
Backus/February 23, 1998

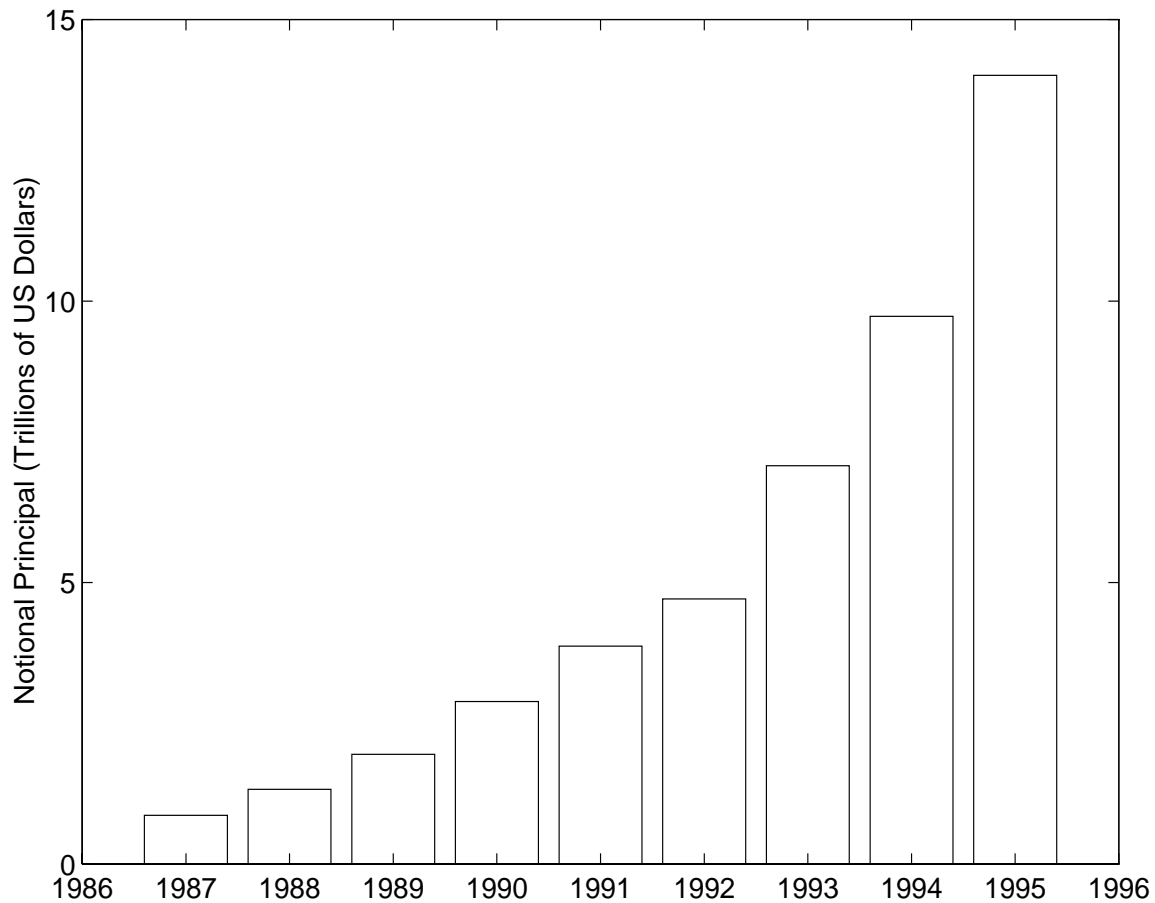
Floater and Swaps

0. Overview

- Swaps as Derivatives
- Floaters and Inverse Floaters
- Swap Analytics
- Swap Engineering
- OTC v Exchange-Traded Products
- Credit Risk

1. The Swap Market

- Market is an outgrowth of the interbank market for currencies and short-term loans/deposits
- Started with international commercial banks, now includes major investment banks
- Market has grown dramatically:



1. The Swap Market (continued)

- Swaps by category and currency (1995):

Product	Notional Principal (US tr)
Interest rate swaps	12.811
US dollar	4.372
Japanese yen	3.854
Deutsche mark	2.128
Pound sterling	0.856
Cross-currency swaps	1.295
US dollar	0.419
Japanese yen	0.200
Deutsche mark	0.110
Pound sterling	0.046

Source: IMF, *International Capital Markets*, 1997.

2. Examples of Floating Rate Notes

- Example 1: Istituto Bancario San Paolo Torino
 - 5-year floating rate notes (FRNs)
 - Maturing June 18, 1997
 - Denominated in ecu's (European currency units)
 - Semiannual payments of ECU LIBOR + 20 bps
 - Rate set every 6 months, paid 6 months later
 - LIBOR day count convention (reminder):

$$\text{Interest Payment} = \frac{\text{“Actual”}}{360} \times (\text{LIBOR} + 0.20)$$

for LIBOR quoted as a percent.

