FE620 Pricing and Hedging

Lecture 5: Swaps

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Nature of Swaps

A swap is an agreement to exchange cash flows at specified future times according to certain specified rules

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

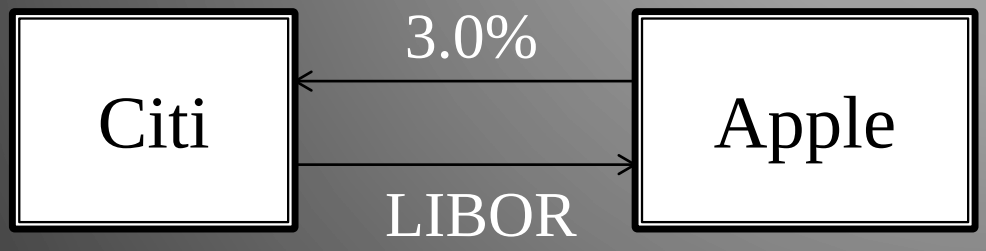
(See Table 7.1, page 157

		---------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

Typical Uses of an Interest Rate Swap

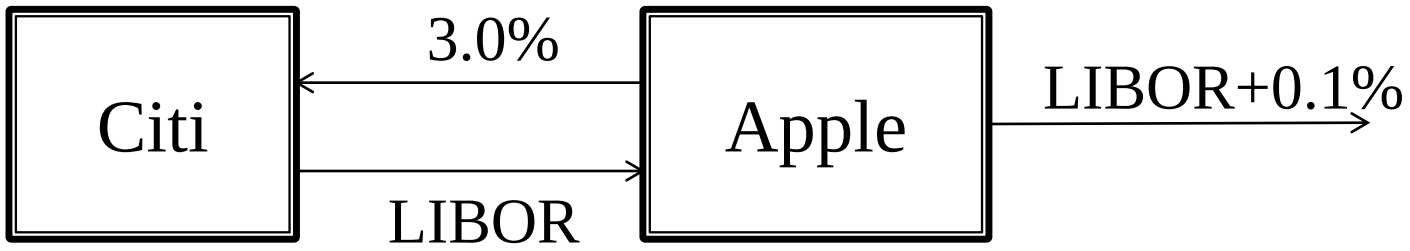
- Converting a liability from
  - fixed rate to floating rate
  - floating rate to fixed rate
- Converting an investment from
  - fixed rate to floating rate
  - floating rate to fixed rate

Interest Rate Swap Between Apple and Citigroup (Figure 7.1, page 156)

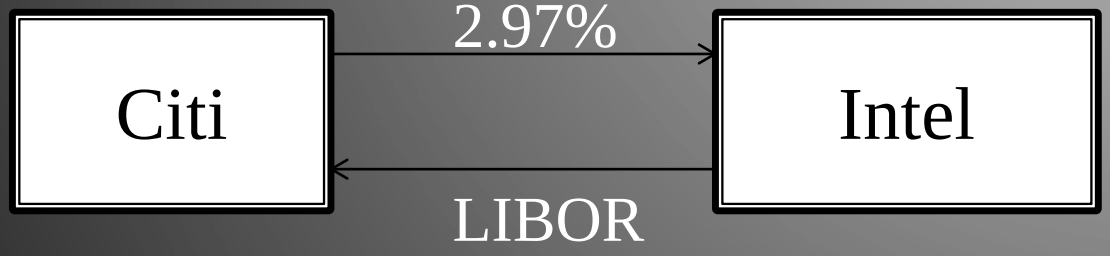


Apple Transforms a Liability from Floating to Fixed

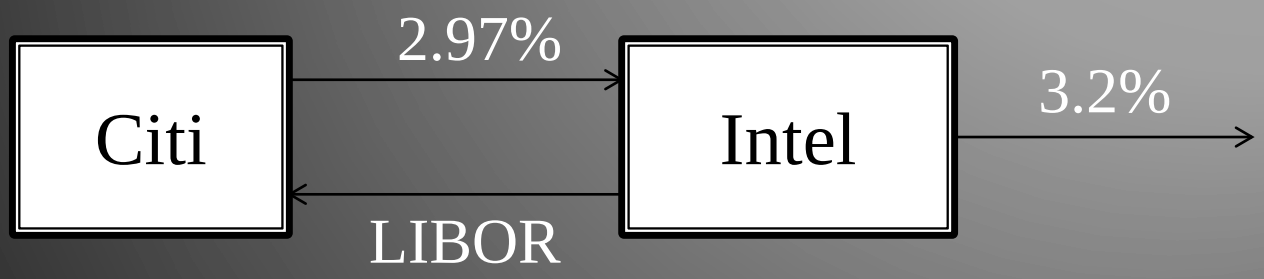
(Figure 7.2, page 158)



