Swaps

Chapter 7

Outline

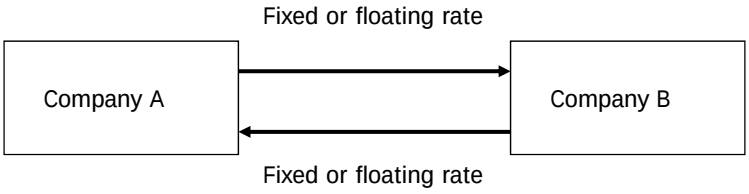
- Interest rate swaps
- Using interest rate swaps
- The comparative advantage argument
- Valuation of interest rate swaps
  - As long and short bond positions
  - As a portfolio of FRAs

Outline

- Currency swaps
- Using currency swaps
- The comparative advantage argument
- Valuation of currency swaps

Nature of Swaps

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

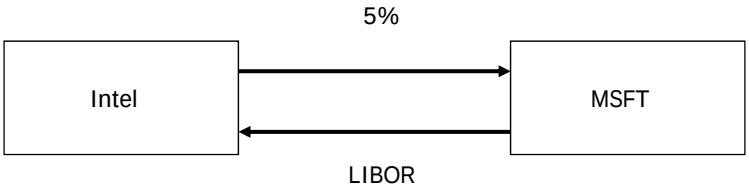


Interest rate swaps

- Periodic cash flow exchange as percentage of notional amount which is not exchanged
- Example of plain 'vanilla' interest rate swap: An agreement between Microsoft (MSFT) and Intel for MSFT to receive 6-month LIBOR & pay a fixed rate of 5% per annum every 6 months for 3 years on a notional principal of $100 million.

Interest rate swaps

- The floating rate is determined at the beginning of the payment period



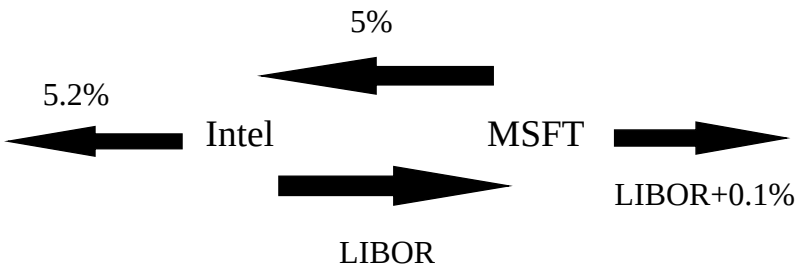
Cash Flows to Microsoft

		---------Millions of Dollars---------		
Date	LIBOR Rate	*FLOATING* Cash Flow	*FIXED* Cash Flow	Net Cash Flow
Mar.5, 2001	4.2%			
Sept. 5, 2001	4.8%	+2.10	–2.50	–0.40
Mar.5, 2002	5.3%	+2.40	–2.50	–0.10
Sept. 5, 2002	5.5%	+2.65	–2.50	+0.15
Mar.5, 2003	5.6%	+2.75	–2.50	+0.25
Sept. 5, 2003	5.9%	+2.80	–2.50	+0.30
Mar.5, 2004	6.4%	+2.95	–2.50	+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

Intel and Microsoft (MSFT) Transform a Liability



Convert liability

- Original liability of Intel = 5.2% fixed rate
- After entering into the swap, Intel's liability =

= 5.2% - 5% + LIBOR

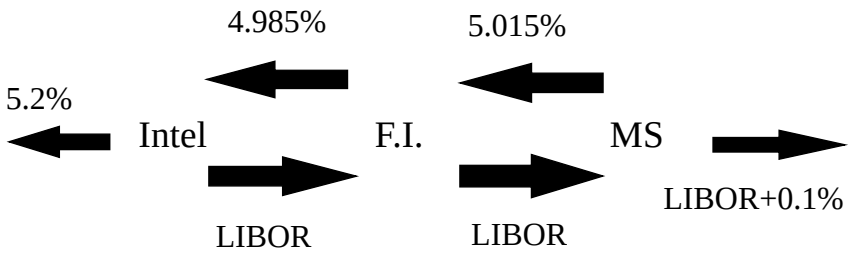
= (LIBOR +0.2%)

- Original liability of MSFT = LIBOR+0.1%
- After entering into the swap, MSFT's liability