- Example 2: Citicorp DM notes
 - 5-year floaters
 - Maturing December 15, 1999
 - Quarterly payments of DM LIBOR + 25 bps

2. Examples of Floating Rate Notes (continued)

- Example 3: Daiwa Europe yen notes
 - 5.25-year floaters
 - Maturing March 17, 2000
 - Semiannual payments of 5-year yen swap rate – 90 bps

- Example 4: IBRD (World Bank) inverse floaters
 - 5-year US dollar floaters
 - Maturing October 1, 1997
 - Semiannual payments at a rate of
$$\text{Rate} = 14.5\% - 2 \times \text{Dollar LIBOR}$$
(with a minimum of zero)

- Example 5: Deutsche Bank Finance NV notes
 - 10-year C-dollar floaters
 - Maturing September 3, 2002
 - Quarterly rate of 3-month BAs - 30 bps
 - Cap of 8.90, floor of 5-7/8

- Remark: Lots of variety!

3. Floating Rate Note Arithmetic

- Standard floater: 6-month payments of 6-month LIBOR
- Consider a 6-month floater
 - Let y be the bond equivalent of 6-m LIBOR
 - Value in 6 months is principal (100) plus interest
 - Present discounted value is

$$\text{Price} = \frac{100(1 + y/2)}{1 + y/2} = 100.$$

- Consider a 12-month floater
 - Value in 6 months is market price (100) plus interest
 - Present discounted value is

$$\text{Price} = \frac{100(1 + y/2)}{1 + y/2} = 100.$$

- Consider an 18-month floater ... (you get the idea)
- Remarks:
 - Floaters trade at par on reset dates
 - Despite the uncertain interest payments, this is no more complex than a conventional bond

4. Interest Rate Sensitivity of FRNs

- Standard floaters have short durations
- If fraction w of a period remains until the next payment:

$$\text{Price} = \frac{100 + \text{Interest}}{(1 + y/2)^w}$$

(NB: the numerator was set at the start of the period.)

- DV01 computed the usual way (increase y by .01)
- Duration is

$$D = (1 + y/2)^{-1}w/2$$

5. Inverse Floaters

- Can be valued by replication
- Example: 5-year, Rate = 20% – LIBOR
10% flat spot rate scenario of previous chapter
- Replication of cash flows:

Position	Interest Rate	Principal
Inverse Floater	20% – LIBOR	100
Long 2 10% Bonds	20%	200
Short FRN	– LIBOR	–100

- Estimate price from components:

$$\text{Price} = 2 \times 100 - 100 = 100$$

- Duration:

$$D = 3.86 \left(\frac{200}{100} \right) + 0.48 \left(\frac{-100}{100} \right) = 7.25$$

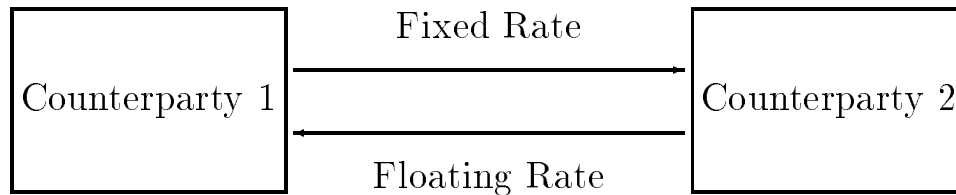
- Remarks

- Despite the uncertain interest payments,
this is no more complex than a conventional bond
- Caveat: floater has floor at zero, replication doesn't
- Long duration!

6. Plain Vanilla Interest Rate Swaps

Description

- Swap parties exchange fixed and floating interest payments:



- Only net payments are made
- Principals not exchanged (net to zero)
- Other parameters:
 - Notional principal (amount interest is applied to)
 - Maturity
 - Payment frequency
 - Index rate (floating rate typically tied to LIBOR)
 - Currency

6. Plain Vanilla Interest Rate Swaps (continued)

Swap arithmetic

- Vanilla swap has semiannual payments of 6-month LIBOR
- Fixed rate typically set to give swap zero value at start
- Valuation: What's the appropriate fixed rate?
 - Add principal payments \Rightarrow exchange of bonds
 - Value to Counterparty 1 is

$$\text{Value of Swap} = \text{Price of FRN} - \text{Price of Fixed Rate Note}$$

- Since FRN trades at par, we choose fixed rate so that the fixed rate note is par, too.
- Swap rate satisfies

$$100 = (d_1 + \dots + d_n)(\text{Swap Rate}/2) + d_n 100$$
$$\text{Swap Rate} = 2 \times \frac{1 - d_n}{d_1 + \dots + d_n} \times 100$$

- Remarks:
 - Par yields again
 - Day count convention follows LIBOR

6. Plain Vanilla Interest Rate Swaps (continued)

Interest sensitivity

- DV01 is difference between DV01's of the two notes
- Duration not used: percent not defined when price is zero
- Duration of components sometimes used instead

