ISMA CENTRE - THE BUSINESS SCHOOL
OF THE FINANCIAL MARKETS

UNIVERSITY OF READING
ENGLAND

IFID Certificate Programme

Rates Trading and Hedging

Swaps

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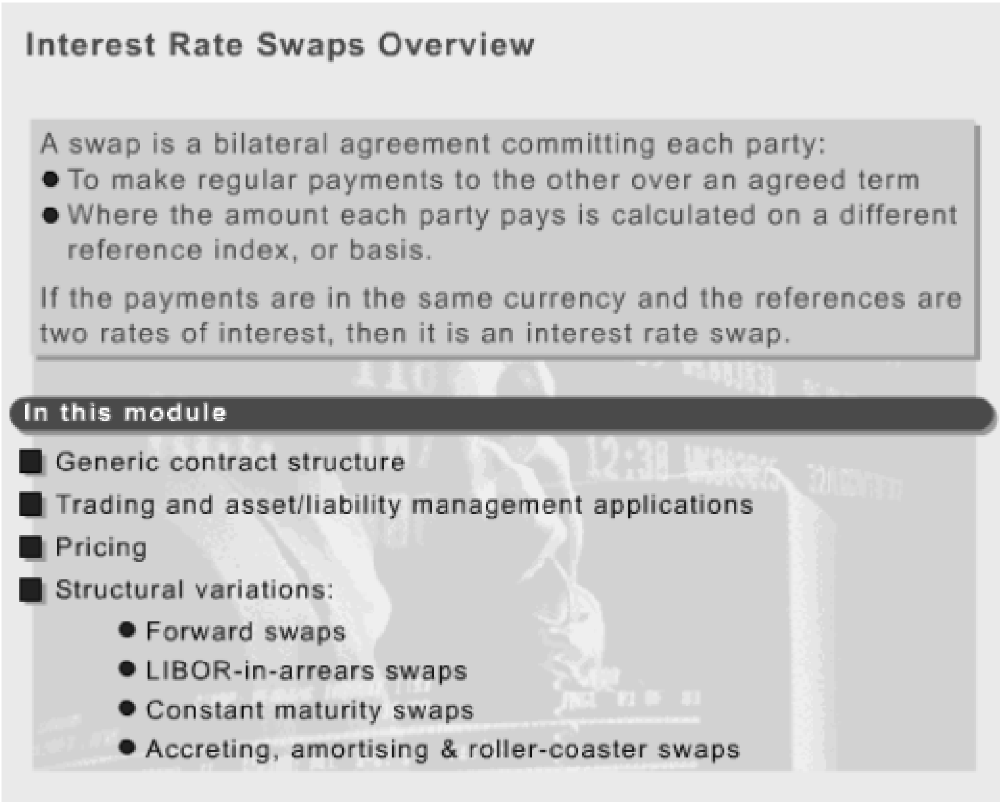
1. Overview



A swap is a bilateral agreement committing each party:

- To make regular payments to the other over an agreed term
- Where the amount each party pays is calculated on a different reference index, or **basis**.

If the payments are *in the same currency* and the references are *two rates of interest* then it is an **interest rate swap**.

In this module we explore how the generic concept of a swap is applied in the interest rate market, both for trading as well as in asset and liability management. We also explain how swap rates are priced and discuss certain structural variations in this product.

Note:
In this module we make extensive use of **zero-coupon yields**, **forward yields** and **discount factors**, which are explained in *Yield Curve Analysis*. If you are not familiar with these concepts you should tackle that module first!

Learning Objectives

By the end of this module, you will be able to:

1. - Define the key terminology of a vanilla interest rate swap contract:
    - Notional amount
    - Effective date
    - Settlement dates
    - Maturity
    - Fixed payer and receiver
    - ISDA Master Swap Agreement

2. - Calculate the net amount payable by one of the parties in a swap on a given settlement data

3. - Interpret swap rate quotations and convert them to any required compounding or day-count basis

4. - Explain why the market sometimes quotes slightly different fixed rates for a vanilla swap, depending on the settlement frequency of the LIBOR leg (e.g. 1, 3 or 6 month LIBOR)

5. - Calculate the all-in rates receivable or payable on swap-overlaid assets or liabilities, taking into account different compounding and day-count conventions for both the swap and the underlying positions

6. - Derive a theoretical swap rate from a strip of interest rate futures

7. - Explain why a convexity adjustment is required when pricing swaps off the futures strip and identify the factors that affect the size of this adjustment

8. - Mark to market a swap position, given a discount function and a forward curve

9. - Explain how to calculate the delta or basis point value (BPV) on a swap position

10. - Construct a futures strip that hedges the market risk on a swap position

11. - Calculate the amount of government bonds, or the number bond futures contracts, necessary to hedge the market risk on a given swap position

12. - Identify the residual risks that are present in a swap position that is hedged using government bonds or bond futures

13. - Explain how long-dated swaps are priced off the government bond curve

14. - Identify the credit risk on an interest rate swap position and explain the contingent nature of that risk

15. - Identify some of the market factors that affect the swap spread (or the TED spread)

16. - Describe the structure and typical applications of the following swap products:
    - Forward-start swaps
    - Overnight index swaps
    - Currency swaps
    - Inflation swaps

17. - Outline the structure of a par-par asset swap and identify the factors that affect the breakeven LIBOR spread payable on it

18. - Describe the technique of pricing illiquid bonds from their swapped spread to LIBOR

2. Generic Structure

Generic swap: the most common type of interest rate swap, where:

- One party pays a fixed rate of interest
- The other party pays LIBOR
- The swap becomes effective on the spot date and matures on a single specified date
- The notional amount is constant

Also known as: **Vanilla Swap**.

Contract Terms

Below is a typical term sheet for an interest rate swap deal.

Interest Rate Swap Confirmation

Date:	1 July 2002
To:	Party B Inc.
From:	Party A Bank
Our Ref:	IRS 9871-1

We are pleased to confirm our mutually binding agreement to enter into a Rate Swap Transaction with you in accordance to our telephone agreement with [Mr Swapper] on [1 July 1998], pursuant to the ISDA Master Agreement between us dated [10 November 1996].

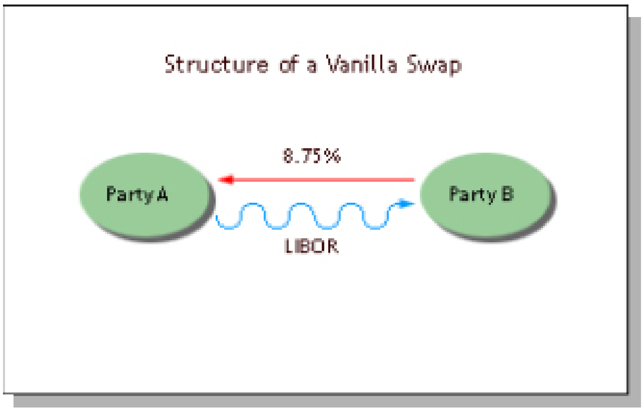
Effective date:	3 July 2002
Termination date:	3 July 2007
Notional amount:	USD 50,000,000.00
Fixed rate payer:	Party B Inc.
Floating rate payer:	Party A Bank
Fixed rate:	8.75 percent per annum
Day count:	30/360
Floating rate index:	LIBOR
Designated maturity:	Six months
First rate:	5.53 percent per annum
Day count:	Actual/360
Reset dates:	Two London business days prior to the First day of each Party A Calculation Period, based on the rate published by the British Bankers Association ("BBAIRS").
Payment dates:	Each party pays on its own Period End Dates
Settlement instructions:	Standard
Party A calculation periods for payments	
First period:	Effective Date to but excluding 3 January 2003 (the "Period End")
Later period dates:	Each 3 July and 3 January after the First Period End Date, subject to the Modified Following Banking Day convention, and finally the Termination Date.
Party B calculation periods for payments	
First period:	Effective Date to but excluding 3 January 2003 (the "Period End Date")
Later period dates:	Each 3 July and 3 January after the First Period End Date, subject to the Modified Following Banking Day convention, and finally the Termination Date.

Please confirm to us that the terms set forth herein accurately reflect our Transaction.

For Party A Bank,
John Smith
Settlements Manager

2.1. Calculating Settlement Amounts

The figure below illustrates the cash flows involved in the swap specified on the previous page.



At each designated maturity date the counterparties settle the net difference in amounts payable and a new LIBOR is reset for the new calculation period.

Example

Date: 3 January 2003 (the first payment date in the contract on the previous page)

Party B Inc. is liable for $\frac{8.75}{100} \times \frac{180}{360} \times 50 \text{ million} = \text{USD } 2{,}187{,}500.00$

Party A Bank is liable for $\frac{5.53}{100} \times \frac{184}{360} \times 50 \text{ million} = \text{USD } 1{,}413{,}222.22$

Net Settlement Amount (in favour of Party A) = **USD 784,277.78**

At the first payment date the net beneficiary was Party A because LIBOR happened to be fixed below the rate for the fixed leg of the swap, but there is no guarantee this will also be the case on subsequent calculation periods.

3. Applications

Interest rate swaps may be used for speculation, but corporate and institutional investors commonly use them to manage interest rate exposures.

Example - Credit Arbitrage

Credit spreads paid by different quality of borrowers tend to be wider in the fixed rate bond markets, which is traditionally dominated by institutional and retail investors, than that in the floating rate market which is the domain of the commercial banks. Differences in credit risk perceptions among investor groups open up 'windows of opportunity' for bond issuers, as the following example illustrates.

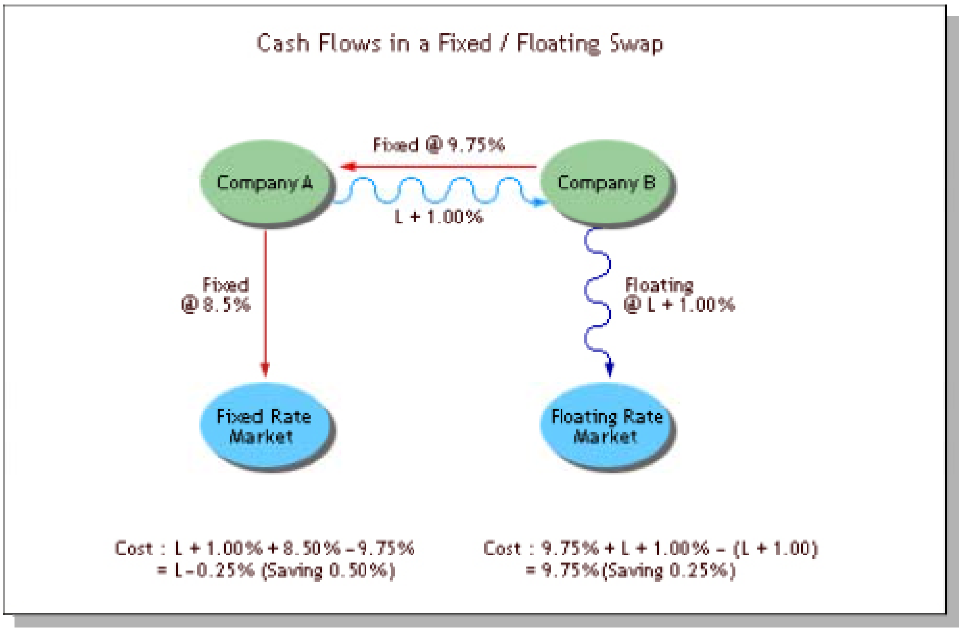
Two companies need to borrow USD 50 million for 5 years. The borrowing terms available to each company are as follows:

Can Borrow:	**Company A**	**Company B**	**Cost Difference**
Fixed Rate	8.50% (US Treasury + 0.50%)	10.00% (US Treasury + 2.00%)	1.50%
Floating Rate	LIBOR + 0.25%	LIBOR + 1.00%	0.75%
Required basis	Floating	Fixed	

Without a swap, A would borrow on a floating basis and pay LIBOR + 0.25%, while B would issue a bond with a 10% coupon. Instead, the two companies proceed as follows:

- Company A issues a straight bond with an 8.50% coupon
- Company B issues floating rate debt paying LIBOR + 1.00%
- The two parties then agree to enter into a swap, for a notional of USD 50 million, on the following terms:
  - B makes fixed rate payments to A of 9.75%
  - A makes floating rate payments to B of LIBOR + 1.00%

The figure below identifies all the cash flows associated with each party.



