



Option-Like Nature of Variable Annuities

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GMxB = Guaranteed Minimum Benefit

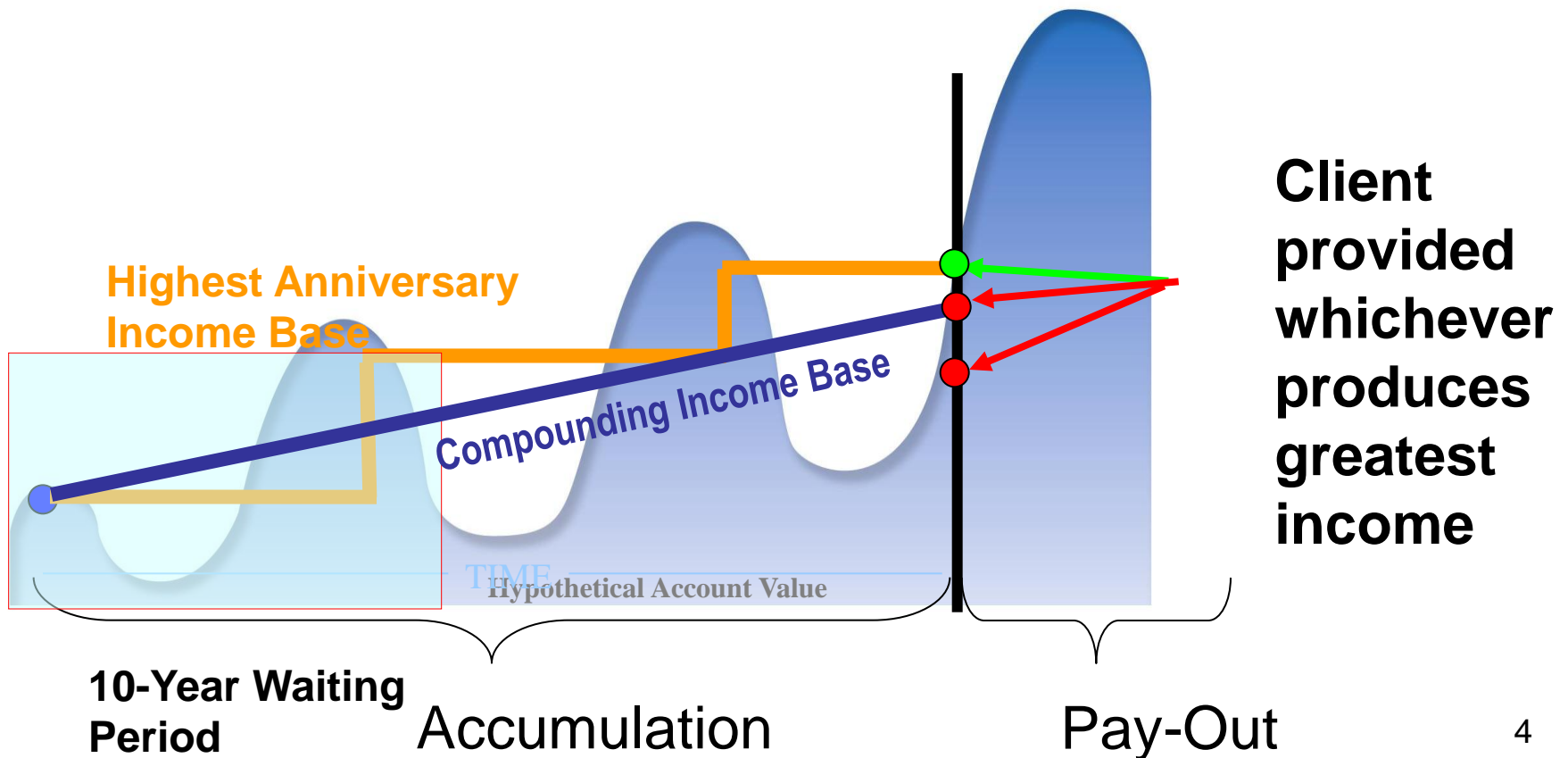
- GMIB I = Income
- GMWB W = Withdrawal
- GMDB D = Death
- GMAB A = Accumulation

