Swaps

Interest Rate Swaps

Jonathan Kinlay

Copyright © 1997-20006 Investment Analytics

Interest Rate Swaps

- Vanilla interest rate swaps
- Basis swaps
- Amortizing swaps

Copyright © 1997-20006 Investment Analytics

Indicative Pricing Schedule

VANILLA SWAP

- CITIBANK (Reuters: CBSP)
- Monday May 15, 1999
- Spot Reference -- USD Libor

1 Year	6.17-22
18 Month	6.19-24
2 Year	6.31-36
3 Year	6.44-49

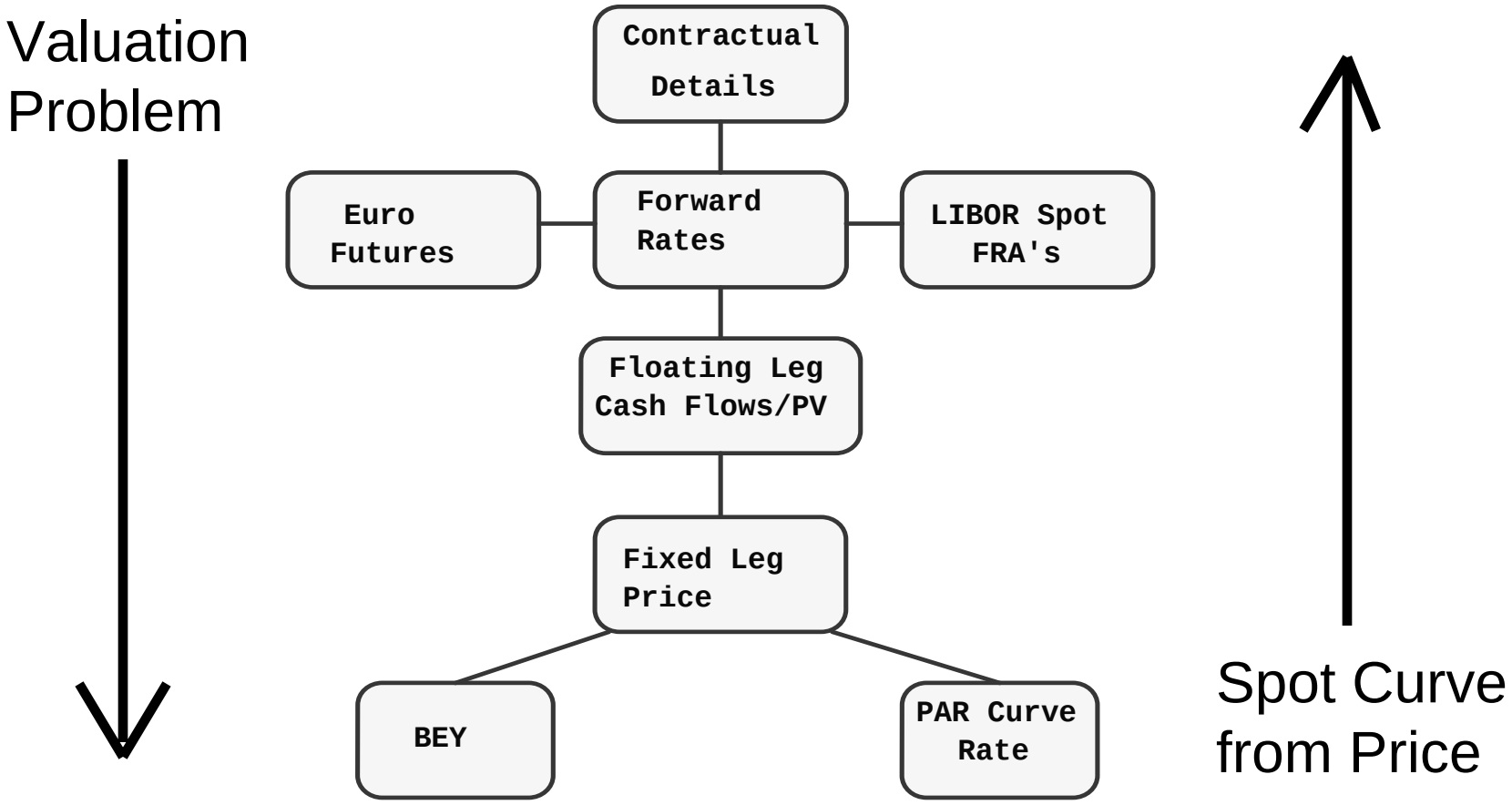
Copyright © 1997-20006 Investment Analytics

One-Year Swap

- Buyer: Pays fixed 6.22 to CITIBANK
  CITIBANK pays 3-Month LIBOR
- Seller: Pays LIBOR to CITIBANK
  CITIBANK pays fixed 6.17
- Spread: 1.25 bps relative to $100 million (approx. $12,500 per qtr)