Net Benefits

Provided all rates are calculated on the same notional amount and interest rate basis, we can add up these rates directly. Thanks to the swap, both sides have saved money:

- A saves a net 0.50% per annum, paying LIBOR - 0.25% instead of LIBOR + 0.25% through a floating rate issue

- B saves 0.25%, paying 9.75% all-in instead of 10% through a fixed bond issue

The swap enables two parties to borrow in the most cost-effective way:

- **By separating the interest rate basis of a loan**
- **From the instrument in which the principal is raised**

The swap allows each party to exploit its **comparative advantage** in a specific funding market. Company A has an absolute funding advantage over B in both the fixed and the floating rate markets. However, A has a comparative advantage in the fixed rate market, being able to pay 150 basis points below B, whereas in the floating market A's advantage is only 75 basis points. To exploit this opportunity:

- Each party first borrows in the market and on terms in which it has a comparative advantage

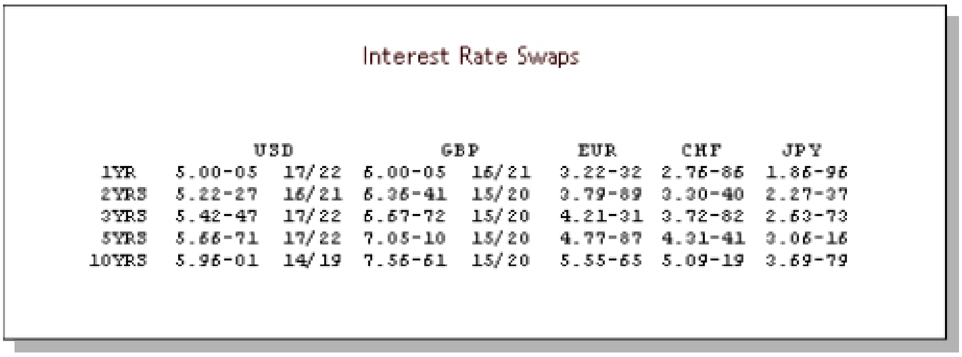
- The two parties then exchange the interest rate basis of their borrowing through a swap

Nowadays it is rare for two commercial companies to enter into such a swap directly: typically each company will deal separately with a market maker. (See section *Quotation*).

4. Quotation

4.1. Swap Rates

Banks make active two-way markets in swaps. The figure below illustrates a typical swap rates screen from a market maker or broker.



Interest Rate Swaps

	USD		GBP		EUR	CHF	JPY
1YR	5.00-05	17/22	6.00-05	16/21	3.22-32	2.76-86	1.86-96
2YRS	5.22-27	16/21	6.36-41	15/20	3.79-89	3.30-40	2.27-37
3YRS	5.42-47	17/22	6.67-72	15/20	4.21-31	3.72-82	2.63-73
5YRS	5.66-71	17/22	7.05-10	15/20	4.77-87	4.31-41	3.06-16
10YRS	5.96-01	14/19	7.56-61	15/20	5.55-65	5.09-19	3.69-79

A swap quotation 5.42-47 (for a 3-year USD swap) means the market maker is willing to:

- Pay 5.42% per annum fixed, against receiving LIBOR flat
- Receive 5.47% per annum fixed, against payment of LIBOR flat

By convention, swap rates are quoted against LIBOR flat, so the market maker only quotes you the rate for the fixed leg of the swap. The swap contract specifies who is the fixed rate payer and who is the floating rate payer, but swap traders often speak of buying or selling swaps:

- **The buyer** in a swap is the party receiving ('buying') the LIBOR stream
  - i.e. paying the fixed rate

- **The seller** in a swap is the party paying ('selling') the LIBOR stream
  - i.e. receiving the fixed rate

The quoted swap rate is the price for buying or selling a stream of LIBORs.

Market makers typically quote swap rates for fixed periods, ranging from 1 to 10 years or longer. In the major currencies, bid/offer spreads are very tight, amounting to only 3 - 5 basis points. Such tight spreads reflect the very high liquidity of these markets.

The swap curve: a graphical representation of swap rates for various maturities, similar to a bond yield curve.

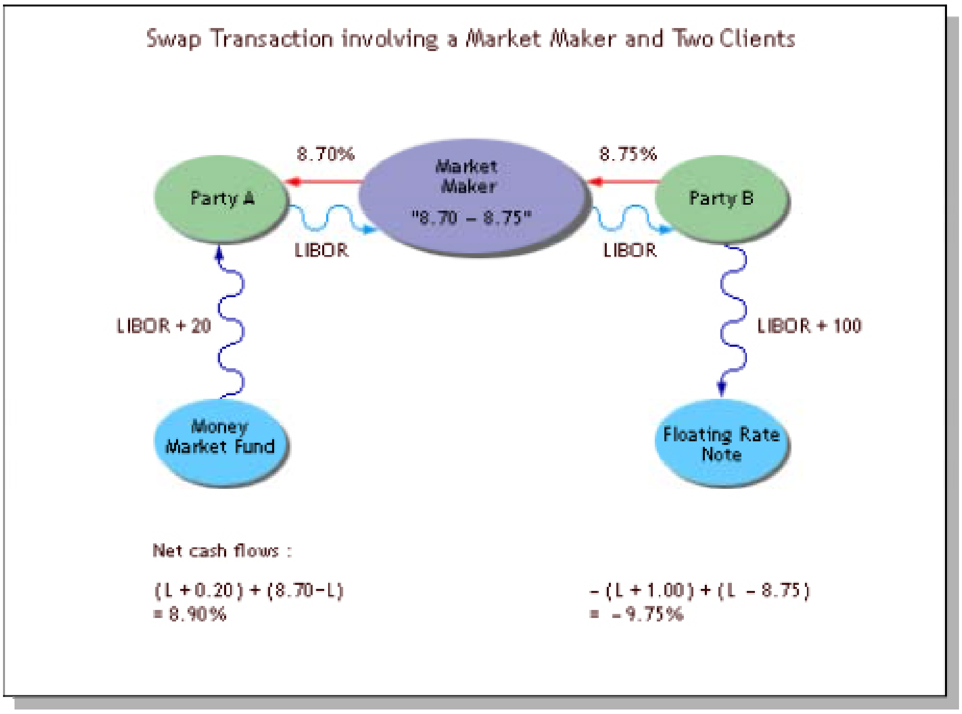
In the US dollar sector, swap rates are quoted both as an **all-in rate** (e.g. 5.42-47) and also as spreads over the yield on Treasury bond with comparable maturities. Thus, if the yield on the 3 year Treasury is 5.25%, then a price 17/22 means an all-in rate of 5.25 + 0.17 = 5.42% and 5.25 + 0.22 = 5.47%.

Swap spread = Swap rate - Underlying benchmark bond yield

This convention is designed to show the credit risk element in the swap rate separately from the general cost of funding in the current market, in the same way as corporate bonds are often priced on a yield spread over Treasuries. However, not all currencies have well-developed government bond markets, with plenty of benchmark bonds right across the yield curve, so in most other currencies swap rates are quoted just as all-in rates.

4.2. Conventions

The figure below illustrates how a market maker might interact with two counterparties.



- Counterparty B is the same corporate as in the example in section Applications, except B are now paying 8.75% fixed against LIBOR flat on the swap, instead of 9.75% against LIBOR + 1.00%. The net cost of finance to B still comes out at 9.75%, as before. For the duration of the swap the corporate has effectively converted its borrowing into a synthetic straight bond, an example of a **liability swap**.

- Counterparty A is now a money market fund. This fund is invested in floating rate assets yielding on average LIBOR + 20 basis points. The manager of the fund fears LIBOR rates might fall and has contracted with the market maker to receive 8.70% fixed against paying LIBOR. For the duration of the swap the fund has converted its floating rate assets into synthetic straight bonds yielding 8.90%, all-in, an example of an **asset swap** (see *Asset Swaps*).

Quoting Conventions

In each currency area the majority of the market tends to default to a standard swap structure, in terms of calculation period and day-count basis. For example, unless otherwise specified, the statement:

"I'm a payer of 5 year Euro at 4.12"

means I pay 4.12% annually, on a 30/360 basis, and receive 6 months Euribor, on an actual/360 basis, reset semi-annually and paid in arrears.

Below is a summary of the structures that are most commonly quoted in some key markets. Of course, it is an OTC market and swap traders are prepared to quote rates on any required basis. If in doubt, you should always specify the exact terms of the structure.

Ccy	Quoted As	Calculation Period	Day Count
USD	All-in fixed rate (or spread over T-bonds)	Semi-annual fixed vs. 6 month LIBOR	Actual/360 (or Actual/actual) Actual/360
EUR	All-in fixed rate	Annual fixed vs. 6 month EURIBOR	30E/360 (or Actual/actual) Actual/360
CHF	All-in fixed rate	Annual vs. 6 month LIBOR	30E/360 Actual/360
GBP	All-in fixed rate (or spread over Gilts)	Semi-annual fixed vs. 6 month LIBOR	Actual/365 (or Actual/actual) Actual/365
JPY	All-in fixed rate	Semi-annual vs. 6 month LIBOR	Actual/365 Actual/360

The floating legs of the swaps typically follow the same day-count conventions that apply in the local money markets. The fixed legs mirror the instruments that the traders typically use to hedge, or **warehouse**, their positions (see section *Warehousing*). For example:

- In the USD sector, where traders typically hedge using the very liquid Eurodollar futures strips, swap rates are routinely quoted on a money market day-count basis

- In the EUR sector, where the liquidity in the Euribor futures is more limited so traders tend to hedge using government bonds, swap rates are quoted on a bond basis (see Bond Pricing and Yield - Yield Conversions).

4.3. Calculating All-in Rates

Failure to adjust for different market quoting conventions can result in potentially serious calculation errors.

Example

In the illustration on the previous page we concluded that, thanks to the swap, party B was able to fund effectively at 9.75%. In fact, there are two problems with this analysis.

Problem 1
If the USD swap rate of 8.75% is semi-annual, actual/actual, the LIBOR is actual/360, so we need to convert all the money market rates into bond equivalent yields (BEY) using the formula developed in Money Market Cash Instruments - Yield Conversions:

BEY = MMY x 365/360
= [- (LIBOR + 1.00) + LIBOR] x 365/360
= - 1.01%

Now we can add this cash flow to the 8.75% fixed on the swap:

Net cash flow = - 8.75 - 1.01
= **- 9.76%**

Problem 2

Moreover, if party B is comparing the net cost of this strategy with the alternative of issuing a straight Eurobond at 10% (30/360, annual) then we need to annualise the semi-annual swapped rate using the formula developed in Bond Yield - Yield Conversions:

Annual yield $= (1 + \text{Semi-annual yield} / 2)^2 - 1$
$= (1 + 0.0976 / 2)^2 - 1$
$= 0.10$ or **10.00%**

After these conversions it turns out that there is no real cost advantage to party B in borrowing on a floating basis and swapping into fixed! (Remember: no adjustment is required to convert an actual/actual BEY into a 30/360 equivalent).

Similar conversions may be necessary to calculate the all-in yield to party A in the illustration on the previous page.

5. Exercise 1

5.1. Question 1

Question 1

Market Conditions
USD 4 year swap: 7.50 - 7.60%
Basis: Semi-annual, Act/360 against 6 month LIBOR

Situation
Hybex Electrics is a highly rated company with a considerable amount of fixed rate liabilities. The Treasurer would like to increase the percentage of floating rate debt in the company's liabilities. There is currently a 7 5/8% USD 100 million Eurobond (annual, 30/360) outstanding with four years to maturity.

Gartside Trust is a medium-sized fixed income fund. The manager of this fund feels strongly that interest rates will rise and would like to take advantage of this perceived trend. The fund currently has USD 100 million invested in fixed rate corporate US bonds yielding 8.00% (semi-annual, 30/360). The manager would like to convert this onto a LIBOR basis for a period of four years.

a) How could Hybex achieve its objectives using swaps, and what swap rate would apply to them?

Hybex should become a:

- ☐ Payer
- ☐ Receiver

b) of fixed @ (rate) :

c) on a swap against _____ of LIBOR

- ☐ payment
- ☐ receipt

d) How could Gartside achieve its objectives using swaps, and what swap rate would apply to them?

Gartside should become a:

- ☐ Payer
- ☐ Receiver

e) of fixed @ (rate)

f) on a swap against _____ of LIBOR

- ☐ Payment
- ☐ Receipt

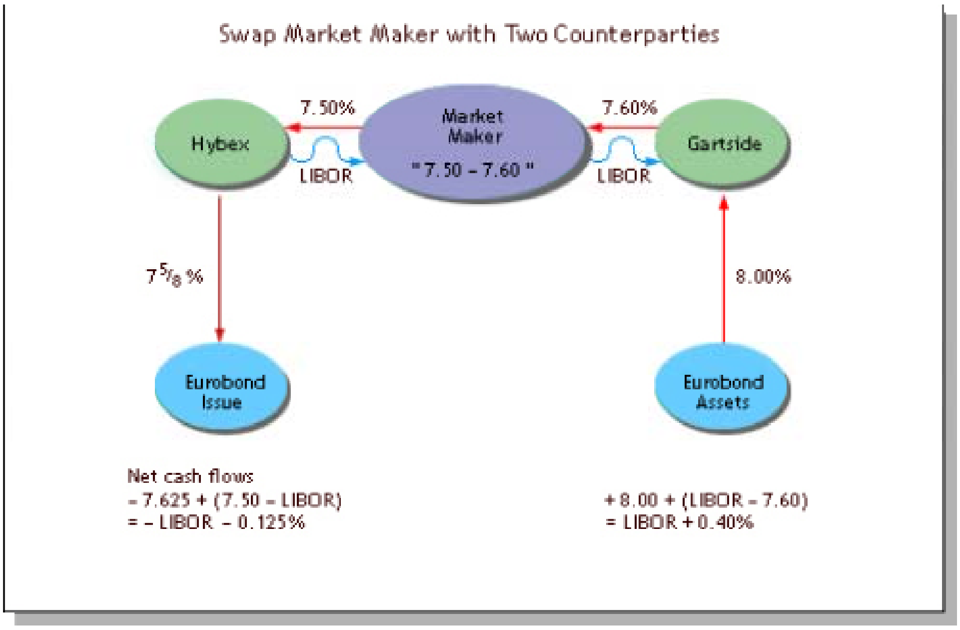
5.2. Question 2

Four year swap: 7.50 - 7.60%

In *Question 1*, Hybex becomes a receiver of 7.50% fixed on a swap, against payment of LIBOR, while Gartside becomes a payer of 7.60% fixed. Identify in a 'plumbing diagram' like the one in section *Quotation* all the interest flows associated with each counterparty, including:

- Their underlying positions
- Their swaps with the market maker

Explanation



- Hybex receives 7.50% fixed through the swap but pays 7.625% on its underlying debt, so its net funding cost appears to be LIBOR + 1/8%.

