Corporate Finance

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MANAGING INTEREST RATE RISK: DERIVATIVES AND STRATEGIES

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Short-term interest rate futures

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Short-term interest rate futures

- Notional fixed-term deposits, usually for three-month periods starting at a specific time in the future
- The buyer of one contract is buying the right to deposit money at a particular rate of interest for three months
- Unit of trading for a three-month sterling time deposit is £500,000
- Cash delivery by closing out the futures position is the means of settlement
- Short-term interest contracts are quoted on an index basis rather than on the basis of the interest rate itself. The price is defined as:

$P = 100 - i$ where:
P = price index;
i = the future interest rate in percentage terms

Interest rate futures

INTEREST RATES – FUTURES

Dec 2		Open	Sett	Change	High	Low	Est. vol.	Open int.
Euribor 3m*	Jan	98.92	98.84	–0.09	98.92	98.85	471	2.840
Euribor 3m*	Apr	0.00	98.94	–0.06	0.00	0.00	–	–
Euribor 3m*	Jun	99.05	98.99	–0.04	99.06	98.97	73.019	383.444
Euribor 3m*	Sep	99.05	99.01	–0.02	99.06	98.98	83.531	376.547
Euroswiss 3m*	Dec	100.02	99.97	–	100.03	99.96	2.627	51.251
Euroswiss 3m*	Mar	100.14	100.09	+0.08	100.18	100.08	9.329	62.430
Euroswiss 3m*	Jun	100.15	100.11	+0.08	100.21	100.09	9.139	52.988
Sterling 3m*	Jan	0.00	98.95	–0.01	0.00	0.00	–	–
Sterling 3m*	Mar	98.95	98.93	–0.01	98.96	98.91	50.677	322.946
Sterling 3m*	Jun	98.94	98.92	–	98.95	98.89	52.389	199.546
Sterling 3m*	Sep	98.92	98.92	+0.03	98.94	98.88	49.335	194.771
Eurodollar 3m †	Jan	99.450	99.43	–0.030	99.450	99.420	6.038	21.495
Eurodollar 3m †	Apr	0.000	99.35	–0.040	0.000	99.350	–	426
Eurodollar 3m †	Jun	99.350	99.32	–0.035	99.365	99.295	216.837	1,101.244
Eurodollar 3m †	Sep	99.315	99.30	–0.030	99.340	99.270	236.535	745.680
Fed Fnds 30d ‡	Dec	0.000	99.91	–	0.000	0.000	–	74.479
Fed Fnds 30d ‡	Jan	0.000	99.90	–	0.000	0.000	–	63.547
Fed Fnds 30d ‡	Feb	0.000	99.89	–	0.000	0.000	–	51.980
Euroyen 3m ‡‡	Jan	0.000	99.675	–	0.000	0.000	–	–
Euroyen 3m ‡‡	Mar	99.660	99.660	–0.005	99.665	99.660	2.466	228.119
Euroyen 3m ‡‡	Jun	99.665	99.660	–0.005	99.665	99.660	5.014	147.333
Euroyen 3m ‡‡	Sep	99.660	99.665	–	99.665	99.660	2.438	85.514

Contracts are based on volumes traded in 2004 Sources: *NYSE LIFFE. † CME. ‡‡ TIFFE

Notes: Euribor 3m: A benchmark interest rate in euros for three-month deposits.
Euroswiss 3m: Three-month interest rate in Euro-Swiss francs.
Sterling 3m: Sterling three-month interest rate.
Eurodollar 3m: Three-month notional deposit rate for Eurodollars.
Fed Fnds 30d: Federal funds 30-day interest – a US benchmark rate.
Euroyen 3m: Three-month interest rate for euroyen deposits.

Example

- On 2 December 2011 the settlement price for a June three-month sterling future was 98.92, which implies an interest rate of 100 − 98.92 = 1.08 per cent for the period June to September
- The March quote would imply an interest rate of 100 − 98.93 = 1.07 per cent for the three months March to June 2012
- The 1.08 per cent rate for three-month money starting from June 2012 is the annualised rate of interest even though the deal is for a deposit of only one-quarter of a year
- If traders in this market one week later, on 9 December 2011, adjusted supply and demand conditions because they expect generally raised inflation and raised interest rates by the middle of 2012, they would push up the interest rates for three-month deposits starting in June 2012 to, say, 1.6 per cent. Then the price of the future would fall to 98.40

Hedging three-month deposits

- The treasurer of a large company anticipates the receipt of £100m in late September 2012, almost 10 months hence
- The money will be needed for production purposes in January 2013 but for the three months following late September it can be placed on deposit
- The Sterling 3m September future shows a price of 98.92, indicating an interest rate of 1.08
- To achieve certainty in September 2012 the treasurer buys, in December 2011, September 2012 expiry three-month sterling interest rate futures at a price of 98.92. She has to buy 200 to hedge the £100m inflow

Hedging three-month deposits (continued)

- Suppose in September 2012 that three-month interest rates have fallen to 0.5 per cent

Return at 1.08 per cent (£100m × 0.0108 × $^{3}/_{12}$)	= £270,500
Return at 0.5 per cent (£100m × 0.005 × $^{3}/_{12}$)	= £125,000
Loss	£145,000

Futures profit

- The 200 futures contracts were bought at 98.92
- The futures in September have a value of 100 – 0.5 = 99.5
- The treasurer in September can close the futures position by selling the futures for 99.5
- The gain that is made amounts to 99.5 – 98.92 = 0.58
- A tick is the minimum price movement on a future
- A tick is a movement of 0.01 per cent on a trading unit of £500,000
- One-hundredth of 1 per cent of £500,000 is equal to £50
- £50/4 = £12.50 is the value of a tick movement in a three-month sterling interest rate futures contract
- We have a gain of 58 ticks with an overall value of 58 × £12.50 = £725 per contract or £145,000 for 200 contracts