Copyright © 1997-20006 Investment Analytics

Vanilla: Relation Between Spot Curve and Price



Copyright © 1997-20006 Investment Analytics

Vanilla Swap Valuation: Forward Curve Approach

- Two equivalent problems:
  - Given spot curve how do we value/hedge a vanilla swap?
  - Given a schedule of vanilla swap prices what spot curve can we infer?
- Objective: Value the vanilla swap from the spot LIBOR curve

Copyright © 1997-20006 Investment Analytics

Lab: Pricing a Fixed for Floating "Vanilla" Swap

Notional principal amount	**$100,000,000**
Effective date	**September 22, 1994**
Day count between each reset date:	
December 22, 1994	**91 days**
March 22, 1995	**90 days**
June 22, 1995	**92 days**
September 22, 1995	**92 days**
Maturity date	**September 22, 1995**
Interest settlements are in arrears.	
Fixed Side (Leg):	
Fixed-rate (Swap Coupon)	**6.1220%**
Compounding frequency	**quarterly**
Day count	**90/360***
Floating Side (Leg):	
Reference Rate	**3-month LIBOR**
Payment frequency	**quarterly resets**
Day count	**actual/360**
First Coupon	**5.25%**

*** Assumption: Fixed Side Cash Flows Equal over Time**

Copyright © 1997-20006 Investment Analytics

Key Steps

- Step 1: Project cash flows
  - Contract specifies timing and magnitude of cash flows
- Step 2: Value cash flows
  - Apply time value of money principles

Copyright © 1997-20006 Investment Analytics

Step 1: Cash Flow Projections

Quarter	LIBOR	Forward Rate*	Expected Variable Interest**
December	5 1/4	5.25	$1,327,083
March	5 11/16	6.0496%	$1,512,395
June	5 15/16	6.2506%	$1,597,378
September	6 3/16	6.6308%	$1,694,535

*LIBOR Forward Rates computed using actual/360 day count.
**Unbiased Expectations

Copyright © 1997-20006 Investment Analytics

Step 2: Discounting Cash Flows

- Problem: LIBOR is quoted in an add-on form
- Ignores: Compounding across reset periods
- Objective: Construct the "par LIBOR curve" for discounting LIBOR rates

Copyright © 1997-20006 Investment Analytics

Unadjusted Spot Libor Rates: Not the Par Curve

Quarter	Day Count	LIBOR	Forward Rate	E(Variable Int.)	Present Value
December	91	5 1/4	5.25	$1,327,083	$1,310,028.80
March	181	5 11/16	6.05%	$1,512,395	$1,470,912.00
June	273	5 15/16	6.25%	$1,597,378	$1,529,014.70
September	365	6 3/16	6.63%	$101,694,535	$95,689,015.90
Total					$99,998,971.40

* Including Notional for Expositional Purposes

Fails to equal Notional

$$99{,}998{,}971.4 = \frac{1327083}{1.0525^{\frac{91}{360}}} + \frac{1512395}{1.056875^{\frac{181}{360}}} + \frac{1597378}{1.059375^{\frac{273}{360}}} + \frac{101694535}{1.061875^{\frac{365}{360}}}$$

Copyright © 1997-20006 Investment Analytics

No Arbitrage Restriction

- Net present value must be zero
  - At time of issue the present value of floating rate cash flows discounted back at the floating rate must equal the notional
- What mistake has slipped in?
  - Compounding across reset periods is ignored

Copyright © 1997-20006 Investment Analytics

Correcting LIBOR Spots: Effective Annual Yield

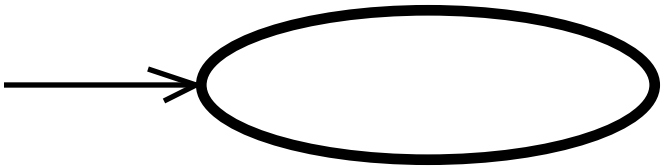
- Spot Curve Correction
  - Adjust for compounding over reset periods

$$1 + {}_0 r_m^1 = \left(1 + {}_0 r_m \times \frac{\sum \tau}{360}\right)^{\frac{360}{\sum \tau}}$$

$$1.057679 = \left(1 + 5\frac{11}{16} \times \frac{181}{360}\right)^{\frac{360}{181}}$$

Copyright © 1997-20006 Investment Analytics

PV Floating Side

P.V. at EAY = Notional 

Copyright © 1997-20006 Investment Analytics

Fixed Side: Mid-Market Rate

- Fixed side is the Swap Curve
  - Swap rate discounted using “par LIBOR curve” = notional principal
  - Equates present value of both legs of the swap
- Computation
  - STEP 1: Swap rate generates future cash flows for fixed leg
  - STEP 2: PV of Cash Flows - Notional

