



# MANAGING INTEREST RATE RISK

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# OVERVIEW

- ❖ Scope
- ❖ Risk management by hedging
- ❖ Valuation
- ❖ Careers

## ESSENTIALS OF RISK MANAGEMENT:

1. DON'T DO ANYTHING WRONG TODAY.
2. DON'T DO ANYTHING WRONG TOMORROW.
3. REPEAT.



GLASBERGEN

# FIXED INCOME INVESTORS

- ❖ Fixed income investments experience price fluctuations due to interest rate volatility
- ❖ Price is inversely proportional to interest rates
- ❖ Sensitivity of FI assets to interest rates is proportional to asset's maturity



# MORTGAGE LENDERS & SERVICERS

- ❖ Lenders provide a locked in mortgage fixed rate
- ❖ Lenders are exposed to the risk of rising rates before loans are closed
- ❖ Servicers are exposed to the risk of losing borrowers due to prepayment



# SMALL & LARGE BUSINESSES

- ❖ Lot of companies use debt for financing operations and expansion
- ❖ Companies often get floating rate loans from banks and investors
- ❖ Companies with floating rates are exposed to interest rate hikes





# THE FED CHAIR WHO KEPT YELLEN' WOLF





# INTEREST RATE SWAPS

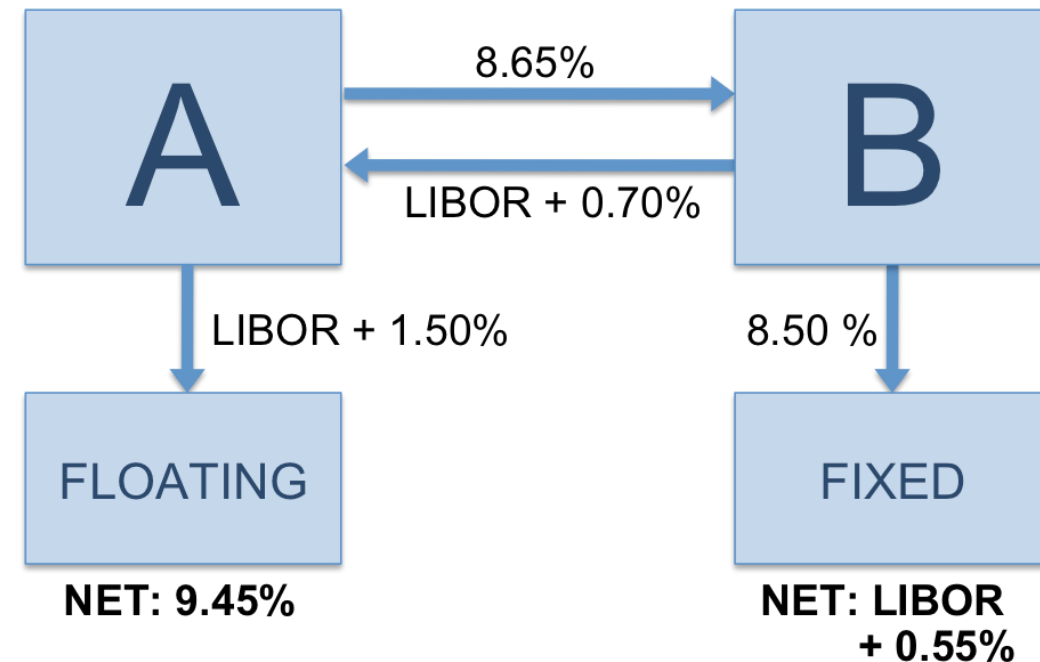
## ❖ Vanilla Structure

- ❖ A pays fixed to B and receives floating rate
- ❖ B pays floating rate to A and receives fixed rate

## ❖ Types

- ❖ Fixed for floating, same or different currencies
- ❖ Floating for Floating
- ❖ Fixed for Fixed
- ❖ Amortizing notional swap

## ❖ Cancellable Feature

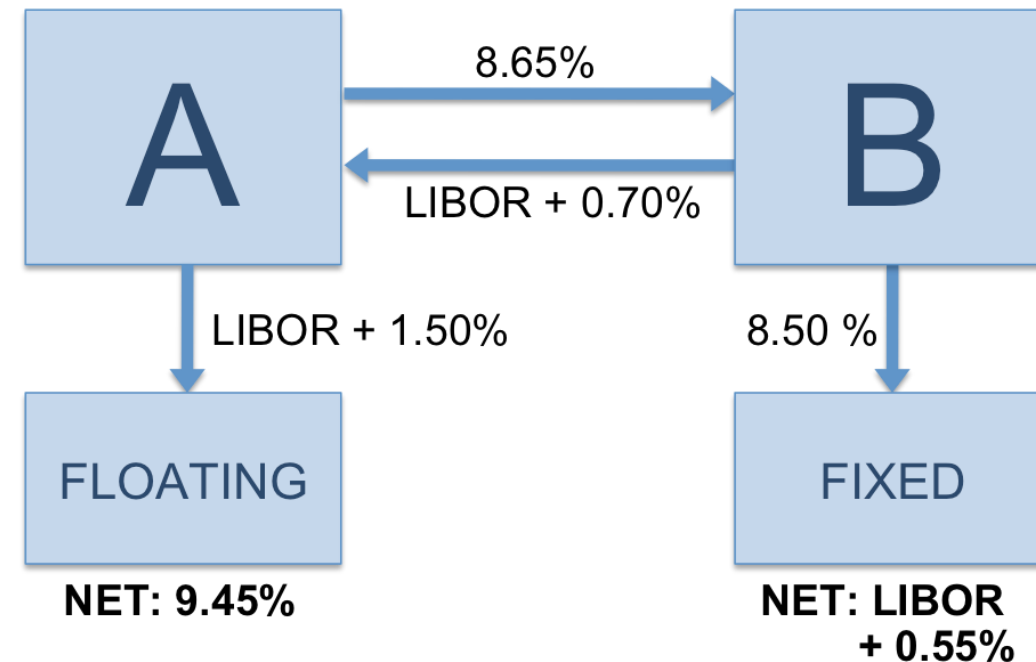


Credit: Suicup, Wikipedia



# INTEREST RATE SWAP

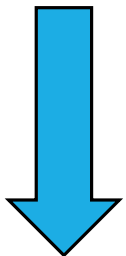
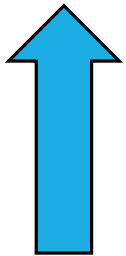
- ❖ Swap rate is the rate that the fixed payer pays (8.65%)
- ❖ A nets:  $(L + 1.5\%) + 8.65 - (L + 0.70\%) = 9.45\%$
- ❖ B nets:  $8.5\% - 8.65\% + (L + 0.7\%) = L + 0.55\%$
- ❖ Value of the swap is net present value of the net cashflows



