MANAGING INTEREST RATE RISK

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Financial Engineer

OVERVIEW

- Scope
- Risk management by hedging
- Valuation
- Careers


THE FED CHAIR WHO KEPT YELLEN' WOLF
RATE HIKE! COMING!
RATE HIKE! ON THE WAY!
RATE HIKE! GREAT ECONOMY!
RATE HIKE! NEXT MONTH!
RATE HIKE! SOON!
RATE HIKE! NEXT TIME!
BEN GARRISON 9/17/15
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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

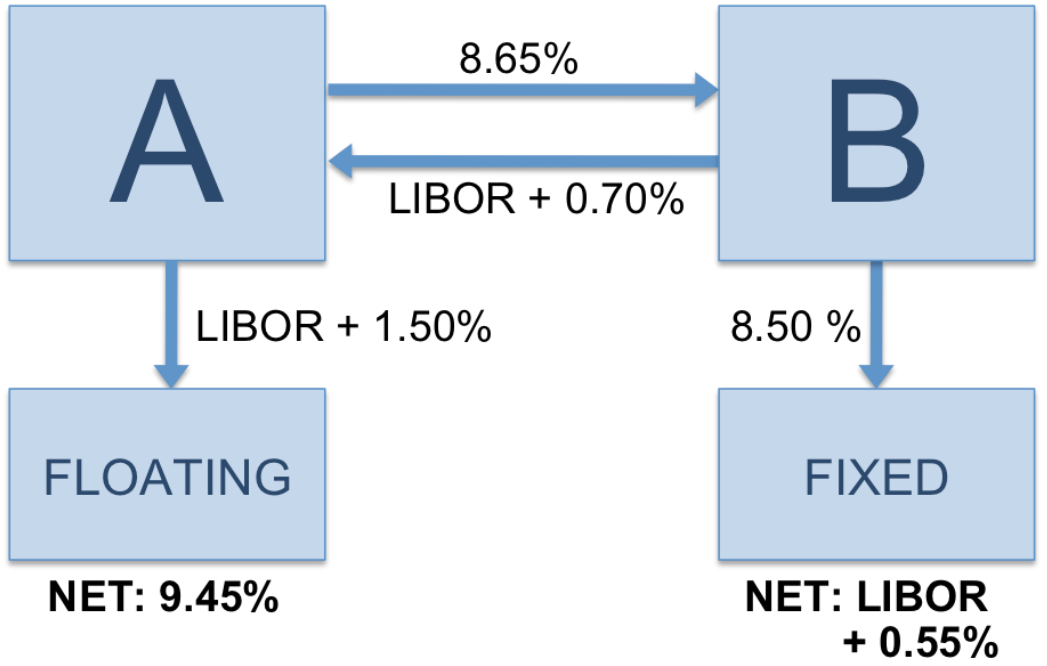
- Lenders provide a locked in mortgage fixed rate
- Lenders are exposed to the risk of rising rates before loans are closed
- Servicers are exposed to the risk of losing borrowers due to prepayment

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

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

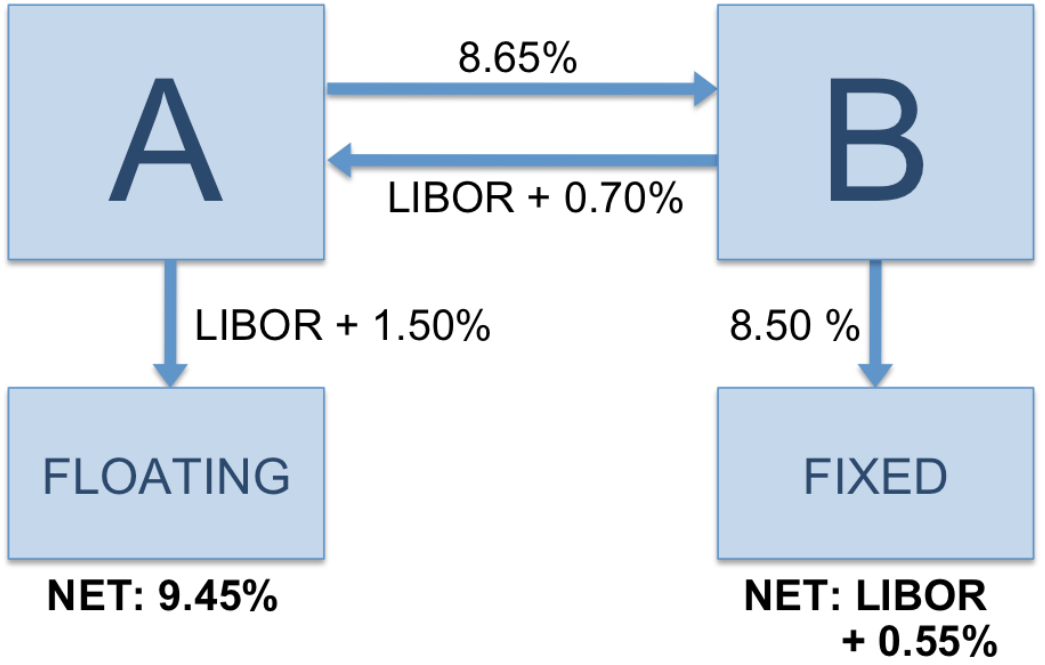


Credit: Suicup, Wikipedia

Suggested Reading: http://europe.pimco.com/EN/Education/Pages/InterestRateSwapsBasics1-08.aspx

