


Brit Training
Debt Instruments & Markets

**Managing Bond Portfolio Risk:
Tools and Techniques**

Dr. Ian Giddy
New York University



The Goal

- Minimize exposure to interest rate risks – and related risks such as basis risk, liquidity risk and counterparty risk
- Use the tools of risk management in a way that limits the risks while not costing an arm and a leg.

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Interest Rate Risk: Effect on a Portfolio

- ❑ How can we measure the effect of interest rate fluctuations on the value of a bond investment portfolio?
- ❑ Bond price fluctuations will affect *both sides* of the balance sheet
- ❑ Can be hedged, using *duration* as a risk/sensitivity measurement tool
- ❑ Can be hedged with futures, swaps, and bond options.

Pepsico Pension

Assets (each \$10m):


- ❑ 1-year E\$ deposit
- ❑ 5-year, 6% T-note D=4.6
- ❑ 10-year Strip

Pension liabilities:

- ❑ \$10m 3 years
- ❑ \$10m 5 years
- ❑ \$10m 7 years

What is Pepsico pension fund's risk?


- ❑ Duration of the assets (+ve)
- ❑ Duration of the liabilities (-ve)
- ❑ *Net duration is the risk to be hedged!*



Immunization

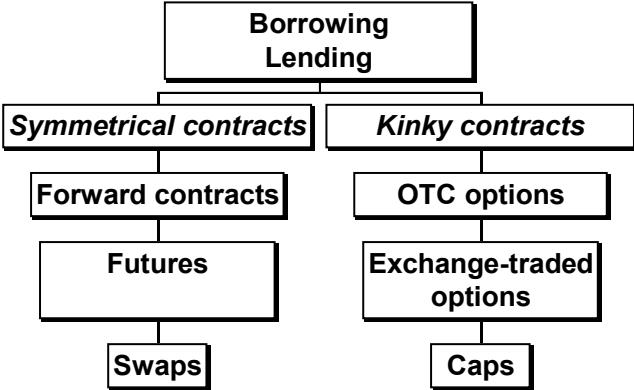
- immunization can be done on a *net worth* basis (e.g. banks try to mitigate effects of interest rates on their worth) or in terms of a *target date* (e.g. pension funds, any institution with a fixed future obligation)
- immunization is accomplished by equating the duration of assets and liabilities, i.e. set $D_A \times A = D_L \times L$

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The Tools of Asset-Liability Management


- Banks can hedge with cash instruments as well as derivatives.



```

graph TD
    A[Borrowing Lending] --> B[Symmetrical contracts]
    A --> C[Kinky contracts]
    B --> D[Forward contracts]
    C --> E[OTC options]
    D --> F[Futures]
    E --> G[Exchange-traded options]
    F --> H[Swaps]
    G --> I[Caps]
  
```


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Derivatives: A Classification

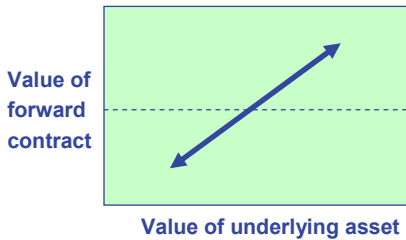
	Over the Counter	Exchange Traded
Forwards & Futures	Example: Currency Swaps	Example: Treasury Bond Futures
Options	Example: Foreign Exch. Options	Example: S&P Options
Hybrids & Exotics	Example: Interest Rate Collars	Example: Nikkei Put Warrants

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Forwards and Futures

- Forwards, futures and swaps are symmetrical. As a rule,
 - They track the underlying, both up and down
 - You can gain or lose, symmetrically
 - You pay nothing, and receive nothing, up front



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Heineken Hedges

- ❑ Heineken plans to borrow \$15 million in 3 months to expand its Heineken Ice advertising campaign.
- ❑ The Treasurer wishes to lock in a cost of funds.
- ❑ One way is with a FRA: Barclays agrees to pay Heineken if 3-mo Libor > 6%, and vice-versa.

