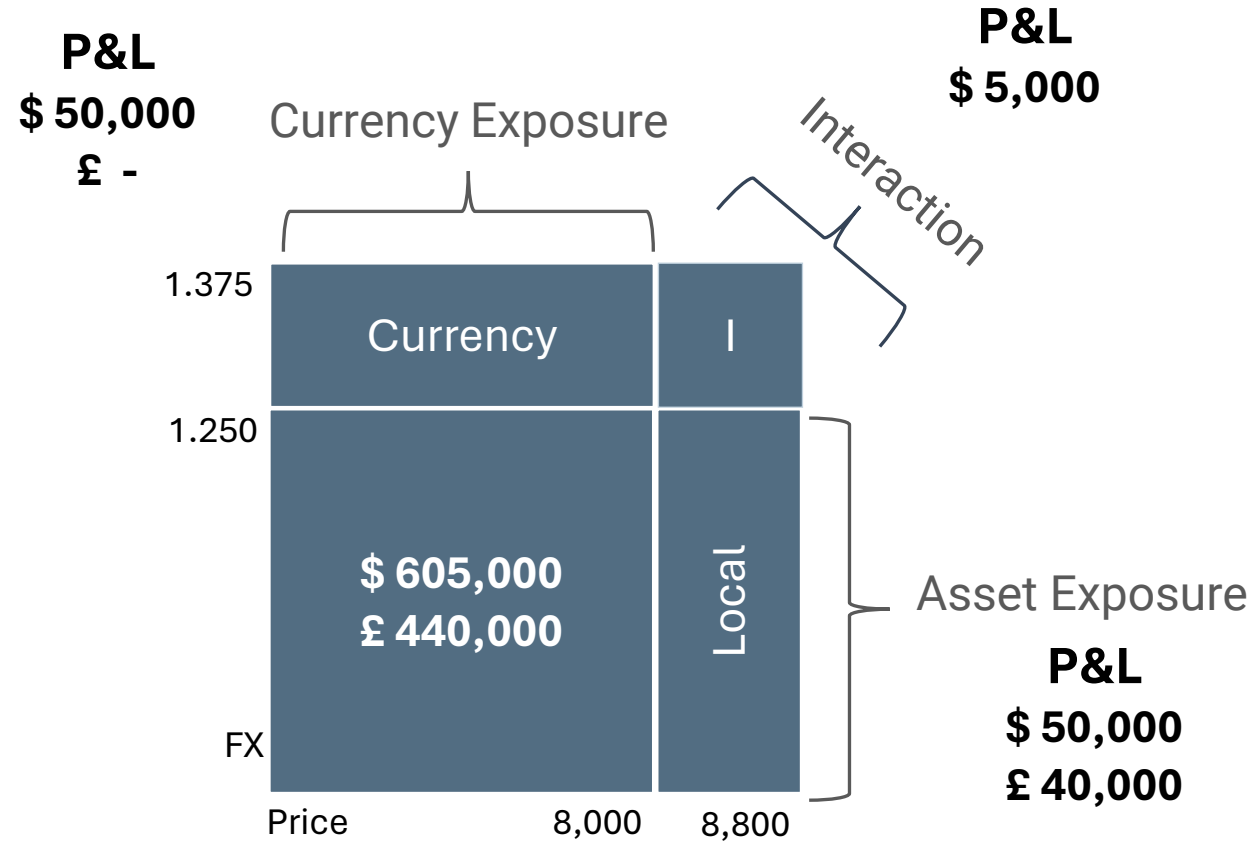