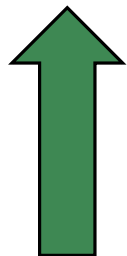
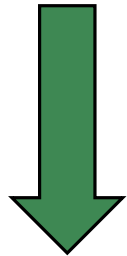
Credit: Suicup, Wikipedia

# INTEREST RATE SWAP DYNAMICS

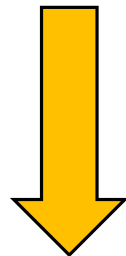
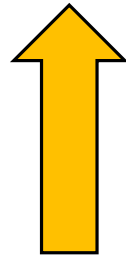
Interest Rate



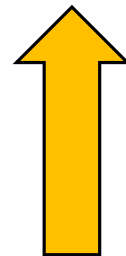
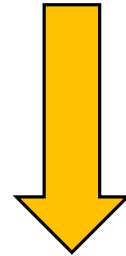
Fixed Income Asset



Fixed Payer



Fixed Receiver



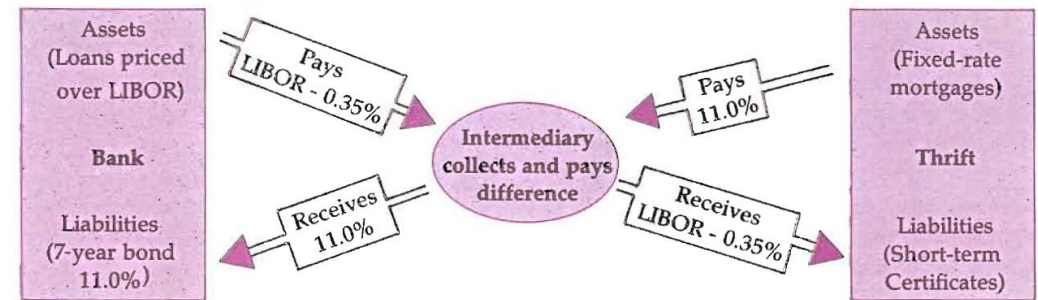
# RISKS ASSOCIATED WITH INTEREST RATE SWAPS

## ❖ Interest Rate Risk

- ❖ The payer loses when rates rise
- ❖ The receiver loses when the rates fall

## ❖ Credit Risk

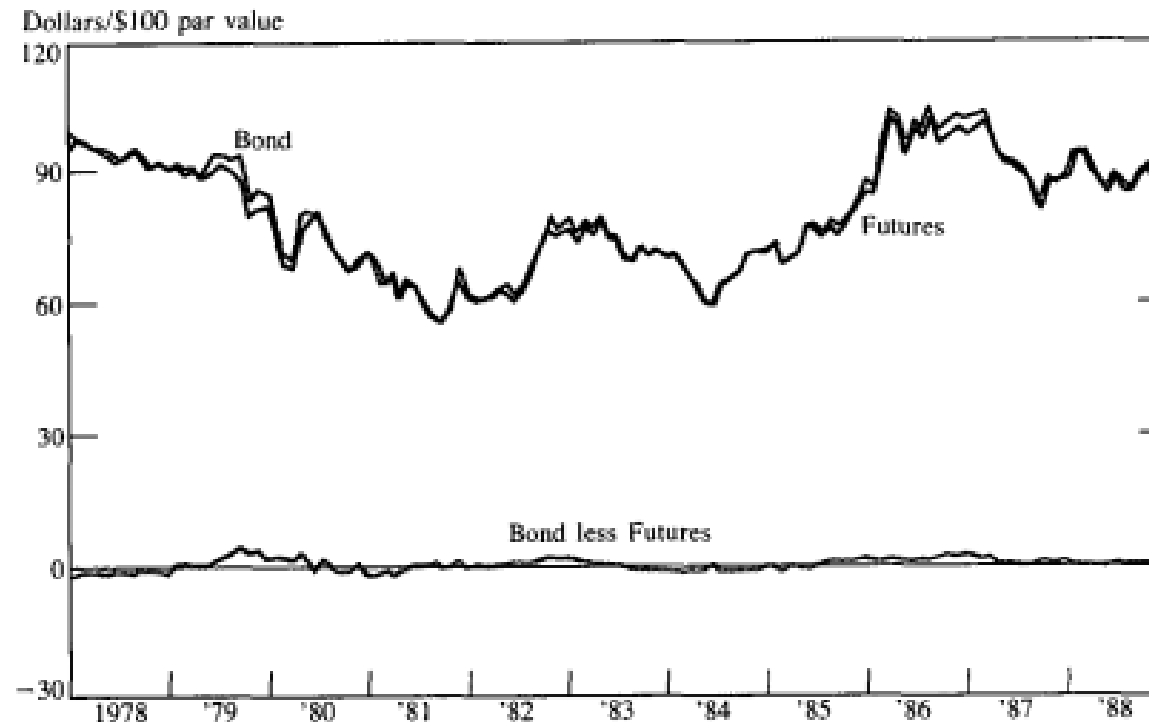
- ❖ Counterparty could default
- ❖ This could expose the company to IR Risk



# INTEREST RATE FUTURES

- ❖ Agreement between two parties to buy or sell a fixed income asset at a given time in the future.
- ❖ The underlying could be an asset such as treasury bond or treasury bill
- ❖ Futures contract can be closed out before delivery
- ❖ Contracts can be valued by finding the cheapest to deliver