- Gartside earns 8.00% fixed on the underlying portfolio but pays 7.60% against LIBOR through the swap, so its net yield appears to be LIBOR + 0.40%.

- The market maker pays 7.50% to Hybex and earns 7.60% from Gartside, both against LIBOR so the LIBORs just wash through.

5.3. Question 3

Question 2

USD 4 year swap: 7.50 - 7.60%
Basis: Semi-annual, Act/360 against 6 month LIBOR

In *Question 1*:

- Hybex swaps a 7 5/8% USD Eurobond issue (annual, 30/360)
- Gartside swaps an investment in a bond yielding 8.00% (semi-annual, 30/360)

Calculate the all-in LIBOR spread achieved by these parties after the swap. Express the spreads as percentages on a semi-annual Act/360 basis, rounded to 2 decimal places.

a) Hybex's LIBOR spread:

b) Gartside's LIBOR spread:

6. Pricing

6.1. Principles

The swap rate is the fixed rate of interest that equates the present value (PV) of its fixed cash flows with the PV of its floating cash flows.

As we saw in section *Generic Structure*, an interest rate swap involves exchanging:

- A set of fixed cash flows, based on a fixed rate of interest
- Against a set of variable cash flows, based on a floating rate such as LIBOR

We price swaps using a version of the formula that we developed in module Spot and Forward Yields - Par from Forward Yields, which establishes equivalence between the PV of a set of fixed coupons and the PV of a set of floating coupons, as represented by a strip of forward rates:

$$\mathbf{C / t \times (\Sigma D_{0,i}) = \Sigma (R_i / t \times D_{0,i})}$$

C	= Swap rate
i	= Interest period, i = S...L
R_i	= Forward rate for period I, money market basis (R_1 is a spot rate)
$D_{0,i}$	= Discount factor for period 0 to i
d_i	= Number of days in period i
Basis	= 360 or 365, depending on the local money market
t	= Payment frequency (1 = annual, 2 = semi-annual, etc.)

From this equality you can calculate C if you are given the the strip of R_i. However, in most markets swap rates are quoted on a bond basis, while the strips of forward rates come from the Eurocurrency futures market so they are on a money market basis (see Eurocurrency Futures - Definition). Therefore, the version of the above formula that is typically used in the swap market is[1]:

$$C = t \times \frac{\Sigma (R_i \times d_i / \text{Basis} \times D_{0,i})}{\Sigma D_{0,i}}$$

6.2. Example

Date: 18 March 2002

Situation
Suppose we observe the following Eurodollar cash LIBOR and IMM futures prices.

[1] To calculate a swap rate money market style (e.g. Act/360 basis) the formula would be:

$$C = \frac{\Sigma (R_i \times d_i / \text{Basis} \times D_{0,i})}{\Sigma (d_i / \text{Basis} \times D_{0,i})}$$

You will not be required to use this version of the formula in the IFID exam.

Contract	Delivery	Nr. Days Covered	Price or Yield
3 mth LIBOR	20 Mar 2002	91	4.55%
JUN futures	19 Jun 2002	91	95.32 => 4.68%
SEP futures	18 Sep 2002	91	95.30 => 4.70%
DEC futures	18 Dec 2002	91	95.22 => 4.78%

? What is the 1 year swap rate (quarterly, actual/actual basis) implied in this strip?

Analysis
To derive the swap rate we need to calculate the discount factors implied in this strip of rates. As explained in module Spot and Forward Yields, we can calculate the required spot discount factors from the discount factors for the forward rates, as follows:

I	$D_{i-1,i}$	$D_{0,i}$
1	1 / (1 + 0.0455 x 91/360) = 0.98863	0.98863
2	1 / (1 + 0.0468 x 91/360) = 0.98831	0.98863 x 0.98831 = 0.97707
3	1 / (1 + 0.0470 x 91/360) = 0.98826	0.98863 x 0.98831 x 0.98826 =0.96560
4	1 / (1 + 0.0478 x 91/360) = 0.98806	0.98863 x 0.98831 x 0.98826 x 0.98806 = 0.95407

Now that we have the required discount factors we can derive the swap rate by applying the formula shown above.

$$\Sigma D_{0,i} = 0.98863 + 0.97707 + 0.96560 + 0.95407 = 3.88537$$

$$C = t \times \frac{\Sigma (R_i \times d_i / \text{Basis} \times D_{0,i})}{\Sigma D_{0,i}}$$

$$= 4 \times (0.0455 \times 91/360 \times 0.98863 + 0.0468 \times 91/360 \times 0.97707 + 0.0470 \times 91/360 \times 0.96560 + 0.0478 \times 91/360 \times 0.95407) / 3.88537$$

= 0.04728 or **4.73%**, rounded.

The table on the next page shows the cash flows of a 1 year swap, effective 20 March, receiving 4.728% in quarterly instalments against the 3 month LIBOR for a notional of USD 100,000. The cash flow on the fixed leg is 4.728% / 4 x 100,000 = USD 1,182 per quarter and the table shows the equivalence between the PV of these fixed cash flows and the PV of the floating cash flows implied by the current forward rates.

Settle.	Fixed	PV Fixed	Floating	PV Floating
19 Jun 02	1,182	1,182 x 0.98863 = 1,169	-100K x 0.0455 x 91/360 = (1,150)	-1,150 x 0.98863 = (1,137)
18 Sep 02	1,182	1,182 x 0.97707 = 1,155	-100K x 0.0468 x 91/360 = (1,183)	-1,183 x 0.97707 = (1,156)
18 Dec 02	1,182	1,182 x 0.96560 = 1,142	-100K x 0.0470 x 91/360 = (1,188)	-1,188 x 0.96560 = (1,147)
19 Mar 03	1,182	1,182 x 0.95407 = 1,128	-100K x 0.0478 x 91/360 = (1,208)	-1,208 x 0.95407 = (1,153)
Sum		**4,593**		**(4,593)**

The swap rate of 4.73% is quarterly compounded on a bond basis. To convert this into an actual/360 basis we would need to multiply this rate by 360/365, as explained in Money Market Instruments - Yield Conversions).

Conclusions

This analysis illustrates the strong arbitrage relationship that exists between a swap rate and its corresponding cash market stub[2] and futures strip:

- If the market swap rate is higher than the rate derived from the strip, the arbitrageur may lock in a profit by selling the futures strip and receiving fixed on the swap

- If the market swap rate is lower than the rate derived from the strip, the arbitrageur may lock in a profit by buying the futures strip and paying fixed on the swap.

But note:

1. The interest periods covered by this swap do not match exactly the IMM futures dates, from which the swap rate was derived. Strictly speaking, the relevant forward dates for pricing the swap should be those spanning the swap settlement dates, but in practice it is common to disregard the impact of these small date mismatches.

2. For swaps whose settlement dates fall in between IMM futures dates, the corresponding strip of forward rates is derived by interpolating between the rates implied in the observed futures prices, using one of the techniques explained in Yield Curve Fitting.

3. Eurodollar futures contracts may be traded for delivery in up to 7 or more years, so it is possible to derive a good part of the USD swap curve from that market. Longer-dated USD swaps, or swaps in other currencies where the liquidity of the Eurocurrency futures is more limited, are typically priced off the underlying government yield curve, as we shall see.

Analytic systems

Examples of Bloomberg and Reuters interest rate swap pricing functions

Below are sample screens from two widely-used providers of market information and analytics.

These examples are for illustration purposes only and do not form part of the IFID Certificate syllabus.

[2] The cash deposit market rate from spot to the delivery date of the first (or **front month**) futures contract.

Bloomberg interest rate swap

Payment Dates	Payments(Rcv)	Payments(Pay)	Net Payments	Discount	Net PV
06/30/2004	0.00	-17813.93	-17813.93	0.998224	-17782.29
12/30/2004	210004.66	0.00	210004.66	0.994155	208777.11
12/31/2004	0.00	-41230.43	-41230.43	0.994126	-40988.21
06/30/2005	0.00	-66031.29	-66031.29	0.987604	-65212.76
12/30/2005	210004.66	-91046.45	118958.21	0.978693	116423.59
06/30/2006	0.00	-104091.83	-104091.83	0.968611	-100824.47
12/29/2006	209421.31	-123160.16	86261.16	0.956827	82536.96
06/29/2007	0.00	-134492.67	-134492.67	0.944129	-126978.39
12/31/2007	211171.35	-152978.58	58192.77	0.929903	54113.64
06/30/2008	0.00	-157838.50	-157838.50	0.915464	-144493.85
12/30/2008	10210004.66	-10171750.43	38254.23	0.899996	34428.66
Total					-0.00

Notes

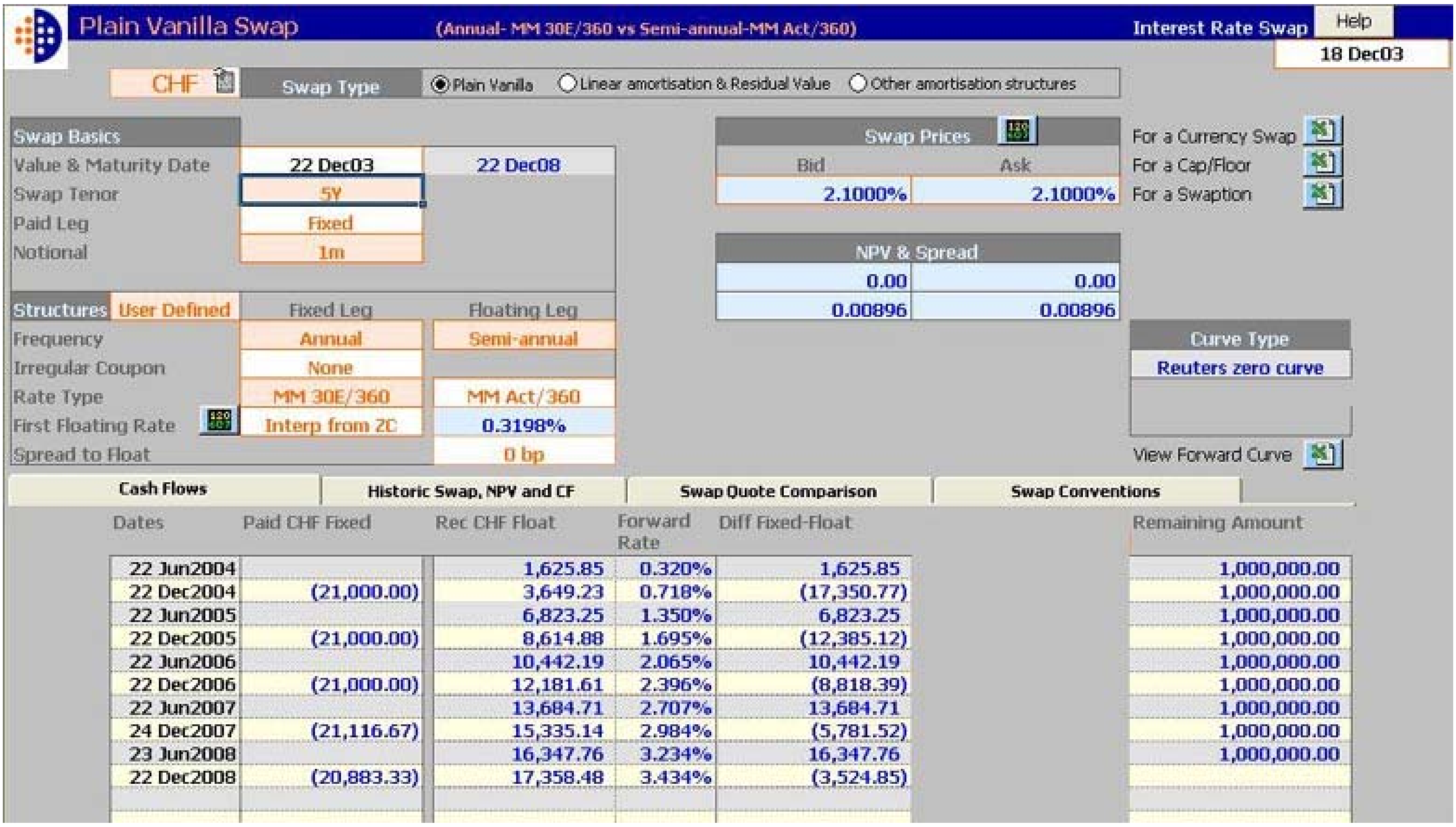
- The example is a 5 year CHF fixed / CHF LIBOR flat swap for CHF 10 million; the fixed leg is annually settled while the LIBOR leg is every 6 months.