GMxBs - Key Features

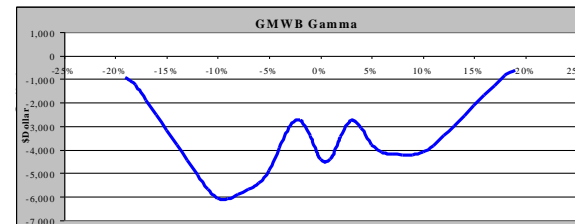
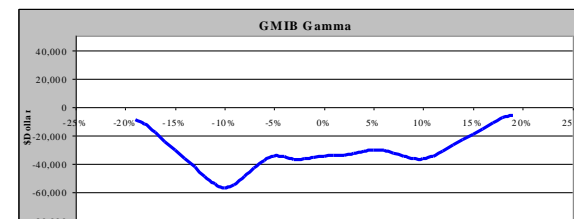
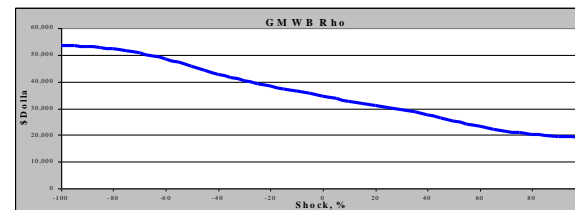
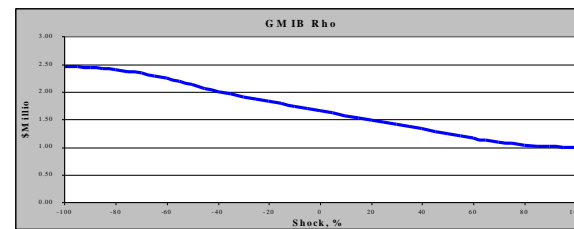
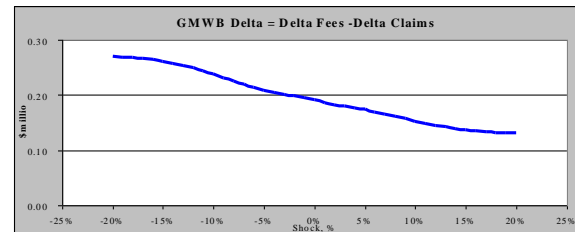
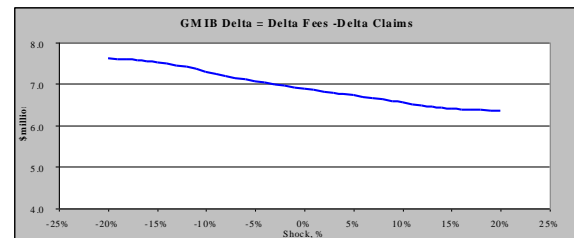
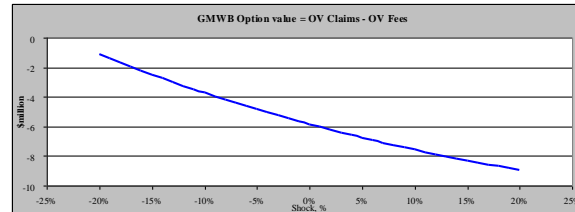
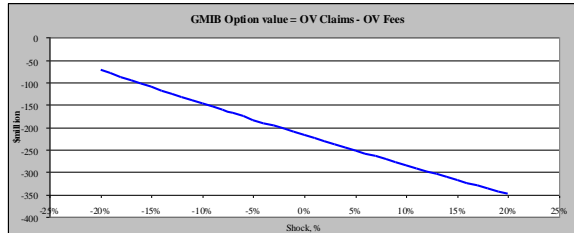
	Benefit	Guarantee
GMDB	Death Benefit	Return of Premium Annual Step-up (a.k.a. Ratchet) 5%-6% Roll-up (a.k.a. compounding)
GMWB	Withdrawal Benefit	105% of Deposit 7% Maximum Withdrawal Rate
GMAB	Accumulation Benefit	Return of Premium
GMIB	Income Benefit	Maximum of (a) Annual Step-up, or (b) 5% - 6% Roll-up @ Contractual GMIB Payout Rates

Guaranteed Minimum Income Benefit – What is it?

- An optional feature designed to provide a *predictable level of future retirement income* regardless of investment performance



Which GMxB is Which?