Hedging a loan

- In December 2011 Holwell plc plans to borrow £5m for three months beginning in June 2012
- Holwell hedges by selling ten three-month sterling interest rate futures contracts with June expiry
- The price of each futures contract is 98.92, so Holwell has locked into an annual interest rate of 1.08 per cent or 0.27 per cent for three months
- The cost of borrowing is therefore: £5m × 0.0027 = £13,500
- Suppose that interest rates rise to annual rates of 2 per cent, or 0.5 per cent per quarter £5m × 0.005 = £25,000
- However, Holwell is able to buy ten futures contracts to close the position on the exchange
- Each contract has fallen in value from 98.92 to 98.00; this is 92 ticks
    - Bought at 98, sold at 98.92:
    - 92 ticks × £12.50 × 10 contracts = £11,500

Forward rate agreements (FRAs)

MANAGING INTEREST RATE RISK: DERIVATIVES AND STRATEGIES

Forward rate agreements (FRAs)

- FRAs are agreements about the future level of interest rates
- The rate of interest at some point in the future is compared with the level agreed when the FRA was established and compensation is paid by one party to the other based on the difference
- For example, a company needs to borrow £6m in six months' time for a period of a year. It arranges this with bank X at a variable rate of interest. The current rate of interest is 7 per cent
- Separate agreement with another bank (Y) – an FRA. It 'purchases' an FRA at an interest rate of 7 per cent to take effect six months from now and relates to a 12-month loan
- Bank Y has committed itself to paying compensation should interest rates (Libor) rise above 7 per cent

FRAs (continued)

- Suppose that in six months spot one-year interest rates are 8.5 per cent. The company will pay Bank X £6m × 0.085 = £510,000; this is £90,000 more than if the interest rates were 7 per cent
- However, the FRA with Bank Y entitles the company to claim compensation equal to the difference between the rate agreed in the FRA and the spot rate. This is (0.085 − 0.07) × £6m = £90,000
- If rates fall below 7 per cent the company makes payments to Bank Y
- In reality FRAs are generally agreed for three-month periods
- The ‘sale’ of an FRA by a company protects it against a fall in interest rates. If £10m is expected to be available for putting into a one-year bank deposit in three months the company could lock into a rate now by selling an FRA to bank. Suppose the agreed rate is 6.5 per cent and the spot rate in three months is 6 per cent, then the depositor will receive 6 per cent from the bank into which the money is placed plus $^1/_2$ per cent from the FRA counterparty bank

A comparison of options, futures, forwards and forward rate agreements

Options	Futures	Forwards and FRAs
Advantages		
Downside risk is limited but the buyer is able to participate in favourable movements in the underlying.	Can create certainty: specific rates are locked in.	Can create certainty: specific rates are locked in.
Available on or off exchanges. Exchange regulation and clearing house reduce counterparty default risk for those options traded on exchanges.	Exchange trading only. Exchange regulation and clearing house reduce counterparty default risk.	Tailor-made, off-exchange. Not standardised as to size, duration and terms. Good for companies with non-standard risk exposures.
	No premium is payable. (However margin payments are required.)	No margins or premiums payable. (Occasionally a good faith performance margin is required by one or more parties in a forward. Also credit limits may be imposed.)
For many options there are highly liquid markets resulting in keen option premium pricing and ability to reverse a position quickly at low cost. For others trading is thin and so premiums payable may become distorted and offsetting transactions costly and difficult.	Very liquid markets. Able to reverse transactions quickly and cheaply.	

A comparison of options, futures, forwards and forward rate agreements (continued)

Disadvantages		
Premium payable reduces returns when market movements. are advantageous	No right to let the contract lapse. Benefits from favourable movements in underlying are forgone	No right to let the contract lapse. Benefits from favourable movements in underlying are forgone.
	In a hedge position if the underlying transaction does not materialise the future position owner can experience a switch from a covered to an uncovered position, the potential loss is unlimited.	In a hedge position if the underlying transaction does not materialise the forward/FRA position owner can experience a switch from a covered to an uncovered position, the potential loss is unlimited.
Margin required when writing options.	Many exchange restrictions – on size of contract, duration (e.g. only certain months of the year), trading times (e.g. when Euronext.liffe is open).	Greater risk of counterparty default – not exchange traded therefore counterparty is not the clearing house.
		Generally the minimum contract size is for millions rather than a few thousand (as on the futures or options markets).
	Margin calls require daily work for 'back office'.	More difficult to liquidate position (than with exchange-traded instruments) by creating an offsetting transaction that cancels position.

