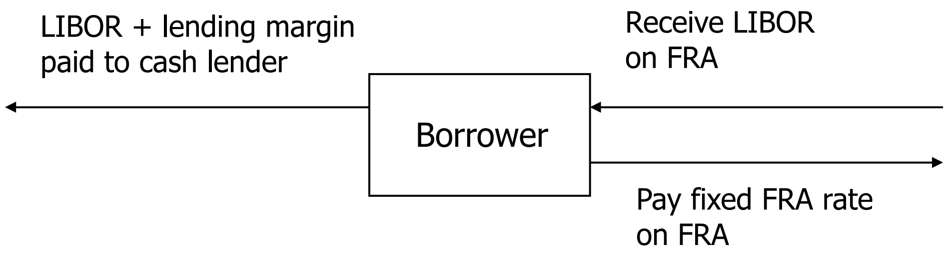
# Interest Rate Swaps (IRS)

# Definitions

- A **swap** is a derivative in which two counterparties agree to exchange one stream of cash flows against another stream.
- These streams are called the **legs** of the swap.
- An **interest rate swap** is a derivative in which one party exchanges a stream of interest payments for another party's stream of cash flows.

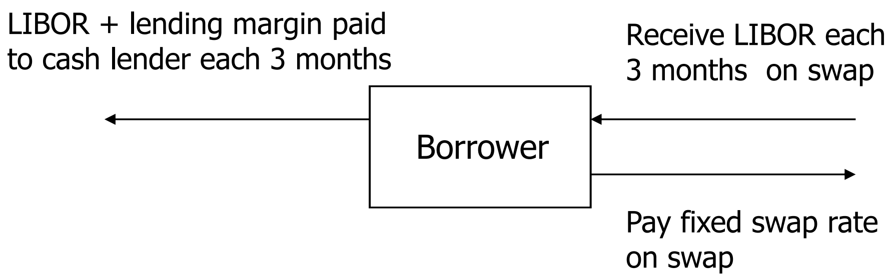
# Hedging with an FRA






# Hedging with an IRS

Very similar to an FRA, but is applied to a series of cashflows



# Characteristics of IRS

## Similar to FRA

- No exchange of principal
- Only interest flows are exchanged and netted

## Different from FRA

- Settlement amount paid at the end of relevant period



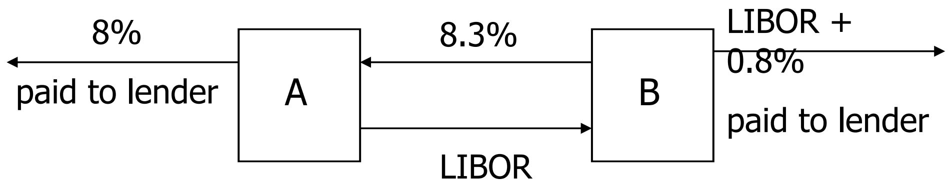
# Motivation

Company A has access to
floating-rates borrowing at LIBOR+0.1%
fixed rate borrowing at 8.0%
Company A would prefer floating-rate borrowing

Company B has access to
floating-rate borrowing at LIBOR+0.8%
fixed rate borrowing at 9.5%
Company B would prefer fixed rate borrowing

How to create a win-win?