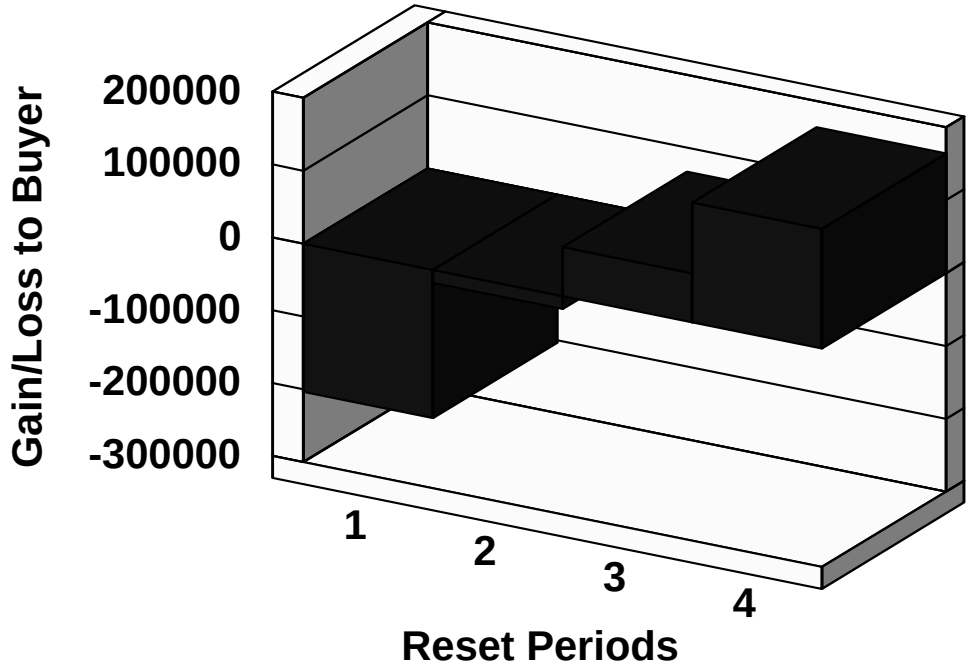
Copyright © 1997-20006 Investment Analytics

Swap Price

Qtr	LIBOR Yield Curve	Fixed Interest @ 6.1219933%	Present Value @ EAY
Dec	5 1/4	$1,530,498	$1,510,453
March	5 11/16	$1,530,498	$1,487,950
June	5 15/16	$1,530,498	$1,464,555
Sept	6 3/16	$101,530,498	$95,537,042
Total		Both legs exactly equal	$100,000,000

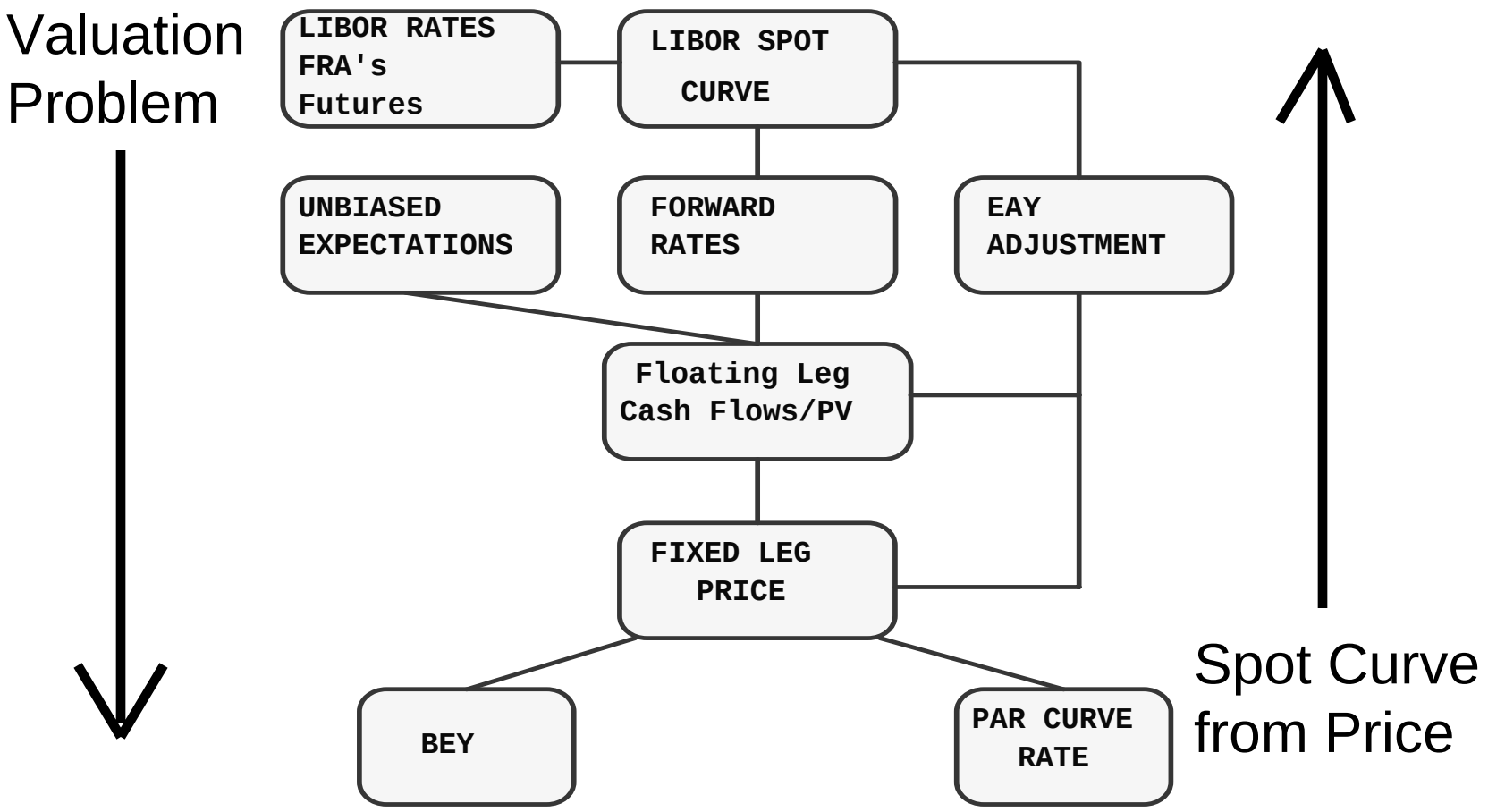
Copyright © 1997-20006 Investment Analytics