# TREASURY BOND HEDGED



Treasury bond futures and treasury bond prices



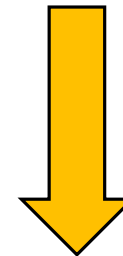
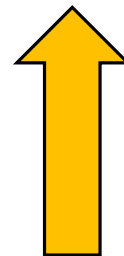
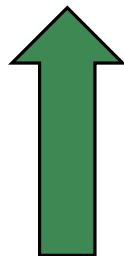
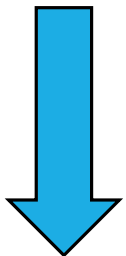
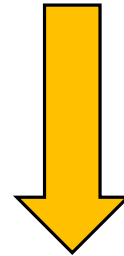
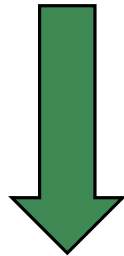
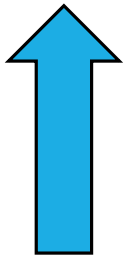
# INTEREST RATE FUTURES DYNAMICS

Interest Rate

Fixed Income Asset

Long Treasury Futures

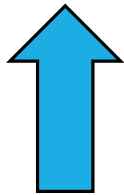
Short Treasury Futures



# TREASURY FUTURES USE CASE - MORTGAGE BANKER

- ❖ Mortgage banker commits to 4% interest rate on a \$100,000 mortgage in 2 months
- ❖ If rates remain the same, then he can sell for \$100,000
- ❖ If rates rise, then the value of the mortgage drops, say \$98,000

Interest Rate



Mortgage Asset



Short Treasury Futures



# TREASURY FUTURES USE CASE - SECURITY DEALER

- ❖ Security dealer agrees to deliver \$10M face value of bonds in two months
- ❖ Agreed price is \$90 for a par of \$100, current price is \$89.50
- ❖ Rates drop, price rise, dealer has to purchase at a high cost, profits can shrink