  The function calculates:

  - Either the breakeven swap rate, given a zero premium
  - Or, if you specify the fixed swap rate, the appropriate premium payable or receivable

- In our example - and under normal circumstances - the breakeven swap rate is calculated assuming a net market value of zero, so this swap is priced **at the market**

Reuters interest rate swap



Dates	Paid CHF Fixed	Rec CHF Float	Forward Rate	Diff Fixed-Float	Remaining Amount
22 Jun2004		1,625.85	0.320%	1,625.85	1,000,000.00
22 Dec2004	(21,000.00)	3,649.23	0.718%	(17,350.77)	1,000,000.00
22 Jun2005		6,823.25	1.350%	6,823.25	1,000,000.00
22 Dec2005	(21,000.00)	8,614.88	1.695%	(12,385.12)	1,000,000.00
22 Jun2006		10,442.19	2.065%	10,442.19	1,000,000.00
22 Dec2006	(21,000.00)	12,181.61	2.396%	(8,818.39)	1,000,000.00
22 Jun2007		13,684.71	2.707%	13,684.71	1,000,000.00
24 Dec2007	(21,116.67)	15,335.14	2.984%	(5,781.52)	1,000,000.00
23 Jun2008		16,347.76	3.234%	16,347.76	1,000,000.00
22 Dec2008	(20,883.33)	17,358.48	3.434%	(3,524.85)	

Notes

- The example maps the cash flows and NPV of a 5 year USD fixed / LIBOR flat swap for USD 1 million; the fixed leg is annually settled while the LIBOR leg is every 6 months
- As in any interest rate swap, the rates used for the future LIBOR cash flows are the forward rates consistent with the current swap curve (or the futures strip) for that market
- The PV of the fixed leg equals the PV of the floating leg, so this swap is priced **at the market**

6.3. General Formulas

Vanilla swap pricing from forward money market strip
(IFID exam formulas)

$$C = t \times \frac{\Sigma (R_i \times d_i / Basis \times D_{0,i})}{\Sigma D_{0,i}}$$

C = Coupon (or swap) rate, bond basis

i = Interest period, i = S+1...L

R_i = Forward rate for period i, money market basis (R_1 is a spot rate)

$D_{0,i}$ = Discount factor for period 0 to i ($D_{0,0}$ = 1)

d_i = Number of days in period i

Basis = 360 or 365, depending on the local money market

t = Payment frequency (1 = annual, 2 = semi-annual, etc.)

As shown in module Spot and Forward Yields – Par from Forward Yields, an equivalent and simpler derivation of the vanilla swap rate is:

$$C = \frac{(D_{0,S} - D_{0,L})}{\Sigma D_{0,i}} \times t$$

Swap premium and market value of a swap position to a fixed payer:

Premium (%) = $(D_{0,S} - D_{0,L}) - (C/t \times \Sigma D_{0,i})$

Market value ($) = Premium x Notional amount

Using the figures in the example on the previous page:

$$C = \frac{(1 – 0.95407)}{3.88537} \times 4$$

= 0.04728 or **4.73%.**

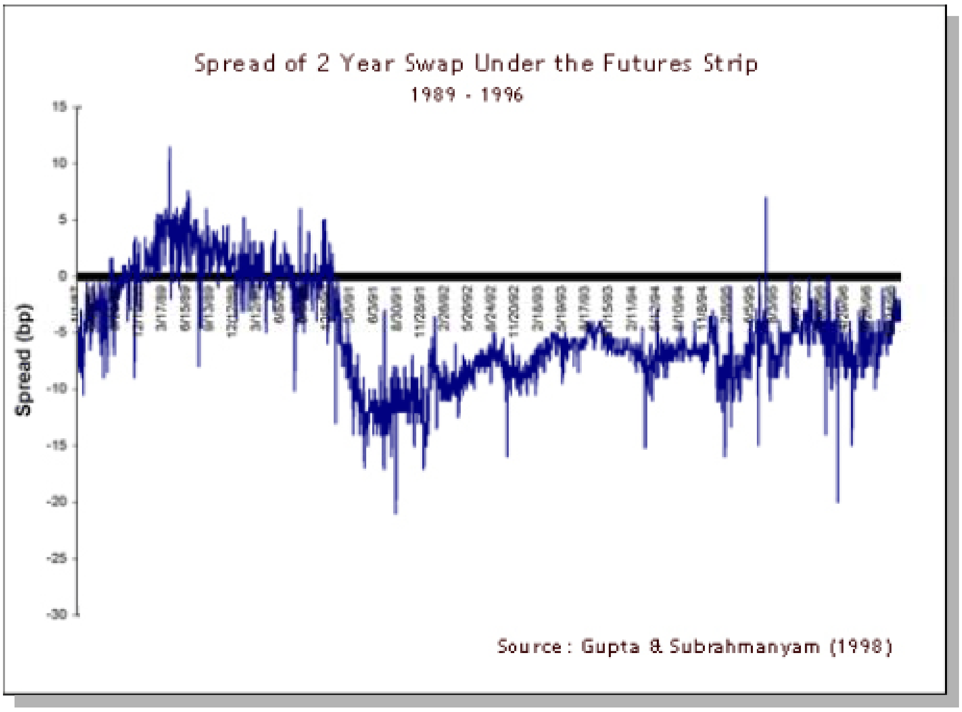
6.4. Convexity Adjustment

The arbitrage swap rate that we just derived did not take into account the fact that a swap position has convexity, whereas a futures position does not.

Like most fixed income instruments, swaps have convexity (see Bond Market Risk - Convexity): the BPV of a swap position will decline as market rates rise and vice versa. On the other hand, the BPV of a futures position (i.e. its tick value) remains constant. Therefore, a swap trader who hedges a receiver swap position by shorting the futures strip is net long convexity:

- When rates rise, profits on the short futures hedge will outperform mark-to-market losses on the swap position
- When rates fall profits on the swap position will outperform losses on the futures hedge

This inherent net profit bias means that in practice swaps tend to trade at rates that are slightly lower than those derived straight off the futures strip, as the figure below illustrates, so that a swap trader hedging with futures will on average break even.



Nowadays, most swaps-futures arbitrage systems allow the trader to make a **convexity adjustment** to the 'static' swap rate derived from the futures strip using option-like models which make the size of this adjustment a function of:

- The swap's maturity – the longer its maturity, the larger its convexity
- The market volatility of the swap rate – the higher the volatility, the larger is the profit bias

The size of the convexity bias may be negligible for short-dated positions, but can be of the order of 6-10 basis points for swaps with 2-5 year maturities and more for longer-dated structures.

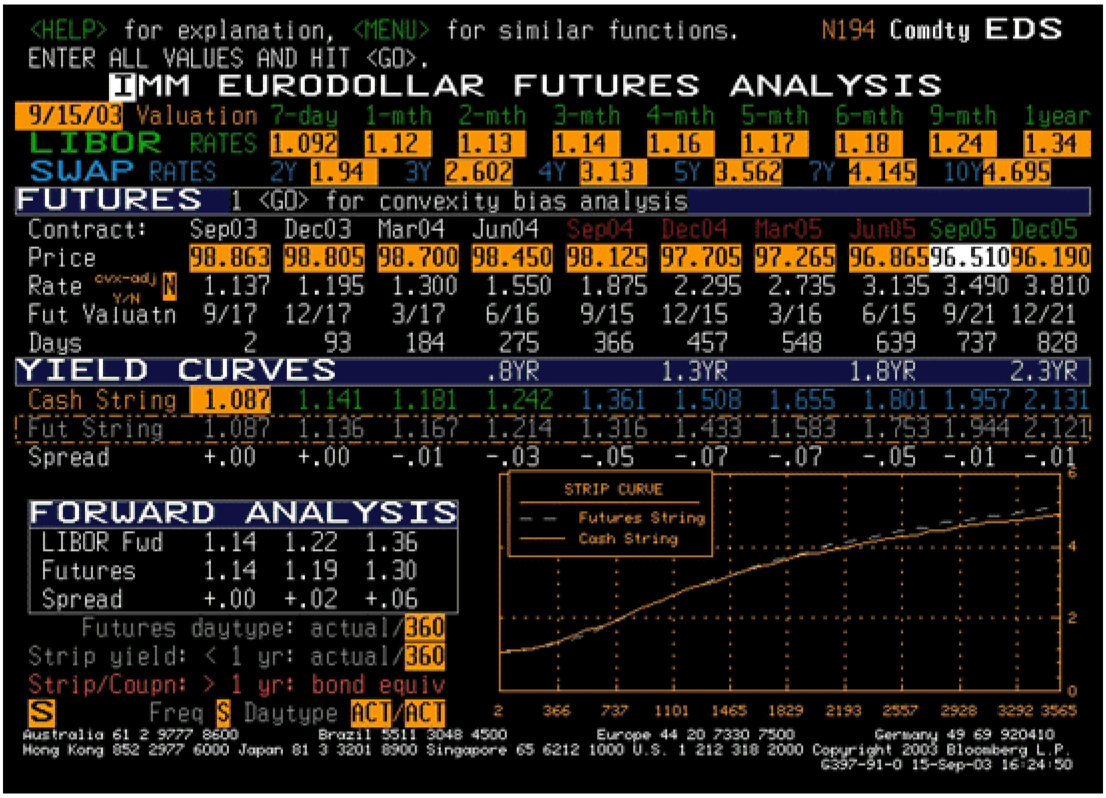
Analytic systems

Example of Bloomberg Eurodollar futures vs LIBOR/swap price analysis function

Below is a sample screen from a widely-used provider of market information and analytics.

This example is for illustration purposes only and does not form part of the IFID Certificate syllabus.

Bloomberg Eurodollar futures analysis



Notes

- The *Futures* panel on this screen displays the 3 month LIBORs implied in the futures strip up to the DEC05 contract, together with their delivery dates and number of days from today. The implied rates are simply (100 – futures price), with no convexity adjustment has been made to them

- The *Yield Curves* panel compares the yield curve derived from the (convexity-unadjusted) futures strip and the LIBOR-plus-swap curve specified at the top of the screen

- The chart on the bottom-right plots the differences between the two curves shown in the *Yield Curves* panel. In this case, the differences up to 5 years are not significant but beyond that they are, going all the way up to 6 basis points in the 10 years

7. Market Risk

7.1. Basis Point Val

Basis point value (BPV) of a swap position: the change in the net present value (NPV) of a swap position for a 1 basis point change in the swap rate.

Also known as: **Present value of a basis point** (PVBP),
Value of an 01 (VAL-01), **Dollar modified duration**,
Risk factor, **Delta**.

In Bond Market Risk - Basis Point Value, we showed how you derive the BPV of a fixed coupon bond from its duration. We also showed how you may calculate BPV directly, by repricing the bond for a 1 basis point change in yield.

Knowing the BPV of a swap position is useful when trading or hedging swaps against comparable government bonds, as we shall see in the next section. As with a bond, the BPV of a swap may be derived from its duration. Alternatively, you can calculate it directly, as follows:

1. Revalue the swap at current cash and forward market rates
2. Revalue the same swap by adding 0.01% to each cash and forward market rate
3. Take the difference between the two revaluations.

7.2. Example

Revaluation date: 20 May 2002

Situation
A trader at Bank A had contracted to enter into the following swap transaction (this is the same swap that we had priced in section *Pricing*):

Effective date: 20 March 2002
Termination date: 19 March 2003
Notional amount: USD 100,000,000
Fixed rate receiver: Bank A
Fixed rate: 4.73 percent per annum (Actual/Actual), payable quarterly
Floating rate: 3 month LIBOR (Actual/360)
First Rate: 4.55 percent per annum

? What is the delta of this swap position?

