Calculating VaR

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How is VAR Calculated?

- **Sensitivity Estimate Models** - use sensitivity factors such as duration to estimate the change in value of the portfolio to changes in market rates and prices.
- **Full Revaluation Models** - use pricing algorithms such as bond formulae or option pricing models to estimate the change in value of the portfolio to changes in market rates and prices.

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VAR for One Asset
Sensitivity Approach

Product	Position Size	Sensitivity	95% Daily Volatility	1 Day VAR
UST 10 Year Note 5.5%	$10MM	$7,600/bp	10 basis points	$76,000

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VAR for One Asset
Revaluation Approach

Product	Position Size	Current Price	New Price	1 Day VAR
UST 10 Year Note 5.5%	$10MM	100 (YTM = 5.5%)	99.305 (YTM = 5.6%)	$75,766

Requires Pricing Model

Why is the VAR Different?

- The Sensitivity VAR assumed that the bond's value would change by $7,000/basis point.
- But, as interest rates decrease, bond price become **more** sensitive to changes in interest rates.
- The change in sensitivity at different interest rate levels is commonly referred to as convexity.
- Virtually all fixed income securities and all options exhibit covexity.
- The full revaluation approach properly accounts for convexity because it actually reprices the security.

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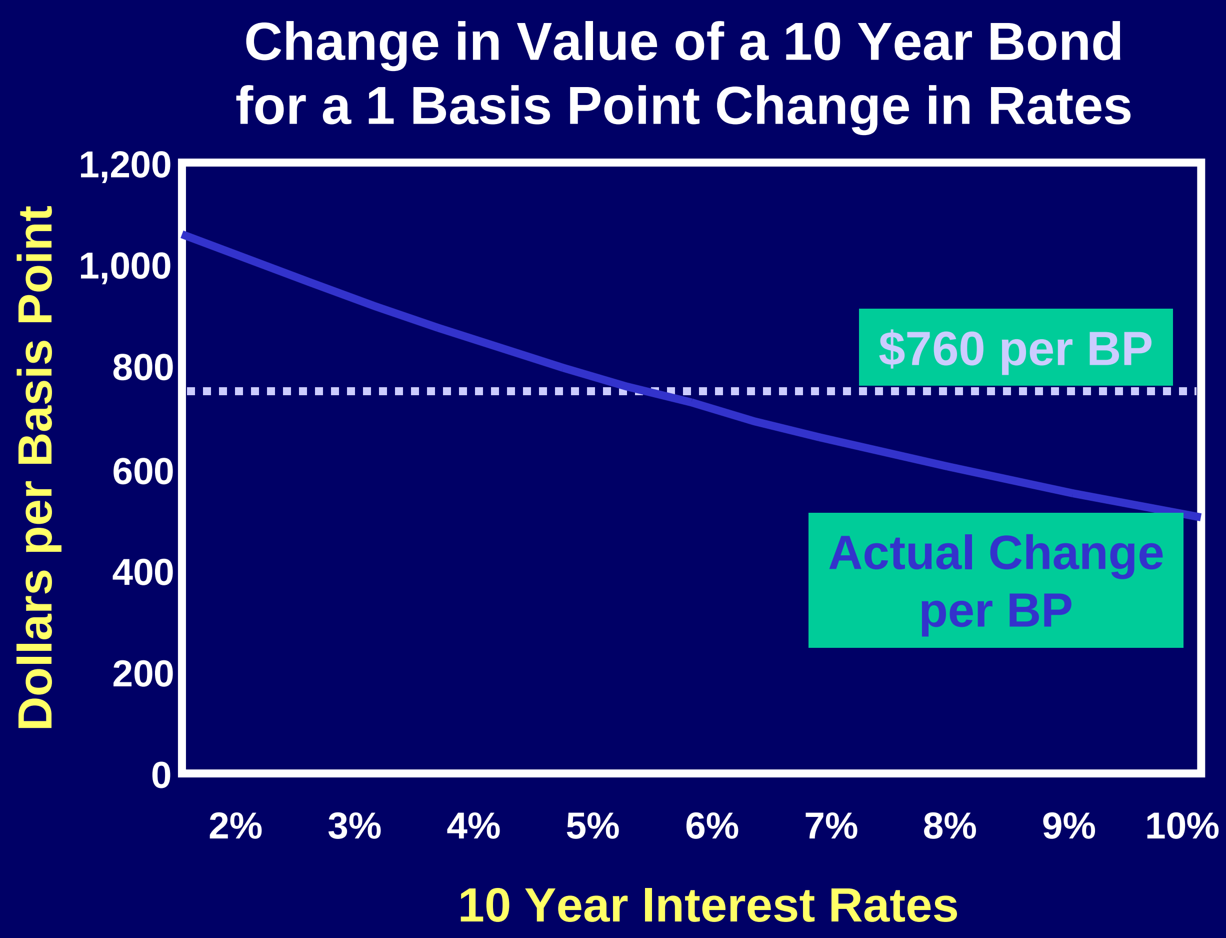
Convexity



Change in Value of a 10 Year Bond
for a 1 Basis Point Change in Rates
1,200
1,000
800
600
400
200
0
Dollars per Basis Point
$760 per BP
Actual Change
per BP
2%
3%
4%
5%
6%
7%
8%
9%
10%
10 Year Interest Rates

Sensitivity vs. Revaluation

10 Year Rate	Sensitivity Estimated P&L	Revaluation (Actual) P&L	Difference	
8.0%	1,900,000	- $1,698,493	$201,507	12%
6.0%	380,500	- 371,864	8,636	2%
5.5%	0	0	na	na
5.0%	380,500	389,684	9,184	2%
3.0%	1,900,000	2,145,584	245,584	11%