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



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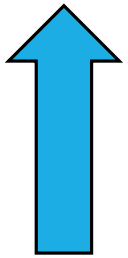
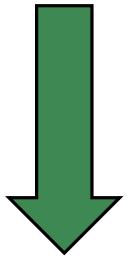
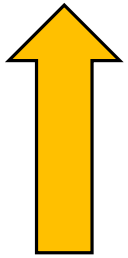
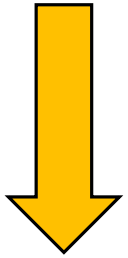
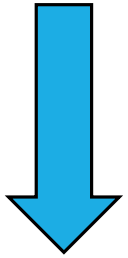
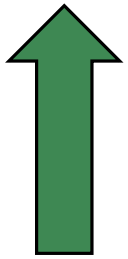
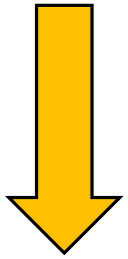
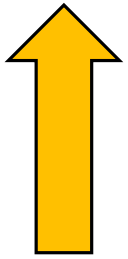
INTEREST RATE SWAP DYNAMICS

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

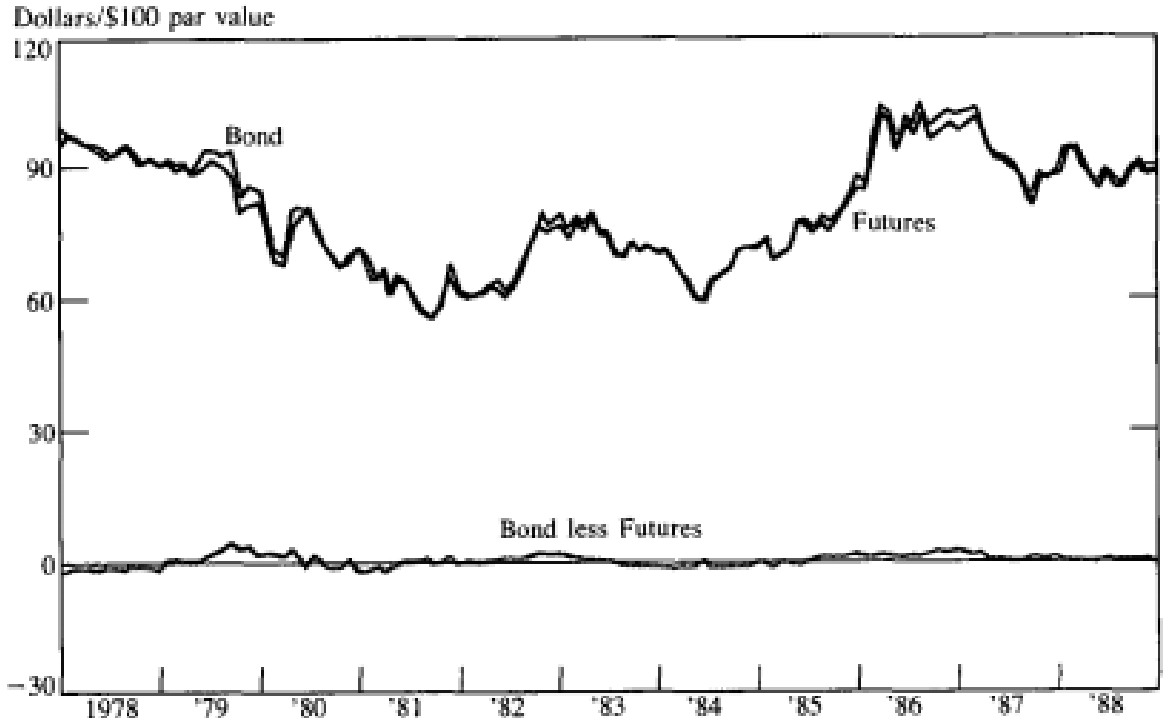
INTEREST RATE FUTURES

- 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

Suggested Reading: Charles S. Morris, *Managing Interest Rate Risk with Interest Rate Futures,* Economic Review, March 1989