Option Value

Delta

Rho

Gamma

GMIB versus European Put

GMIB

- risk free rate
- volatility
- income base/AV adjusted by Guaranteed/Current rates
- waiting period
- Basket transfers
- Total return

European Put

- risk free rate
- volatility
- in-the-moneyness
- Tenor
- Price return

Why Accounting Matters

- Economic vs GAAP vs Stat
- Economic gain or loss
- GAAP income volatility
- Statutory solvency

Small product variations can drive big changes in strategy

US GAAP Accounting Influence on Risk Management

	<u>GMDB</u>	<u>GMIB</u>	<u>GMWB/GMAB</u>
Accounting Guidance	SOP 03-1	FAS 133 / SOP 03-1	FAS 133
Balance Sheet	Additional Liability	Embedded/ Add. Liability	Embedded Derivative
Accounting Correlation	Low	Moderate	High
Hedging Instruments	Reinsurance/ Derivatives	Derivatives/ Reinsurance	Derivatives

Challenges to Hedging Programs

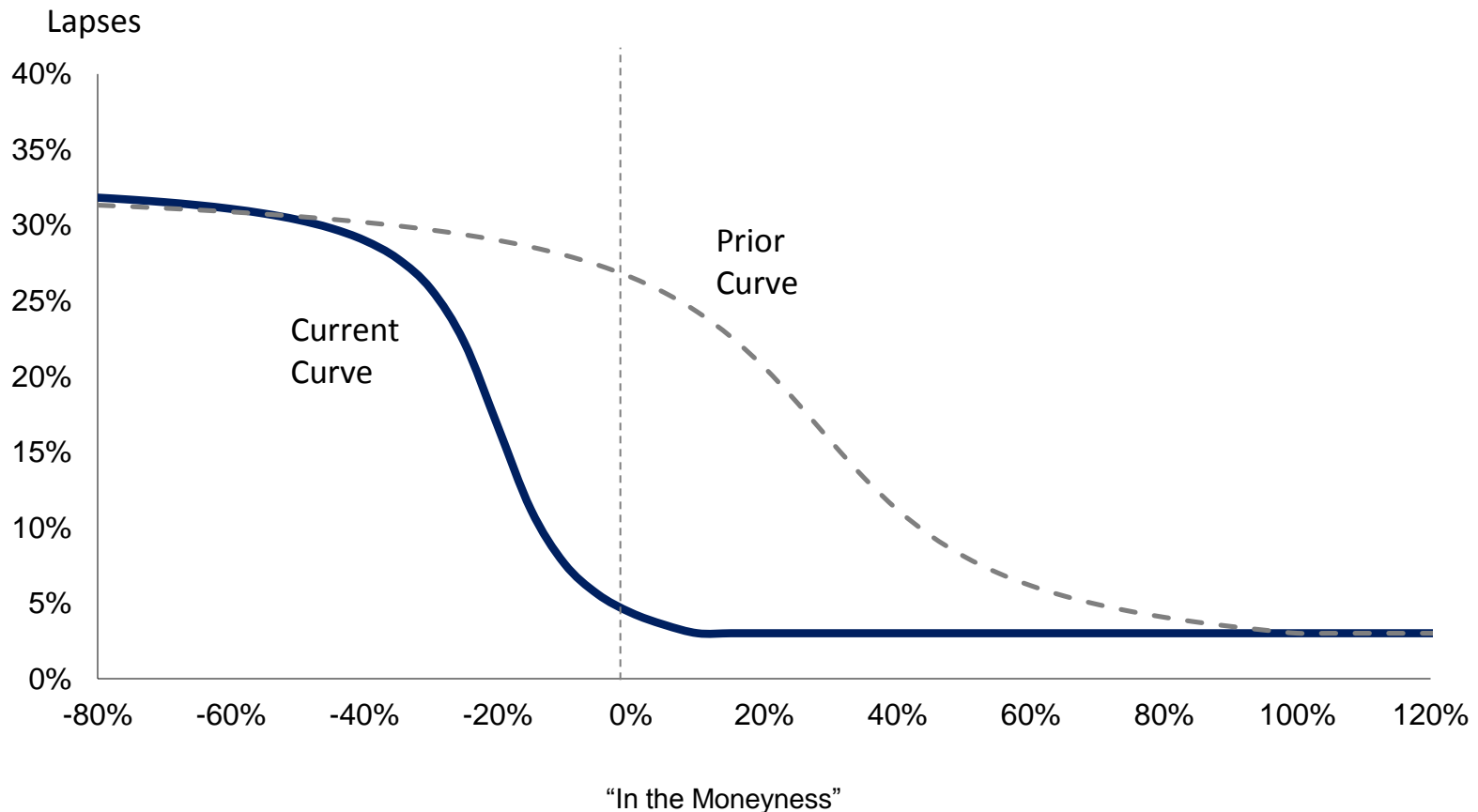
- VA writers would normally use the following risk mitigation techniques:

Strategy	Market Risk Exposure
Dynamic Hedging	Realized volatility of equities and interest rates
Underhedging, e.g. due to SOP 3-01	Direction and realized volatility of equities, level and volatility of interest rates - tail risk
Static Hedging with vanilla Puts	High cost, basis risk, cross-effects

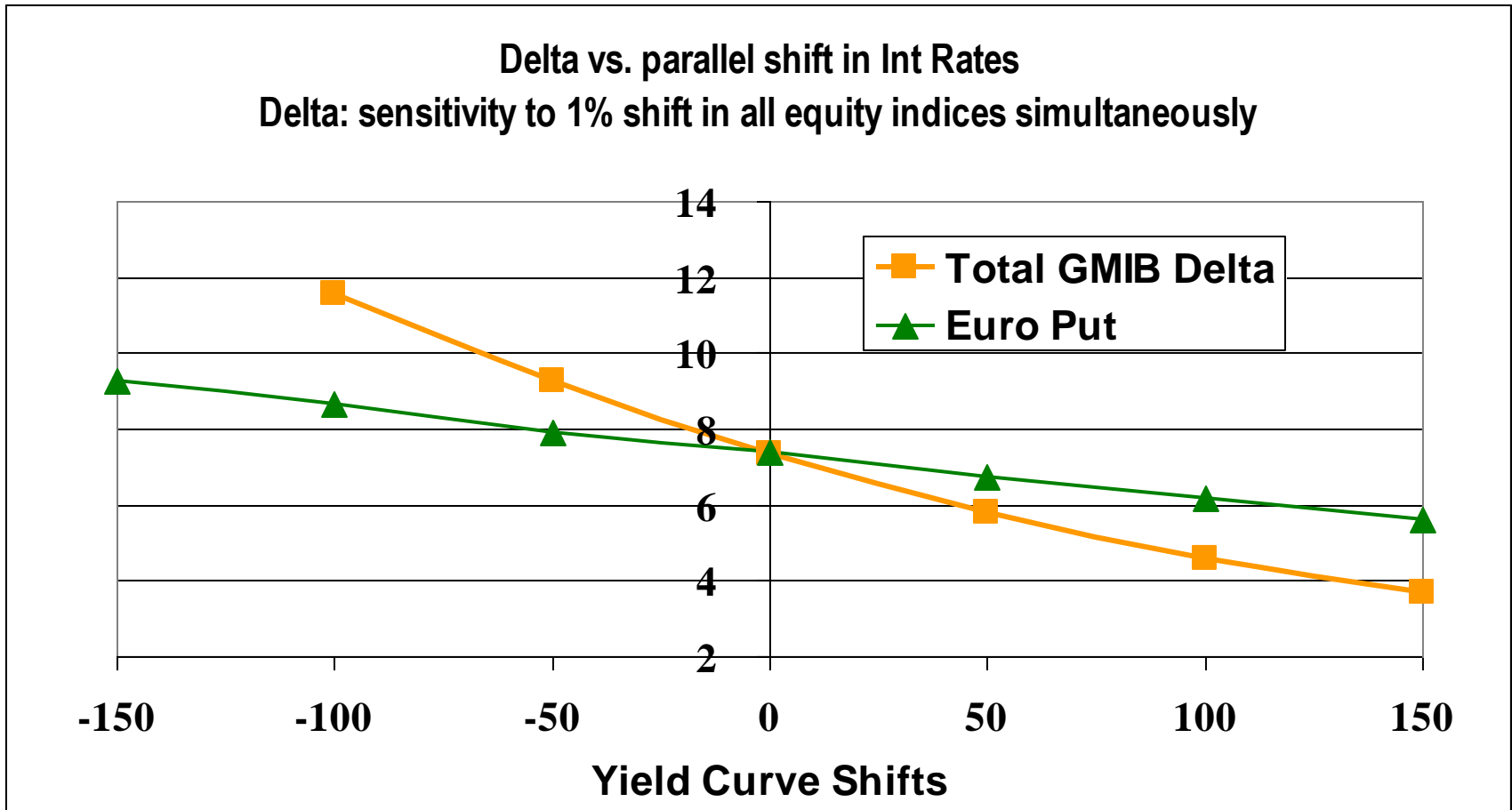
- Managed volatility funds were designed as a response to address these issues