Analysis

1. Current Market Rates

Period	Nr. Days Covered	Yield	$D_{i-1,i}$	$D_{0,i}$
18 May - 19 Jun 02	30	4.35%	0.99639	0.99639
19 Jun – 18 Sep 02	91	4.50%	0.98875	0.98518
18 Sep – 18 Dec 02	91	4.62%	0.98846	0.97381
18 Dec 02 - 19 Mar 03	91	4.73%	0.98818	0.96230

Swap Valuation

Settlement	Fixed	PV Fixed	Floating	PV Floating
19 Jun 02	1,182,500	1,178,229	(1,150,139)	(1,145,985)
18 Sep 02	1,182,500	1,164,977	(1,137,500)	(1,120,644)
18 Dec 02	1,182,500	1,151,529	(1,167,833)	(1,137,247)
19 Mar 03	1,182,500	1,137,924	(1,195,639)	(1,150,567)
Sum		**4,632,659**		**(4,554,443)**
Net			**+ 78,216**	

2. Market Rates + 0.01%

Period	Nr. Days Covered	Yield	$D_{i-1,i}$	$D_{0,i}$
18 May - 19 Jun 02	30	4.36%	0.99638	0.99638
19 Jun – 18 Sep 02	91	4.51%	0.98873	0.98515
18 Sep – 18 Dec 02	91	4.63%	0.97843	0.97375
18 Dec 02 - 19 Mar 03	91	4.74%	0.98816	0.96222

Swap Valuation

Settlement	Fixed	PV Fixed	Floating	PV Floating
19 Jun 02	1,182,500	1,178,219	(1,150,139)	(1,145,975)
18 Sep 02	1,182,500	1,164,939	(1,140,028)	(1,123,097)
18 Dec 02	1,182,500	1,151,462	(1,170,361)	(1,139,642)
19 Mar 03	1,182,500	1,137,829	(1,198,167)	(1,152,904)
Sum		**4,632,449**		**(4,561,618)**
Net			**+ 70,831**	

3. BPV	= 78,216 – 70,831
	= **USD 7,385**

Thus, for a USD 100 million position, the swap's delta is USD 7,385; for a USD 100 position it is 0.007385.

Alternative Approximation

The methodology illustrated here requires quite a bit of yield curve modelling. However, you can get a reasonably good approximation to the BPV of a single swap if you use the alternative revaluation method illustrated in section *Revaluation*. The principle is:

BPV of swap = BPV of 4.73% 'bond' - BPV of 4.55% 'CD'

Example

You can get a reasonably close approximation of the BPV of the swap position illustrated in this section if you interpret it as equivalent to being:

- Long a 1 year 'bond' with a quarterly coupon of 4.73% (the swap contract rate) and a yield of 4.64% (the current market swap rate). The bond matures on 19 March 2003 and is for settlement 20 May 2002.

- Short a 92-day 'certificate of deposit' with a coupon of 4.55% (the current LIBOR fixing on the floating leg) to yield 4.35% (the current market LIBOR). The CD matures on 19 June 2003 (the next settlement date) and is for value 20 May 2002. It has an original tenor of 91 days and a residual maturity of 30 days.

  BPV of swap = BPV of 'bond' - BPV of 'CD'

Calculations

Using a bond pricing model we find:

	Clean Price
Yield = 4.64%	100.071424
Yield = 4.65%	100.063316
Difference (BPV)	0.008108

Using the CD settlement formula introduced in Money Market Cash Instruments - Pricing CDs:

$$\textbf{Settlement amount} = \frac{\textbf{Principal x (1 + Coupon rate x t / Year basis)}}{\textbf{(1 + Yield x n / Year basis)}}$$

Where:

t	=	Actual number of days from issue to maturity (the **tenor** or term of the loan)
n	=	Actual number of days from settlement to maturity (the **residual maturity**)
Year basis	=	360 for most currencies except GBP (i.e. actual/360)

In this case, when yield is 4.35%:

$$\text{Settlement amount} = \frac{100 \times (1 + 0.0455 \times 91/360)}{(1 + 0.0435 \times 30/360)}$$

$$= 100.784794$$

And when yield is 4.36%:

$$\text{Settlement amount} = \frac{100 \times (1 + 0.0455 \times 91/360)}{(1 + 0.0436 \times 30/360)}$$

$$= 100.783957$$

Therefore, BPV of 'CD' = 100.784794 - 100.783957
= 0.000837

And BPV of the swap = 0.008108 - 0.000837
= 0.007271% of USD 100 million
= **USD 7,271**

The BPV obtained using this method is not identical to that obtained if we present-valued each cash flow explicitly using the zero coupon curve, but it is useful as a quick-reckoner of what the position might be worth.

8. Warehousing

8.1. Hedging with Futures

Swaps warehousing: hedging the market risk on a swap position with offsetting positions in Eurocurrency futures, government bonds or other fixed income instruments.

The concept of warehousing implies that the swaps trader will implement temporary hedges, until the swaps positions are matched with offsetting swaps.

Hedging with Futures Strips

In section *Pricing* we showed how you price swaps off the Eurocurrency futures strip, so naturally the swaps trader will look to the futures strip as the obvious hedging instrument.

Example - Risk-weighted Strip

Trade date: 15 March 1999

Situation
A swap trader at Bank A has entered into the following position:

Effective date:	17 March 1999
Termination date:	17 March 2001
Notional amount:	EUR 100,000,000.00
Fixed rate payer:	Bank A
Fixed rate:	3.48%, quarterly
Day count:	Actual/360
Floating rate:	3 month EURIBOR (Actual/360)
First LIBOR fixing:	3.00%

? How many EURIBOR futures contracts should the trader buy in order to hedge the market risk on this position?

Analysis
The risk in this case is that the future EURIBORs will fall and we are tempted to suggest that the trader buys a strip of 100 contracts for delivery in JUN 1999 through to DEC 2000. This is a total of 700 contracts, each lot of 100 contracts hedging the risk on a single interest period.

However, in Eurocurrency Futures - Pricing we saw that, while the BPV of each futures contract is constant (in this case EUR 25.00), the BPV of each forward interest period will vary, depending on the forward date.

Buying a strip of 100 contracts may therefore be too much. The idea is to construct a futures strip such that:

- The total BPV of the futures strip is the same as the total BPV on the swap position, and
- The number of futures contracts bought for each delivery month has the same BPV as the BPV of the interest period that it hedges.

The table below shows the risk profile of this swap and the number of futures required to hedge each interest period.

Interest Period	Days	Spot Yld.	Fwd Yld.	BPV	Nr. Contracts
Jun - Sep 99	91	3.03%	3.07%	2,494	100
Sep - Dec 99	91	3.10%	3.24%	2,474	99
Dec 99 - Mar 00	91	3.20%	3.49%	2,447	98
Mar - Jun 00	91	3.30%	3.72%	2,417	97
Jun - Sep 00	91	3.39%	3.81%	2,389	96
Sep - Dec 00	91	3.45%	3.81%	2,365	95
Dec 00 - Mar 01	91	3.49%	3.75%	2,343	94
Net				**(16,929)**	**679**

Notice that we do not need to worry too much about the first interest period, from 17 March to 17 June 1999, as the LIBOR for this period has already been fixed at 3.00%.

The BPV of each forward interest period on the swap is the PV of the change in the net settlement amount for that period as a result of a 1 basis point parallel shift in the swap curve.

Thus, the BPV for the second interest period is:

$$\text{BPV} = 100 \text{ million} \times \left[\frac{(0.0307 - 0.0348) \times 91/360}{(1 + 0.0303 \times 91/360)^2} - \frac{(0.0308 - 0.0348) \times 91/360}{(1 + 0.0304 \times 91/360)^2} \right]$$

= - **EUR 2,494**

The BPV for the third interest period is:

$$\text{BPV} = 100 \text{ million} \times \left[\frac{(0.0324 - 0.0348) \times 91/360}{(1 + 0.0310 \times 91/360)^3} - \frac{(0.0325 - 0.0348) \times 91/360}{(1 + 0.0311 \times 91/360)^3} \right]$$

= - **EUR 2,474**

And so on for the other interest periods.

In the last column we calculate the number of futures contracts required to hedge the market risk of each interest period.

Thus, for the second interest period:

Nr. futures contracts = 2,494 / 25.00
= **100 contracts**, rounded.

For the third interest period:

Nr. futures contracts = 2,474 / 25.00
= **99 contracts**, rounded.

And so on for the other interest periods.

To hedge this swap the trader will have to buy a total of 679 futures contracts, but notice how the strip is front-loaded and tapers towards the tail end. Other things being equal, as the swap position approaches maturity, the BPV of the forward interest periods will become larger, so the number of futures contracts required to hedge each one will have to be increased accordingly.

8.2. Hedging with Bonds

Swaps for maturities that exceed the available futures strips are typically priced off (and hedged with) government bonds. The example below illustrates this technique.

Example

Trade date: 15 March 1999

Situation
A swap trader at Bank A has been asked to quote for the following:

Effective date:	17 March 1999
Termination date:	17 March 2009
Notional amount:	EUR 100,000,000.00
Fixed rate payer:	Bank A
Floating rate:	12 months EURIBOR (Actual/360)
First LIBOR fixing:	3.10%

EUR LIBOR futures are only traded for delivery up to 4 years forward, but the yield on a 10 years German 7.25% government bond (Bund) is currently 6.75% (annual, actual/actual).

? What rate should the trader quote for this swap?
How should she hedge her risks?

Analysis
These two questions are interrelated: as with any other derivative, the pricing of this swap will depend on the method by which the trader intends to hedge its risks. Here the trader will pay the fixed rate so her risk is that swap rates may subsequently fall, resulting in a revaluation loss on her position. The trader therefore requires a hedging instrument that will generate compensating profits in that scenario.

Since the trader cannot buy the EUR LIBOR strip to match the swap's maturity, an alternative is a long position in the benchmark Bund with the same market risk as her swap.

Suppose that swap rates for maturities up to 4 years are priced 10 basis points higher than the yields on comparable-maturity government bonds. As a first approximation, the trader may apply the same **swap spread** to her 10-year swap and therefore quote 6.75% + 0.10% = 6.85%.

Swap spread = Swap rate - Yield on benchmark bond with comparable maturity

As we shall see below, the swap spread actually quoted will depend on, among other things, the cost of repoing the underlying bond, but for the moment let's assume the trader quotes 6.85%.

The next step is to calculate how many of the 10-year Bunds the trader should buy in order to hedge the market risk on the swap position. The idea is to construct a **risk-weighted** hedge such that:

Amount of Bunds x BPV_{Bunds} = Notional on swap x BPV_{Swap}

Therefore:

$$\textbf{Amount of Bunds = Notional on swap = x } \frac{BPV_{Swap}}{BPV_{Bunds}}$$

Using one of the techniques described in Bond Market Risk - Basis Point Value, we calculate the BPV on this Bund to be 0.07267%.

Using one of the techniques explained in section *Market Risk*, we calculate the BPV on the fixed leg of the swap to be 0.07069% and the BPV on the floating leg to be 0.00983. Therefore, if the first LIBOR on the swap has already been fixed:

BPV on the swap	= 0.07069	- 0.00983	
	= 0.06086		
Amount of Bunds bought	= 100 million	x	0.06086 / 0.07267
	= **EUR 83,500,757** nominal		

This hedging technique is similar to the one we use when designing a yield curve or credit spread trade involving two bonds (see Bond Market Risk - Trading Applications).

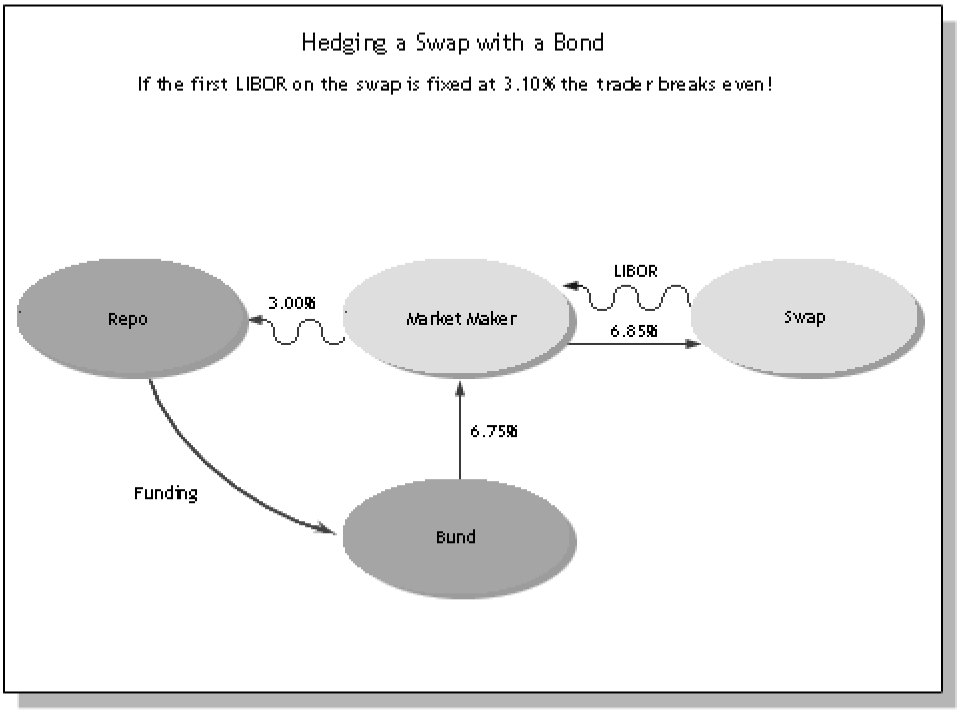
8.3. Funding the Bond Hedge

The rate that the trader quotes on a swap that will be warehoused with bonds will depend to some extent on how the hedging position is funded. Suppose there are two funding alternatives open to this trader:

Repo rates:
Overnight 2.95%
12 months 3.00%

Funding the Bunds on overnight repo is cheaper than on term repo, but it exposes the trader to **funding risk**: the overnight repo has to be re-negotiated daily and its rate may vary. Below is a summary of all the market maker's cash flows, if the Bund was funded on term repo.