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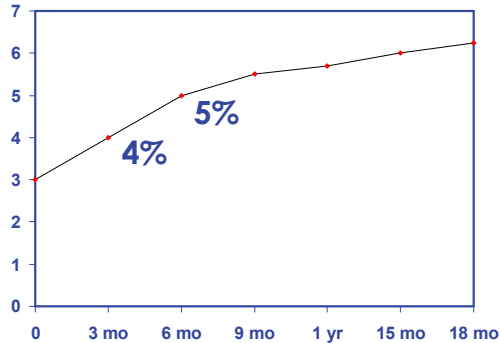
10



Forward Interest Rates

Borrow for 6 months at 5%

Invest for 3 months at 4% Lock in cost at ? Ans: 6%



Time	Interest Rate (%)
0	3%
3 mo	4%
6 mo	5%
9 mo	~5.5%
1 yr	~5.8%
15 mo	~6.1%
18 mo	~6.2%

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Calculating Implied Forward Rates

I can buy a 2-year note or buy a 1-year note and reinvest it at some "forward" rate f .

$$(1+y_2)^2 = (1+y_1)(1+f)$$

Find f !

Calculating Implied Forward Rates

- In general find the forward rate f_n , starting in m periods and running for n periods, that satisfies the equation

$$(1+r_{m+n})^{m+n} = (1+r_m)^m (1+f_n)^n$$

$$f_n = \left[\frac{(1+r_{m+n})^{m+n}}{(1+r_m)^m} \right]^{1/n} - 1$$

FRA Mechanics

Borrow for 6 months at 5%

Invest for 3 months at 4%	Lock in cost at 6%
----------------------------------	---------------------------

SET RATE AT 6%

IF LIBOR > 6%, B PAYS H
IF LIBOR < 6%, H PAYS B
HOW MUCH?
 $PV[(LIBOR-6\%)/4]$

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Swaps: Mechanics and Valuation

GE


Fixed 8%

*Floating
USD Libor*

Chase

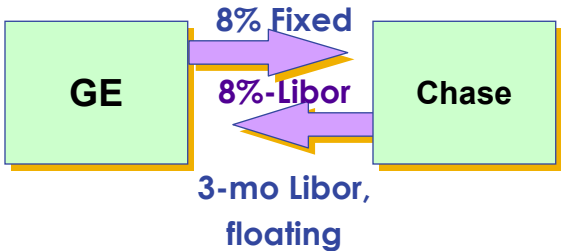
Periodic exchanges of interest payments are made during the life of the swap. (The principal amount is not exchanged.)

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Interest Rate Swap: An Extended FRA

The typical interest-rate swap is an exchange of a fixed for a floating interest rate for a period of time.
Effectively, it involves paying the difference between a fixed rate and Libor, like a FRA:

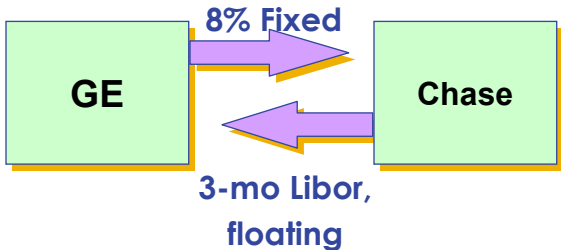


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Interest Rate Swap Valuation

- How does a swap's value change over time?
- It depends mainly on what happens to the fixed rate (the "swap rate")



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Swaps: Applications of Valuation

Labatt's

Fixed 9%

Floating Libor

RBC

B
O
N
D

FRN

- Valuation
- Off-market swaps
- Cancellation
- Counterparty exposure
- Hedging swap positions

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Swap Valuation

The value of a swap equals the "net worth" of the swap cash flows expressed as a balance sheet

Labatt's

Fixed USD 9%


Floating USD Libor s.a.

Bank

Labatt's swap:
Receive floating, pay fixed

"ASSETS"	"LIABILITIES"
Receiving floating 6-mo US\$ Libor Semi-annual for 5 years Principal US\$100m <i>Like a 5-year US\$ FRN</i>	Paying fixed 9% Annual for 5 years Principal US\$100m <i>Like a 5-year bond</i>

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At Inception, Standard Swap is Worth Zero

Labatt's swap:
Receive floating, pay fixed

"ASSETS"	"LIABILITIES"
Receiving floating 6-mo US\$ Libor Semi-annual for 5 years Principal US\$100m <i>Like a 5-year US\$ FRN</i>	Paying fixed 9% Annual for 5 years Principal US\$100m <i>Like a 5-year bond</i>
<i>Value=\$100m</i>	<i>Value=\$100m</i>


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Two Years Later, Rates Have Fallen...