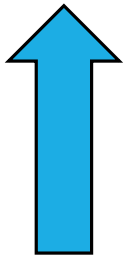
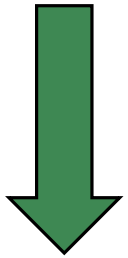
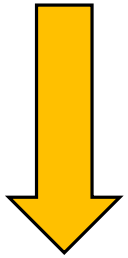
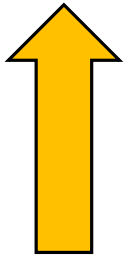
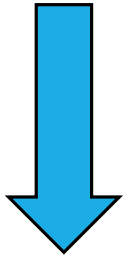
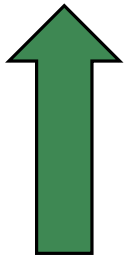
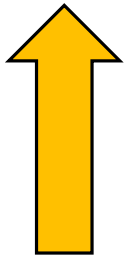
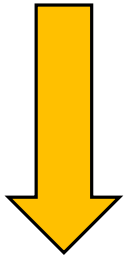
TREASURY BOND HEDGED



Treasury bond futures and treasury bond prices

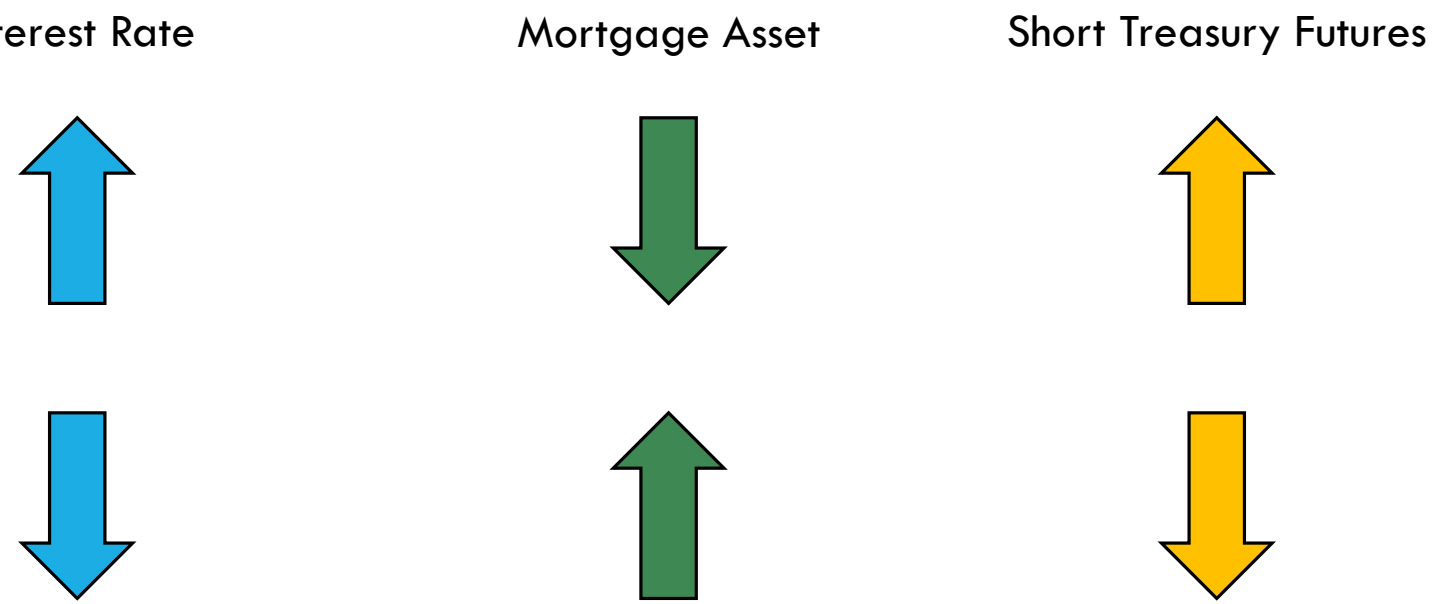
Source: Charles S. Morris, *Managing Interest Rate Risk with Interest Rate Futures,* Economic Review, March 1989

INTEREST RATE FUTURES DYNAMICS

Interest Rate	Fixed Income Asset	Long Treasury Futures	Short Treasury Futures
			
			