Fixed leg of swap	- 6.85%
First LIBOR fixing	+ 3.10%
Yield on hedging bond	+ 6.75%
Repo rate	- 3.00%
Net cash flow	**0.00%**



At the rates quoted in this example, if the Bund hedging the swap is funded on term repo then during the first interest period the warehouse breaks even. On subsequent interest periods the profitability of the warehouse will depend on the future cost of repoing the bonds:

- If the repo rate is less than 10 basis points below LIBOR the swap becomes unprofitable
- If the repo rate is more than 10 basis points below LIBOR the swap is profitable.

Thus, the spread quoted for this swap has to factor in, among other things, the likely future cost of repoing the hedging bond relative to LIBOR. In particular, a trader hedging a receiver swap with a short position in the underlying bond may lose money if the bond went on special.

9. The Swap Spread

What drives the swap spread is the subject of much debate, as there are complex forces at work and it is often difficult to assess the significance of each one. Below are some of the most important factors:

Hedging of US mortgage backed securities (MBS) portfolios

MBS portfolios guaranteed by US government agencies offer attractive yields but also display negative convexity, which is an undesirable feature (see Asset-backed Securities – Convexity). To offset the declining duration of their US MBS portfolios when market yields fall, investors enter into receiver swaps and this drives swap spreads down. Conversely, when yields are high investors offset the rising duration of MBS portfolios by entering into payer swaps, driving the swap spreads higher.

This has become one of the most significant drivers of USD swap spreads in recent years, as the amount of MBS outstanding has continued to increase.

The interest rate cycle

As rates reach historically low levels, waves of borrowers enter the swap market wanting to lock into these rates by becoming fixed-rate payers on swaps, so spreads widen. The opposite is the case when rates are perceived to have peaked[3].

The shape of the curve is also significant: a positive curve allows borrowers to reduce their cost of funding (at least in the short term) by swapping into floating, so positive curves tend to be associated with wide swap spreads and vice versa.

Credit spreads

Unlike a corporate bond, where all the principal lent is at risk, the credit risk on a swap position is typically much less than its notional amount.

Credit risk on a swap
= Mark to market profit on the position (if positive)
+ Statistical add-on to allow for future potential profit

However, to the extent that:

- Swaps are arbitraged against the futures strip
- The futures are arbitraged against fixed deposits

then we would expect swap spreads to reflect LIBOR spreads. Nowadays, both LIBOR and swap rates tend to be associated with AA credit ratings, so we would expect swap spreads to be comparable with credit spreads on AA-rated instruments.

Repo market conditions

The example in section *Warehousing* shows how liquidity in the repo market may have an impact on the spread quoted for swaps that are priced off government bonds: the lower the repo rate is relative to LIBOR, the higher will be the swap spread. For example, the swap spread would widen if the benchmark bond used for hedging it went on special.

[3] This factor has the opposite effect on swap spreads than MBS hedging, so it is more noticeable in non-USD swaps markets.

Trading the Spread

Warehousing swaps with offsetting bond positions hedges the trader against market risk, but leaves her exposed to spread risk.

The risk is that the swap rate may change *relative to* the yield on the underlying bond. In our example in section *Warehousing*, the trader paying the fixed rate and hedging with a long bond position will suffer a net loss if the yield on the bond were to rise relative to the swap rate - i.e. if the swap spread narrowed. You could therefore use the technique illustrated in that section to actively trade the swap spread:

- Pay the fixed rate on a swap and buy the underlying bonds if you believe swap spreads will widen

- Receive the fixed rate and short the underlying bonds if you believe the swap spread will narrow

10. Main Product Variations

In this section we discuss other ways in which the cash flows on an interest rate swap can be structured, other than the way it's done in the vanilla fixed vs. floating swap. In particular, we look at the following:

- Forward-start swap
- Overnight index swap
- Inflation swap
- Currency swap

These are just some of the structures that are commonly traded in the fixed income markets today, but the possibilities for variations are almost infinite.

A swap is any exchange of future cash flows and therefore an OTC derivatives trading book is effectively just 'a cash flow reprocessing plant'.

For any deal, the trader needs to ensure that the expected future cash flows that will be paid out of the book have at least the same PV as the cash flows that the counterparty will pay into the book. In this module we have already developed most of the basic architecture of an OTC derivatives trading book:

1. A forward rates curve to 'fix' any future floating rates on the contract

2. A discount function to PV all the future cash flows (no matter how they are calculated)

As we shall see in this section and in the *Exercise* that follows, once we have this basic architecture in place the different types of swap product can be priced relatively easily. As with the pricing of any other financial instrument (see module Time Value of Money – Overview) the pricing of exotic swaps always involves the following 2 steps:

1. Identify the size and the timing of all the future cash flows that are receivable and payable on the swap

2. PV those future cash flows using the appropriate discount rates

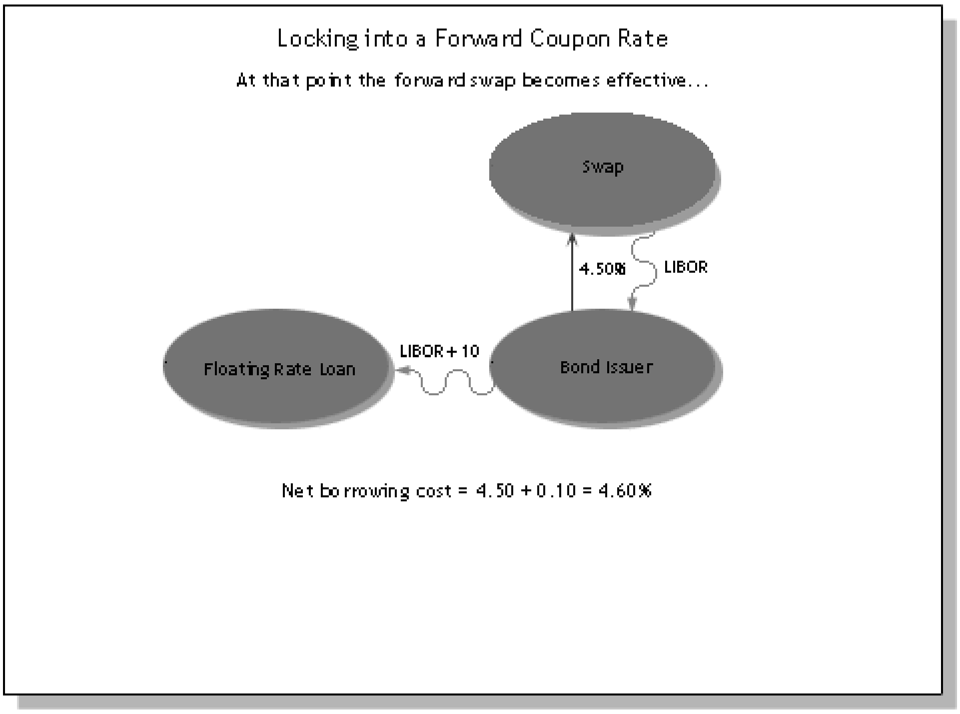
10.1. Forward-start Swaps

A forward swap (or forward-start swap) is a swap contract that becomes effective (i.e. begins accruing interest) not at the spot date, as with the plain vanilla swap, but at some agreed forward date.

Example - Locking into forward coupon rates

A corporation has an outstanding issue of a 6% bond that matures in 6 months. Currently, 5-year yields are lower than 6% but they are widely expected to rise in the near future. The company would like to fix today the rate at which it can refinance its debt with a new bond issue for a further 5 years.

Solution:
The company becomes a payer of fixed on a **6 months into 5 years** forward swap. When the existing bond matures, the issuer repays the principal on the bond by borrowing on a floating rate basis. At that point the forward swap becomes effective and covers the market risk on the floating rate loan.



Notice that the forward swap locks the company into a new fixed rate for another 5 years, so if market rates do not rise as predicted the company will forego the benefit of cheaper funding.

A more flexible alternative might be for the company to buy a **payer swaption** (the option to be a fixed payer on a forward swap) but, as with any option, there would of course be an additional premium cost involved. As we shall see in module Interest Rate Options - Swaptions, forward swaps may also be combined with swaptions to create structures such as **advancing swaps** and **extendible swaps**.

? How do you price a forward swap?

As with the vanilla spot-start swap, the price of a forward swap is that fixed rate of interest that makes the PV of its future fixed rate cash flows equal to the PV of its floating rate cash flows. The only difference here is that, since the contract does not start immediately, one or more of the early cash flows that exist in the vanilla swap are simply 'missing' in the forward swap. We shall model this contract in the *Exercise* that follows this section.

10.2. Overnight Index Swaps

An overnight index swap (OIS) is a swap in which the floating leg is index on an overnight rate of interest.

As in the vanilla interest rate swap, there is no exchange of principal. What makes the OIS rather special is that:

- Maturities normally range from one week to one year
- Typically, there is only one settlement of net cashflows at the maturity of the deal
- The settlement amount is the difference between the amount that is accrued on the fixed leg (a simple interest calculation) and the amount that is accrued on the floating leg (a daily compounded rate at a variable rate)

The floating leg is designed to replicate the accrued interest on a notional amount that is rolled-over daily at a floating overnight rate. It could be thought of as a swap of the effective return on overnight money against a fixed rate.

The Floating Rate

The floating leg of the OIS is calculated using an agreed overnight reference rate. Notable examples are:

- **Euro-denominated OIS deals**: most are referenced to **EONIA** (the Euro Overnight Index Average), which is calculated daily by the European Central Bank (ECB).

  This index is computed as a weighted average of all overnight unsecured lending transactions in the interbank market. The weights are the size of each deal, usually subject to a minimum threshold.

- **Sterling-denominated OIS deals**: most are referenced to **SONIA** (the Sterling Overnight Index Average). This is a weighted average interest rate of all unsecured overnight sterling deposits arranged by a number of selected London brokers, calculated daily by the Bank of England.

The Fixed Rate

The fixed rate on the OIS is the rate of interest that makes the NPV of both legs of the transaction equal to zero.

The quoted fixed rate has to be consistent with the strip of current and forward strip rates derived from the LIBOR curve, as the example on the next page shows. Since the interest on the fixed leg is calculated on a simple interest basis, this rate tends to trade close to the corresponding LIBOR for that term.

Like any swap, the OIS is an interest rate management tool, as the following example illustrates.

? What is the net settlement amount payable or receivable by the bond trader at maturity of this OIS contract?

Settlement example

Situation:
Settlement date: 17 September 2003

A trader intends to carry a long position in EUR 10 million of the 5.5% German Bund maturing January 2031. The current overnight repo rate is 2.40% but the trader believes there is a risk that rates could rise significantly in the coming days.

Solution:
The trader continues to roll over her bond position in the overnight repo market but to protect against funding risk, she also enters into the following OIS transaction with another bank:

Effective date	Wednesday 17 Sep 2003
Maturity	Wednesday 24 Sep 2003
Tenor	1 week
Notional	EUR 10,000,000
Trader pays	Fixed rate of 2.650%
Trader receives	Euro Overnight Index Average (EONIA)
Settlement	At maturity

During the term of the OIS, the following EONIA and overnight repo rates were recorded:

	EONIA	**Repo**	**Difference**
Wednesday 17 Sep	2.451%	2.400%	0.051%
Thursday 18 Sep	2.658%	2.608%	0.050%
Friday 19 Sep	2.813%	2.764%	0.049%
Monday 22 Sep	HOLIDAY		
Tuesday 23 Sep	2.972%	2.921%	0.051%

Analysis:
The first step is to convert the strip of EONIA fixings into an effective simple interest rate using a formula that is similar in structure to the one used in Eurocurrency Futures - Pricing:

Effective Return = Implied return on strip of overnight rollovers

$$(1 + R_E \times FD / Basis) = (1 + R_1 \times D_1 / Basis) \times (1 + R_2 \times D_2 / Basis) \times ... \times (1 + R_n \times D_n / Basis)$$

Where:
R_E = Effective rate
R_i = SONIA rate for the i^{th} overnight rollover
D_i = Number of days in the i^{th} overnight period
(normally 1 but more at week-ends and business holidays)
FD = Number of days in the OIS contract ($FD = D_1 + D_2 + ... + D_n$)
Basis = 360 or 365, depending on local day-count conventions

Using the figures in this example:

$$(1 + R_E \times 7/365) = (1 + 0.02451 \times 1/360) \times (1 + 0.02658 \times 1/360) \times (1 + 0.02813 \times 4/360) \times (1 + 0.02972 \times 1/360)$$

$$= 1.00053711$$

$$R_E = (1.00053711 – 1) \times 360/7$$

= 0.02762 or **2.762**%, rounded.