Caps, Floors and Collars

MANAGING INTEREST RATE RISK: DERIVATIVES AND STRATEGIES

Caps

- An **interest rate cap** is a contract that gives the purchaser the right effectively to set a maximum level for interest rates payable
- Compensation is paid to the purchaser of a cap if interest rates rise above an agreed level
- Used to cover interest rate risk on longer-term borrowing (usually two to five years)
- Oakham plc wishes to borrow £20m for five years. It arranges this with bank A at a variable rate based on Libor plus 1.5 per cent
- The interest rate is reset every quarter based on three-month Libor. Currently this stands at an annual rate of 3 per cent
- Oakham buys an interest rate cap set at Libor of 4.5 per cent
- Assume that this costs 2.3 per cent of the principal amount, or £20m × 0.023 = £460,000 payable immediately to the cap seller
- So if for the whole of the third year Libor rose to 5.5 per cent Oakham would pay interest at 5.5 per cent plus 1.5 per cent to bank A but would also receive 1 per cent compensation from the cap seller

Floors and collars

- If the interest rate falls below an agreed level, the seller (the **floor writer**) makes compensatory payments to the **floor buyer**
- Returning to Oakham, the treasurer could buy a **cap** set at 4.5 per cent Libor for a premium of £460,000 and sell a floor at 2 per cent Libor receiving, say, £200,000
- If Libor fell below 2 per cent Oakham would save on the amount paid to bank A but will have to make payments to the floor buyer, thus restricting the benefits from falls in Libor
- Oakham, for a net premium of £260,000, has ensured that its effective interest payments will not diverge from the range 2 per cent + 1.5 per cent = 3.5 per cent at the lower end, to 4.5 per cent + 1.5 per cent = 6 per cent at the upper end
- **Collar**: The combination of selling a floor at a low strike rate and buying a cap at a higher strike rate

Swaps

MANAGING INTEREST RATE RISK: DERIVATIVES AND STRATEGIES

Swaps

- A swap is an exchange of cash payment obligations.
- An interest-rate swap is where one company arranges with a counterparty to exchange interest-rate payments
- To reduce or eliminate exposure to rises in interest rates
- To take advantage of market imperfections

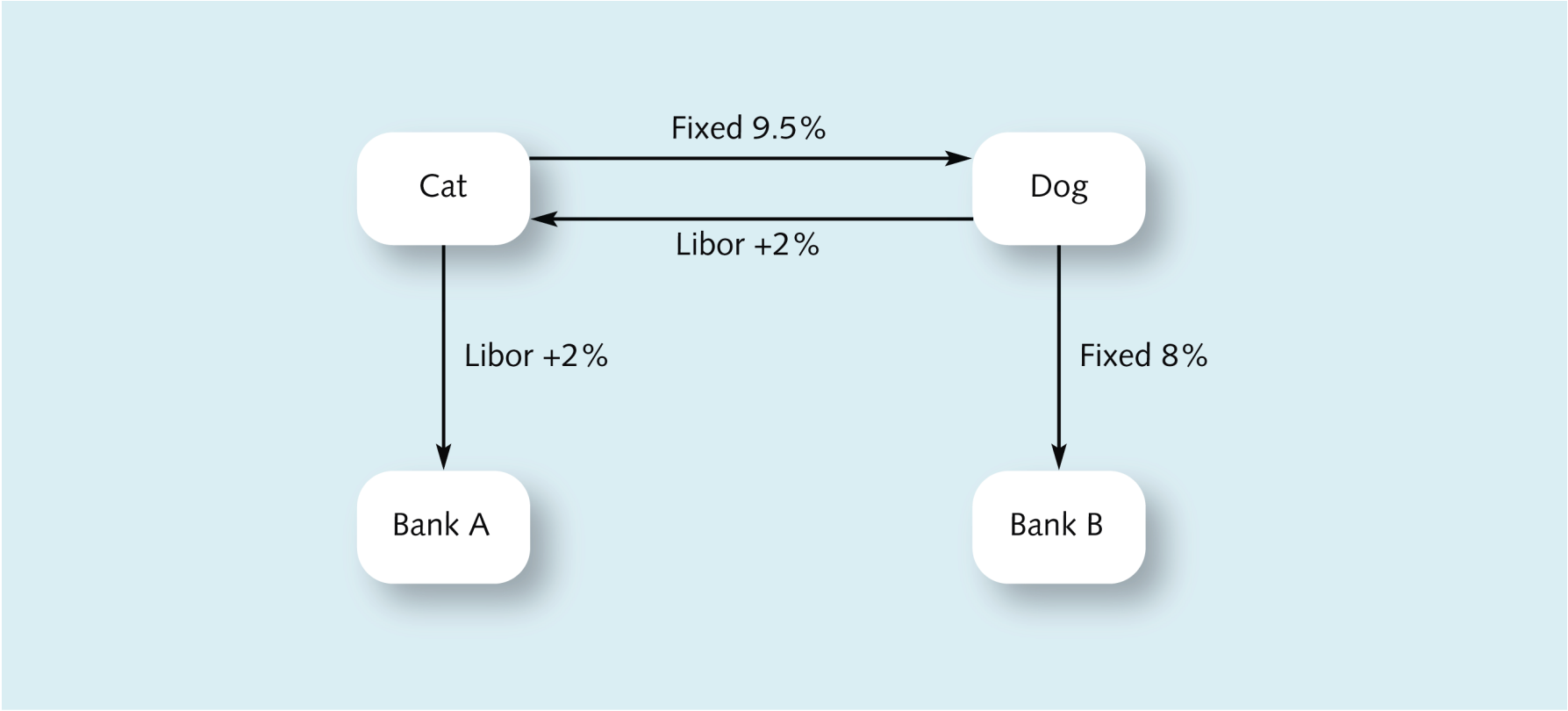
Swaps (Continued)

- Cat plc and Dog plc, both want to borrow £150m for eight years
- Cat would like to borrow on a fixed-rate basis
- Dog prefers to borrow at floating rates

	Fixed	Floating
Cat can borrow at	10%	Libor + 2%
Dog can borrow at	8%	Libor + 1%

- Dog has an absolute advantage in both
- Cat has an absolute disadvantage in both, but has a comparative advantage in the floating-rate market
- Cat borrows floating-rate funds, paying Libor + 2 per cent, and Dog borrows fixed-rate debt, paying 8 per cent