Lapse Assumption Lowered to Fully Reflect Post-Crisis Experience

Lapse Function Relative to “In the Moneyness (ITM)”



Cross Greeks



Why Volatility Matters

- Vega = Sensitivity of Economic Value to equity volatility movements
- SOP liabilities not as sensitive to these movements
 - SOP 03-1 Paragraph 31
 - implied vol versus historic vol
- Balance hedging of Economic Value to GAAP income volatility

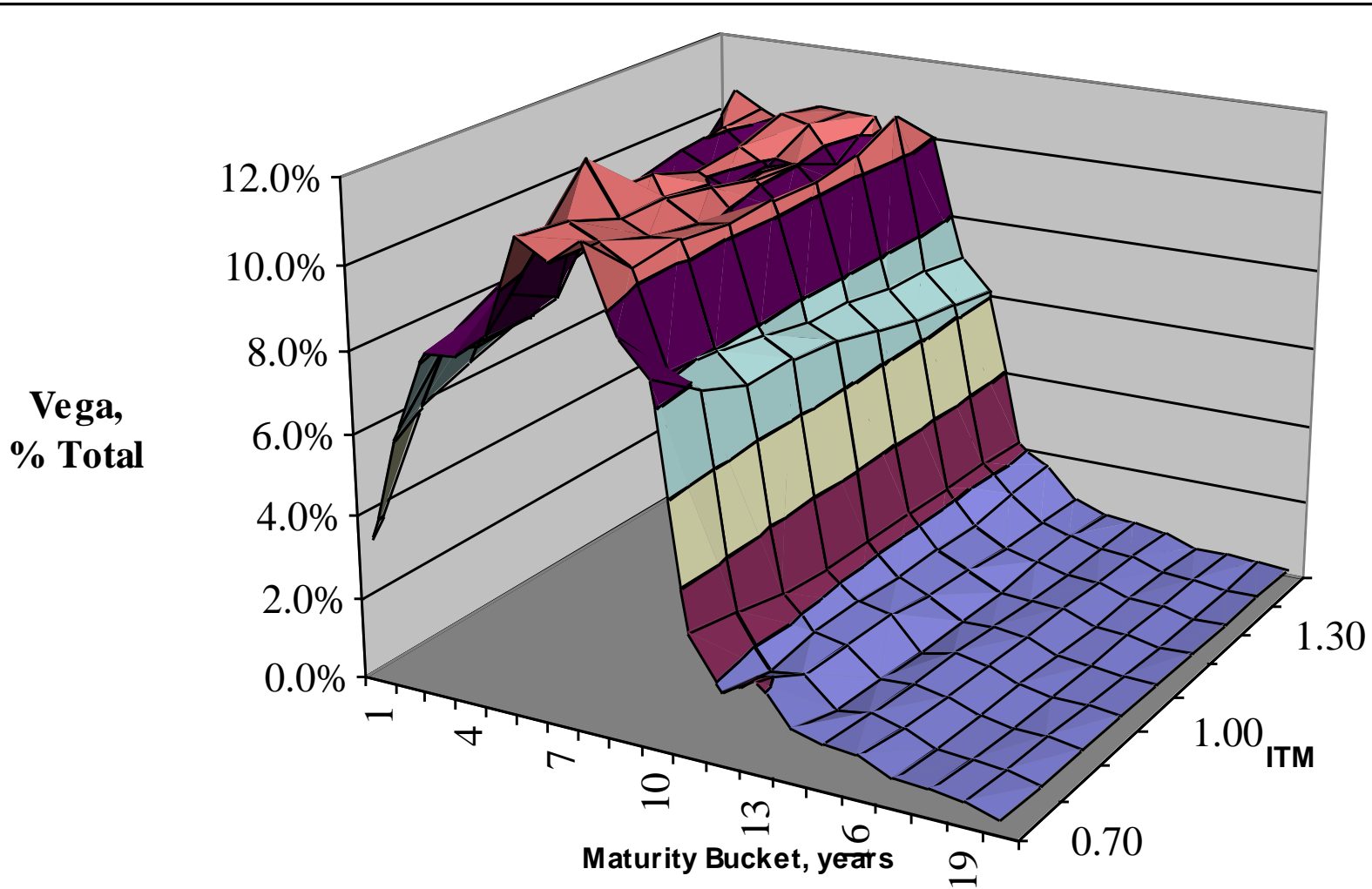
Tradeable Indices

- S & P 500 (SPX)
- NASDAQ 100 (NDX)
- Russell 2000
- Morgan Stanley EAFE

Constructing an Implied Volatility Surface

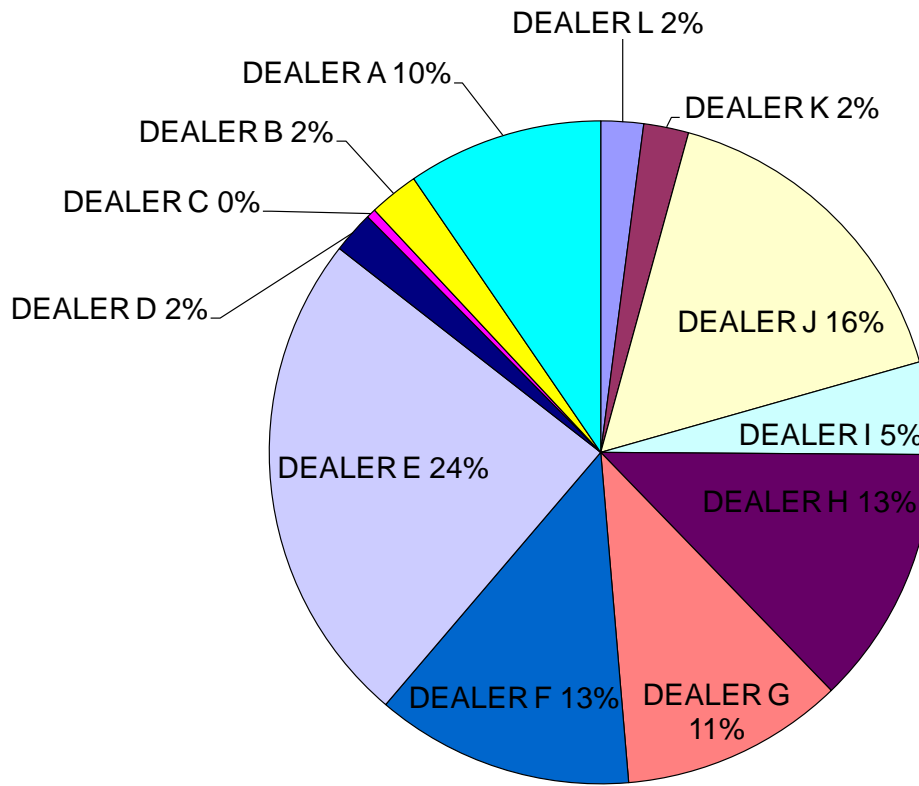
- Step 1 : SPX
 - Incorporate market traded long dated vol
 - SPX 15yr implied vol level higher than 10yr implied vol
 - Apply historical vol starting at 20yr point
 - Grade down **forward** vol to historical vol between 15yr and 20yr
- Step 2 : Other Indices
 - Generate other curves based on dealer indications to 10yr
 - Apply SPX vol slope between 10yr and 15yr points
- Step 3 : Apply Skew Adjustments
 - e.g. 3% of ATM spot implied vol per 10% in/out moneyness
 - Adjust overall vol surface or make policy level adjustments

Key Rate Vega



VA Hedging Program – Distribution by Dealer

Distribution of Vega by Dealer Counterparty



MetLife®