The final step is to calculate the net settlement amount on the swap as the difference between this effective rate and the contract's fixed rate:

Net settlement amount = (0.02762 - 0.02650) x 7/360 x 10,000,000
= **EUR 217.78** (the bank pays)

Thanks to the OIS, the dealer's net cost of funding the bond position was approximately 2.60% - the fixed OIS rate of 2.65% less the average 5 basis points difference between the repo rates paid and the EONIA rates received. The dealer's funding cost would have been 11 basis points higher (2.71% = 2.762% – 0.05%) without the OIS overlay.

OIS is commonly used as a means of hedging funding risk on securities positions and nowadays in many transactions like this one the floating rate is indexed directly on EUREPO rather than on EONIA (see Repurchase Agreements – EUREPO).

10.3. Currency Swaps

The currency swap is contractually similar to an interest rate swap. The main differences are:

- Each interest rate is in a different currency
- The notional amount is now replaced by two **principal amounts** - one in each currency
- These principal amounts are typically exchanged at the start of the swap and then re-exchanged at maturity

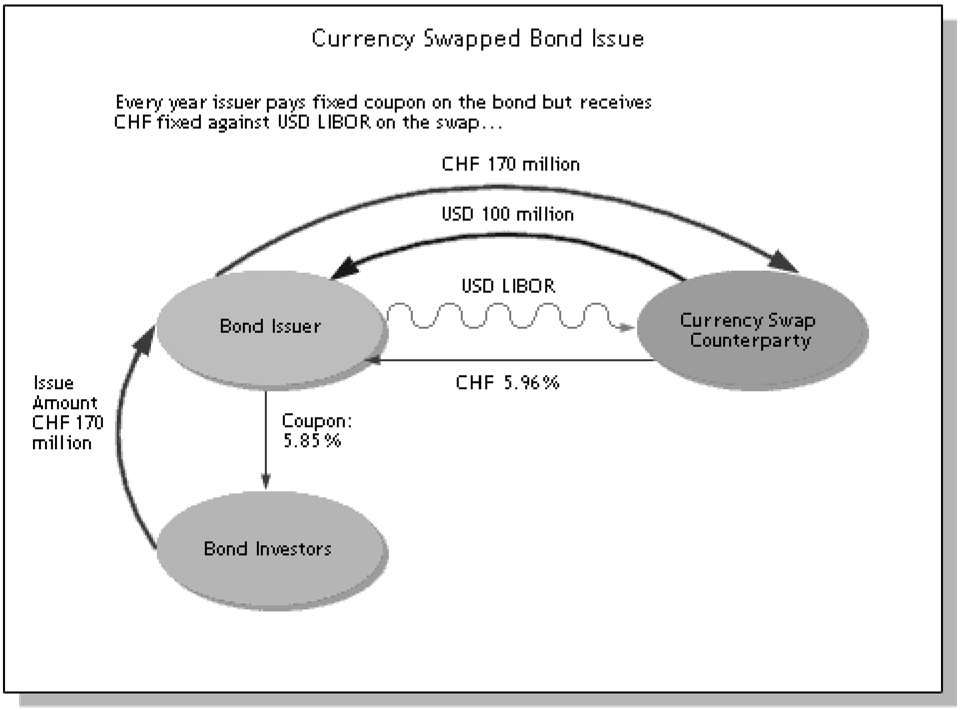
Example

Situation
A Swiss bank requires 5 year USD floating rate finance to fund its growing US loan portfolio. It is considering two alternatives:

- Continue funding in the interbank market at USD LIBOR flat
- Issue a 5 year CHF Eurobond with a coupon of 5.85%

Strategy
Issue the CHF bond and swap with a currency swap on the following terms:

- Receive 5.96% fixed (in CHF)
- Pay USD LIBOR flat



Unlike the interest rate swap, where there is no exchange of principal, in a currency swap there is an exchange of principal amounts at the start and at the end of the contract period.

Details of the cash flows

Stage 1
The bond issuer receives a total of CHF 170 from the bond issue

Stage 2
On the effective date of the swap the two parties exchange principal amounts: bond issuer hands over CHF 170 million against receipt of USD 100 million (this is based on the spot rate of exchange of 1.7000 at the time)

Stage 3
Every year, the bond issuer receives a payment of 5.96% of CHF 170 million on the swap and pays USD LIBOR flat on USD 100 million. At the same time the issuer pays the coupon of 5.85% on the underlying bond.

Net cash flows = - CHF 5.85 + (CHF 5.96 - USD LIBOR)
= - USD LIBOR + CHF 0.11%

Through the swapped bond, the issuer is able to fund at USD LIBOR minus CHF 18,700,000 (11 basis points on CHF 170 million). These Swiss francs may be sold forward in the FX market, resulting in a series of fixed USD payments. Depending on the forward rates of exchange - i.e. on interest rate differentials - these will amount to a little more or a little less than 11 basis points in USD (see section *Conversion Factors*).

Stage 4
At the maturity of the swap the two parties re-exchange the principal amounts on the swap: issuer receives CHF 170 against payment of USD 100. At the same time the issuer repays the principal on its maturing CHF bond.

11. Inflation Swaps

11.1. Structures

Inflation swaps involve an exchange of cash flows, with one or both of its legs calculated with reference to an inflation index.

The currency sectors that account for the majority of inflation swaps are those that also have active markets in inflation bonds[4]:

- EUR indexed on Eurozone HICP[5] or French CPI[6]
- GBP indexed on RPIX[7]
- USD indexed on CPI-U[8]

This suggests two main types of swap:

- Fixed cashflows vs. inflation linked cashflows
- LIBOR cashflows vs. inflation linked cashflows

11.2. Example

Below is a typical term sheet for an inflation swap against LIBOR-based payments. In this example the swap's inflation-linked payments are structured to simulate the cash flows of an inflation-linked bond.

Date: 1 July 2003
To: Party B Plc
From: Party A Bank
Our Ref: IRS 9871-1

We are pleased to confirm our mutually binding agreement to enter into a Rate Swap Transaction with you in accordance to our telephone agreement with [Mr Swapper] on [1 July 2003], pursuant to the ISDA Master Agreement between us dated [10 November 1996].

[4] This is not surprising, because swap market makers use the underlying inflation bonds to hedge their exposures to inflation (see section *How to Price Them*, below).

[5] Harmonised index of consumer prices

[6] Consumer price index

[7] Retail price index excluding mortgage interest payments

[8] CPI for urban consumers

Effective date:	15 July 2003
Termination date:	15 July 2024
Notional amount:	GBP 50,000,000.00

Party A pays: 3.57% per annum fixed, semi-annual, plus inflation adjustment, calculated according to the following formula:

$$\text{Notional amount} \times \frac{0.0357}{2} \times \frac{RPIX_{i-8}}{173.10}$$

Where:
$RPIX_{i-8}$ = UK Retail Price Index, excluding mortgage interest payments, for the month that is 8 months prior to the month when the i^{th} settlement payment is due

Day count: Act/Act

Additional payment from Party A, due on 15 July 2024:

$$\text{Notional amount} \times \frac{RPI_{\text{November 2023}}}{173.10}$$

Party B pays: Six month LIBOR + 1.30%

Day count:	Actual/365
Reset dates:	Two London business days prior to the First day of each Party A Calculation Period, based on the rate published by the British Bankers Association ("BBAIRS").

Payment dates:	Each party pays on its own Period End Dates
Settlement instructions:	Standard

Party A calculation periods for payments

First period:	Effective Date to but excluding 15 January 2003 (the "Period End")
Later period dates:	Each 15 July and 15 January after the First Period End Date, subject to the Modified Following Banking Day convention, and finally the Termination Date.

Party B calculation periods for payments

First period:	Effective Date to but excluding 15 January 2003 (the "Period End Date")
Later period dates:	Each 15 July and 15 January after the First Period End Date, subject to the Modified Following Banking Day convention, and finally the Termination Date.

Please confirm to us that the terms set forth herein accurately reflect our Transaction.

For Party A Bank,
John Smith
Settlements Manager

11.3. Typical Users

In the term sheet on the previous page, Party A Bank could be described as the **inflation payer** and Party B Plc as the **inflation receiver**. In that example the contract was structured so as to mirror exactly the coupon dates and inflation-linked payments on the UK Treasury 2½% Index Linked of 2024. It therefore allows Party B to earn an inflation linked return, against payment of a fixed LIBOR spread, while giving Party A Bank an obvious mechanism for hedging its exposure to inflation[9].

- **Typical inflation payers**
  - Public utilities whose future revenues are linked to inflation
  - Consumer retailers worried about the risk of deflation

- **Typical inflation receivers**
  - Institutional investors whose liabilities are linked to inflation (e.g. pension funds and insurance companies)

An environment of falling consumer prices not only squeezes retailers' profit margins, because adjustments to purchase prices lag behind re-sale prices, but is also known to inhibit real consumer spending as households defer their purchasing decisions in the expectation of even lower prices in the future.

Case of UK pension funds
Financial institutions and corporations who offer defined benefit pension have suffered in recent years, as equity valuations failed to keep up with inflation.

Defined Benefit Schemes

Two types of pension scheme exist in the UK:

- **Defined benefit** (or **final salary**) schemes, which pay individuals pensions based on their final salary and the number of years' service to the company

- **Defined contribution** (or **money purchase**) schemes, where the payments are made out of the funds accumulated over the years from investing the members' pension contributions in a portfolio of equity and bonds, whose future value upon retirement may be uncertain

The inflation risk on a defined benefit scheme tends to lie with the scheme sponsor, whereas the inflation risk on a defined contribution scheme tends to lie with the beneficiary

Defined benefit schemes feature prominently in the UK public sector but many private sector corporations have also traditionally offered these to their employees. In both cases, the schemes tend to be managed by financial institutions that specialise in this type of business.

Problems for Providers of Such Schemes

Providers of defined benefit pensions have grown increasingly concerned in recent years, as:

- Investment portfolios which were heavily weighted in favour of equities in the early 1990s (as a way of hedging against inflation risk) seriously underperformed in the late 1990s with the fall in equity values

- Changes in UK law have made it impossible for investment funds to claim back taxes paid on equity dividends

- An increase in life expectancy has increased the value of the funds' expected future liabilities

[9] By buying the same nominal amount of the 2½% Index Linked of 2024!

- Under a new accounting standard (FRS 17) to be fully implemented in 2005, UK corporations will have to change the way in which they account for their in-house defined benefit pension schemes:
    - All the assets of the scheme will be re-stated at their market value
    - All liabilities will be estimated on an actuarial basis, taking future inflation into account and discounted using AA rating market rates
    - Any resulting net surplus or deficit in the scheme will be shown on the corporation's balance sheet

Proposed Solutions

Defined benefit schemes have 3 broad types of liability:

- **Active liabilities** – future pensions payable to people that are still at work and contributing to the scheme

- **Deferred liabilities** – future pensions payable to people who are no longer contributing to the scheme (e.g. because they have moved jobs) but who have not yet retired

- **Pensioners** – pensions payable to already retired people who expect to continue collecting for some years

Active liabilities rise in line with salaries and the other two types of liability must, by UK law, rise by the Limited Price Index (LPI), which is the standard UK Retail Price Index (RPI) but with a 5% cap and a 0% floor.

From an asset and liability perspective, it makes sense to match inflation linked liabilities with inflation linked assets and those companies that plan to continue offering defined benefit schemes[10] will shift the majority of their assets into more stable investments, such as inflation linked bonds or straight bonds overlaid with inflation swaps.

11.4. How to Price Them

If you know how to hedge the risk, then you know how to price it!

As with any other swap, at inception the contract must represent an equitable exchange of cashflows: the PV of the cash flows on the inflation leg must equal the PV of the cash flows on the other leg.

? What future inflation rates should the market maker assume in order to establish the sizes of the future inflation cash flows to be present-valued?

The financial engineer typically approaches this problem by looking at how the risks on the derivative's cash flows can be hedged in the marketplace and then prices the derivative on the assumption that those risks have been hedged at the given rates (plus a profit margin). In other words, the approach used here will be similar to how we 'fixed' the future LIBORs of a vanilla swap in the interest rate futures market (see section *Pricing*, above) except that here we are 'fixing' future inflation rates.

Inflation can be traded (and hedged) in the inflation bond markets and in module Bond Pricing & Yield – Real Yields and Inflation we showed how implied (or breakeven) forward inflation rates can be derived from the yields observed on straight government bonds and the real yields on inflation-linked bonds with similar maturities.

Fixing the cash flows on the inflation leg of the swap therefore involves the following steps:

---

[10] Many have already indicated their intentions to wind-down such schemes and replace them with defined contributions schemes.