An interest rate swap



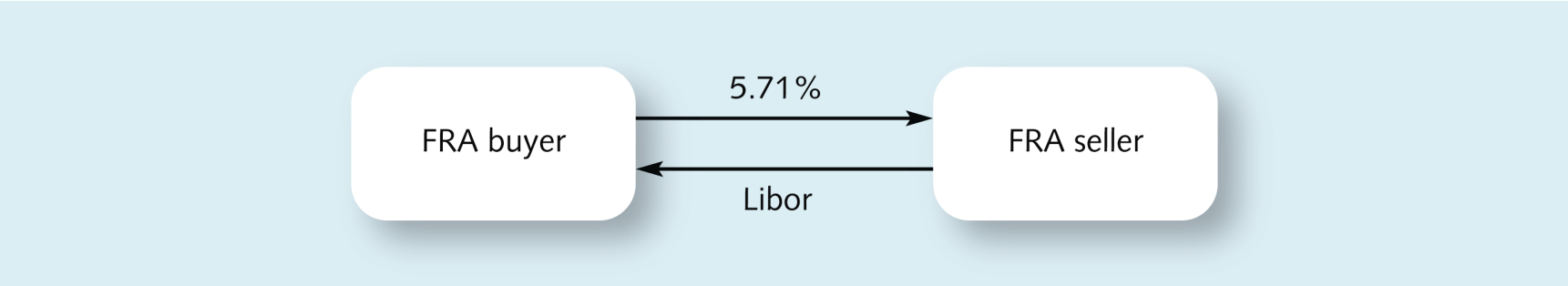
An interest rate swap (continued)

Cat:		
	Pays	Libor +2%
	Receives	Libor +2%
	Pays	Fixed 9.5%
Net payment		Fixed 9.5%
Dog:		
	Pays	Fixed 8%
	Receives	Fixed 9.5%
	Pays	Libor +2%
Net payment		Libor +0.5%

The relationship between FRAs and swaps

- A sequence of Libor-based FRAs stretching over, say, two years, in which each of the three-month periods making up that two years is covered by an FRA is very similar to a two-year swap
- Colston plc has a loan for £100m, a floating-rate liability
- Interest is set at three-month Libor every three months over its two-year life
- The current time is June and spot Libor rate is set at 5.09 per cent
- To lock in a rate for the next rollover date, i.e. in September, the company could buy (in June) an FRA set at Libor for the three months starting in September and ending in December (a 3 × 3 forward rate agreement)