Buyer: Net Interest Rate Exposure



Copyright © 1997-20006 Investment Analytics

Short Tenor Fixed-for-Floating



Copyright © 1997-20006 Investment Analytics

Adjustment for Risk Premium?

- Problem: Forward rate is a biased estimate of expected future spot rate
- Suppose we replace spot curve on floating side with an *expected spot curve*
  - more accurate cash flow projections
  - PV remains unchanged because discount rates also adjust

Copyright © 1997-20006 Investment Analytics

Hedging Interest Rate Swaps

- Balanced book
  - Ideal solution
- Hedging problem is relatively simple
  - Eurodollar futures
    - Problem: marking to market, convexity
  - Strips
    - Problem: hedge ratio is constant
  - Treasury markets
    - Problem: TED spread, demand for basis swaps

Copyright © 1997-20006 Investment Analytics

Basis Swaps

- First appeared in 1988 --- key building block for any complex structure
- Both cash flow streams linked to floating indices
  - LIBOR/T-Bills
  - LIBOR/CP
  - LIBOR/Prime
- Applications
  - Arbitrage Swap & MM spreads
  - Lock in narrow spreads
  - Switch to responsive index when rates expected to fall

Copyright © 1997-20006 Investment Analytics

Basis Swaps: Index Selection

- TED Spread
  - Spread between LIBOR and T-Bills widens when banking industry hits problems
    - Range 30bp - 130 bp typical
    - 240 bp in ‘84 (Continental Illinois), 260 bp in ‘87 crash
- Prime-LIBOR Spread
  - Should narrow (widen) when s/t rates rise (fall)
    - Prime is ‘sticky’ & lags the market driven rates LIBOR
- LIBOR-CP Spread
  - Fell consistently throughout 1980’s

Copyright © 1997-20006 Investment Analytics

Basis Swap Indices

Index	Quoting Convention	Effective Period
T-Bills	Discount	91 days
CP	Discount	1 month
LIBOR	MMY	6 months
Prime	MMY	1 month

Copyright © 1997-20006 Investment Analytics

Basis Swap Quotes (vs. 6-m LIBOR)

	CP/ LIBOR	T-Bill/ LIBOR	Prime LIBOR
2 year	CP+5/1	B+76/59	P-158/165
3 year	CP+6/1	B+86/71	P-150/161
5 year	CP+6/2	B+99/84	P-148/156

- Swap spreads are quoted on a MM basis
  - Yield on T-Bills & CP have to be converted to MM equiv. before spread is added

Copyright © 1997-20006 Investment Analytics

Basis Swap Quotes: Fixed Margin over Reference

Copyright © 1997-20006 Investment Analytics

Interpreting Quotes

- 3-Month: T-bill for LIBOR
- Quote is on a relative basis:
- B + 32, B + 38
- B = Determined from 3-month auction, converted to MM yield