Interest Rate



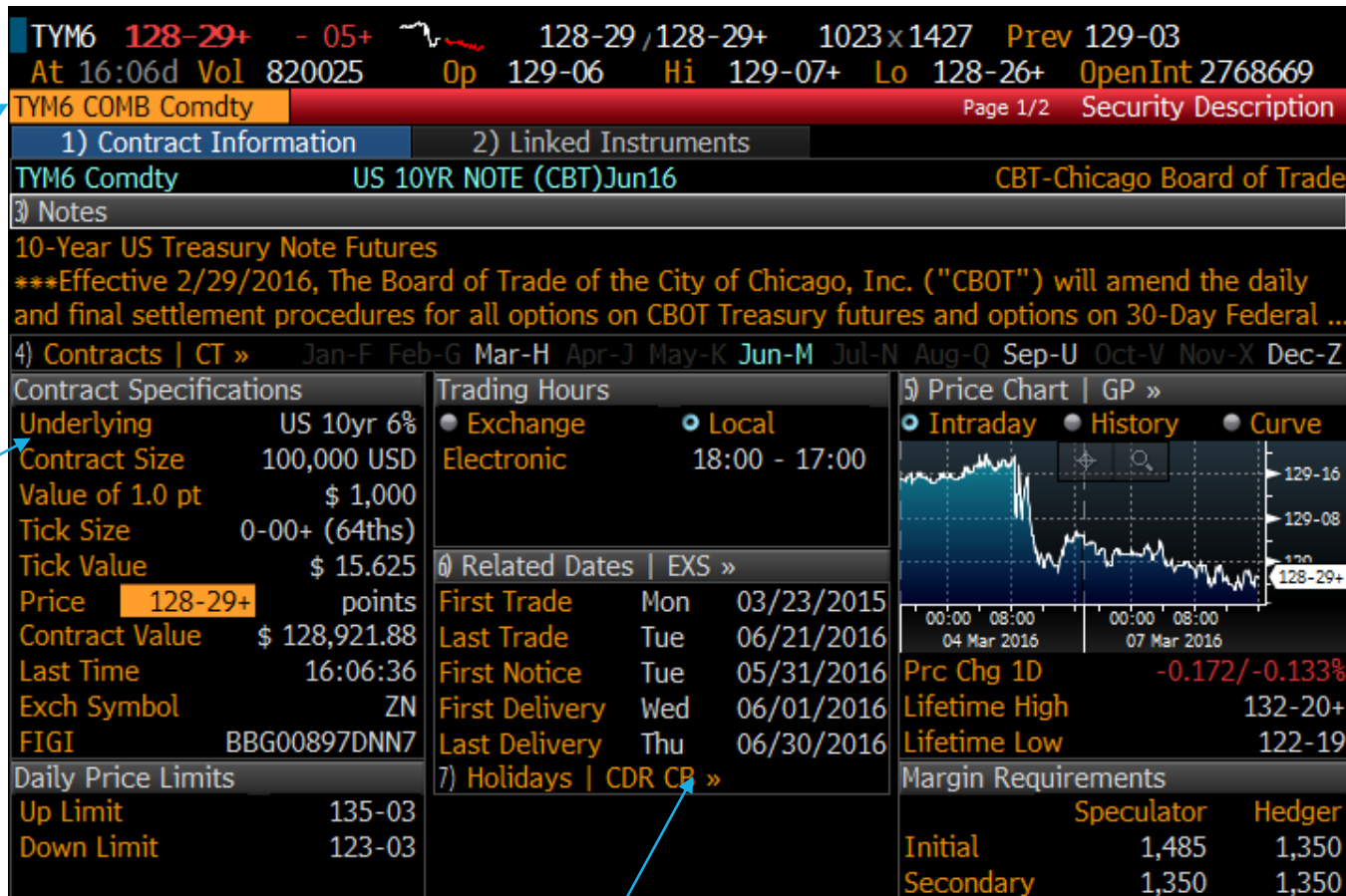
Dealer Profit



Long Treasury Futures



# TREASURY FUTURES VALUATION



Futures price

10 Year Note  
Futures for  
June 2016  
deliverable

Underlying  
Information

Delivery Information

# DELIVERABLE BASKET

Security	CF	Maturity	Coupon	Price
912828P7 Govt	0.7607	2/28/2023	1.5000%	98.65625
912828P4 Govt	0.6867	2/15/2026	1.6250%	97.484375
912828P3 Govt	0.774	1/31/2023	1.7500%	100.296875
912828VB Govt	0.7669	5/15/2023	1.7500%	100.1875
912828UN Govt	0.7873	2/15/2023	2.0000%	101.984375
912828J2 Govt	0.7367	2/15/2025	2.0000%	100.921875
912828K7 Govt	0.7249	8/15/2025	2.0000%	100.75
<b>912828N3 Govt</b>	<b>0.7939</b>	<b>12/31/2022</b>	<b>2.1250%</b>	<b>102.8125</b>
912828XB Govt	0.7391	5/15/2025	2.1250%	101.890625
912828G3 Govt	0.7587	11/15/2024	2.2500%	103.046875
912828M5 Govt	0.7367	11/15/2025	2.2500%	102.890625
912828D5 Govt	0.7723	8/15/2024	2.3750%	104.140625
912828VS Govt	0.8023	8/15/2023	2.5000%	105.40625
912828WJ Govt	0.7855	5/15/2024	2.5000%	105.15625
912828WE Govt	0.8111	11/15/2023	2.7500%	107.140625
912828B6 Govt	0.806	2/15/2024	2.7500%	107.140625

Adjusted Futures Price = Futures Price x Conversion Factor =  $128.921 \times 0.7939 = 102.3503$

Basis = Cash Price - Adjusted Futures Price =  $102.8125 - 102.3503 = 0.46212$  per \$100



# FACE VALUE WEIGHTED HEDGING — TREASURY FUTURES

- ❖ The par of the security matches the par of the futures contract
- ❖ Extremely simple hedge
- ❖ Ignores differing risk characteristics of different coupons and maturities

Asset: \$10 million face value of the 1-3/4% 22 note

Hedge: Sell 100 futures contract

# CF WEIGHTED HEDGING — TREASURY FUTURES

- ❖ Use conversion factor to determine the hedge
- ❖ Treasury futures will tend to track or correlate with the CTD security
- ❖ Other coupons and maturity will not be well hedged

Asset: \$10 million face value of the 1-3/4% 22 note

Conversion Factor Asset: 0.7077

Hedge: Sell 71 futures contract with reference to the 0.7077 conversion factor to execute a hedge

# BPV WEIGHTED HEDGING — TREASURY FUTURES

$$HR = \frac{\Delta_{asset}}{\Delta_{futures}}$$
$$BPV \ HR = CF_{ctd} \times \left( \frac{BPV_{asset}}{BPV_{ctd}} \right)$$

- ❖ Hedge incorporates interest rate sensitivity of asset and CTD security
- ❖ Could potentially work for portfolio of securities as well

Asset: \$10 million face value of the 1-3/4% 22 note

CTD security: 3-3/8%-19 note

BPV Asset: \$8550 per \$10 million

BPV CTD security: \$7050 per \$10 million

Conversion Factor CTD: 0.8604

$HR = 0.8604 * 8550 / 7050 = 104.3$

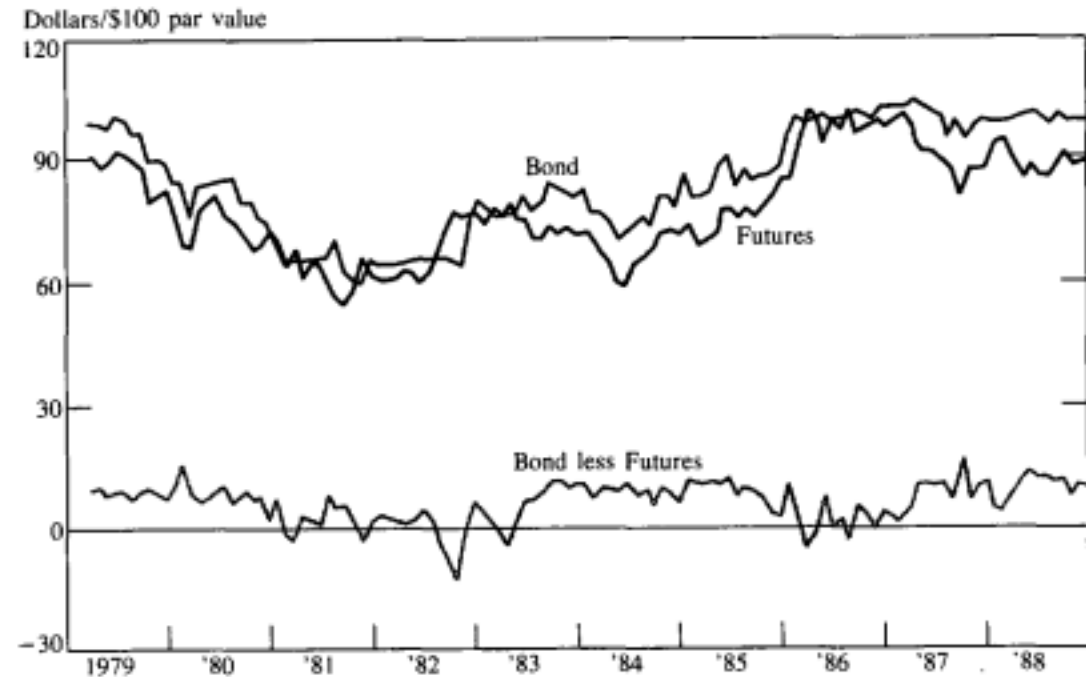
Hedge: Sell 104 futures contract

# FUTURES VS SWAPS

- ❖ Futures contracts are standardized contracts, with specific delivery dates (3 month intervals)
- ❖ Futures contracts are readily available, and cost less
- ❖ Futures are guaranteed by the exchange and by margins held
- ❖ Swaps are private contracts and the agreement can be customized to business operation needs
- ❖ Swaps need a counterparty and can cost more
- ❖ Swaps have the risk that a counter party may default