Colston

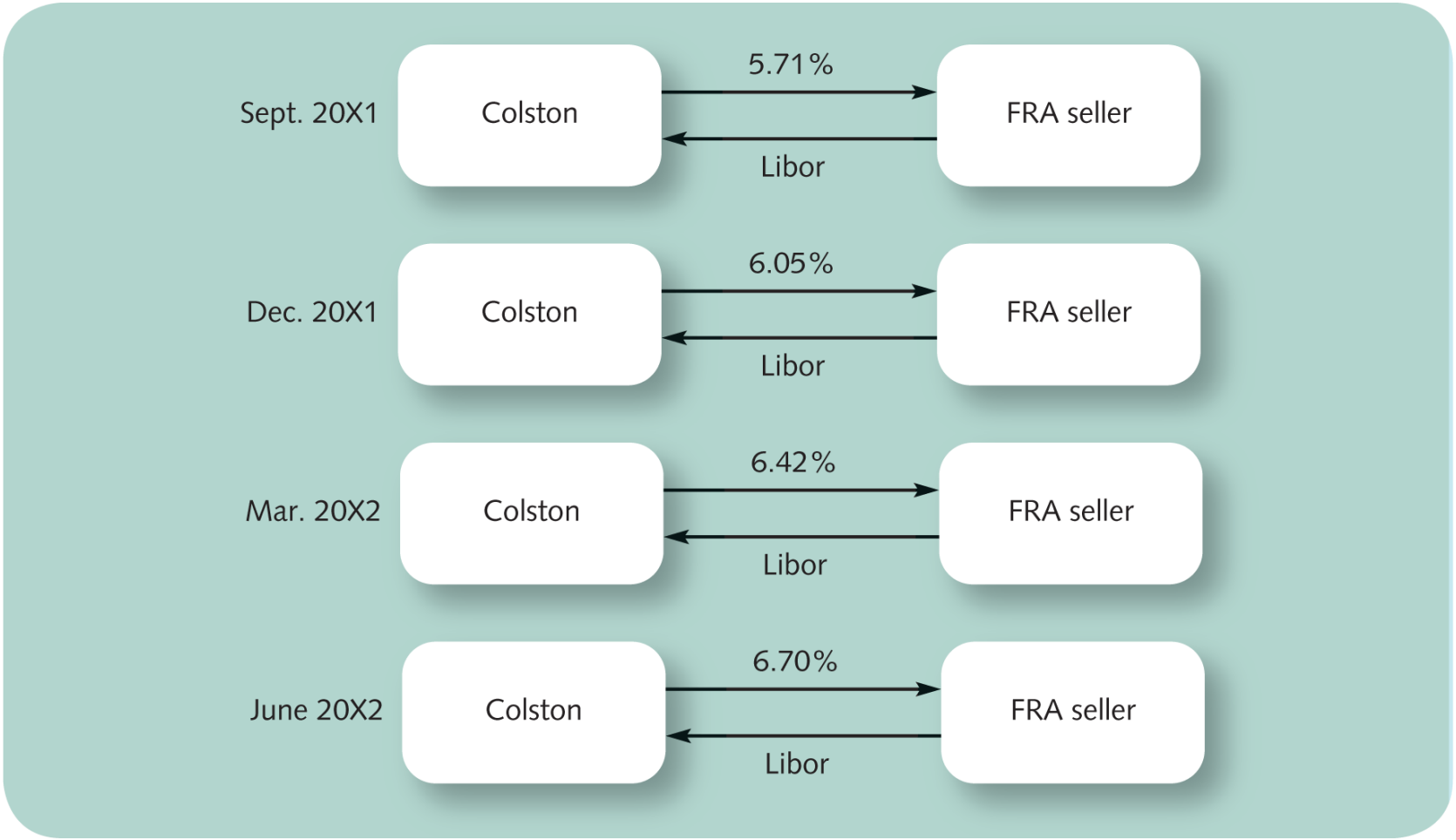


- If Libor is 5.71 per cent in September no payment is made by either side
- If Libor in September resets at 6.2 per cent Colston will receive a settlement cash flow of 0.49 per cent, or 49 basis points, on £100m for the three-month period. Thus a payment of £122,500 is received (£100m × 0.0049 × 3/12) from the FRA seller
- If the spot Libor in September is 5.5 per cent, Colston will pay a settlement cash flow of 21 basis points: £100m × 0.0021 × 3/12 = £52,500
- FRAs are priced at-the-money

Colston (continued)

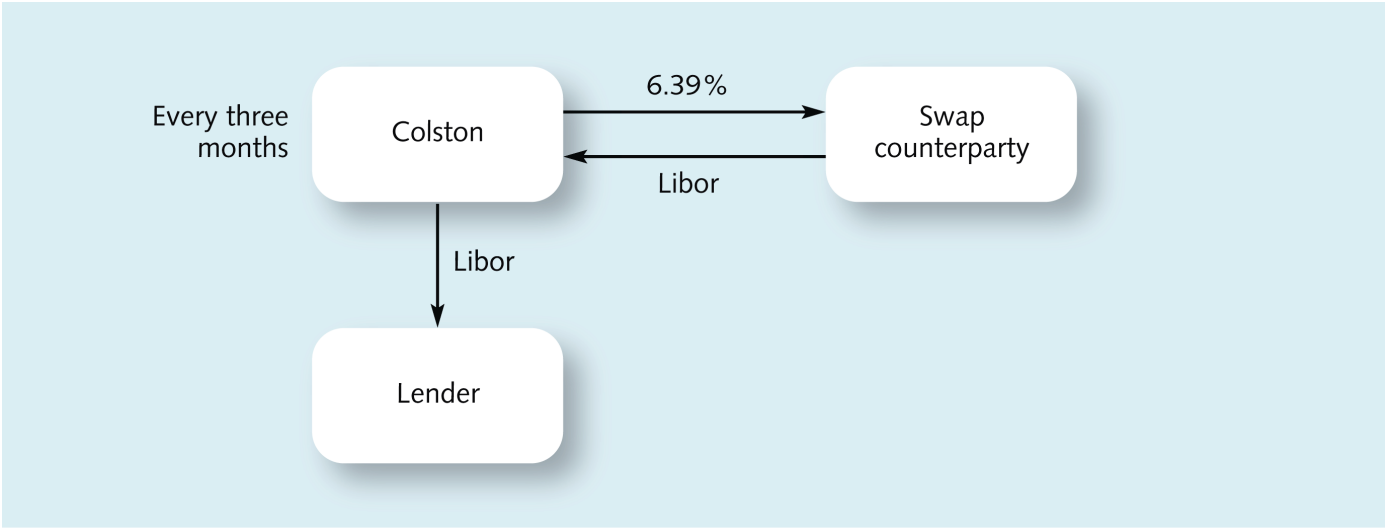
Time	Libor rate quoted in June 20X1 for three-month periods starting at various dates over next two years
June 20X1 (Spot)	5.09
Sept. 20X1	5.71
Dec. 20X1	6.05
Mar. 20X2	6.42
June 20X2	6.70
Sept. 20X2	6.98
Dec. 20X2	7.06
Mar. 20X3	7.18

Colston – first four payment



Colston – a swap

- An alternative open to Colston is to buy a contract with the same rate payable in each of the eight quarters
- This rate would be an approximate average of the FRA rates stretching over the two years. This is called a swap
- A rough average of the eight Libor rates payable is 6.39 per cent



Interest Rate Swaps: Examples and Valuation

MANAGING INTEREST RATE RISK: DERIVATIVES AND STRATEGIES

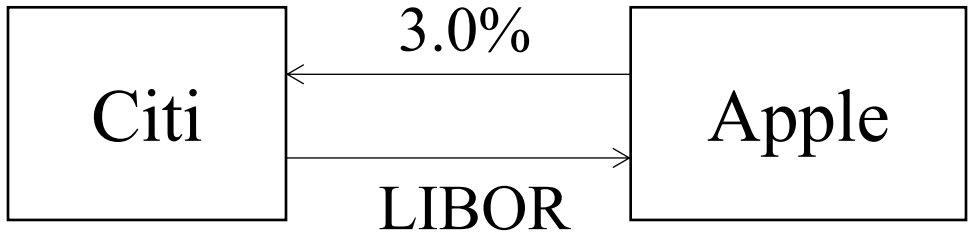
An Example of a “Plain Vanilla” Interest Rate Swap

- An agreement by Apple to receive 6-month LIBOR & pay a fixed rate of 3% per annum every 6 months for 3 years on a notional principal of $100 million
- Next slide illustrates cash flows that could occur (Day count conventions are not considered)