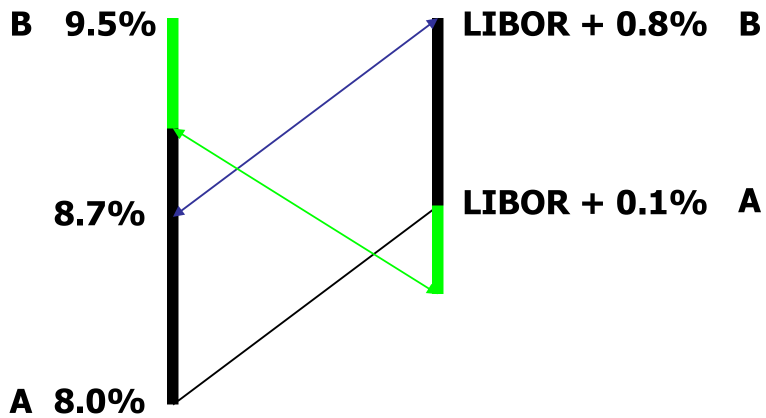
# Win-Win




$$\text{Net cost for A is}: (8.0\% - 8.3\% + \text{LIBOR}) = \text{LIBOR} - 0.3\%$$
$$\text{Net cost for B is}: (\text{LIBOR} + 0.8\% + 8.3\% - \text{LIBOR}) = 9.1\%$$



# Relative Advantage



# FRAs and IRS

| | | | |
|---|---|---|---|
| 3-month LIBOR | | 14.0625% | (91 days) |
| FRA | 3 v 6 | 12.42% | (91 days) |
| | 6 v 9 | 11.57% | (91 days) |
| | 9 v 12 | 11.25% | (92 days) |

Consider the following:

- Borrow USD 1 now for 3 months. At end of 3 months, repay:

$$\mathrm{USD}\left(1+0.140625\times\frac{91}{360}\right)=\mathrm{USD}\,1.03555$$

- Borrow USD 1.03555 and use FRA 3 v 6. Assume repayment at the end of 6 months:

$$\mathrm{USD}\,1.03555\times\left(1+0.1242\times\frac{91}{360}\right)=\mathrm{USD}\,1.06806$$



# FRAs and IRS

- Borrow USD 1.03555 and use FRA 6 v 9. Assume repayment at the end of 9 months:

$$\mathrm{USD}\,1.06806\times\left(1+0.1157\times\frac{91}{360}\right)=\mathrm{USD}\,1.09929$$

- Borrow USD 1.03555 and use FRA 9 v 12. Assume repayment at the end of 12 months:

$$\mathrm{USD}\,1.09929\times\left(1+0.1125\times\frac{92}{360}\right)=\mathrm{USD}\,1.13090$$

Valuing the cashflows

$$1=\left(\mathrm{i}\times\frac{91}{360}\times\frac{1}{1.03555}\right)+\left(\mathrm{i}\times\frac{91}{360}\times\frac{1}{1.06806}\right)+\left(\mathrm{i}\times\frac{91}{360}\times\frac{1}{1.09929}\right)+\left(\left(1+\mathrm{i}\times\frac{92}{360}\right)\times\frac{1}{1.13090}\right)$$

$$\mathrm{i}=12.35\%$$

# Pricing IRS from futures or FRAs

- For each successive futures maturity, create a strip to generate a discount factor
- Use the series of discount factors to calculate the yield of a par swap



# Valuing Swaps

Value the following IRS on 27 March 2002

| | |
|---|---|
| Notional amount: | 10 million |
| Start of swap: | 23 July 2001 |
| Maturity of swap: | 23 July 2004 |
| Receive: | 7.4% (annual 30/360) |
| Pay: | LIBOR (semi-annual ACT/360) |
| Previous LIBOR fixing: | 9.3% from 23 Jan 2002 to 23 Jul 2002 |

Zero-coupon discount factors from 27 Mar 2002:

| | | | |
|---|---|---|---|
| 23 Jul 2002: | 0.9703 | 23 Jan 2003: | 0.9249 |
| 23 Jul 2003: | 0.8825 | 23 Jan 2004: | 0.8415 |
| 23 Jul 2004: | 0.8010 | | |

# Valuing Swaps

Cashflows:

| | | |
|---|---|---|
| 23 Jul 2002: | $+10\text{m}\times 7.4\%$ | $-10\text{m}\times 9.3\%\times\frac{181}{360}$ |
| 23 Jan 2003: | | $-10\text{m}\times L_1\times\frac{184}{360}$ |
| 23 Jul 2003: | $+10\text{m}\times 7.4\%$ | $-10\text{m}\times L_2\times\frac{181}{360}$ |
| 23 Jan 2004: | | $-10\text{m}\times L_3\times\frac{184}{360}$ |
| 23 Jul 2004: | $+10\text{m}\times 7.4\%$ | $-10\text{m}\times L_4\times\frac{182}{360}$ |

where $L_1, L_1, L_1$ and $L_1$ are LIBOR



# Valuing Swaps

- To Value an IRS, we calculate ?
- How?