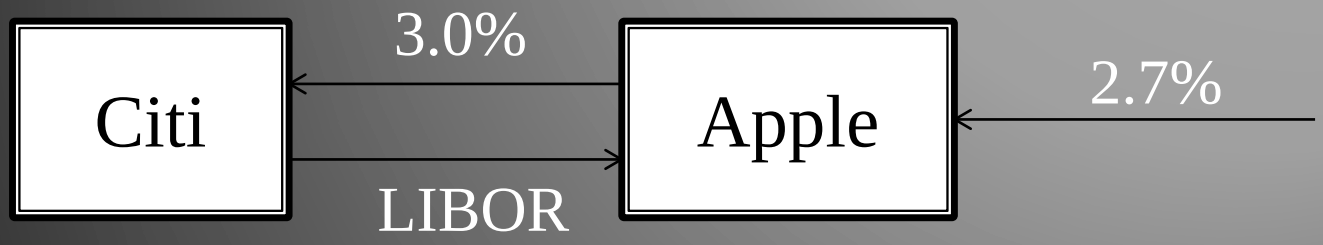
Interest Rate Swap Between Citigroup and Intel (Figure 7.3, page 159)



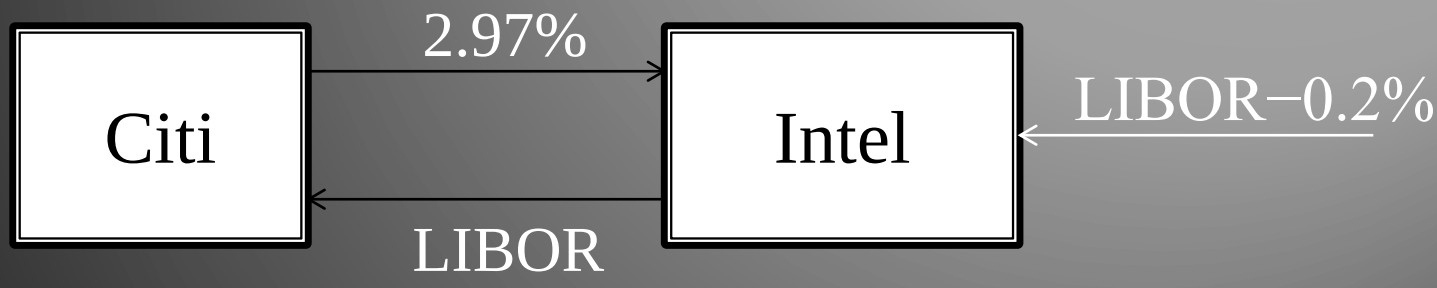
Intel Transforms a Liability from Fixed to Floating (Figure 7.4, page 159)



Apple Transforms an Asset from Fixed to Floating (Figure 7.5, page 159)



Intel Transforms an Asset from Floating to Fixed (Figure 7.6, page 160)



Quotes By a Swap Market Maker

(Table 7.3, page 161)

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

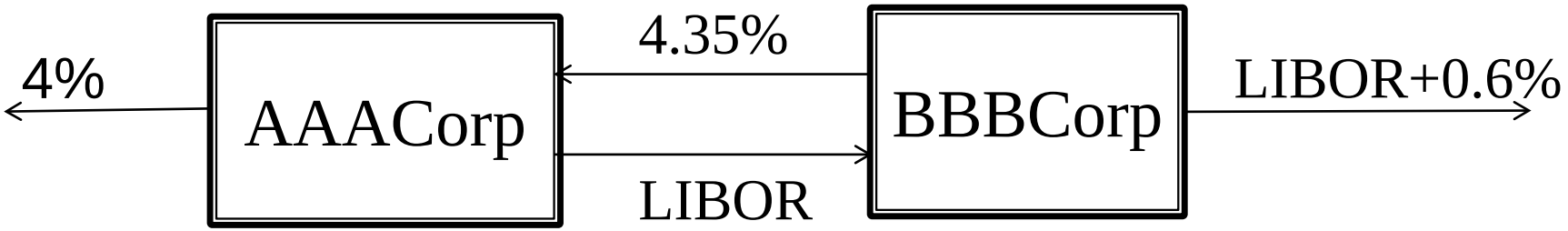
- Confirmations specify the terms of a transaction
- The International Swaps and Derivatives has developed Master Agreements that can be used to cover all agreements between two counterparties
- CCPs are used for most standard swaps between two financial institutions