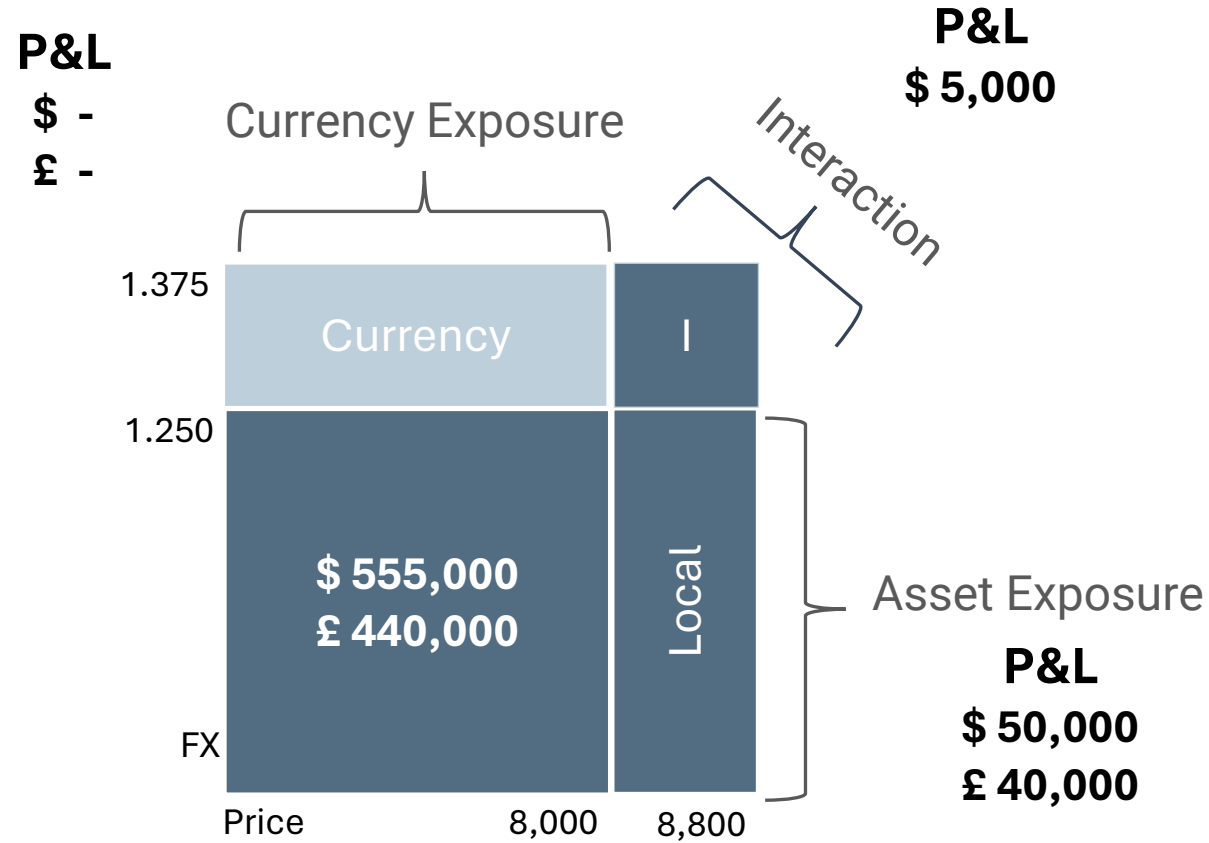
Currency Exposure
Futures