Labatt's swap:
Receive floating, pay fixed

"ASSETS"	"LIABILITIES"
Receiving floating 6-mo US\$ Libor Semi-annual for 3 years Principal US\$100m <i>Like a 3-year US\$ FRN</i>	Paying fixed 9% Annual for 3 years Principal US\$100m <i>Like a 3-year bond</i>
<i>Value still \$100m</i>	<i>Swap rate = 6%</i> <i>Value=\$108m</i>



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Swap Price Risk is Like Price Risk of Treasuries

- ❑ Liquidity - traders quote wider bid-ask spreads for illiquid bonds/swaps
- ❑ Duration - sensitivity of price to a change in interest rates - is based on the bond's/swap's coupon levels and maturity date (low duration means less risky)
- ❑ Convexity – exactly like bonds, measures how duration changes with a change in rates (high convexity is desirable)

Hence you can use swaps to hedge bond portfolios.



Swap Quotations from SwapPX

GovPX/GGB			SwapPX US Medium Term Swaps vs 3M LIBOR				8/6/96		Page 261
Term	Cpn	Mty	TrPrice	TrYld-SB	SwapSpd-SB	SwapRate-SB	CBA-TED		
2Y	6.250	07/98	100.214 /216	5.952 /948	19.50 21.00	6.143 /162	20.23		
3Y	6.375	05/99	100.174 /176	6.103 /100	22.80 23.00	6.327 /333	22.92		
4Y				6.202 /200	26.00 26.50	6.460 /468	25.66		
5Y	6.625	07/01	100.114 /120	6.302 /299	27.00 27.80	6.569 /580	26.31		
6Y				6.351 /348	30.00 31.00	6.648 /661	29.46		
7Y				6.400 /397	33.00 34.00	6.726 /740	32.47		
8Y				6.449 /446	33.50 34.50	6.781 /794	33.10		
9Y				6.498 /494	34.50 35.50	6.839 /853	34.16		
10Y	7.000	07/06	103.084 /094	6.547 /543	35.00 36.00	6.893 /907	34.73		
11Y				6.558 /554	38.00 40.00	6.923 /947			
12Y				6.569 /565	41.00 43.00	6.953 /977			
13Y				6.581 /577	44.00 45.00	6.983 /997			
14Y				6.592 /588	48.00 49.00	7.023 /037			
15Y				6.603 /599	51.00 52.00	7.053 /067			
20Y				6.659 /654	53.00 55.00	7.113 /127			
25Y				6.715 /710	54.00 55.00	7.108 /122			
30Y	6.000	2/26	90.065 /085	6.771 /766	35.50 37.50	7.121 /146			



Basis Swaps from SwapPX

GovPX/GGB		GovPX Index		Basis Swaps vs 3M LIBOR 8/6/96		Page 262	
		Prime vs LIBOR		Fix LIBOR		Fed Funds vs LIBOR	
Term	Pay Prime	Rec Prime		Term	Pay FF	Rec FF	
1Y	P- 271	P- 267	1M 5 7/16	1Y	FF+ 21 1/2	FF+ 23 1/2	
2Y	P- 268	P- 264	3M 5 1/2	2Y	FF+ 23	FF+ 25	
3Y	P- 267	P- 263	6M 5 11/16	3Y	FF+ 23 1/2	FF+ 25 1/2	
4Y	P- 265	P- 261	Mkt LIBOR	4Y	FF+ 24 1/2	FF+ 26 1/2	
5Y	P- 263	P- 259	1M 5 7/16	5Y	FF+ 25	FF+ 27	
7Y	P- 260	P- 255	3M 5 1/2	7Y	FF+ 26	FF+ 28	
10Y	P- 259	P- 254	6M 5 11/16	10Y	FF+ 26	FF+ 28	
		3M T-Bill vs LIBOR		Prime 8.25		CP vs LIBOR	
Term	Pay T-Bill	Rec T-Bill		Term	Pay CP	Rec CP	
1Y	B+ 37	B+ 40	Fed Funds	1Y	CP+ 4 3/4	CP+ 6 3/4	
2Y	B+ 39	B+ 42	5 1/16-1/8	2Y	CP+ 5	CP+ 6	
3Y	B+ 40 1/2	B+ 43 1/2		3Y	CP+ 5 1/4	CP+ 6 1/2	
4Y	B+ 43	B+ 47	3M T-Bill Yld	4Y	CP+ 5 1/2	CP+ 6 3/4	
5Y	B+ 44	B+ 48	5.171-166	5Y	CP+ 6	CP+ 7	
7Y	B+ 45	B+ 49		7Y	CP+ 6 1/2	CP+ 8	
10Y	B+ 46	B+ 50	30D CP 5.32	10Y	CP+ 7	CP+ 9	
Alert Line							



The Yield Curve, Swaps and FRAs

- Benchmark Treasury yields + default risk spread = corporate bond yields
- Corporate bond yield = swap rate (for a Libor borrower)
- FRA= implied forward rate from Libor curve
- Strip of FRAs = Swap