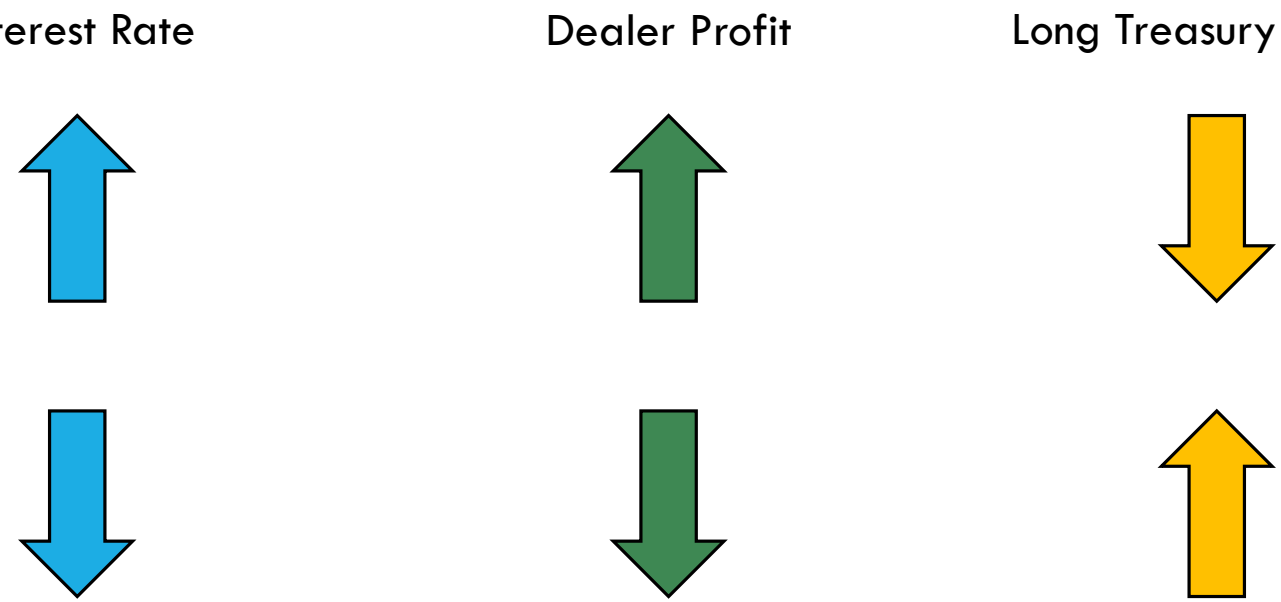
TREASURY FUTURES USE CASE - MORTGAGE BANKER

- 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



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



TREASURY FUTURES VALUATION

10 Year Note Futures for June 2016 deliverable

Underlying Information

Futures price

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
912828N3 Govt	**0.7939**	**12/31/2022**	**2.1250%**	**102.8125**
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*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

$$HR = \frac{\Delta_{asset}}{\Delta_{futures}}$$

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

- 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

Source and recommended reading: https://www.cmegroup.com/education/files/understanding-treasury-futures.pdf