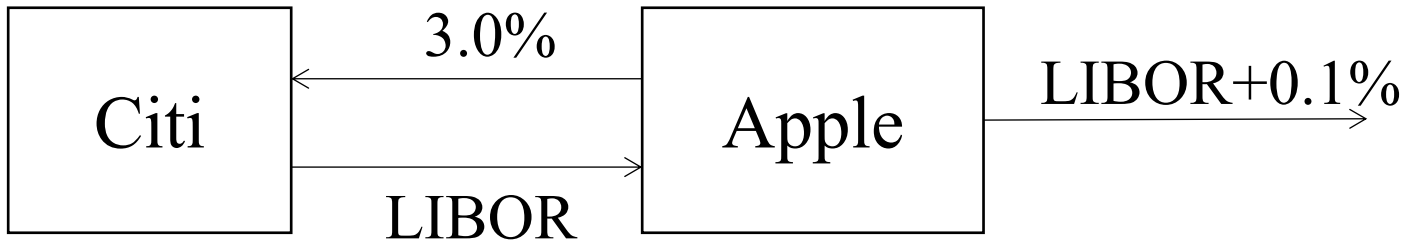
Cash Flows to Apple

		---------Millions of Dollars---------		
Date	LIBOR Rate	*FLOATING* Cash Flow	*FIXED* Cash Flow	Net Cash Flow
Mar. 8, 2016	2.2%			
Sept. 8, 2016	2.8%	+1.10	–1.50	–0.40
Mar. 8, 2017	3.3%	+1.40	–1.50	–0.10
Sept. 8, 2017	3.5%	+1.65	–1.50	+0.15
Mar. 8, 2018	3.6%	+1.75	–1.50	+0.25
Sept. 8, 2018	3.9%	+1.80	–1.50	+0.30
Mar. 8, 2019	3.4%	+1.95	–1.50	+0.45

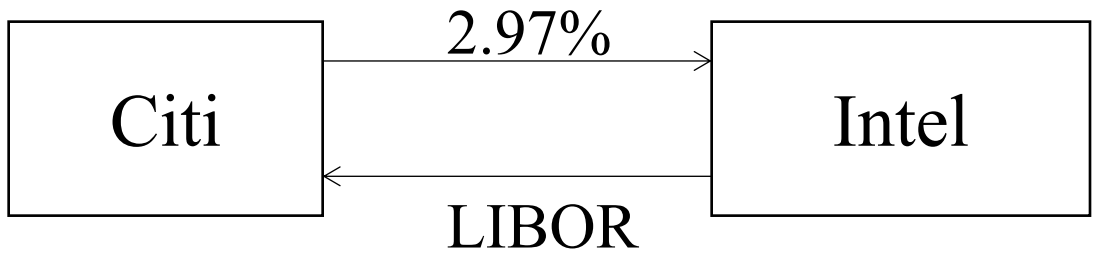
Interest Rate Swap Between Apple and Citigroup



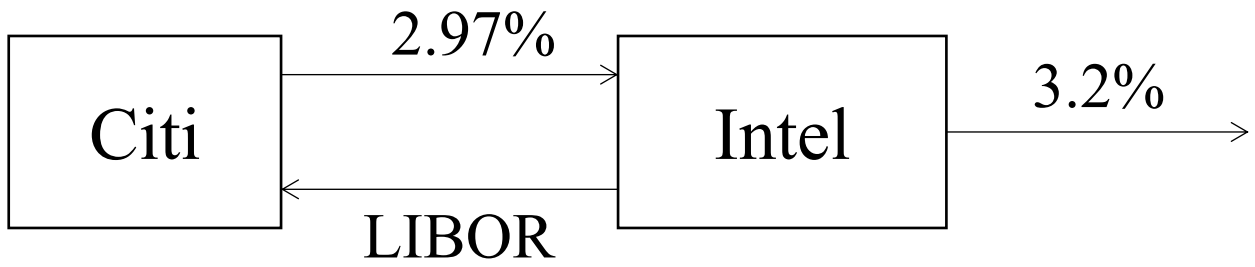
Apple Transforms a Liability from Floating to Fixed



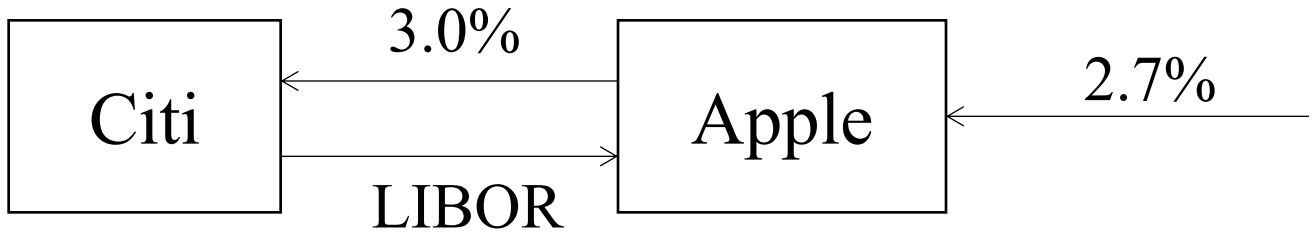
Interest Rate Swap Between Citigroup and Intel