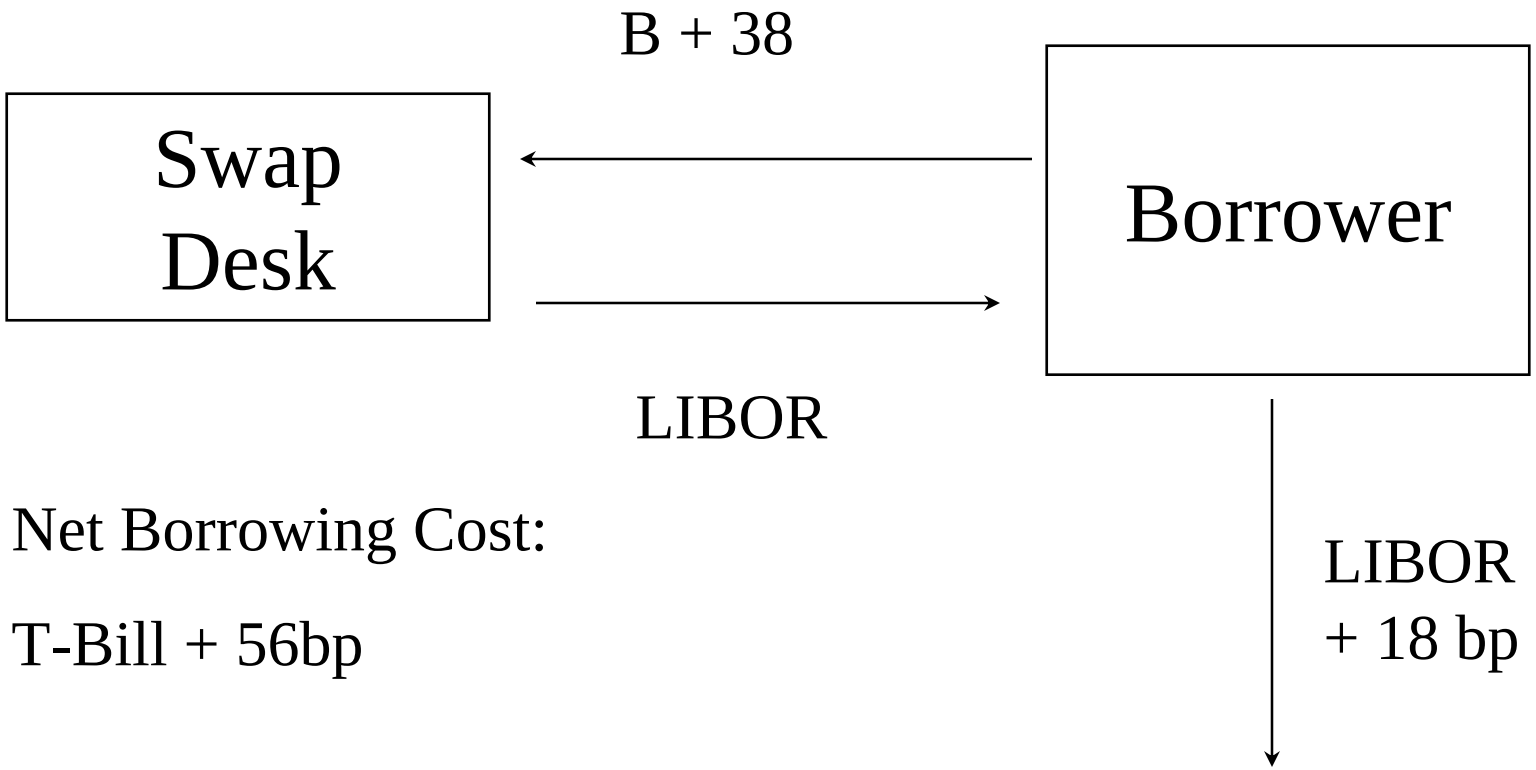
Copyright © 1997-20006 Investment Analytics

Trading

- Buyer of T-bill for LIBOR:
  - Pay Desk B+38, Receive 3-month LIBOR
- Seller of T-bill for LIBOR:
  - Gets B+32 from Desk, Pays 3-month LIBOR
- Projected cash flows defined by indexes
- Value both streams from *same* spot curve