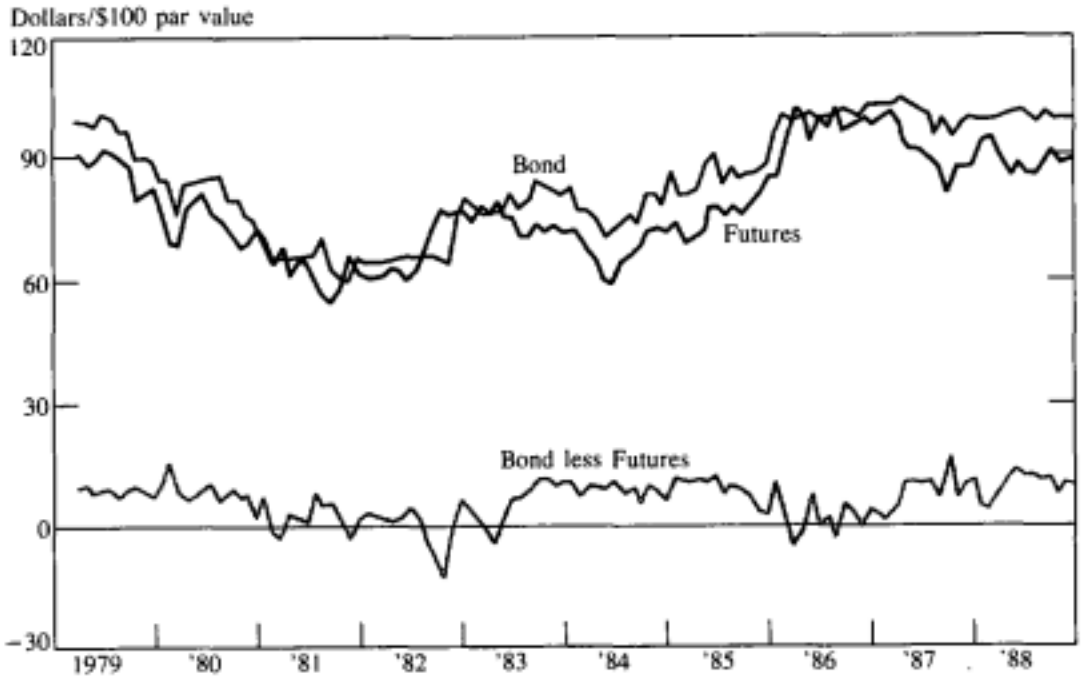
FUTURES VS SWAPS

- 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

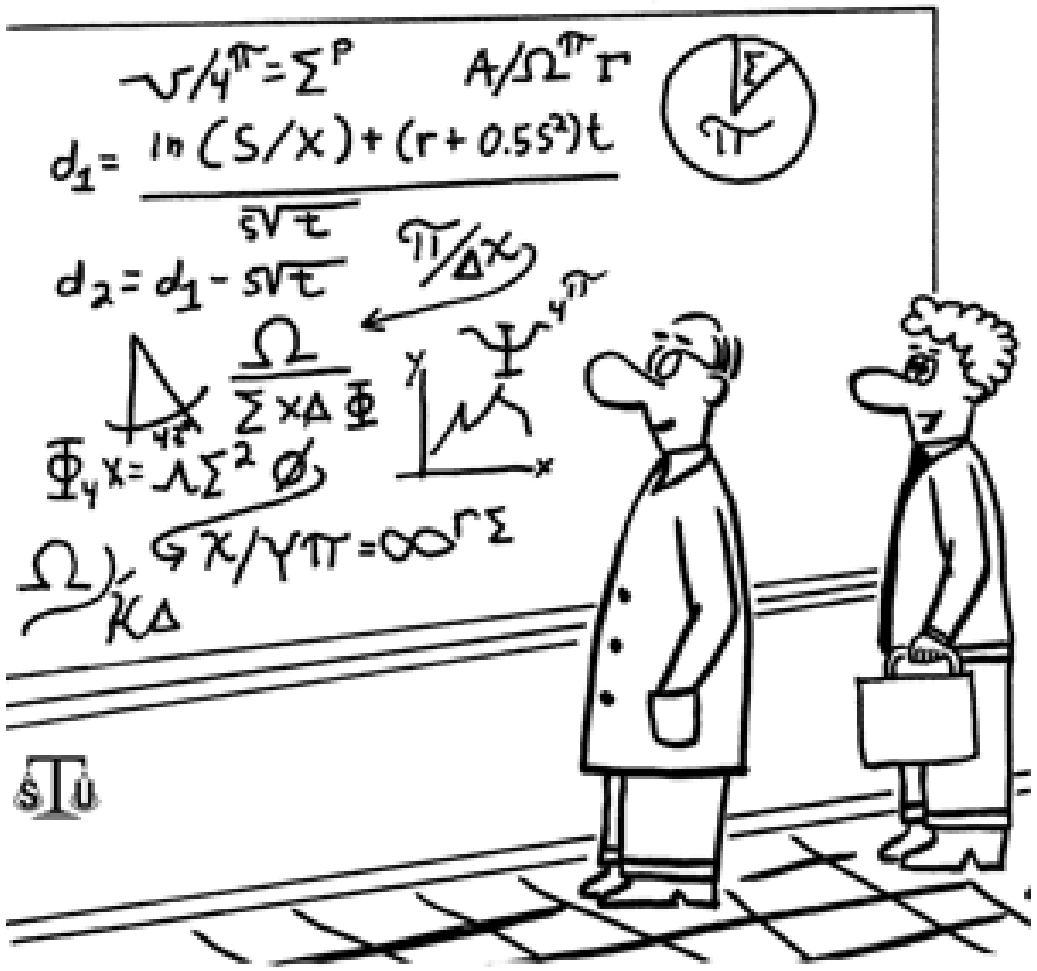
- Swaps are private contracts and the agreement can be customized to business operation needs
- Swaps need a counterparty and can cost more
- Swaps have the risk that a counter party may default

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:

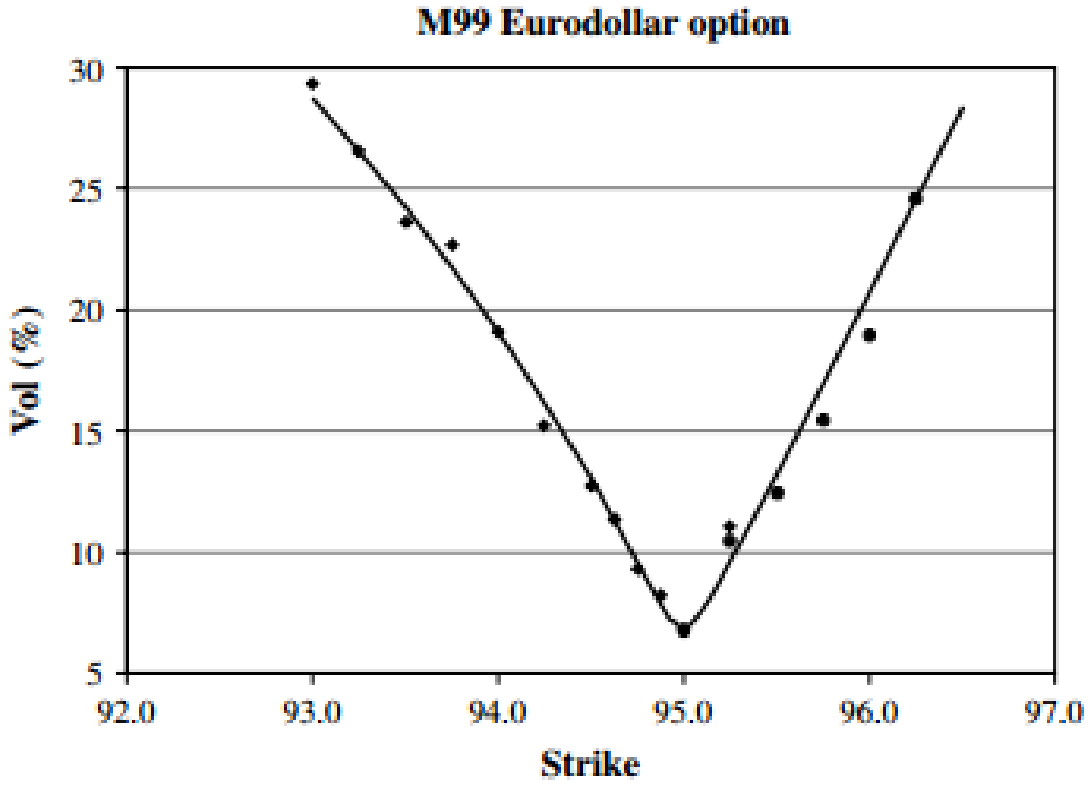
$$c = e^{-rT}[\, F\, N(d_1) - K\, N(d_2)]$$