= LIBOR+0.1%- LIBOR + 5%

= 5.1%

Financial Institution is Involved



Convert liability

- Original liability of Intel = 5.2% fixed rate
- After entering into the swap, Intel's liability =

= 5.2%% - 4.985% + LIBOR

= (LIBOR +0.215%)

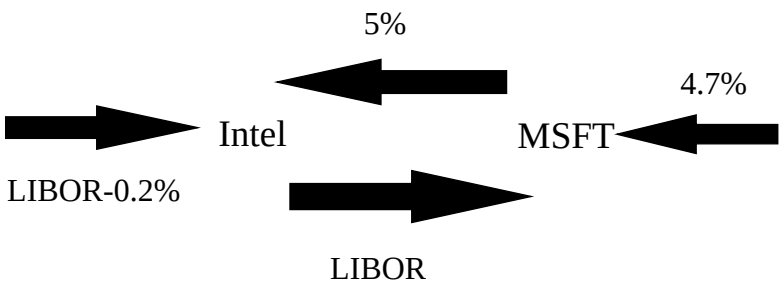
- Original liability of MSFT = LIBOR+0.1%
- After entering into the swap, MSFT's liability

= LIBOR+0.1%- LIBOR + 5.015%

= 5.115%

- F.I gets 3bps*100M=$30,000 every year

Intel and Microsoft Transform an Asset



Convert an asset

- After entering into the swap, Intel's asset

= LIBOR-0.2% + 5%- LIBOR

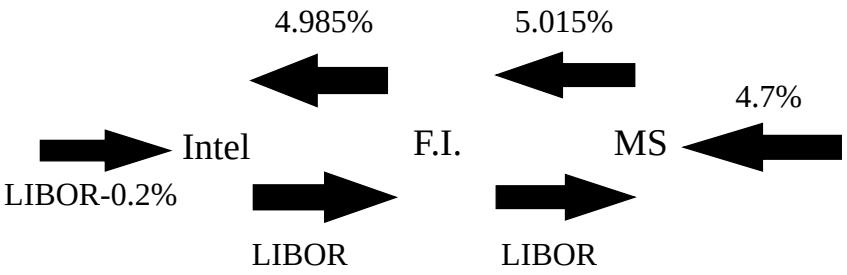
= 4.8%

- After entering into the swap, MSFT's asset

= 4.7%-5% + LIBOR

= LIBOR -0.3%

Financial Institution is Involved



Convert an asset

- After entering into the swap, Intel's asset
= LIBOR-0.2% + 4.985%- LIBOR
= 4.785%
- After entering into the swap, MSFT's asset
= 4.7%-5.015% + LIBOR
= LIBOR-0.315%
- F.I get 3 bps

Day count convention

- 6-month LIBOR is a money market rate which is quoted on an actual/360 basis
- Cash flow from a 6-month LIBOR rate between Mar 5 and Sept 5 should be 100M*0.042*184/360 = 2.1467M
- Fixed rate payment is often quoted as a semi-annual bond rate (bond equivalent yield) which is based on actual/365
- Cash flow of 5% fixed rate should be 0.05*100M*184/365=2.5205M

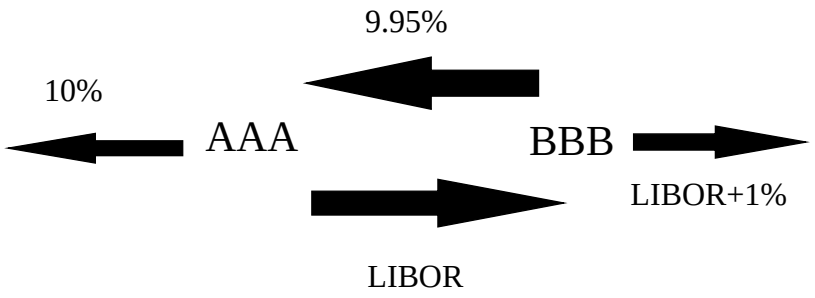
The Comparative Advantage Argument

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

	Fixed	*Floating*
AAACorp	10.00%	6-month LIBOR + 0.30%
BBBCorp	11.20%	6-month LIBOR + 1.00%