Copyright © 1997-20006 Investment Analytics

LIBOR- T-Bill Swap Example

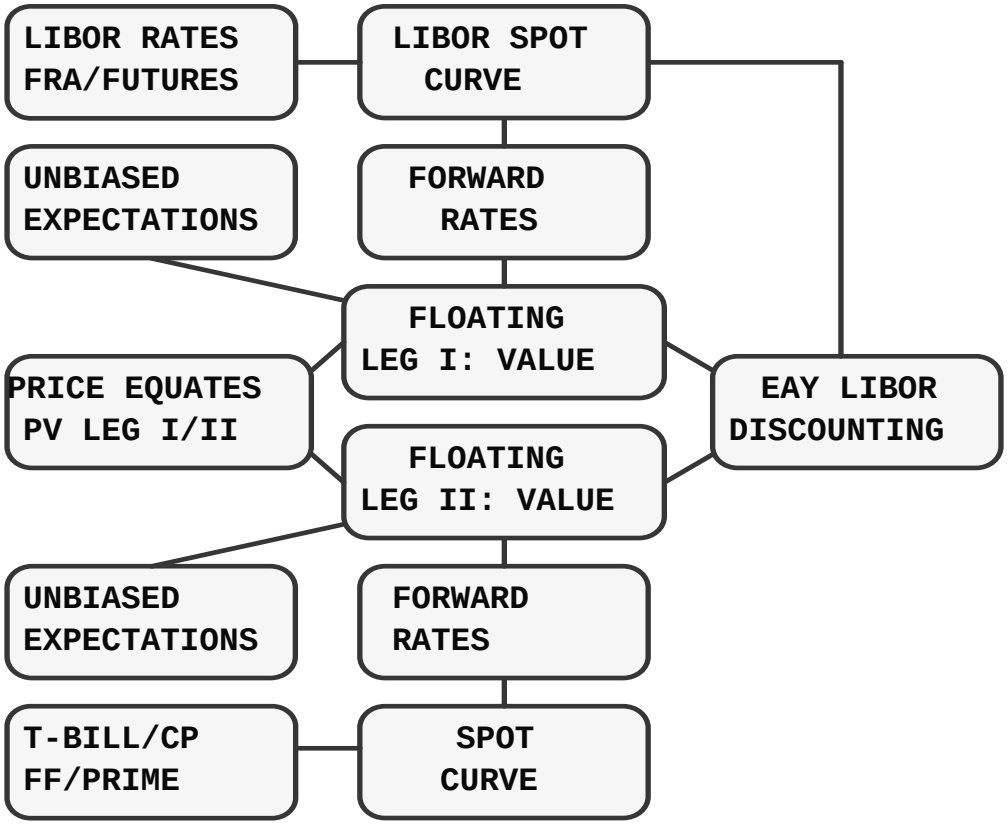


Net Borrowing Cost:

T-Bill + 56bp

Copyright © 1997-20006 Investment Analytics

Floating-for-Floating Swaps



Copyright © 1997-20006 Investment Analytics

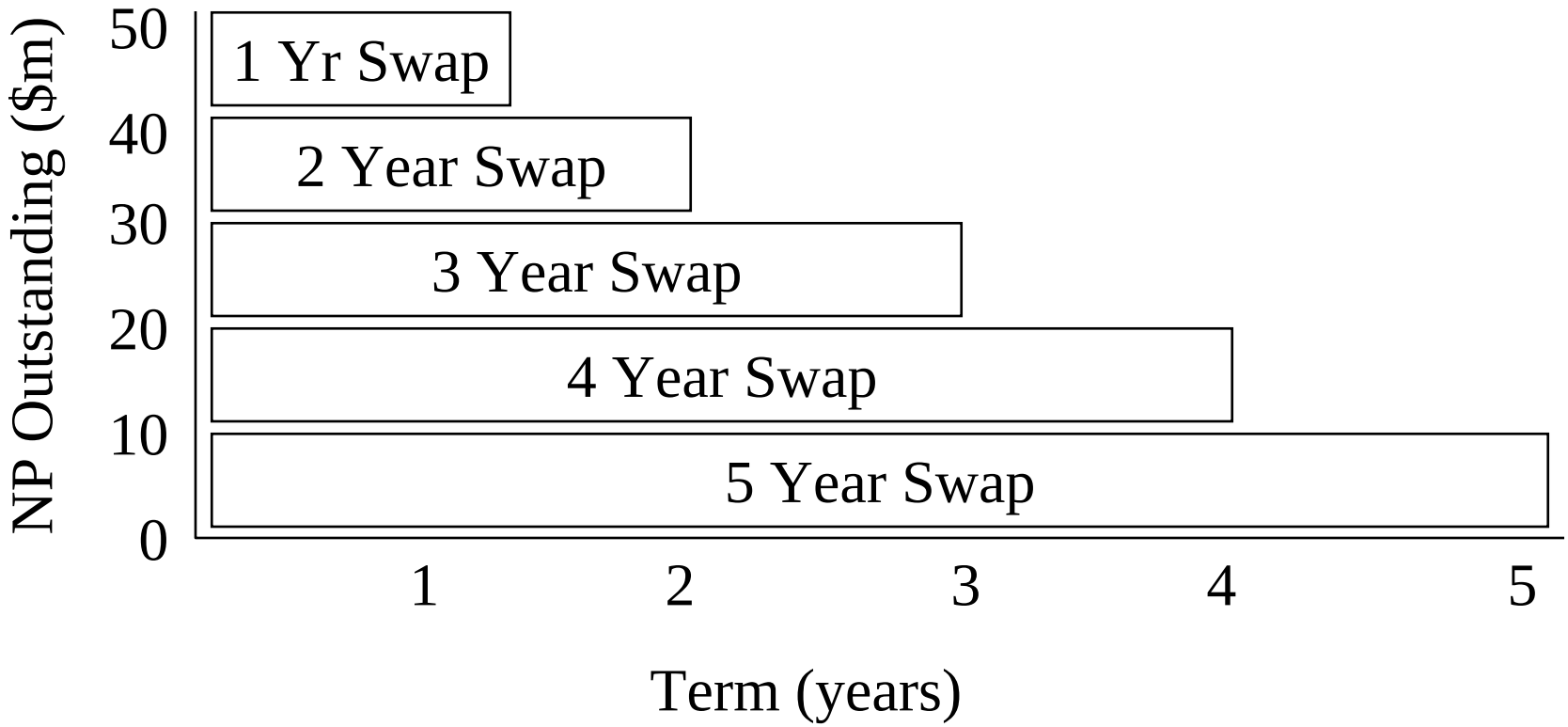
Amortizing Swaps

- Based on amortizing notional principal
  - Widely used for amortizing loans, lease finance
  - Popular during early 1990's - steep US yield curve
  - "Roller-Coaster": NP increases *and* decreases
- Analysis of Amortizing Swaps
  - Treat as series of bullet swaps
    - Compute average maturity, blended swap rate