Interest Rate Futures

- ❑ Relationship to FRAs and swaps
- ❑ Pricing and quotations
- ❑ Marking to market
- ❑ Futures for hedging investments

Value of futures contract

Value of underlying asset

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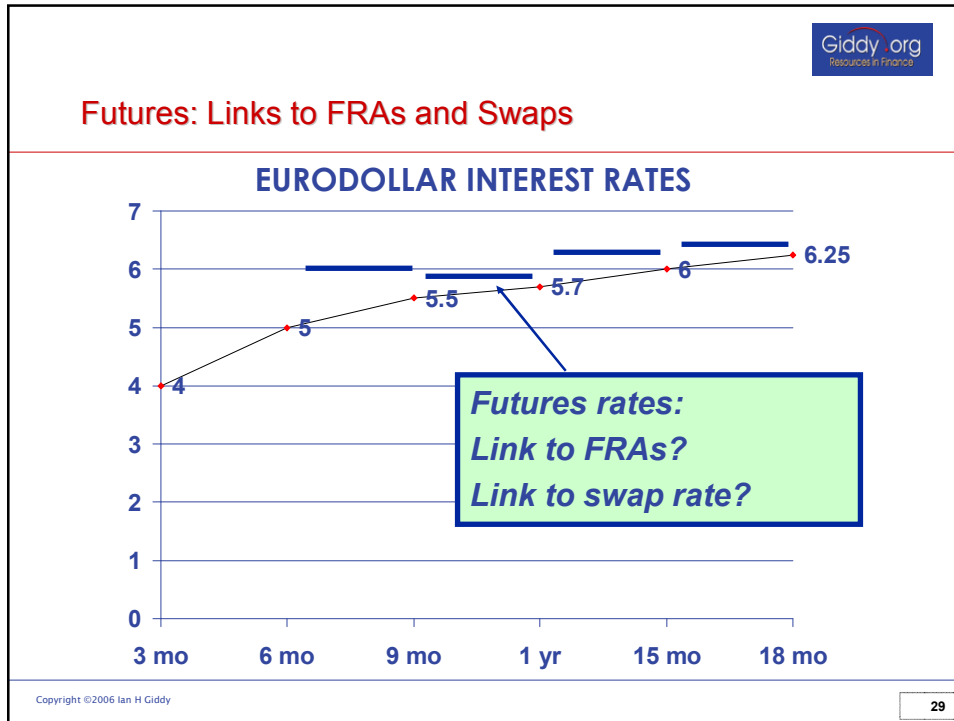
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Futures versus Forward Contracts

- ❑ **Forwards:** OTC agreement to buy/sell assets (or settle in cash) at certain price in the future
- ❑ **Futures:** Standardized, exchange-traded contracts for notional (or actual) future delivery, minimizing default risk via daily marking-to-market
- ❑ Futures can be regarded as “daily recontracted forwards”