The Comparative Advantage Argument
(Table 7.4, page 163)

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

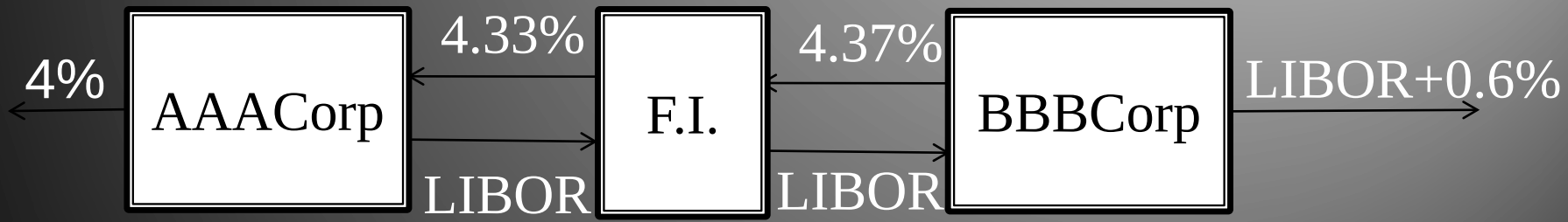
	Fixed	*Floating*
AAACorp	4.00%	6-month LIBOR − 0.1%
BBBCorp	5.20%	6-month LIBOR + 0.6%

A Swap where Companies Trade Directly with Each Other (Figure 7.7, page 164)



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

(Figure 7.7, page 164)



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

Using Swap Rates to Bootstrap the LIBOR/Swap Zero Curve

- Consider a new swap where the fixed rate is the swap rate
- When principals are added to both sides on the final payment date the swap is the exchange of a fixed rate bond for a floating rate bond
- The floating-rate rate bond is worth par assuming LIBOR discounting is used. The swap is worth zero. The fixed-rate bond must therefore also be worth par
- This shows that swap rates define par yield bonds that can be used to bootstrap the LIBOR (or LIBOR/swap) zero curve

Example of Bootstrapping the LIBOR/Swap Curve (Example 7.1, page 164)

- 6-month, 12-month, and 18-month LIBOR/swap rates are 4%, 4.5%, and 4.8% with continuous compounding.
- Two-year swap rate is 5% (semiannual)

$$2.5e^{-0.04\times 0.5} + 2.5e^{-0.045\times 1.0} + 2.5e^{-0.048\times 1.5} + 102.5e^{-2R} = 100$$