1. Calculate the forward year-on-year inflation rates implied in the differences between the yields observed on straight government bonds and the real yields on inflation-linked bonds with same maturities

2. Using those inflation rates, calculate the future consumer price indices (CPIs), starting from the last one published

3. From the strip of future CPIs, calculate the future cash flows payable or receivable on the inflation leg of the swap

Once you have so 'fixed' the cash flows of the inflation leg, the final step is to PV them, as you would do for any other leg of a swap.

12. Exercise 2

Question 3

In this exercise, you will explore the pricing of some of the interest rate swap structures covered in this module.

Please launch the *Swaps Pricing Model* spreadsheet and ensure the following data is specified in the model:

Curve analysis

Years	Swap Rate
1	6.00%
2	6.70%
3	6.85%
4	6.90%
5	6.92%
Shift	0.00%
Pivot	0.00%

Swap details

Maturity	5 years	
Notional	10,000,000	
Pay/receive	Receive	
	Fixed	**LIBOR**
Coupon	6.9200%	6.0000%
Settlement	Annual	Annual
Day count	30/360	ACT/365

The values in the cells labelled **Notional Multiple** should initially be set to 1 throughout.

a) What is the net present value (NPV) of this swap position (to the nearest pound)?

b) Is the fixed rate receiver a net payer or receiver of cash flow at the first settlement date (in 365 days)?

- Payable
- Receiver

c) What will be the net settlement amount payable or receivable at the first settlement date? Enter your answer rounded to the nearest pound.

d) Now shift the entire swap curve up by 50 basis points by entering 0.50% in the **Shift** cell. What is the swap NPV, to the nearest pound?

e) What is the BPV, or delta, of this swap position (in pounds to the nearest £5 and ignoring the sign)?

Instructions

Enter 0.01% in the **Shift** cell and check the **Swap NPV**.

f) If you were hedging the market risk on this position with a government bond that has a BPV of 0.04550 per £100 nominal, how much of this bond should you buy or sell? Enter your answer in £millions to 1 decimal place.

- Buy £6.9 million
- Short £6.9 million
- Short £14.8 million
- Short £0.1 million

g) Make sure that the **Shift cell** has a value of zero again. What is the rate for a 1 year into 3 years forward swap?

Instructions

1. Enter zero into the **Notional Multiple** cells for years 1 and 5 (this eliminates any cash flows for those two years)
2. Enter 1 into the **Notional Multiple** cells for years 2 to 4
3. Find the rate for the fixed leg of the swap that makes its NPV = 0. Select **Tools | Goal Seek** from the Excel menu and enter the data shown in bold into the dialog box:

Set cell:	**NPV**
To value:	**0**
By changing cell:	**Coupon**

13. Asset Swaps

Asset swaps:

- Long a straight bond + pay fixed on a swap = long a synthetic FRN
- Long a FRN + pay floating on a swap = long a synthetic straight bond

Of the two variants, by far the most common one is the synthetic FRN. These are very popular with commercial banks, many of which are unable to find borrowers of sufficient credit quality to place their clients' deposits, so they buy floating rate paper instead.

Investment banks offering asset swaps scour the bond markets in search of straight bonds that yield attractive spreads over LIBOR on a swapped basis.

Example - Par in / Par out Structure

Settlement date:	15 March 1999
Bond:	Samsung Electronics USD 7½% maturing 10 February 2004 Annual, 30/360
Price:	97.82%
Accrued interest:	0.73%
Yield:	8.05%
5 year swap rate:	6.09% (annual 30/360 against 12 month LIBOR)

You are considering offering an asset swap based on this bond.

? What all-in spread over LIBOR could you quote, if the client wants to invest in the structure the same amount of capital as he takes out at maturity - i.e. a par in / par out structure?

Analysis
A simple rule of thumb is:

Yield on synthetic FRN = L IBOR + (Bond yield - Swap rate)
= LIBOR + (8.05 - 6.09)
= LIBOR + 1.96%

In fact, this is only an approximation (a good one in most, but by no means all, cases). The purchase of 100.00 nominal of the bond, overlaid with a swap for a notional of 100.00, would leave the client with various cash flow mismatches:

- The bond itself only costs 98.55 (the dirty price), whereas the client wishes to invest 100.00 up-front and take out 100.00 at maturity

- The bond pays a coupon of 7.50%, whereas in the current market the client would only have to pay 6.09% on the fixed leg of the swap.

On this basis, the client's net income would be LIBOR + 1.41% (i.e. LIBOR + 7.50 - 6.09) at each coupon date, and at maturity he would realize a capital gain of 1.45% (= 100.00 - 98.55) on the underlying bond.

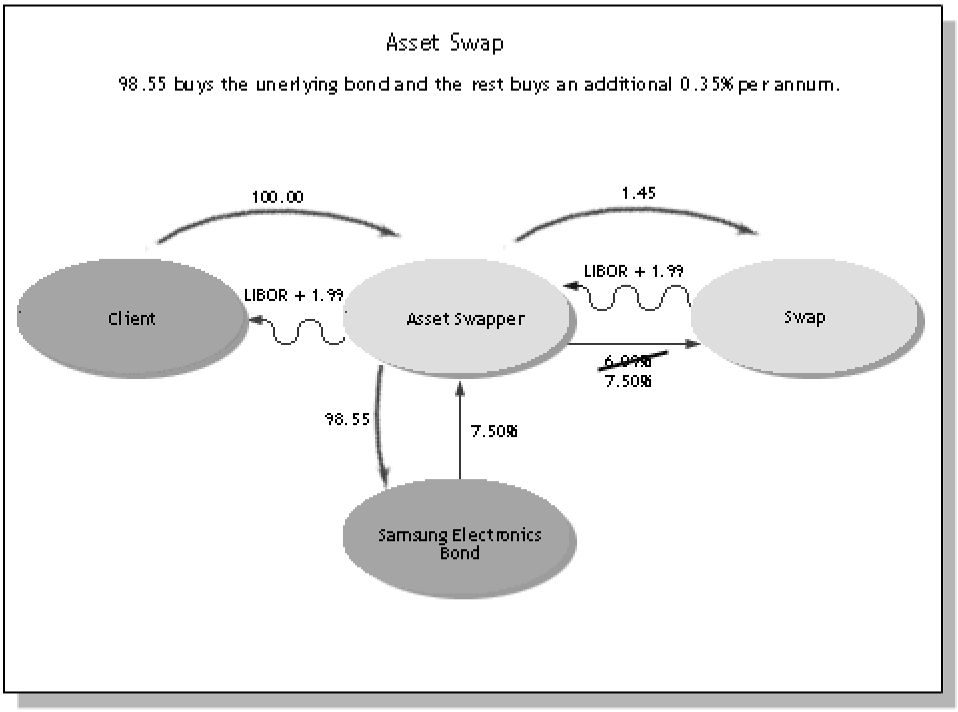
To convert the asset swap into a clean par in / par out structure, we need to make the following adjustments:

1. The coupons payable on the fixed leg of the swap are adjusted to 7.50%, instead of the market rate of 6.09%. Since the investor pays a higher-than-market fixed rate on the swap, the swap counterparty should in return pay LIBOR plus a spread, such that the NPV of the two cash flows(fixed vs. floating) equates to zero.[11]

2. The client invests an extra 1.45% into the structure (the difference between par and the bond's dirty price) in exchange for an additional fixed annuity.

13.1. Resulting LIBOR Spread

The figure below illustrates the steps involved in designing a par in / par out structure and shows the yield spread over LIBOR that can generated after each adjustment.



After these adjustments, the yield on the synthetic FRN turns out to be 3 basis points higher than what we had estimated earlier, using the simple rule of thumb. The explanation in this case is that, since the swap rate is lower than the yield on the bond, the bond's cash flows are worth more in the swap market than they are worth in the bond market! In *Exercise 2* you will have a chance to explore these subtle valuation differences using an asset swap model.

Pricing Bonds off the Swapped Spread

The practice of generating synthetic FRNs out of straight bonds has become so prevalent that many illiquid corporate bonds nowadays are valued on the basis of what they yield on a swapped basis:

1. The bond credit analyst determines what is the appropriate LIBOR spread for a given type of credit

2. The straight bond is valued at a price that yields the required swapped spread, on a par in / par out basis.

[11] Also, the payment dates on the swap are typically set to coincide with the coupon dates on the underlying bond, so the swap typically has a broken maturity date and a short first coupon period. Any cash flow differences on account of this adjustment also have to be factored into the LIBOR spread paid on the swap.

13.2. Credit Risk

In the typical asset swap the investor ('the client') is the legal owner of the underlying bond and retains all of its credit risk.

Typically, the bond's coupons provide the client with the cash flows necessary for the fixed payments under the swap. However, the client remains committed to continue making payments on the interest rate swap[12] regardless of the bond's performance.

If the bond is of investment grade, then it can be pledged as collateral on the swap (or it can be placed with a special purpose vehicle) and this provides credit comfort to the asset swapper.

But if the bond is of poor credit quality, then the asset swapper may either factor some counterparty risk into the swap rate or - more commonly - may require additional cash collateral from the client.

In a par in / par out structure one swap counterparty typically lends funds to the other.

If the underlying bond trades at a discount to par, as in our example, then the client pays over to the asset swapper an additional amount to bring her initial investment up to par. This top-up (the difference between par and the bond's dirty price) represents a loan from the client to the bank and its repayment is included in the LIBOR spread that the bank pays to the client in the swap.

But if the underlying bond trades at a premium to par, it is the asset swapper that pays the difference between par and the bond's dirty price - i.e. lends money to the client to buy the bond. The asset swapper may wish to adjust the net LIBOR spread on the swap, to compensate for the credit risk on this loan.

[12] The client can, of course, negotiate with the bank to close out the swap position by revaluing the residual portion of the contract at current market rates, as explained in section *Revaluation*.

14. Exercise 3

Question 4

In this exercise, you will explore the pricing and risk characteristics of asset swaps using a simple Excel-based model. Please launch the model now and check that the data below has been correctly specified.

Swap Curve

Years	Swap rate
O/N	3.00%
1	3.10%
2	3.50%
3	4.80%
4	5.65%
5	6.12%
6	6.50%
7	6.78%
8	6.97%
9	7.00%
10	7.00%
Shift	0.00%

Asset Swap

		Fixed		**Floating**
Coupon	7.50%	7.00%		3.09%
		+Spread		0.00%
Maturity	10-Feb-08	10 –Feb-08		
Amount	1,000,000	1,000,000		
Effective	15-Mar-99	15-Mar-99		
Payment freq.	Annual	Annual		Annual
Day count	30/360	30/360		act/365
Yield	8.05%			

Please ensure that Type of Swap in the analysis table is set to Par in / par out.

a) On the face of it, if the bond yields 8.05% and the swap rate is 7.00%, what spread over LIBOR should the investor receive on the asset swap? Enter your answers in percent.

Bond yield:

Less swap rate

= LIBOR +

b) What is the price of the bond to be asset-swapped? Enter your answers to 4 decimal places.

Clean price

Dirty price

c) What is the total cost of buying £1 million of this bond?

d) How much additional capital must the investor put up, over-and-above the cost of the bond, for a par in / par out swap for £1 million?

e) The current market rate for a vanilla swap effective on 15 March 1999 and maturing on 10 February 2008 (i.e. matching the dates on the bond) is 7.00%. But if you look in the **Cash Flows** worksheet you will see that the net present value (NPV) of this swap is not zero. Why is that?

- ☐ There is accrued interest on the fixed leg
- ☐ There is accrued interest on the floating leg
- ☐ The first LIBOR has not been fixed at the current market rate
- ☐ There is an up-front cash flow = Par – Bond dirty price

f) To create a clean par in / par out structure, the fixed rate on the payer swap has to be adjusted so that it matches the coupon rate on the underlying bond. Please change the fixed rate on the swap to 7.50%.

After this adjustment, what is the NPV of the interest payer swap, from the point of view of the investor?

Swap NPV (£)

[ ]

g) Who should be compensated for paying the higher fixed rate on the swap?

- ○ The swap counterparty
- ○ The investor

h) So far the investor:

- Pays par for the asset swap (when in fact the underlying bond trades below par)
- Exchanges all the bond's coupons against just LIBOR flat (when in fact the current swap rate is lower than the bond's coupon rate)
- Will have to pay a full coupon on the fixed leg of the swap, at the first settlement date, but will only receive LIBOR for the 332 days in the first interest period

What spread over LIBOR should the swap counterparty pay the investor to compensate her for all these factors? Enter your answer in % to 2 decimal places.

Instructions

Add a spread over LIBOR to the floating leg of the swap such that the NPV of the interest payer swap is zero.

You can do this by trial-and-error or you can let Excel find it for you. Select **Tools | Goal Seek** from the Excel menu and enter the data shown in bold into the dialog box:

Set cell: **NPV_Swap**
To value: **0**
By changing cell: **Swap_floating_spread**

[ ]

i) What is the **risk factor** on this par / par asset swap package (bond plus structured payer swap) - i.e. the gain or loss, in pounds per £100 nominal, for a 100 basis point parallel shift in market rates?

Net market risk

j) How much would a client investing £1 million in this asset swap stand to lose if market rates were to rise by 10 basis points? Enter you answer to the nearest pound.