For performance evaluation purposes, should we remove or not the currency gain on futures' notional values?

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Currency Exposure
Futures

Here is one school of thoughts …

	Ccy	Begin Value	End Value
Cash & Equival	**GBP**	**100,000**	**115,000**
Money Market	GBP	400,000	412,000
Future Offset	GBP	(400,000)	(428,000)
Margin	GBP	100,000	131,000
Equities		**900,000**	**978,000**
Stocks	GBP	500,000	550,000
Future	GBP	400,000	428,000

Keep, if **Currency** is **not leveraged.**
I.e. there is sufficient currency cash to cover the notional value of the future.

Makes return in portfolio currency closer to return of underlying index

	Ccy	Begin Value	End Value
Cash & Equival	**GBP**	**100,000**	**115,000**
Money Market	USD	460,000	460,000
Future Offset	GBP	(400,000)	(428,000)
Margin	GBP	100,000	131,000
Equities		**900,000**	**978,000**
Stocks	GBP	500,000	550,000
Future	GBP	400,000	428,000

Remove, if **Currency is leveraged.**
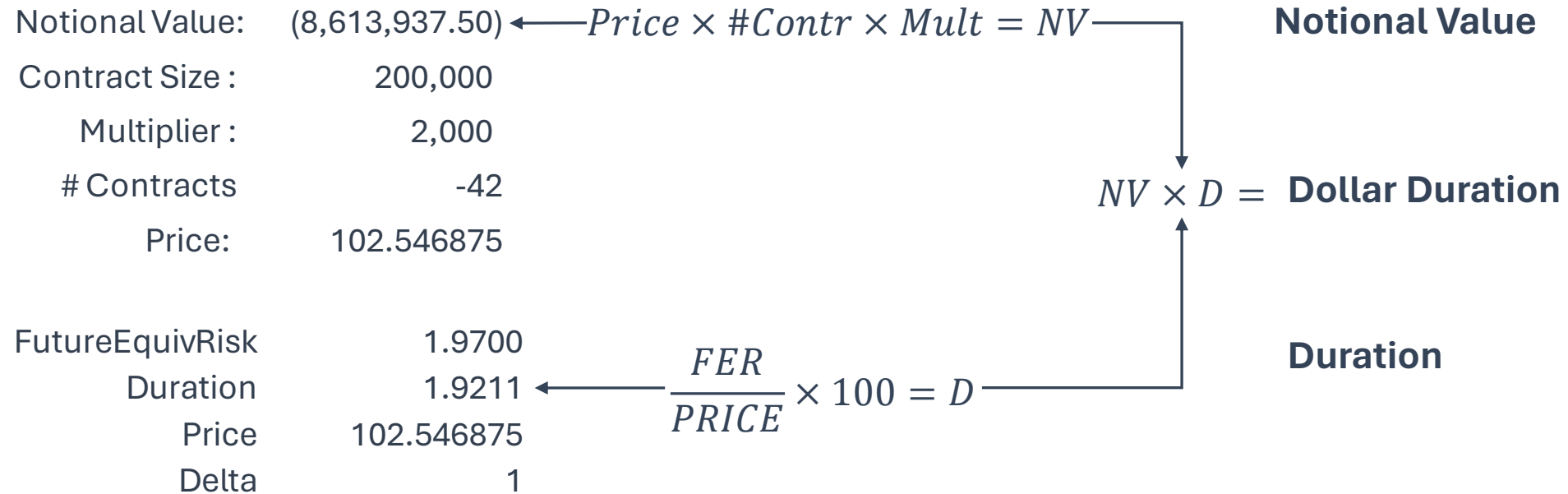I.e. there is not enough currency cash to cover the notional value of future.

Recognizes the fact that futures do not offer currency exposure.

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Bond Future

Exposure = Notional Value x Duration

US 2YR NOTE (CBT) SEP23

Notional Value:	(8,613,937.50)
Contract Size :	200,000
Multiplier :	2,000
# Contracts	-42
Price:	102.546875

FutureEquivRisk	1.9700
Duration	1.9211
Price	102.546875
Delta	1

$$Price \times \#Contr \times Mult = NV \longrightarrow \textbf{Notional Value}$$

$$NV \times D = \textbf{Dollar Duration}$$

$$\frac{FER}{PRICE} \times 100 = D \longrightarrow \textbf{Duration}$$

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Option on Bond Future

Exposure = Notional Value x Duration

Option - US 10YR FUT OPTN Dec23

Contract Size :	100,000
Multiplier :	1,000
Delta :	0.32000
# Contracts :	131
Underlying Bid :	109.52
Price :	0.609375
Market Value Option :	79,828.13

Fundamentally differ from Futures

$$MV = Price \times \#Contr \times Mult$$

Option - Notional Value

Notional Value :	4,590,895.00

$$Bid \times \#Contr \times Mult \times Delta$$

FutureEquivRisk :	6.5300
Underlying Bid :	109.515625
Duration :	5.9626

$$\frac{FER}{Bid} \times 100 = D$$

Notional Value
↓
Dollar Duration
↑
Duration

Note !
- Daily notional values for options are affected by daily delta variations
- Do not generate P&L due to delta variations.

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Option Futures on Bonds
Dollar Duration Exposure

Options on Bond Futures Portfolio
19-Sep-23

Issuer	Local Ccy	Begin Market Value	End Market Value	Cash Flows	$ Earned	Time Weighted Return	Duration Begin	Duration End
Option → US 10YR FUT OPTN Dec23C 111 CALL MAT 2023-11-24	USD	79,828	67,547	-	-12,281	-15.38%	-	-
Option Notional → US 10YR FUT OPTN Dec23C 111 CALL MAT 2023-11-24	USD	4,590,895	4,002,705	-	-	-	5.96	5.96
Cash Offset → [US 10YR FUT OPTN Dec23C 111 CALL MAT 2023-11-24]	USD	-4,590,895	-4,002,705	-	-	-	-	-

Notional **Exposure**

No P&L on notional

Option P&L

Notional **Duration**

Dollar Duration
Total Exposure

Swaps

Interest Rate Swaps (IRS) | Debt-Equity
Credit Defaults (CDS) | Commodity
Total Return (TRS) | Currency

Example: Interest Rate Swaps (IRS)

Notional Value : 41,673,000 SGD
Maturity: 2033-01-11

RECEIVE   Fix 2.787%
PAY   Float

Should be treated as 2-leg instruments

- **Long** leg (RECEIVE)   **Positive** amount
- **Short** leg (PAY)   **Negative** amount