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

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

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

VOLATILITY SMILE



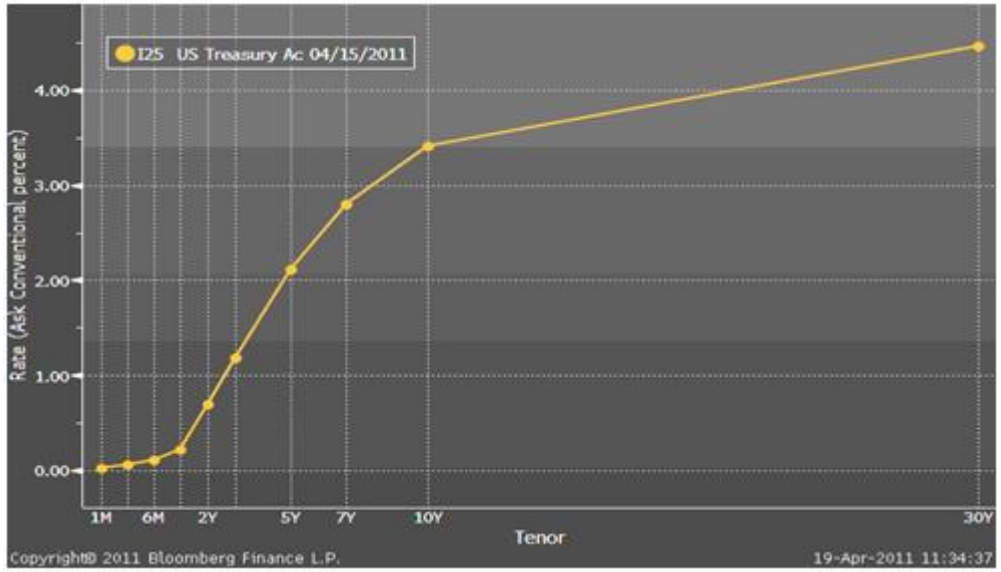
Source and suggested reading: Pat Hagan, Deep Kumar, Andrew S Lesniewski & Diana E Woodward, *Managing Smile Risk,* Wilmott, pp. 84-108 (September 2002)
http://www.math.ku.dk/~rolf/SABR.pdf