# Simplification

Cashflows:

23 Jul 2002: $+10\text{m}\times 7.4\%$ $\quad -10\text{m}\times 9.3\%\times\frac{181}{360}$

23 Jan 2003: $\quad -10\text{m}\times L_1\times\frac{184}{360}$

23 Jul 2003: $+10\text{m}\times 7.4\%$ $\quad -10\text{m}\times L_2\times\frac{181}{360}$

23 Jan 2004: $\quad -10\text{m}\times L_3\times\frac{184}{360}$

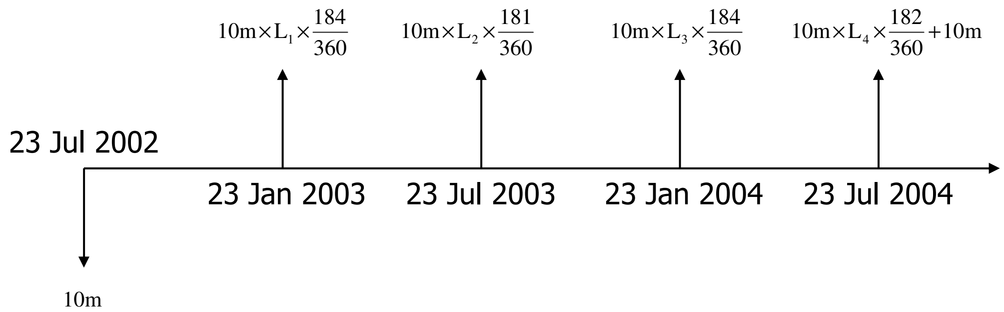
23 Jul 2004: $+10\text{m}\times 7.4\%$ $\quad -10\text{m}\times L_4\times\frac{182}{360}$

where $L_1, L_1, L_1$ and $L_1$ are LIBOR

**What is this?**



# More Detail




$$\text{NPV} = -10\text{m} + \frac{10\text{m}\times L_1\times\frac{184}{360}}{\left(1+L_1\times\frac{184}{360}\right)} + \frac{10\text{m}\times L_2\times\frac{181}{360}}{\left(1+L_1\times\frac{184}{360}\right)\left(1+L_2\times\frac{181}{360}\right)} + \frac{10\text{m}\times L_3\times\frac{184}{360}}{\left(1+L_1\times\frac{184}{360}\right)\left(1+L_2\times\frac{181}{360}\right)\left(1+L_3\times\frac{184}{360}\right)}$$

$$+\frac{10\text{m}\times L_4\times\frac{182}{360}+10\text{m}}{\left(1+L_1\times\frac{184}{360}\right)\left(1+L_2\times\frac{181}{360}\right)\left(1+L_3\times\frac{184}{360}\right)\left(1+L_4\times\frac{182}{360}\right)}$$

# Reversing a Swap

- To close out a previous position
- Transact another swap in the opposite direction for the remaining term of the existing swap
- Fixed rate unlikely to be the same
- Net receipt or payment on each future payment date



# Example

On 23 Jul 2002, we decide to reverse the swap. The same counterparty quotes a swap rate of 8.25% for the remaining 2 years.

Discount factors from 27 Mar 2002:
23 Jul 2003: 0.9250 23 Jul 2004: 0.8530

LIBOR-based flows on the two swaps offset each other exactly. The remaining flows are:

| Date | Original swap | Reverse swap | Net cashflows |
|---|---|---|---|
| 23 Jul 2003 | $+10m \times 7.4\%$ | $-10m \times 8.25\%$ | -85,000 |
| 23 Jul 2004 | $+10m \times 7.4\%$ | $-10m \times 8.25\%$ | -85,000 |

The NPV of the net cashflows is ?