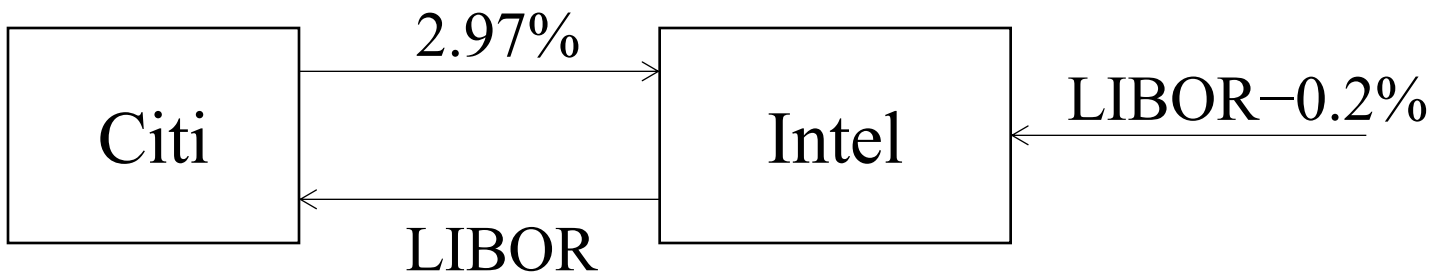
Intel Transforms a Liability from Fixed to Floating



Apple Transforms an Asset from Fixed to Floating



Intel Transforms an Asset from Floating to Fixed



Quotes By a Swap Market Maker

Maturity	Bid (%)	Offer (%)	Swap Rate (%)
2 years	2.55	2.58	2.565
3 years	2.97	3.00	2.985
4 years	3.15	3.19	3.170
5 years	3.26	3.30	3.280
7 years	3.40	3.44	3.420
10 years	3.48	3.52	3.500

Day Count

- A day count convention is specified for fixed and floating payments
- For example, LIBOR is likely to be actual/360 in the U.S. because LIBOR is a money market rate

Confirmations

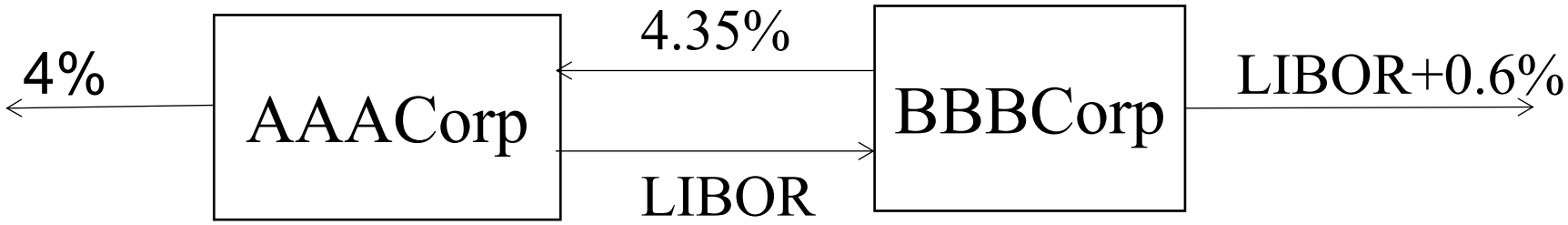
- Confirmations specify the terms of a transaction
- The International Swaps and Derivatives has developed Master Agreements that can be used to cover all agreements between two counterparties
- CCPs are used for most standard swaps between two financial institutions

The Comparative Advantage Argument

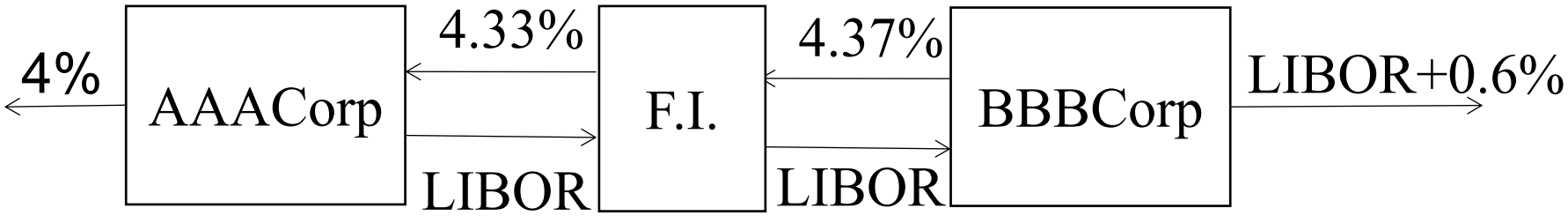
- AAACorp wants to borrow floating
- BBBCorp wants to borrow fixed

	Fixed	*Floating*
AAACorp	4.00%	6-month LIBOR − 0.1%
BBBCorp	5.20%	6-month LIBOR + 0.6%

A Swap where Companies Trade Directly with Each Other



The Swap when a Financial Institution (F.I.) is Involved



Criticism of the Comparative Advantage Argument

- The 4.0% and 5.2% rates available to AAACorp and BBBCorp in fixed rate markets are 5-year rates
- The LIBOR−0.1% and LIBOR+0.6% rates available in the floating rate market are six-month rates
- BBBCorp's fixed rate depends on the spread above LIBOR it borrows at in the future

Valuation of an Interest Rate Swap

- Initially interest rate swaps are worth close to zero
- At later times they can be valued as a portfolio of forward rate agreements (FRAs)
- The procedure is to
  - Calculate LIBOR forward rates
  - Calculate the swap cash flows that will occur if LIBOR forward rates are realized
  - Discount these swap cash flows at OIS rates

Example

- Swap involves paying 3% per annum and receiving LIBOR every six months on $100 million
- Swap has 15 months remaining (exchanges in 3, 9, and 15 months)
- LIBOR rate applicable to exchange in 3 months was determined 3 months ago and is 2.9%
- Forward LIBOR rates for 3-9 month period and 9-15 month periods are 3.429% and 3.734%, respectively
- OIS zero rates for maturities of 3, 9, and 15 months are 2.8%, 3.2%, and 3.4%, respectively