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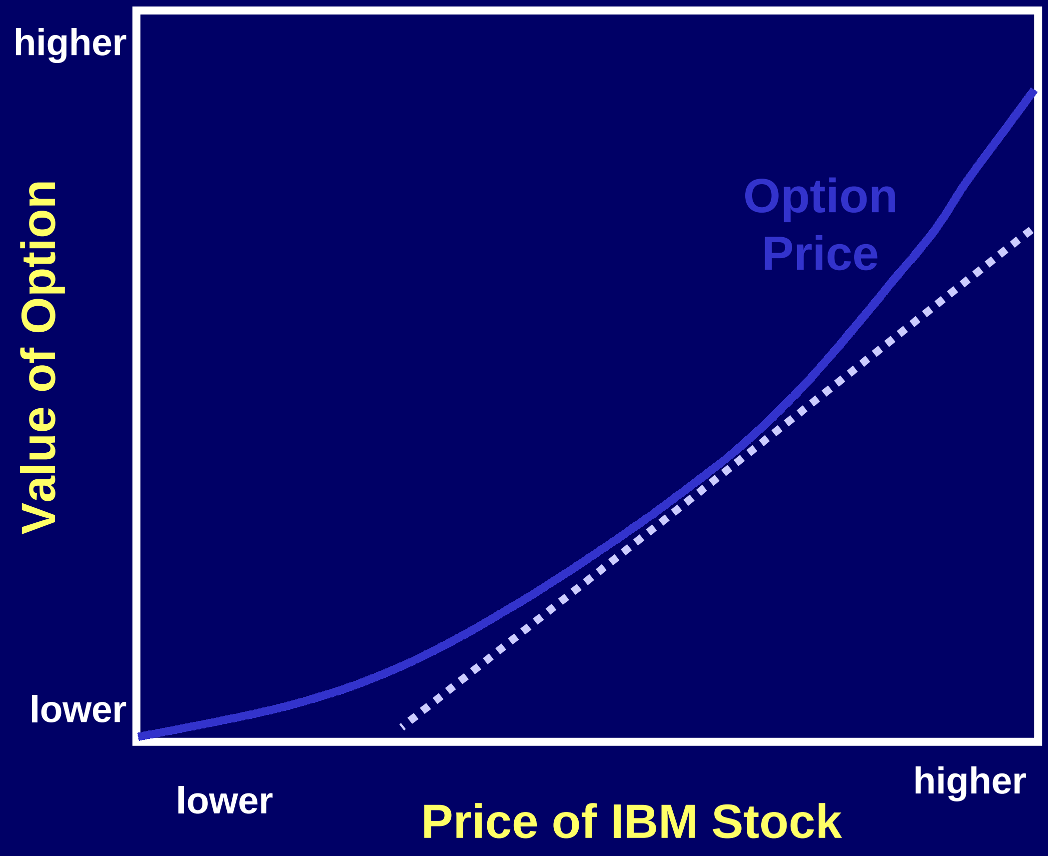
Gamma

Option Price for a Change in Underlying Stock Price



VAR
Sensitivity vs. Revaluation

Sensitivity Models

- **Fast**
- **Don't require model library**
- **Easy to understand**
- **Implement in less time**
- **Less maintenance (no models)**
- **Accept portfolio level data**

Revaluation Models

- **Produce more accurate P&L results**
- **Are price-based**
- **Can handle complex products**
- **Do not rely on estimates**
- **Accept trade level data**

VAR Inputs

- Position Size - The size of the instruments contained in the portfolio.
- Price/Yield Volatility - The magnitude of the underlying prices and yields changes.
- Price/Yield Correlation - Degree to which price and yield changes move together.
- VAR Estimation Period - The time over which P/L is estimated.
- Confidence Level - The frequency which actual losses

Volatility

- Volatility information is a measure of how much prices and interest rates can be expected to change over time.
- Standard Deviation (σ)
- Historic Time Series of Prices and Yields (P_t)

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Correlation

- Correlation is a measure of how much two assets price changes move together.
- Correlation of 1 --> asset prices change together perfectly
- Correlation of 0 --> asset price changes appear independent
- Correlation of -1 --> asset prices move in exact opposite direction

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VAR Estimation Period

- The VAR estimation period is the period of time over which changes in value are estimated.
- Daily
- Time between re-hedging or re-balancing of the portfolio
- Time necessary to unwind the portfolio
- Some longer period over which sufficient capital must be retained

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Confidence Interval

- The confidence interval indicates, on average, how often the actual P&L will be equal to or less than the VAR estimate.
- 99% suggests that one out of every 100 days, the actual P&L (loss only) will be greater than the VAR estimate

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VAR Parameters Technical Choices

- Calculations of Volatilities and Correlations
- Data filling
- Assumptions for scenario generator in Monte Carlo Simulation approach
- Alternative distributions
- Spline estimate for sensitivity based P&L
- Square root of t
- Consistency of valuation models between P&L and VAR models

Common VAR Models

- **Variance Covariance** - Applies a single formula to estimates the change in value of a portfolio from the volatility and correlation inputs.
- **Historic Simulation** - Estimates the change in value of the portfolio for historic market price/rate changes.
- **Monte Carlo Simulation** - Generates market scenarios and estimates the change in value of the portfolio given each scenario.

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VAR Approaches

VAR Approaches

- Variance Covariance
  - Sensitivity
- Historic Simulation
  - Sensitivity
  - Revaluation
- Monte Carlo Simulation
  - Sensitivity
  - Revaluation