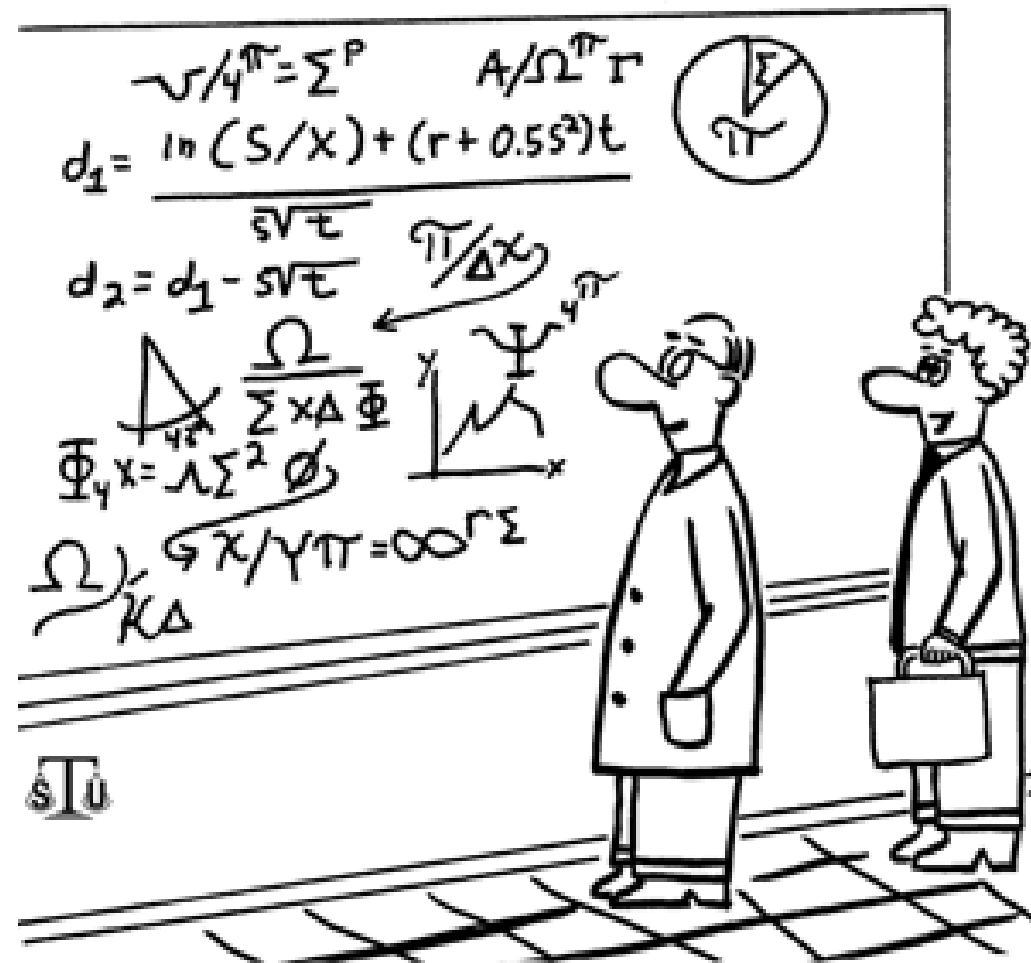
# VARIOUS RISK EXPOSURES

- ❖ Term Structure Risk
  - ❖ Risk due to change in IR term structure
  - ❖ Exposure to IR when assets and liabilities have different maturities
- ❖ Basis Risk
  - ❖ Calendar basis risk
  - ❖ IR risk due to change in spreads
  - ❖ Mortgage investments exposed to mortgage spread changes
- ❖ Options Risk
  - ❖ IR risk due to fixed income options – embedded vs external
  - ❖ Sensitive to changes in interest rates as well as volatilities
- ❖ Counterparty Credit Risk



Treasury bond futures and corporate bond prices





This derivative investment is so complicated that no investor will truly understand it. Thanks!

# BLACK MODEL

Black model is similar to Black-Scholes formula for stocks, except the futures price is the stochastic variable.

Call/Put price for a futures option is give as:

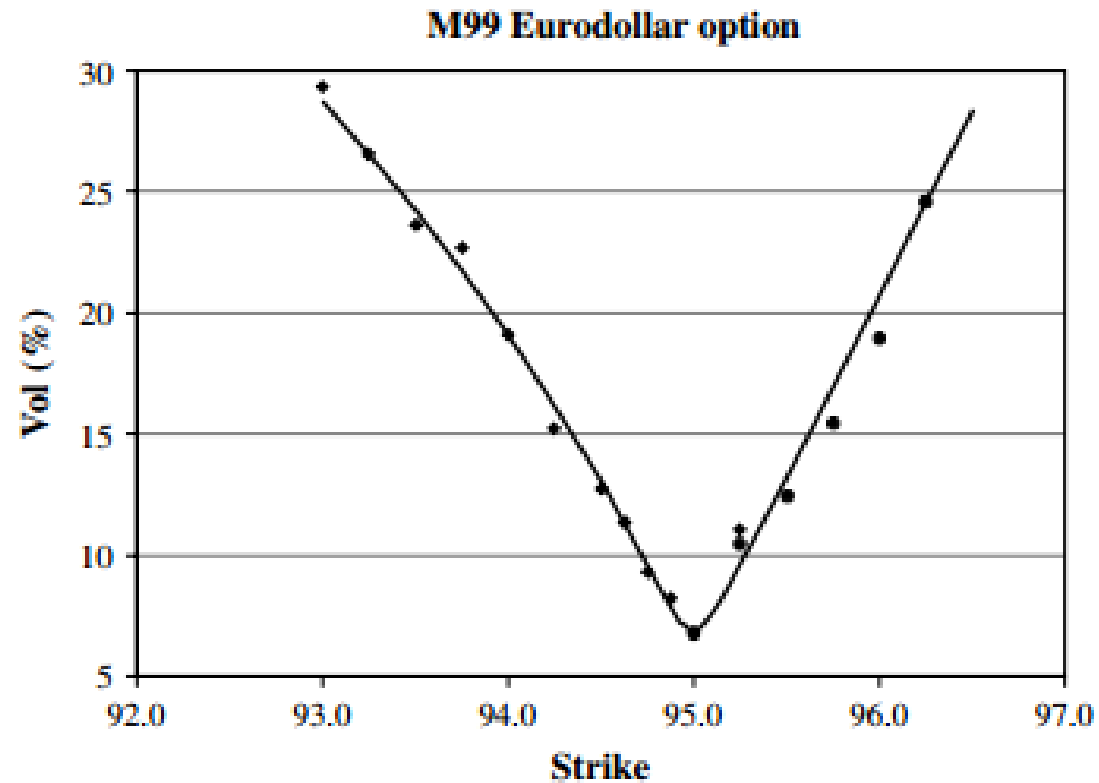
$$c = e^{-rT} [ F N(d_1) - K N(d_2) ]$$

$$p = e^{-rT} [ K N(-d_2) - F N(-d_1) ]$$

$$d_1 = (\ln \left( \frac{F}{K} \right) + \left( \frac{\sigma^2}{2} \right) T) / \sigma \sqrt{T}$$

$$d_2 = (\ln \left( \frac{F}{K} \right) - \left( \frac{\sigma^2}{2} \right) T) / \sigma \sqrt{T}$$