Both legs classified independently

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IRS Swaps

01-Jan-23 to 31-Mar-23

RECEIVE

Issuer	Issue	Invested First	Invested Last	Local Ccy	Local Begin Market Value	End Market Value	Cash Flows	$ Earned	TW Contri-bution	Time Weighted Return
IRS GSIS	FIX 2.787 11JAN33	9-Jan-23	9-Jan-23	SGD	-	41,673,000	41,673,000	-	-	-
IRS GSIS	FIX 2.787 11JAN33	10-Jan-23	10-Jan-23	SGD	41,673,000	41,695,133	-	22,133	0.00%	0.05%
IRS GSIS	FIX 2.787 11JAN33	11-Jan-23	11-Jan-23	SGD	41,695,133	41,765,525	-	70,392	0.01%	0.17%
•••										
IRS GSIS	FIX 2.787 11JAN33	7-Mar-23	7-Mar-23	SGD	39,928,570	39,902,954	-	-25,616	-0.00%	-0.06%
IRS GSIS	FIX 2.787 11JAN33	8-Mar-23	8-Mar-23	SGD	39,902,954	-45,169	-41,726,140	1,778,017	0.22%	4.46%
IRS GSIS	FIX 2.787 11JAN33	9-Mar-23	9-Mar-23	SGD	-45,169	-45,169	-	-	-	-
IRS GSIS	FIX 2.787 11JAN33	10-Mar-23	10-Mar-23	SGD	-45,169	-	-	45,169	0.01%	-

PAY

Issuer	Issue	Invested First	Invested Last	Local Ccy	Local Begin Market Value	End Market Value	Cash Flows	$ Earned	TW Contri-bution	Time Weighted Return
IRS GSIS	FLT SIBCSORA 11JA	9-Jan-23	9-Jan-23	SGD	-	-41,673,000	-41,673,000	-	-	-
IRS GSIS	FLT SIBCSORA 11JA	10-Jan-23	10-Jan-23	SGD	-41,673,000	-41,673,000	-	-	-	-
IRS GSIS	FLT SIBCSORA 11JA	11-Jan-23	11-Jan-23	SGD	-41,673,000	-41,673,000	-	-	-	-
•••										
IRS GSIS	FLT SIBCSORA 11JA	7-Mar-23	7-Mar-23	SGD	-41,673,000	-41,673,000	-	-	-	-
IRS GSIS	FLT SIBCSORA 11JA	8-Mar-23	8-Mar-23	SGD	-41,673,000	45,169	43,866,140	-2,147,971	-0.26%	5.15%
IRS GSIS	FLT SIBCSORA 11JA	9-Mar-23	9-Mar-23	SGD	45,169	45,169	-	-	-	-
IRS GSIS	FLT SIBCSORA 11JA	10-Mar-23	10-Mar-23	SGD	45,169	-	-	-45,169	-0.01%	-

In Summary

Market exposure

- Must reflect notional exposure (using Current Price)

- Offset exposure to Cash (Cash Offset)

  - Long position : Borrow cash (short) – Buy assets (long)

  - Short position : Lend cash (long) – Sell assets (short)

- Group Future Cash Offset and Variation Margin together (in Cash Equivalents)

- Marked-to-Market P&L still considered as asset exposure (not cash) until the future position is liquidated.

- Bonds, exposure = notional value x duration

- Swaps, exposure split into 2 legs

In Summary

Currency exposure

- Must properly recognize the type of exposures.

    - Asset vs Currency

        - Future on FTSE 100 does not offer currency exposure (GBP). Only asset exposure.

        - But you may want to reflect the currency exposure if currency is not leveraged (i.e. sufficient cash to cover notional value of future)

    - The only impact on currency return is FX Rates variation on Future P&L settled in GBP

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In Summary

Cost-of-carry

- Must adjust for Cost-of-Carry (risk free rate)

  - Represent opportunity cost of purchasing the assets rather than engaging in a future contract.

  - To reflect the cost of carry. Referred as the basis, i.e. difference between cash price and futures' price (generally risk-free rate minus expected dividends)

  - Makes return comparable to underlying assets in the benchmark. Otherwise Selection effect is generated

References

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John C. Stannard, Russell Data Services

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VOLUME 1 – NUMBER 3

Measuring Investment Returns of Portfolios Containing Derivatives: Part II – Performance
Attribution
John C. Stannard, Russell Data Services

The **reporting** and **performance measurement** of financial **futures** and **options** in **investment portfolios**

LIFFE Recommendations
January 1992

prepared in conjunction with

WILLIAM M. MERCER

LIFFE
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Questions?

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