AAACorp has a comparative advantage in the fixed rate market

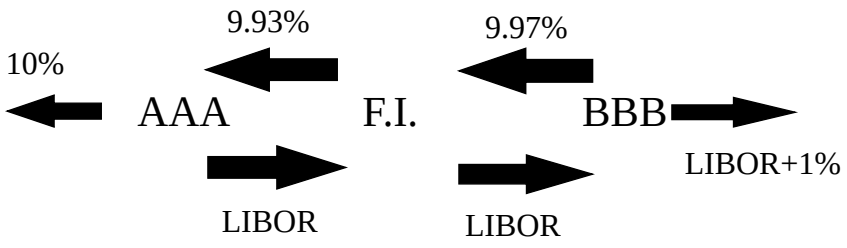
The Swap (5-year)



The swap

- AAACorp borrows at 10% fixed rate
- AAACorp enters into a swap and gets 9.95% fixed rate and pays LIBOR
- AAACorp effectively borrow at LIBOR+0.05%
- BBBCorp borrows at LIBOR+1%
- BBBCorp enters in to a swap and gets LIBOR and pays 9.95% fixed rate
- BBBCorp effectively borrows at 10.95% fixed rate
- Both firms improve their borrowing rates by 0.25%

The Swap when a Financial Institution is Involved



Criticism of the Comparative Advantage Argument

- The 10.0% and 11.2% rates available to AAACorp and BBBCorp in fixed rate markets are 5-year rates
- The LIBOR+0.3% and LIBOR+1% rates available in the floating rate market are six-month rates
- BBBCorp's final fixed rate depends on the spread above LIBOR it borrows in the future

Criticism of the Comparative Advantage Argument

- Six-month LIBOR is a short-term AA borrowing rate
- The 5-year swap rate has a risk corresponding to the situation where 10 six-month loans are made to AA borrowers at LIBOR
- BBBCorp incurs the risk that its credit rating declines and has to pay higher than LIBOR+1% to the original loan
- AAACorp incurs the default risk of BBBCorp

Valuation of an Interest Rate Swap

- Interest rate swaps 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)

Quotes By a Swap Market Maker

Maturity	Bid (%)	Offer (%)	Swap Rate (%)
2 years	6.03	6.06	6.045
3 years	6.21	6.24	6.225
4 years	6.35	6.39	6.370
5 years	6.47	6.51	6.490
7 years	6.65	6.68	6.665
10 years	6.83	6.87	6.850

Valuation in Terms of Bonds

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

Valuation example

- Suppose a financial institution has agreed to pay six-month LIBOR and receive 8% per year (with semiannual compounding) on a notional principal
- The value of this swap is

  $V_{swap} = V_{fix} - V_{fl}$
- The swap has a remaining life of 1.25 years
- The LIBOR at the last payment date was 10.2% semiannual compounding

Valuation example

Time	Bfix	LIBOR rate cont comp.	discount	PV
0.25	4.0	10%	0.9753	3.901
0.75	4.0	10.5%	0.9243	3.697
1.25	104.0	11%	0.8715	90.640
Total				98.238

Valuation example

- Because the value of floating rate bonds equal par (face value) immediately after last payment, the value of this bond equals the discount of par+payment immediately prior to payment. Thus the value of a floating rate bond = (par+payment) exp(-rT)

Time	Bfl	LIBOR rate cont comp.	discount	PV
0.25	105.1	10%	0.9753	102.505

Valuation example

- The value of this swap to the firm paying floating rate and receiving fixed rate is 98.238-102.505=-4.267 (per 100 notional)
- The value of this swap to the firm paying fixed rate and receiving floating rate is 4.267 (per 100 notional)

Valuation in Terms of FRAs

- Each exchange of payments in an interest rate swap is an FRA
- The “plain vanilla” interest rate swap in our example consisted of 6 FRAs
- The FRAs can be valued on the assumption that today’s forward rates are realized

Valuation in Terms of FRAs

Time	fix	fl	net	discount	PV
0.25	4.0	-5.1	-1.1	0.9753	-1.073
0.75	4.0	-5.522	-1.522	0.9243	-1.407
1.25	4.0	-6.051	-2.051	0.8715	-1.787
Total					-4.267

- The floating rates 5.522 and 6.051 are the forward rates between 0.25 to 0.75 and 0.7 to 1.25 in semiannual compounding rates

Valuation in Terms of FRAs

- Why the floating rate swaps can be valued on the assumption that today's forward rates are realized?
- Consider the case where a bank is on the other side of this swap. The bank will pay floating rate in the future, but does not want to be expose to interest rate changes in the future.
- The bank can hedge this risk by using zero-coupon bonds or Eurodollar futures or forward contracts