# VOLATILITY SMILE



Source and suggested reading: Pat Hagan, Deep Kumar, Andrew S Lesniewski & Diana E Woodward, *Managing Smile Risk*, Wilmott, pp. 84-108 (September 2002)

<http://www.math.ku.dk/~rolf/SABR.pdf>

# DIFFERENT VOLATILITY APPROACHES

## ❖ Black Model:

- ❖ Constant volatility approach
- ❖ Cannot reconcile with volatility smiles

## ❖ Dupire Model or Local Volatility Models:

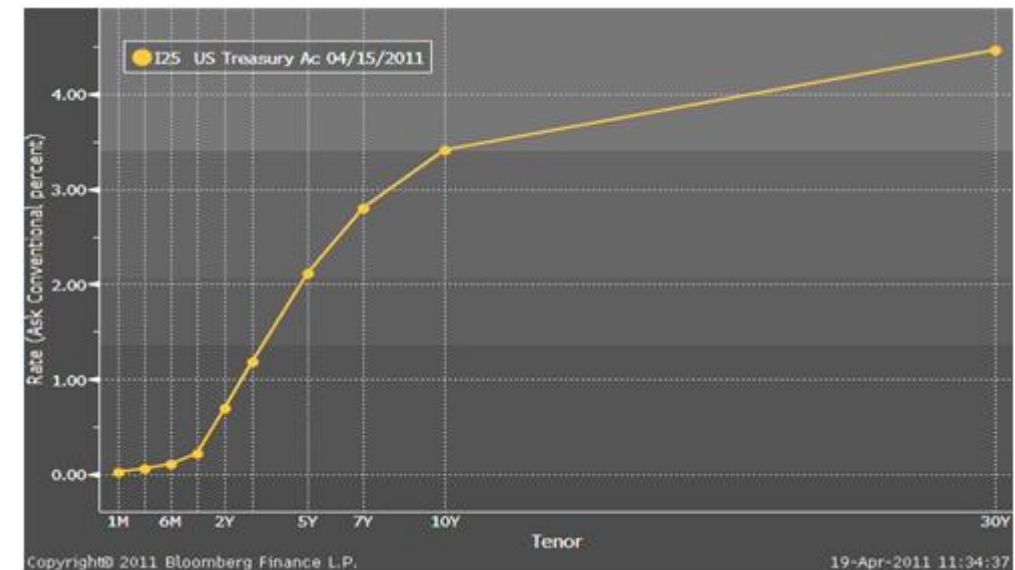
- ❖ Generalizes BS approach by treating vols as a function
- ❖ Cannot reconcile with dynamic behavior of smiles and skews

## ❖ SABR model:

- ❖ Stochastic volatility models

# YIELD CURVE

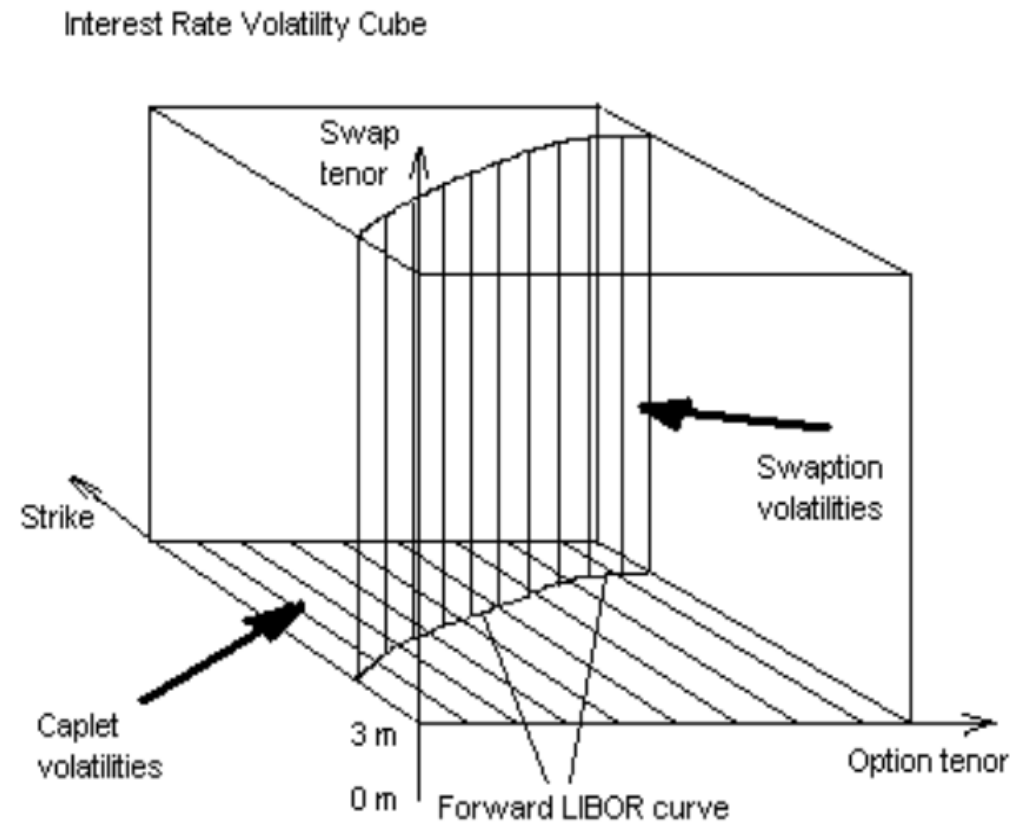
- ❖ Fundamental to pricing fixed income instruments
- ❖ Constructed from liquid instruments that are traded
- ❖ Bootstrapping is employed to construct the curve
- ❖ Yield curve could be positively sloped, inverted or flat