Copyright © 1997-20006 Investment Analytics

Five Year Amortizing Swap Structure

- 5 year swap, $50m NP, 20% annual amortization



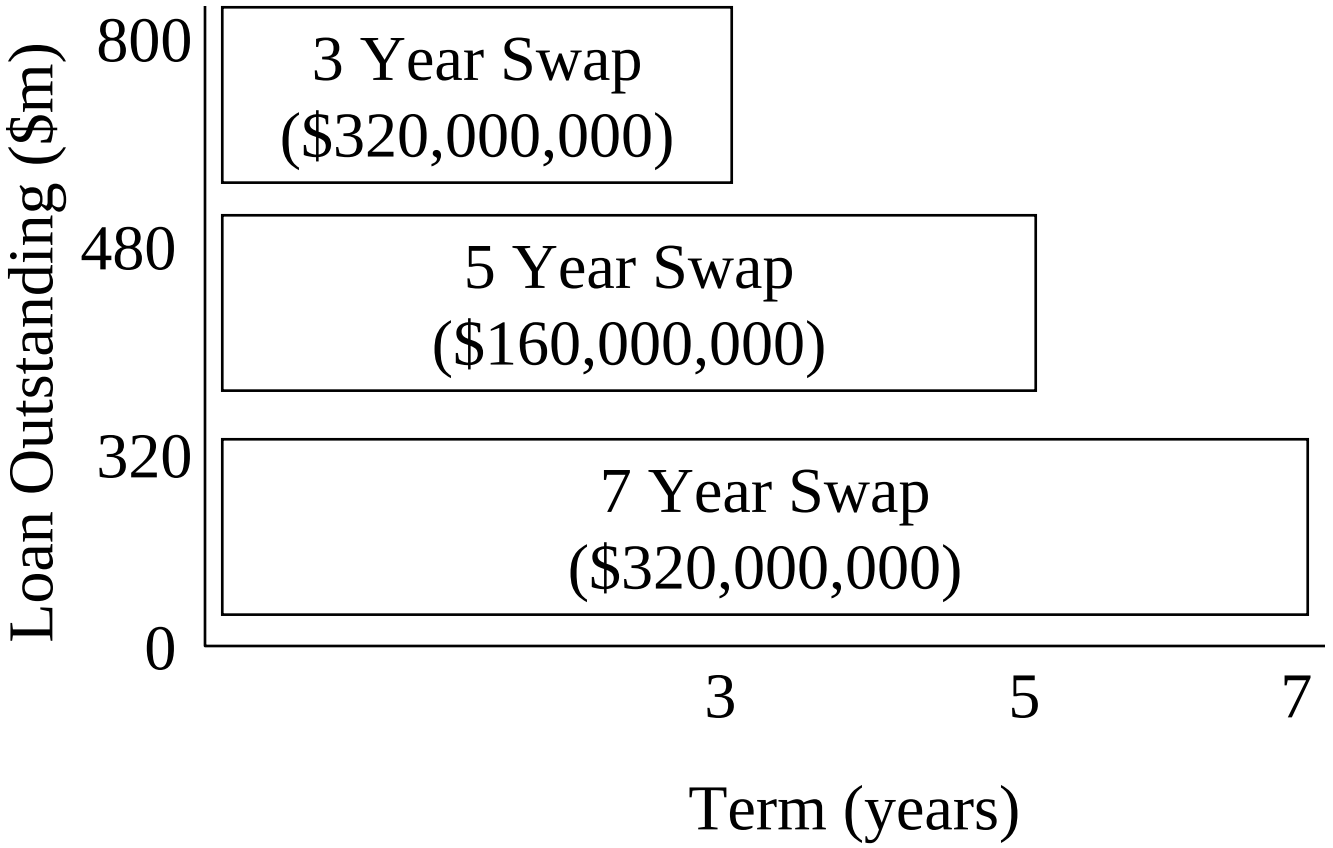
Copyright © 1997-20006 Investment Analytics

Lab: Zancor Inc.

- Loan: $800,000,000 7 year step down revolving credit
  - Price: Prime + 1.5% payable monthly
  - Amortization:
    - $320m end year 3
    - $160m end year 5
    - $320m end year 7
- Client want to swap to fixed rate debt.