- The 2-year LIBOR/swap rate, R, is 4.953%

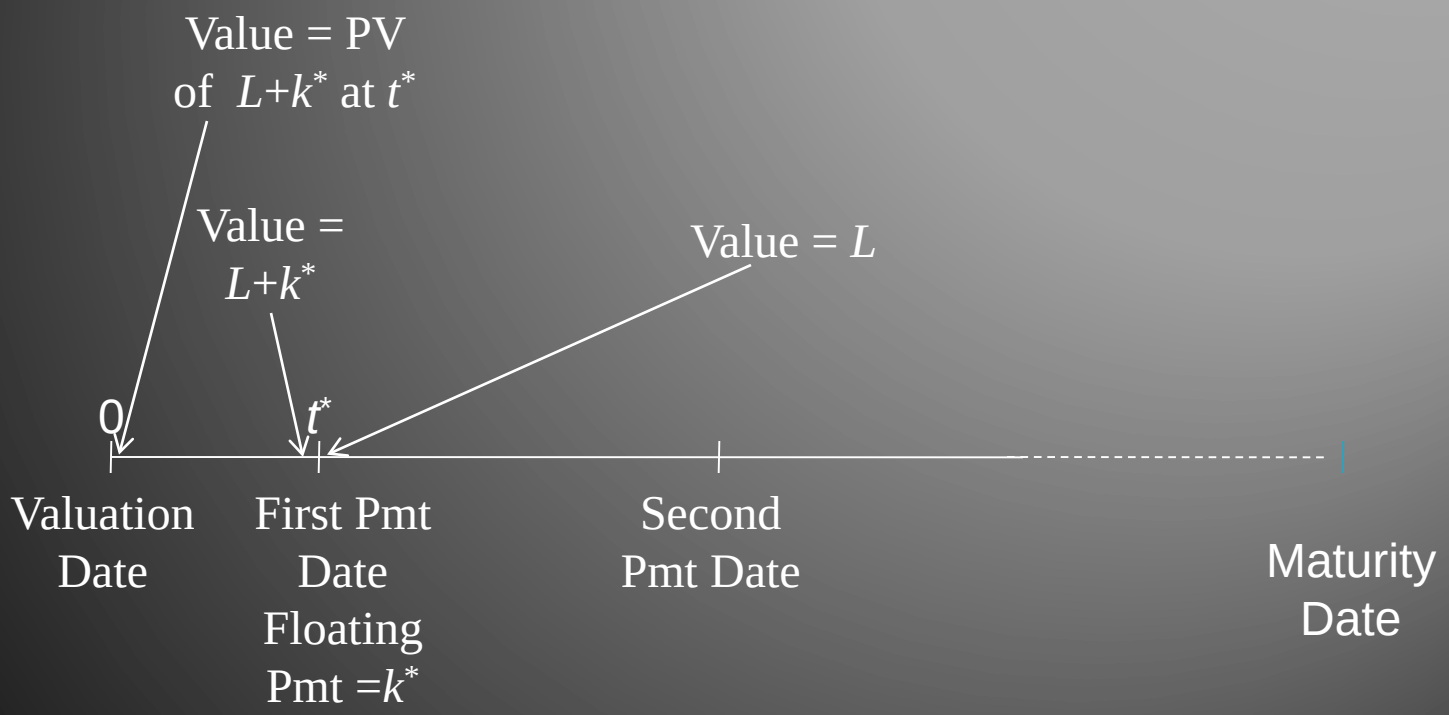
Valuation of an Interest Rate Swap

- Initially interest rate swaps are worth close to zero
- At later times they can be valued as the difference between the value of a fixed-rate bond and the value of a floating-rate bond
- Alternatively, they can be valued as a portfolio of forward rate agreements (FRAs)

Valuation in Terms of Bonds

- The fixed rate bond is valued in the usual way
- The floating rate bond is valued by noting that it is worth par immediately after the next payment date

Valution of Floating-Rate Bond



Example

- Pay six-month LIBOR, receive 8% (s.a. compounding) on a principal of $100 million
- Remaining life 1.25 years
- LIBOR rates for 3-months, 9-months and 15-months are 10%, 10.5%, and 11% (cont comp)
- 6-month LIBOR on last payment date was 10.2% (s.a. compounding)

Valuation Using Bonds (page 161)

Time	B_{fix} cash flow	B_{fl} cash flow	Disc factor	PV B_{fix}	PV B_{fl}
0.25	4.0	105.100	0.9753	3.901	102.505
0.75	4.0		0.9243	3.697	
1.25	104.0		0.8715	90.640	
Total				98.238	102.505

Swap value = 98.238 − 102.505 = −4.267

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

Valuation in Terms of FRAs

- Each exchange of payments in an interest rate swap is an FRA
- The FRAs can be valued on the assumption that today's forward rates are realized

Bootstrapping LIBOR forward rates: Example 7.2 (page 167)

- 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

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

$F = 0.05566$ or 5.566% per annum

An Example of a Fixed-for-Fixed Currency Swap (Figure 7.10, page 169)

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 (Table 7.5, page 170)

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 7.3 and 7.4 (pages 172-174)

- 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 (page 173)

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
(page 174)

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

Swaps & Forwards

- A swap can be regarded as a convenient way of packaging forward contracts
- When a swap is initiated the swap has zero value, but typically some forwards have a positive value and some have a negative value

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