Source: [http://www.naic.org/capital\\_markets\\_archive/110422.htm](http://www.naic.org/capital_markets_archive/110422.htm)



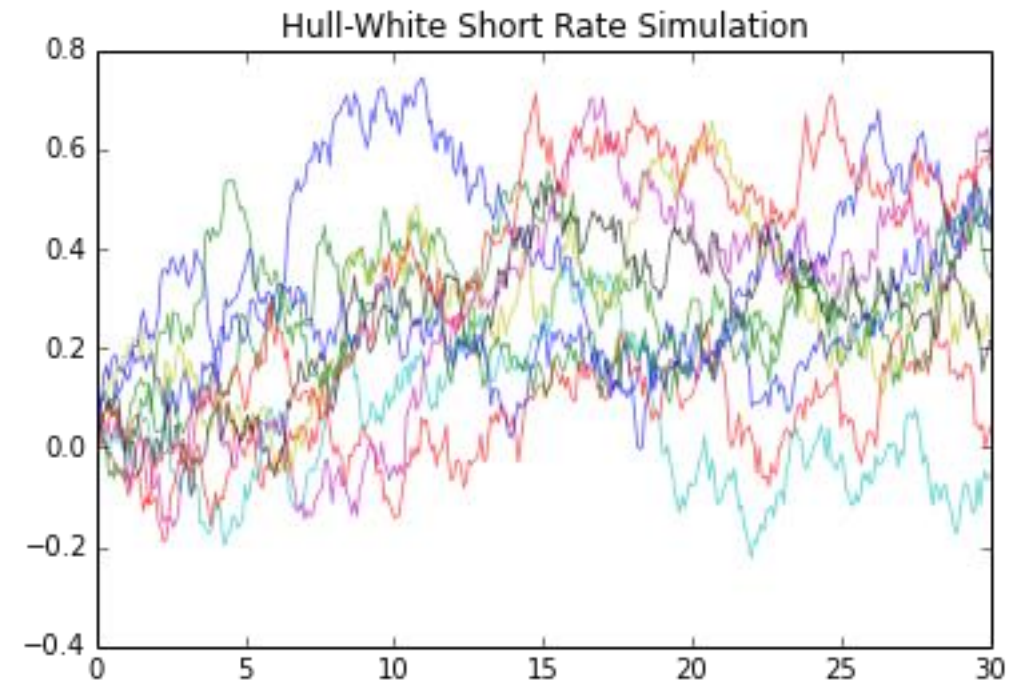
# VOLATILITY SURFACE



Source and suggested reading: Pat Hagan, Michael Konikov, *Interest rate volatility cube: construction and use*, <http://www.javaquant.net/papers/PandorasCube.pdf>

# INTEREST RATE MODELS

- ❖ Short rate models
  - ❖ Single factor
  - ❖ Multi factor
- ❖ Market models
- ❖ Models allowing negative interest rates
- ❖ Models easier to calibrate to the market
- ❖ Models calibrated to market swaptions or caps

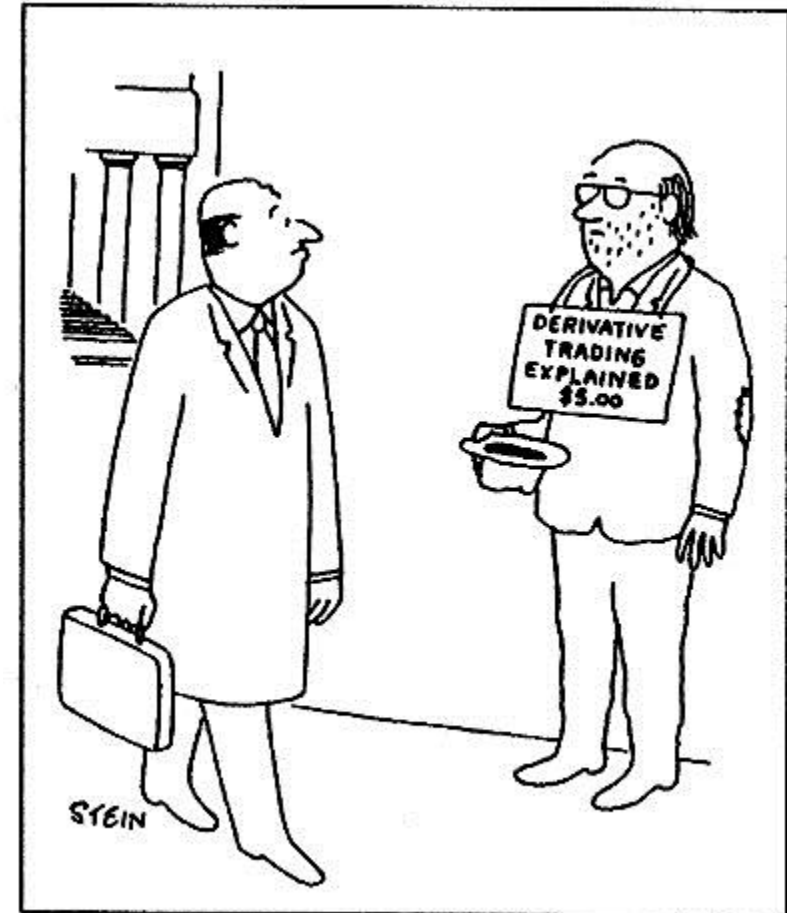


# VALUING (OTC) DEALS

- ❖ Payoffs can be nonstandard – percentage LIBOR
- ❖ Can have optionality embedded – cancellable swaps
- ❖ Nonstandard notionals – amortizing principal
- ❖ Need attention to different nuances in the terms

# CAREER

- ❖ Quantitative Developers / Researchers
- ❖ Financial Engineer
- ❖ Pre-trade support Analyst
- ❖ Post-trade support Analyst
- ❖ Analyst in insurance companies
- ❖ Analysts in Treasury
- ❖ Model Validation Analysts
- ❖ Risk Management in Banks
- ❖ Analysts in mortgage companies