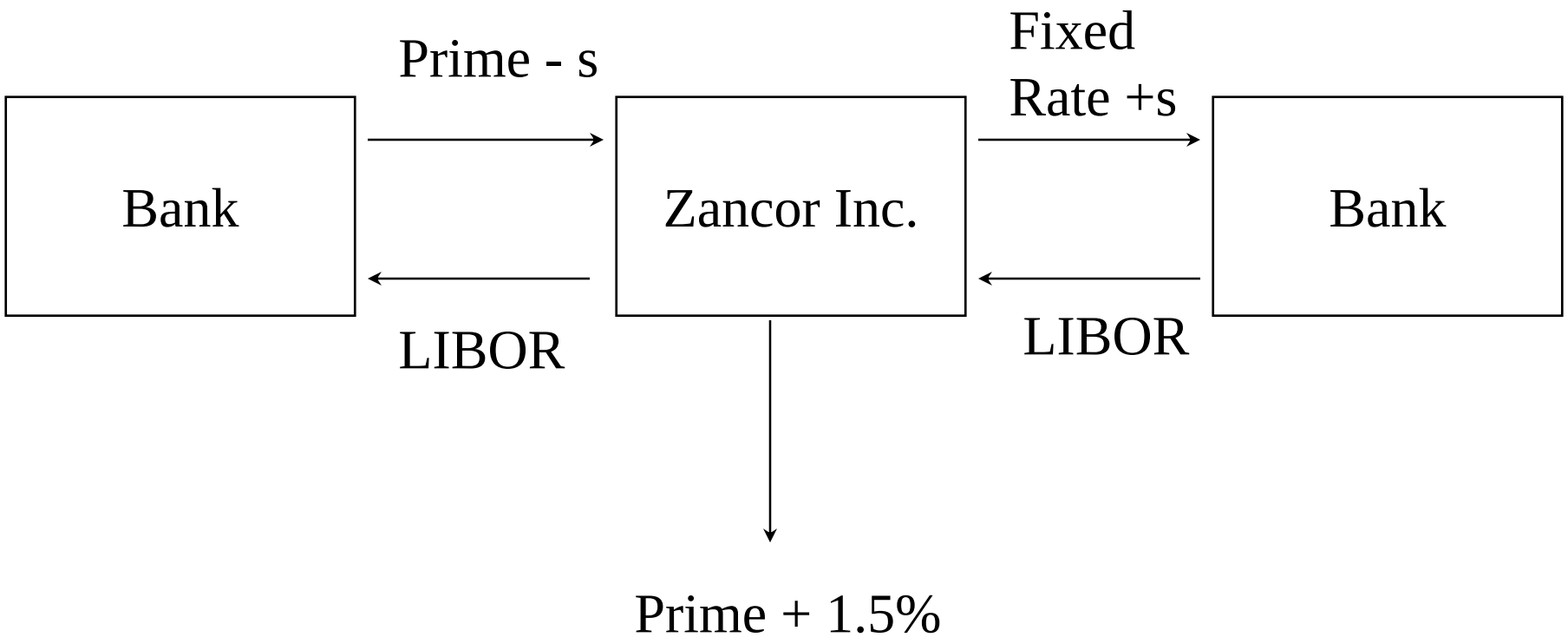
Copyright © 1997-20006 Investment Analytics

Lab: Zancor Inc. - Amortizing Swap



Copyright © 1997-20006 Investment Analytics

Lab: Zancor In. - Swap Structure



Copyright © 1997-20006 Investment Analytics

Lab: Zancor Inc. - Swap Rates

Tenor	Treasuries	Coupon Swap	Basis Swap
3 years	5.57%	T+52/57	P-80/-70
5 years	6.01%	T+57/64	P-80/-70
7 years	6.39%	T+55/62	P-80/-70

- Prime is 6.2%
  - Assumed constant

Copyright © 1997-20006 Investment Analytics

Lab: Zancor Inc.

- Objective:
  - Find blended swap rate
    - This is IRR on composite swap cash flows
  - Find all-in loan cost
- Worksheet: Amortizing Swap
  - Workbook: Swaps.xls
  - See written lab notes & solution
  - Also, solution spreadsheet

Copyright © 1997-20006 Investment Analytics

Zancor Inc. - Solution

COUPON SWAP	3	5	7
NP	320	160	320
Treasury Rate	5.570%	6.010%	6.390%
Coupon Swap Spread	0.570%	0.640%	0.620%
Credit Fee	0.075%	0.125%	0.175%
Total Fixed Rate	6.215%	6.775%	7.185%

BASIS SWAP	3	5	7
Prime	6.200%	6.200%	6.200%
Basis Swap Spread	-0.800%	-0.800%	-0.800%
Basis Swap Coupon	5.400%	5.400%	5.400%
Loan Spread	1.500%	1.500%	1.500%
Loan Cost	7.700%	7.700%	7.700%

- Blended swap rate: 6.8486%
- All-in loan cost: 9.2250%

Copyright © 1997-20006 Investment Analytics