Calculations ($ million)

Value of swap is $0.5117 million

Time (yrs)	Fixed cash flow	Floating cash flow	Net cash flow	Discount factor	PV of net cash flow
0.25	−1.5000	+1.4500	−0.0500	0.9930	−0.0497
0.75	−1.5000	+1.7145	+0.2145	0.9763	+0.2094
1.25	−1.5000	+1.8672	+0.3672	0.9584	+0.3519
					+0.5117

Bootstrapping LIBOR forward rates: Example

- 6,12,18, and 24 month OIS rates are 3.8%, 4.3%, 4.6%, and 4.75% respectively with cont. comp.
- 6-month LIBOR rate is 4% (sa comp.)
- Suppose forward LIBOR rates for 6-12 and 12-18 months have already been calculated as 5% and 5.5%, respectively (sa comp)
- The two year swap rate is 5%
- The next step is to calculate the LIBOR forward rate, *F*, for the18-24 month period.

Bootstrapping LIBOR forward rates: Calculations

- A 2-year swap where 5% is paid and LIBOR is received on $100 is worth zero.
- Value of first three exchanges are

$$0.5\times(0.04-0.05)\times100\times e^{-0.038\times0.5} = -0.4906$$

$$0.5\times(0.05-0.05)\times100\times e^{-0.043\times1.0} = 0$$

$$0.5\times(0.055-0.05)\times100\times e^{-0.046\times1.5} = +0.2333$$

- The value of the fourth payment must be +0.2573 so that the total value is zero

$$0.5\times(F-0.05)\times100\times e^{-0.0475\times2.0} = 0.2573$$

$$F = 0.05566 \text{ or } 5.566\% \text{ per annum}$$

Credit Risk

- When derivatives transactions with a counterparty are cleared bilaterally, they are netted
- There is exposure if the net value of outstanding transactions is greater than the collateral posted

Credit Default Swaps: A Quick First Look

- Notional principal (e.g. $100 million) and maturity (e.g. 5 yrs) specified
- Protection buyer pays a fixed rate (e.g. 150 bp) on the notional principal (the CDS spread)
- If the reference entity (a country or company) defaults protection seller buys bonds issued by the reference entity for their face value and the spread payments stop. Total face value of bonds bought equals notional principal

Other Types of Swaps

- Amortizing/ step up
- Compounding swap
- Constant maturity swap
- LIBOR-in-arrears swap
- Accrual swap
- Equity swap

Other Types of Swaps (continued)

- Cross currency interest rate swap
- Floating-for-floating currency swap
- Diff swap
- Commodity swap
- Variance swap

Currency Swaps: Examples and Valuation

MANAGING INTEREST RATE RISK: DERIVATIVES AND STRATEGIES

An Example of a Fixed-for-Fixed Currency Swap

Five year agreement by BP to

- Pay 3% on a US dollar principal of $15,000,000
- Receive 4% on a sterling principal of £10,000,000

Exchange of Principal

- In an interest rate swap the principal is not exchanged
- In a currency swap the principal is exchanged at the beginning and the end of the swap

The Cash Flows

Date	Dollar Cash Flows (millions)	Sterling cash flow (millions)
Feb 1, 2016	+15.00	−10.00
Feb 1, 2017	−0.45	+0.40
Feb 1, 2018	−0.45	+0.40
Feb 1, 2019	−0.45	+0.40
Feb 1, 2020	−0.45	+0.40
Feb 1, 2021	−15.45	+10.40

Typical Uses of a Currency Swap

- Conversion from a liability in one currency to a liability in another currency
- Conversion from an investment in one currency to an investment in another currency

Comparative Advantage May Be Real Because of Taxes

- General Electric wants to borrow AUD
- Quantas wants to borrow USD

Borrowing costs after adjusting for the differential impact of taxes could be:

	USD	AUD
General Electric	5.0%	7.6%
Quantas	7.0%	8.0%

Valuation of Fixed-for-Fixed Currency Swaps

Fixed for fixed currency swaps can be valued either using forward rates or as the difference between 2 bonds

Examples

- All Japanese interest rates are 1.5% per annum (cont. comp.)
- All USD interest rates are 2.5% per annum (cont. comp.)
- 3% is received in yen; 4% is paid in dollars. Payments are made annually
- Principals are $10 million and 1,200 million yen
- Swap will last for 3 more years
- Current exchange rate is 110 yen per dollar

Valuation in Terms of Forward Rates

Time	Dollar Cash Flow	Yen cash flow	Forward rate	Dollar value of yen cash flow	Net cash flow	Present value
1	−0.4	+36	0.009182	0.3306	−0.0694	−0.0677
2	−0.4	+36	0.009275	0.3339	−0.0661	−0.0629
3	−10.4	+1236	0.009368	11.5786	+1.1786	+1.0934
Total						+0.9629

Valuation in Terms of Bonds

Time	Cash Flows ($ millions)	PV ($ millions)	Cash flows (millions of yen)	PV (millions of yen)
1	0.4	0.3901	36	35.46
2	0.4	0.3805	36	34.94
3	10.4	9.6485	1,236	1,181.61
Total		10.4191		1,252.01

Value = 1,252.01/110−10.4191 = +0.9629 millions of dollars

Other Currency Swaps

- Fixed-for-floating: equivalent to a fixed-for-fixed currency swap plus a fixed for floating interest rate swap
- Floating-for-floating: equivalent to a fixed-for-fixed currency swap plus two floating interest rate swaps