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

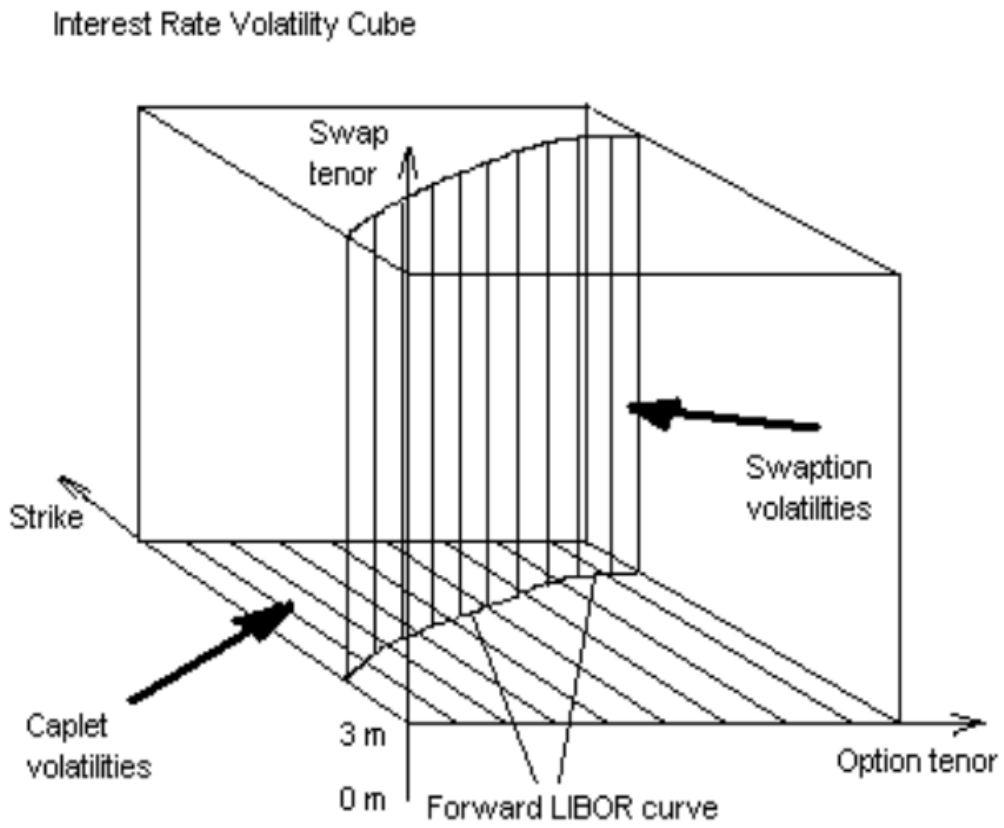
YIELD CURVE

- 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

VOLATILITY SURFACE

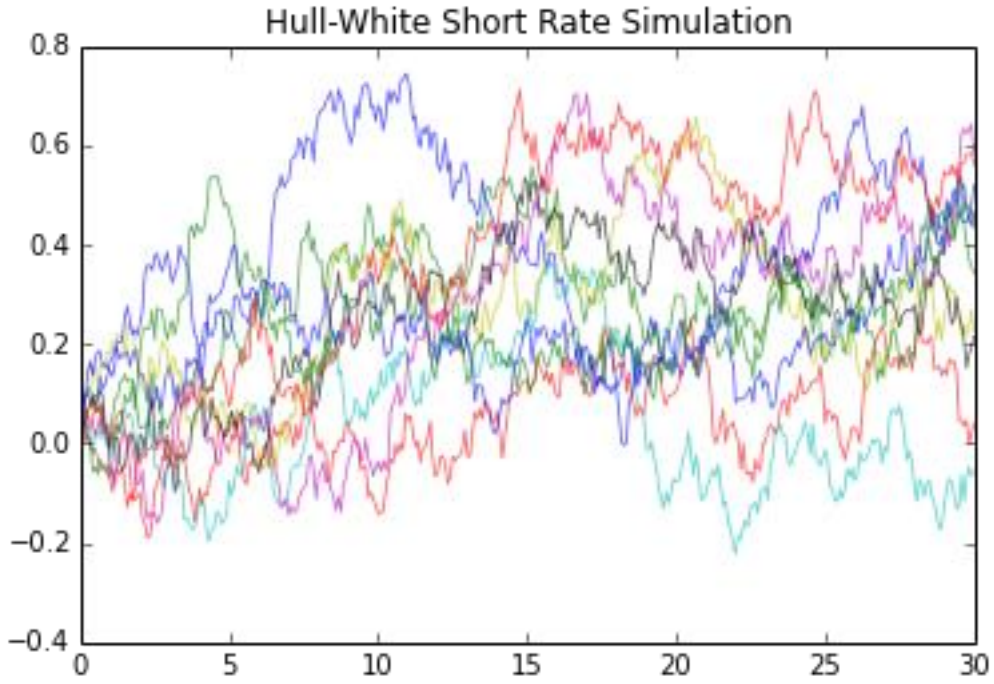


Source and suggested reading: Pat Hagan, Michael Konikov, *Interest rate volatility cube: construction and use*, http://www.javaquant.net/papers/PandorasCube.pdf