6. Plain Vanilla Interest Rate Swaps (continued)

Example

- Infer spot rates from swap quotes, interest rate futures, markup over treasuries, etc.
- Estimates for June 22, 1995:

Maturity (Yrs)	Discount Factor	Spot Rate (Annual %)
0.5	0.9707	6.036
1.0	0.9443	5.809
1.5	0.9175	5.824
2.0	0.8913	5.839
2.5	0.8644	5.914
3.0	0.8378	5.989

- 3-year swap rate:

$$\begin{aligned}\text{Swap Rate} &= 2 \times \frac{1 - d_n}{d_1 + \cdots + d_6} \times 100 \\ &= 5.980\end{aligned}$$

7. Swap Engineering

- Example: you have a 125m position with duration 2
How can we use a swap to reduce duration to 1.5?
- Intuit: Swap should pay fixed
(short the side with the longer duration)
- Swap product: the 3-year swap studied earlier
 - Fixed rate note has duration 2.709 years
 - Floating rate note has duration 0.485 years

- Duration of position plus swap with notional x :

$$D = 1.50 = 2 \left(\frac{125}{125} \right) + 0.485 \left(\frac{x}{125} \right) + 2.709 \left(\frac{-x}{125} \right)$$

Answer: $x = 28.1\text{m}$.

- Remark: this accomplishes the duration target, but a complete risk analysis would include basis risk (non-parallel shifts again)

8. Non-Vanilla Swaps

There's no end to the variety:

- Variation over time in the notional principal:
 - Amortizing and accreting swaps

- Variation over time in the fixed payment:
 - Step up and step down swaps

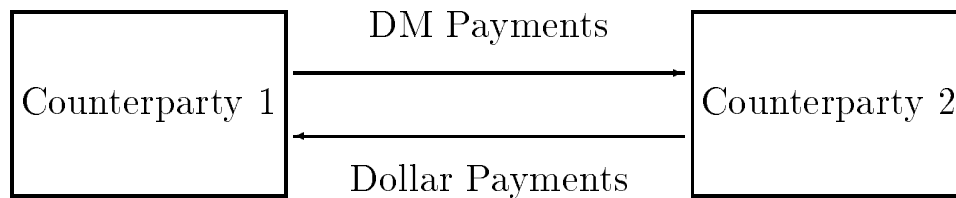
- Basis swaps: two floating rates
 - The TED spread (treasury for LIBOR)
 - LIBOR for the prime rate

- Other index rates:
 - Constant Maturity Treasury (CMT)
 - Swap rates

9. Cross-Currency Swaps

Description

- Exchange interest and principal in two currencies, as in:



- Only net payments are made
- Principals *are* exchanged (they don't net to zero)
- Other parameters:
 - Notional principal (amount interest applied to)
 - Maturity
 - Payment frequency
 - Type of interest payments (fixed or floating)
 - Index rates (for floating rate legs)
 - Currencies

9. Cross-Currency Swaps

Risk assessment

- Value (in dollars) to Counterparty 1:

$$\begin{aligned}\text{Value of Swap} &= \text{Price of Dollar Note} - \text{Price of DM Note} \\ &= p_1 - sp_2\end{aligned}$$

where s is the exchange rate (dollar price of one DM).

- Change in value is approximately:

$$\begin{aligned}\Delta v &\cong \Delta p_1 - s\Delta p_2 - sp_2 \frac{\Delta s}{s} \\ &\cong -D_1 p \Delta y_1 + D_2 sp_2 \Delta y_2 - sp_2 \frac{\Delta s}{s}\end{aligned}$$

(the usual linear approximation that underlies duration, with an extra term due to changes in the exchange rate)

- Sources of change in value:
 - Change in dollar yields (monthly std dev about 0.6%)
 - Change in DM yields (monthly std dev about 0.5%)
 - Change in exchange rate (monthly std dev about 3%)
- Except for very large durations, currency risk dominates!
- Statistical risk systems incorporate correlations among these three components

10. OTC v Exchange-Trade Derivatives

Relative to exchange-traded instruments, OTC products

- Can be custom made
- Generally have less liquidity
- Generally have greater credit risk
- Sometimes get different accounting treatment

11. Credit Risk

Methods used to control credit risk:

- Diversification across counterparties (standard practice)
- Collateral
- Mark-to-market (analogous to futures)
- Credit guarantees
- Termination triggers for downgrades
- Aaa-rated derivatives subsidiaries

Summary

- Floating rate notes make interest payments tied to market rates, typically LIBOR
- Inverse floaters often have long durations
- In a plain vanilla interest rate swap, two parties exchange the difference between fixed and floating interest payments
- In a cross-currency swap, two parties exchange the difference between interest and principal payments in two different currencies
- The OTC swap market has unlimited variety
- Swaps contracts, like futures contracts, are designed to minimize the impact of credit risk