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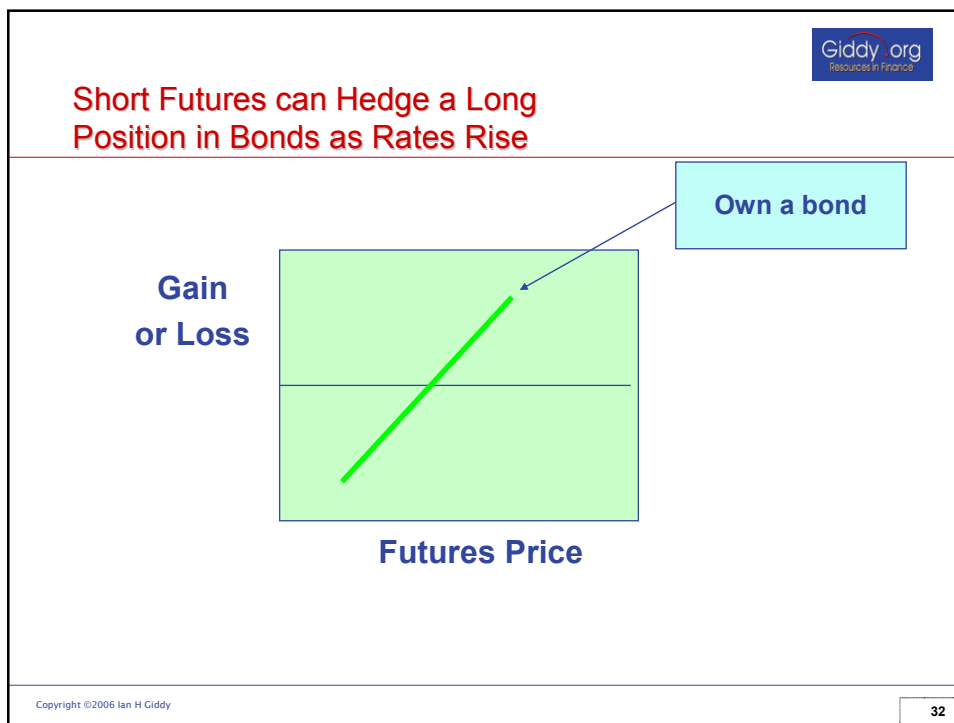
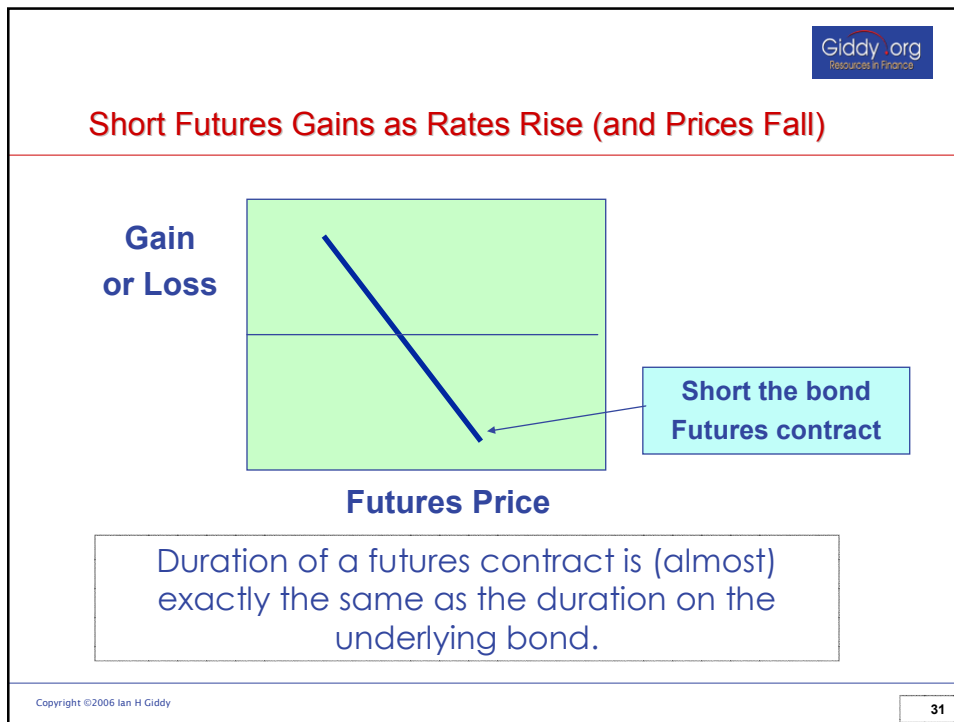
Financial Futures Available for Asset-Liability Management