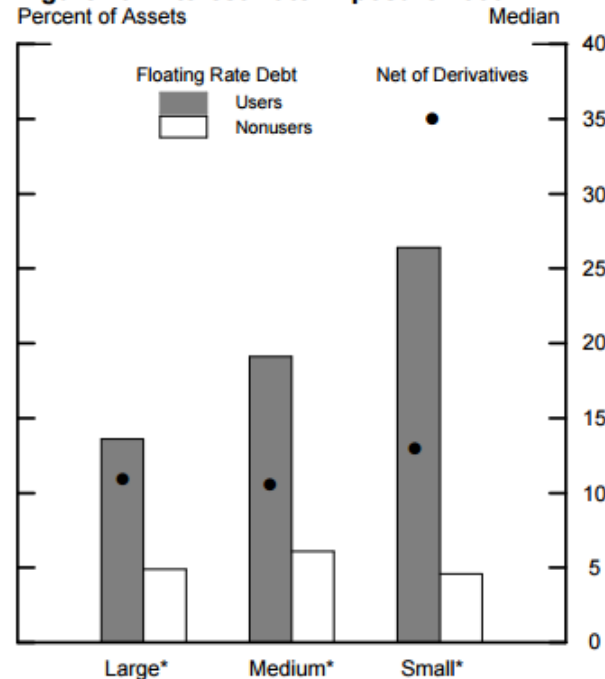
# QUESTIONS



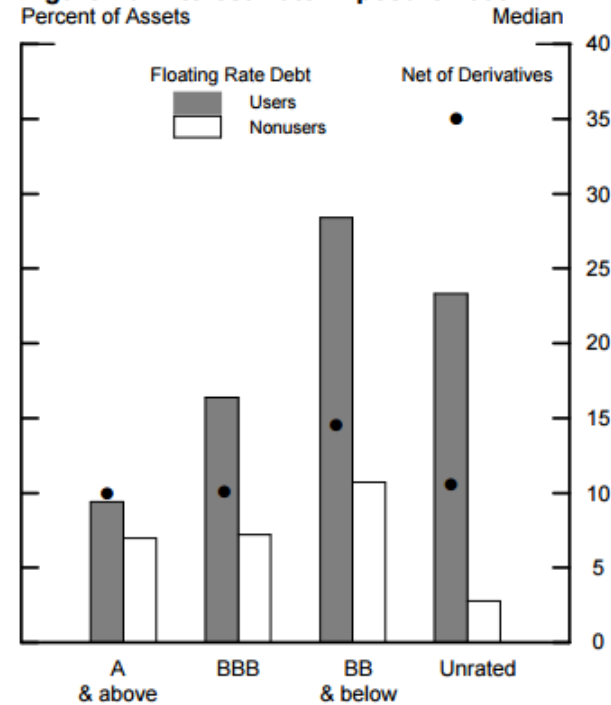
"Did you say 'buy-buy' or 'bye-bye'?"

# INTEREST RATE DERIVATIVE HEDGING

**Figure 2a: Interest Rate Exposure 2000**



**Figure 2b: Interest Rate Exposure 2000**

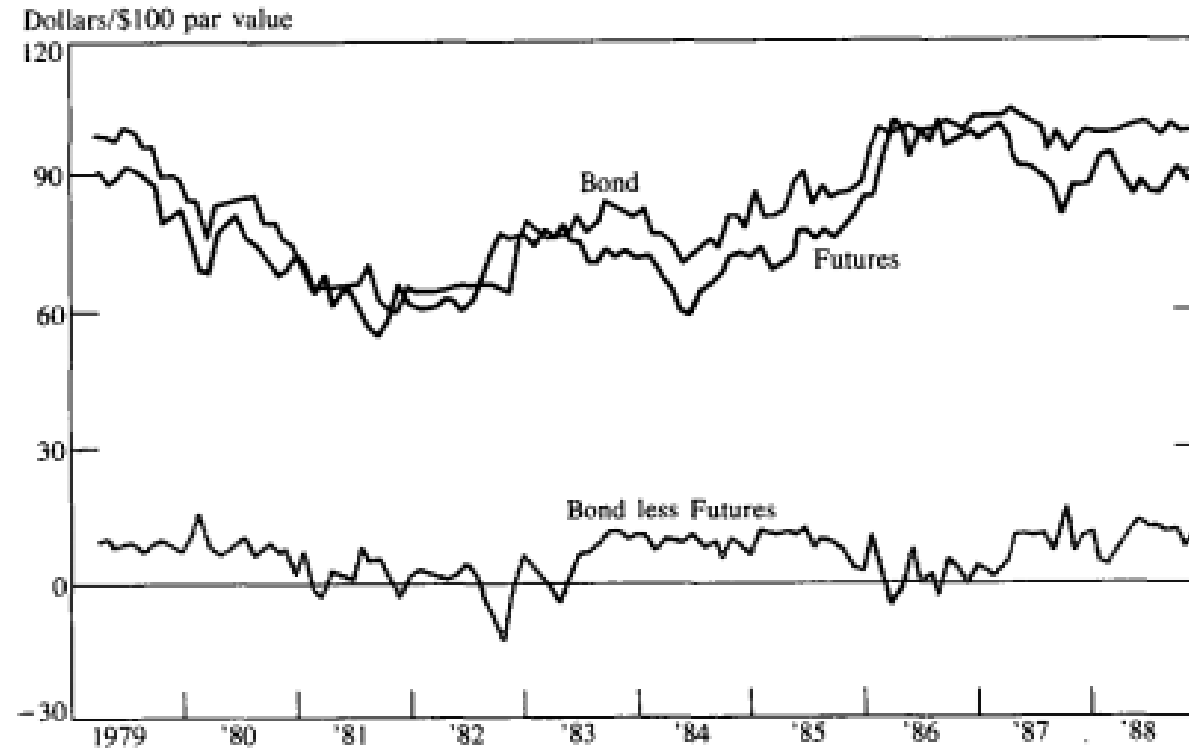


# INSURANCE COMPANIES

- ❖ Insurance companies sell products to
  - ❖ Protect from adverse events – Term Life Insurance
  - ❖ Mitigate exhaustion of financial resources over time - Annuities
  - ❖ Save for future in a tax advantaged way – Permanent Life Insurance
- ❖ Interest rate falls can expose assets to reinvestment risks
- ❖ Interest rate rise can lead policy holders to cashout on their policies



# CORPORATE BOND HEDGED



Treasury bond futures and corporate bond prices