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

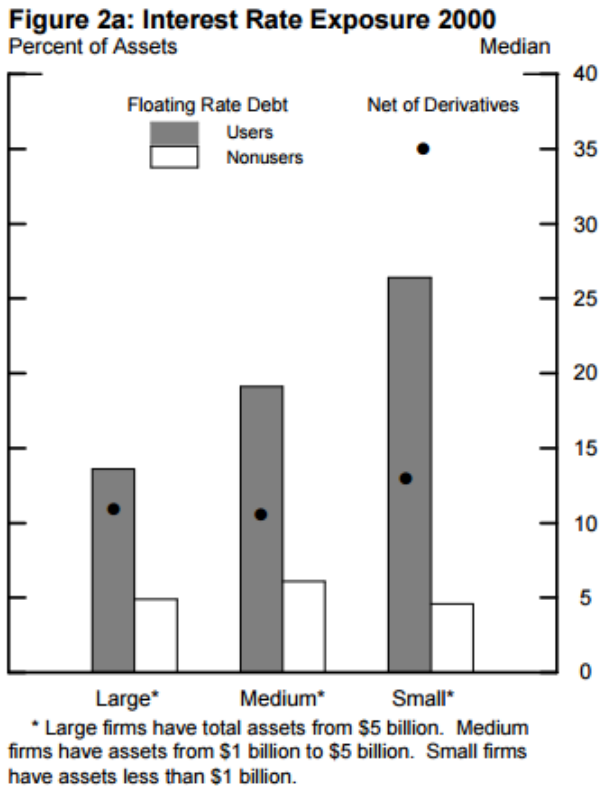
CAREER

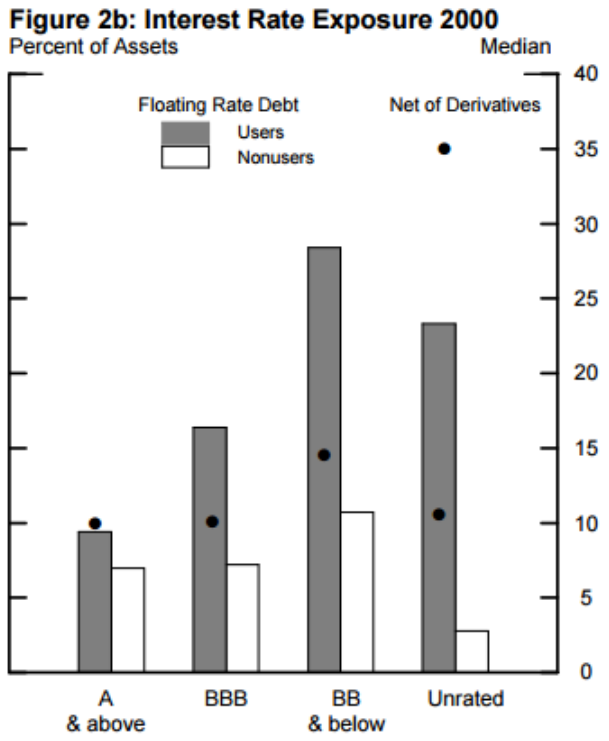
- Quantitative Developers / Researchers
- Financial Engineer
- Pre-trade support Analyst
- Post-trade support Analyst
- Analyst in insurance companies
- Analysts in Treasury
- Model Validation Analysts
- Risk Management in Banks
- Analysts in mortgage companies

THANK YOU

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

INTEREST RATE DERIVATIVE HEDGING



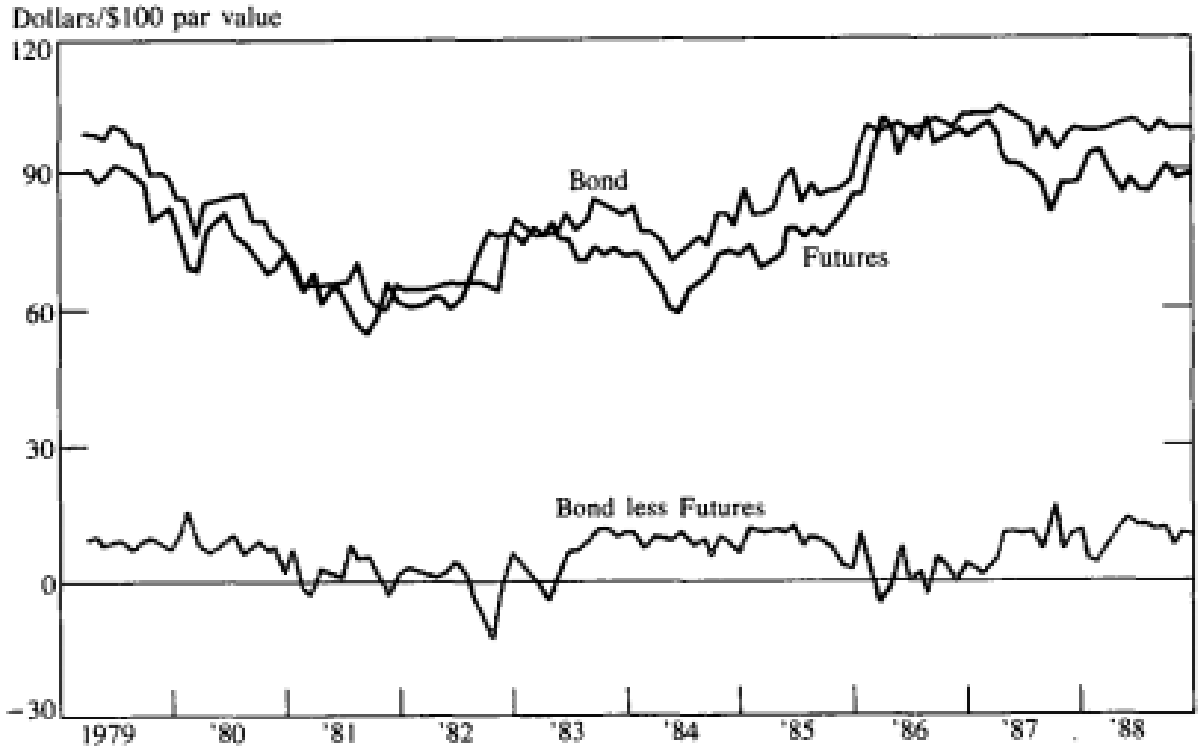


Daniel Covtiz & Steven A. Sharpe, *Do Nonfinancial Firms Use Interest Rate Derivatives to Hedge?*, FEDS 2005-39, http://www.federalreserve.gov/pubs/feds/2005/200539/200539pap.pdf

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



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