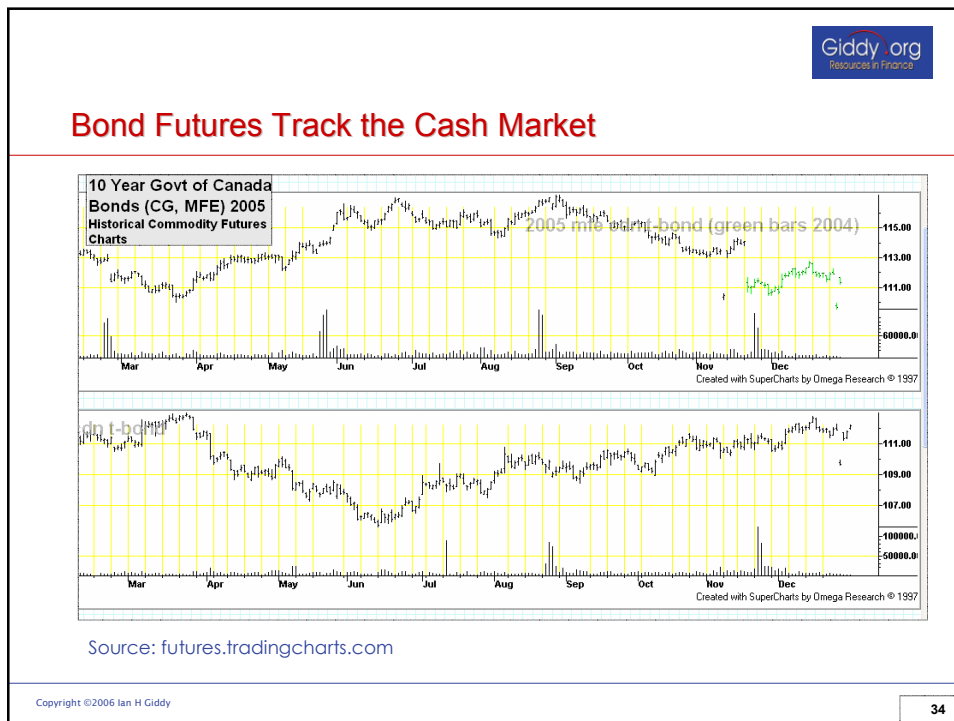
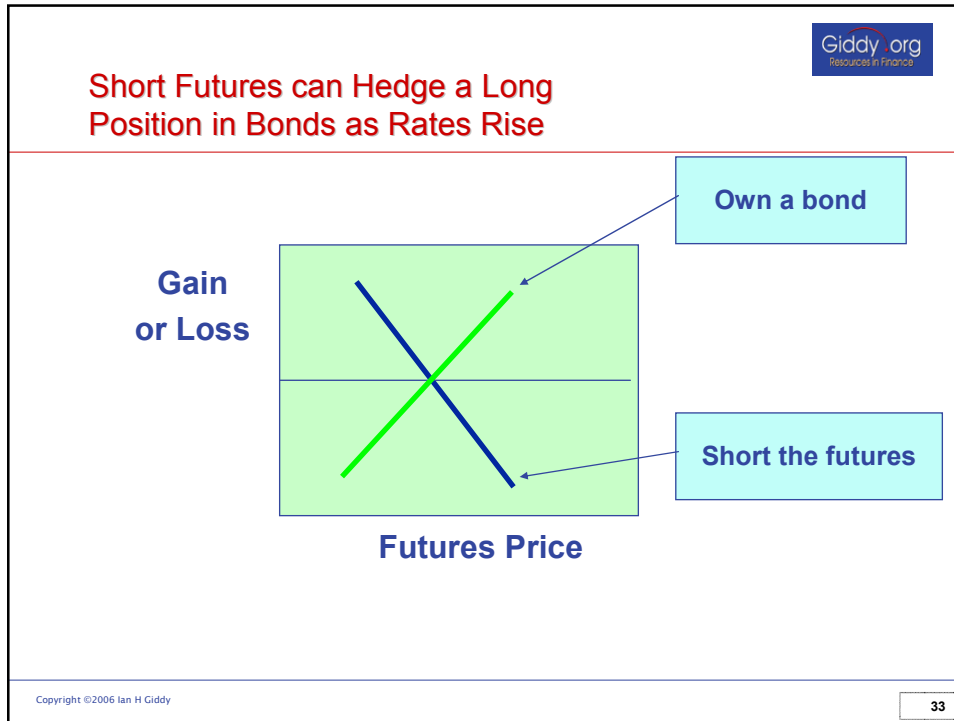
FINANCIAL & INDEX FUTURES							
10 Year Interest Swap (NI, CBOT)	Daily	Weekly	Monthly	---	Quote	---	---
10 Year Gov't of Canada Bonds (CG, MFE)	Daily	Weekly	Monthly	Historical	Quote	News	---
Canadian Bankers Acceptance - 3 Month (BAX, MFE)	Daily	Weekly	Monthly	Historical	Quote	---	---
CRB Index Futures (CR, NYBOT)	Daily	Weekly	Monthly	Historical	Quote	News	---
Dow Jones Industrial Average Futures (DJ, CBOT)	Daily	Weekly	Monthly	Historical	Quote	News	COT
Mini Dow Jones (YM, CBOT)	Daily	Weekly	Monthly	Historical	Quote	News	COT
Euro Dollar (ED, CME)	Daily	Weekly	Monthly	Historical	Quote	News	COT
Euro Yen (EY, CME)	Daily	Weekly	Monthly	Historical	Quote	News	---
Federal Funds 30 Day (FF, CBOT)	Daily	Weekly	Monthly	Historical	Quote	News	---
Gilts Long (GS, LIFFE)	Daily	Weekly	Monthly	Historical	---	News	---
Goldman Sachs Index (GI, CME)	Daily	Weekly	Monthly	Historical	Quote	News	---
LIBOR - 1 Month (EM, CME)	Daily	Weekly	Monthly	Historical	Quote	News	---
London FT-SE 100 (LZ, LIFFE)	Daily	Weekly	Monthly	Historical	---	News	---
Municipal Bonds (MB, CBOT)	Daily	Weekly	Monthly	Historical	Quote	News	---
NASDAQ 100 Index Futures (ND, CME)	Daily	Weekly	Monthly	Historical	Quote	News	COT
NASDAQ 100 E-mini Futures (NQ, CME)	Daily	Weekly	Monthly	Historical	Quote	News	COT
Nikkei Index (NK, CME)	Daily	Weekly	Monthly	Historical	Quote	News	COT

And more...