Valuation in Terms of FRAs

- To hedge using forward contracts, the bank takes positions in

1. long an interest rate forward contract to fix the lending rate between 0.25-0.75. The forward rate should be 11.04% (semiannual compounding)
2. long an interest rate forward contract to fix the lending rate between 0.75-1.25. The forward rate should be 12.10% (semiannual compounding)

Valuation in Terms of FRAs

- Because the bank can set up the floating payments today using forward contracts, the floating rate part of a swap can be viewed as a portfolio of a forward contracts
- Therefore the floating part of the swap should be valued on the assumption that today's forward rates are realized, otherwise there is an arbitrage opportunity

Fix lending rate using zero bonds

Today the bank wants to fix a lending rate between time 0.25 to 0.75.

Cash flow	↑	↓	
0	1000	?	
0	0.25	0.75	years

Short a 0.25-year zero coupon bond

Long a 0.75-year zero coupon bond

Assume $1000 face value

Fix lending rate using zero bonds

t	Zero bond	spot (cont comp)	forward (cont comp)
1	975.3	10%	5%
2	924.3	10.5%	10.75
3	871.5	11%	

Cash flow (year)	0	0.25	0.75
Short one 0.25-year zero	975.3	-1000	
Long 1.0552 (975.3/924.3) of 2.0 year zero	-975.3	0	1055.2
Net	0	-1000	1055.2

Interest rate = (1055.2-1000)/1000 = 5.52%

Fix lending rate using zero bonds

- The rate 5.52% per half year equals 11.04% semiannual compounding or 10.75 continuous compounding
- The bank can set the lending rate between 0.25 – 0.75 today at the forward rate
- The bank can set up the floating payments today using zero-coupon bonds at the forward rates, so the value of the floating rate agreement should be price using the forward rates

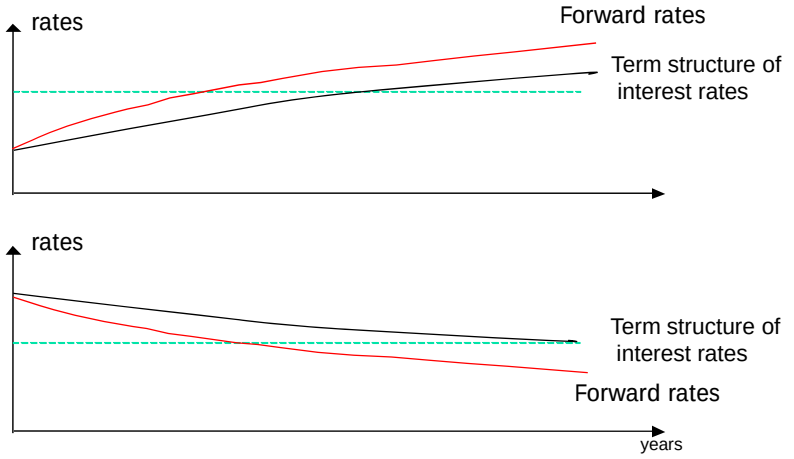
Swaps & Forwards

- The value of the swap is the sum of the values of the forward contracts underlying the swap
- Swaps are normally “at the money” initially (value =0)
  - This means that it costs nothing to enter into a swap
  - It does not mean that the value of each forward contract underlying a swap is zero

Swaps & Forwards

- If the term structure of interest rates is upward sloping and we received fixed and pay floating the value of the shorter-term forward contracts are positive and the value of the longer-term forward contracts are negative
- If the term structure of interest rates is downward sloping and we received fixed and pay floating the value of the shorter-term forward contracts are negative and the value of the longer-term forward contracts are positive

Swaps & Forwards



Currency swap

- 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

An Example of a Currency Swap

An agreement to pay 11% on a sterling principal of £10,000,000 & receive 8% on a US$ principal of $15,000,000 every year for 5 years