Source: futures.tradingcharts.com

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Or You can Use Swap Futures

INTEREST RATE SWAP FUTURES

Nov 22		Open	Sett price	Change	High	Low	Est. vol	Open int.
\$ 10 year*	Dec	107-23	108-01	+0-10	108-01	107-23	2,021	31,611
Euro 10 year†	Dec	119.69	119.82	-0.13	119.89	119.66	299	30,663
Euro 5 year†	Dec	112.29	112.39	-0.05	112.44	112.29	199	18,714
Euro 2 year†	Dec	105.740	105.765	-0.025	105.760	105.735	289	17,358
Yen 5 year‡	Dec	-	110.29	+0.05	-	-	0	1,630

Selection based on trading vols in 2004.

Sources: † Euronext.liffe SWAPNOTE®.; * CBOT; ‡ Tiffe.

Source: ft.com

Basis and Basis Risk

- Basis - the difference between the futures price and the spot price
 - over time the basis will likely change and will eventually converge
- Basis Risk - the variability in the basis that will affect profits and/or hedging performance

The Hedge Ratio Approach

- ❑ Takes into account the correlation between changes in the instrument hedged and changes in the value of particular futures contracts
- ❑ For example, for interest-rate futures, use *duration* to determine the ratio of futures contracts that best hedges one unit of the underlying instrument.
 - ❑ Eg hedge \$1m bond whose value goes down 2 percent for each 1 percent rise in short-term interest rates. The near-term Eurodollar futures contract's value falls only 1/4 percent for a 1 percent rise in the Eurodollar rate. *So you would sell eight E\$ futures contracts.*
- ❑ Drawback: Basis risk

Option Risk

- ❑ Mortgage portfolios have inherent option risk -- for all mortgages that are prepayable
- ❑ Holding a prepayable MBS means you have sold (shorted) a call option -- so best way to hedge is by buying call options on bonds
- ❑ But which, and how many? A clue lies in the option's **delta** – a measure of price sensitivity similar to duration

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Managing Options in MBS: Delta Hedging

We bought a callable bond, which means...

We've written a call option

Delta

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So We Must Buy a Call Option?

FEDERAL NATL MTG ASSN MTN As of 22-Nov-2005

OVERVIEW		
Price:	95.81	
Coupon (%):	4.825	
Maturity Date:	14-May-2015	
Yield to Maturity (%):	5.210	
Current Yield (%):	4.927	
Debt Rating:	AAA	
Coupon Payment Frequency:	Semi-Annual	
First Coupon Date:	14-Nov-2003	
Type:	Corporate	
Industry:	Government Agency	

CALL SCHEDULE		
Date	Price	Yield to Call (%)
14-May-2004	100.000	0.000
2-Dec-2005	100.000	240.820

■ **US TREASURY 10 YEAR OPTIONS \$100,000**

Strike price	CALLS			PUTS			
	Jan 13	Feb	Mar	Jun	Feb	Mar	Jun
108	1-50	1-57	2-17	0-01	0-08	0-37	
109	0-55	1-06	1-39	0-06	0-21	0-58	
110	0-14	0-34	1-04	0-30	0-48	1-23	
111	0-02	0-12	0-42	1-17	1-27	1-61	

Prev day's data: volume: 221,687; calls: 84,025 puts: 137,662; open interest, 2,043,725. Source: Reuters/CBOT.

Source: ff.com/marketsdata

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Other Government Bond Options

■ EURO BUND OPTIONS €100,000(Eurex)

Strike price	CALLS			PUTS		
Jan 13	Feb	Mar	Jun	Feb	Mar	Jun
121.5	0.65	-	1.14	0.06	0.30	-
122	0.44	0.81	0.00	0.17	0.47	-
122.5	0.22	0.53	0.73	0.45	0.76	-
123	0.07	0.33	0.52	-	1.05	-

Calls: 30,414 Puts: 28,179 . Volume: 58,593 . Previous day's Open Interest: 2,255,202. Source: Reuters/Eurex.