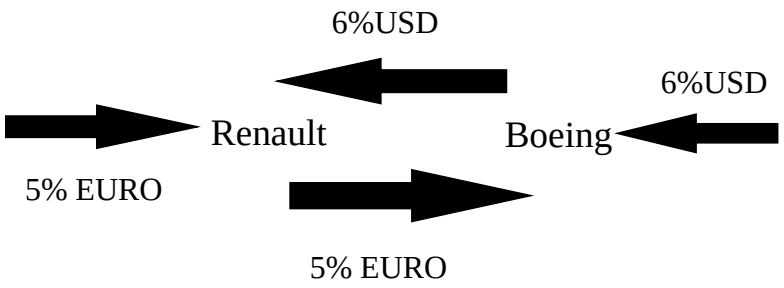
The Cash Flows

	Dollars $	Pounds £
Year	------millions------	
2001	–15.00	+10.00
2002	+1.20	–1.10
2003	+1.20	–1.10
2004	+1.20	–1.10
2005	+1.20	–1.10
2006	+16.20	-11.10

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

Convert assets

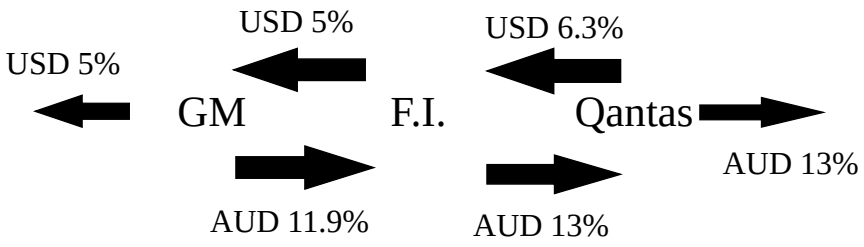


Comparative Advantage Arguments for Currency Swaps

General Motors wants to borrow AUD
Qantas wants to borrow USD

	USD	AUD
General Motors	5.0%	12.6%
Qantas	7.0%	13.0%

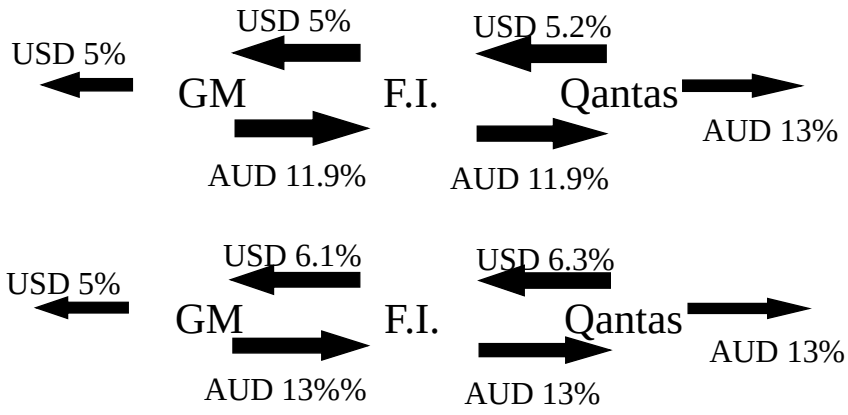
The Swap



Comparative advantage

- The comparative advantage argument is stronger in currency swap
- Lenders may have more information on local companies
- Companies may already have relationship with local lenders
- Lenders may be able to monitor local companies better

Exchange rate risk



Valuation of Currency Swaps

Like interest rate swaps, currency swaps can be valued either as the difference between 2 bonds or as a portfolio of forward contracts

Valuation of Currency Swaps

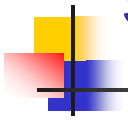
- The LIBOR/swap term structure of interest rate is flat in both Japan and US. The Japanese rate is 4% and the US rate is 9%per annum (cont. comp.)
- A financial institution has entered into a currency swap in which it receives 5% per annum in yen and pays 8% per annum in dollars once a year The principals of the two currencies are $10M and 1,200M yen
- The swap will last for another 3 years and the current exchange rate is 110yen=$1

Valuation in Terms of FRAs

Time	$us	Yen	fw rate	$value of yen cash flow	net	PV
1	-0.8	60	0.009557	0.5734	-0.2266	-0.2071
2	-0.8	60	0.010047	0.6028	-0.1972	-0.1647
3	-0.8	60	0.010562	0.6337	-0.1663	-0.1269
3	-10.0	1200	0.010562	12.6746	2.6746	2.0417
Total						1.5430

Credit Risk

- A swap is worth zero to a company initially
- At a future time its value is liable to be either positive or negative
- The company has credit risk exposure only when its value is positive



Summary

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  - Using interest rate swaps
  - The comparative advantage argument
  - Valuation of interest rate swaps
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