■ 10 YEAR JAPANESE GOVT BOND OPTIONS (TSE)

Strike price	CALLS			PUTS		
Jan 13	Feb	Mar	Jun	Feb	Mar	Jun
1370	1.00	0.98	-	0.12	0.38	-
1375	0.66	0.96	-	0.25	0.60	-
1380	0.35	0.65	-	0.42	0.74	-
1385	0.15	0.39	-	0.70	0.00	-

Calls: Puts: . Volume: . Previous day's Open Interest: . Source: Reuters/TSE.

ft.com



Closing Prices for Financial Markets - 10 January 2006

For more comprehensive market-to-market information: [EUREX BOND](#)

[print page](#)

Future Contract	Closing Bid	Closing Offer	NTM	Spot Price	Volatility
HR060 AB0Q	27.6	28.4	28	27.7	30
JUN06 AB0Q	27.23	28.23	27.73	27.7	30
HR060 ABFQ	95.23	95.03	95.03	94.61	30
JUN06 ABFQ	96.71	97.71	97.21	94.61	30
HR060 AC0Q	5.06	5.66	5.26	5.2	30
JUN06 AC0Q	5.04	5.64	5.34	5.2	30
HR060 AC2Q	25.74	26.4	26.1	22.05	30
JUN06 AC2Q	26.19	26.69	26	22.05	30
HR060 AD0Q	20.88	20.96	20.96	20.8	24
JUN06 AD0Q	20.36	21.36	20.86	20.3	25
HR060 AF0Q	15.03	15.81	15.43	15.25	28
JUN06 AF0Q	15.17	16.17	15.67	15.25	28
HR060 AF2Q	52.89	53.89	53.39	53	30
JUN06 AF2Q	53.17	53.97	53.57	53	30
HR060 AF3Q	21.54	22.54	22.04	22.2	28
JUN06 AF3Q	21.01	22.01	21.51	21.5	28

www.safex.co.za

Options Positions: Delta Hedging and the Gamma

- Delta is not constant: it's low for out of the money options, high for in the money options.
- Change in delta makes it tough to know exactly how many futures to use.
- Change in delta is the *gamma*. Positive gamma is nice. Writing options produces negative gamma, which is nasty.

Managing Options' Sensitivity

A MBS investor has a portfolio of options with different deltas, gammas, etc. The goal is to discover the sensitivities of the portfolio to changes in rates, time, volatility, etc, and to neutralize them.

	Greek	Measures
Δ	Delta	Sensitivity of portfolio value to change in price of the underlying asset
Γ	Gamma	Sensitivity of delta to change in price of underlying asset
θ	Theta	Sensitivity of portfolio value to change in time
Λ	Lambda (Vega)	Sensitivity of portfolio value to change in volatility
ρ	Rho	Sensitivity of portfolio to change in interest rate

Pulling It All Together

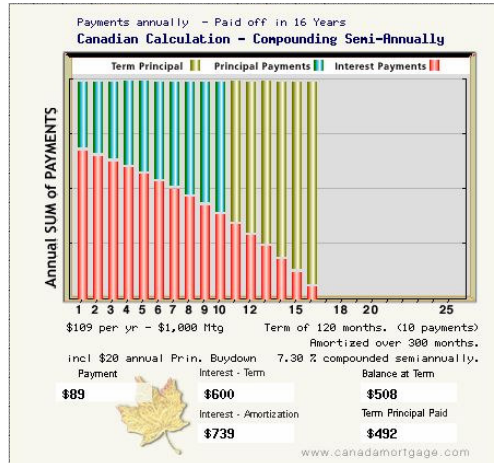
- Using the measures of duration and convexity, *measure* the asset-liability mismatch
- Using the tools of bonds, swaps, futures and options, *reduce* the mismatch.

Assets and Long Positions					Liabilities and Short Positions				
Item	Dollar value	Weight	Duration	Convexity	Item	Dollar value	Weight	Duration	Convexity
1	100	20%	1	20	1	250	50%	1	20
2	100	20%	2	30	2	250	50%	7	50
3	100	20%	3	40	3	0	0%		
4	100	20%	4	50	4	0	0%		
5	100	20%	5	60	5	0	0%		
Total	500	100%	3	40	Total	500	100%	4	35
Duration Gap		-1							
Convexity Gap		5							

Source: portfolio_duration.xls

Case Study: Home to Canadians

- CMHC has purchased a portfolio of mortgage loans
- Recommend a hedging program that minimizes the CMHC's interest rate risk. How could you reduce the duration mismatch by using
 - Bonds?
 - Futures?
 - Swaps?



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