Equity-Based Insurance Guarantees Conference

Nov. 6-7, 2017

Baltimore, MD

Lessons Learned: Integrated Market Risk Management of Equity-linked Insurance Guarantees

Frank Zhang

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Lessons Learned

Integrated market risk management of equity linked insurance guarantees

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Equity-Based Insurance Guarantees Conference

Baltimore MD

1430-1530 HRS November 7, 2017

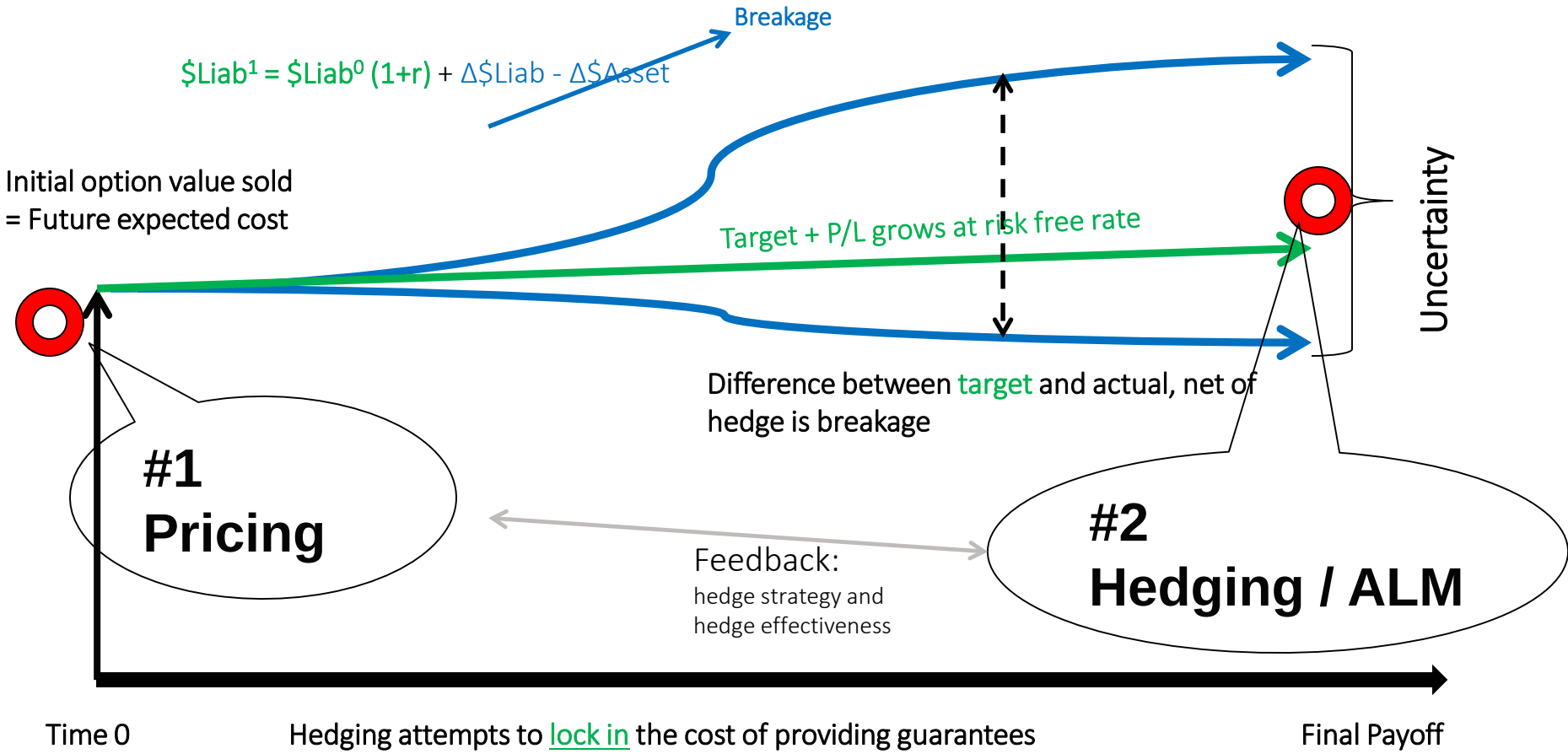
SOCIETY OF ACTUARIES®

Outline

- Integrated market risk management
- Product development
- Hedging/ALM solutions

Integrated risk management for equity linked guarantees

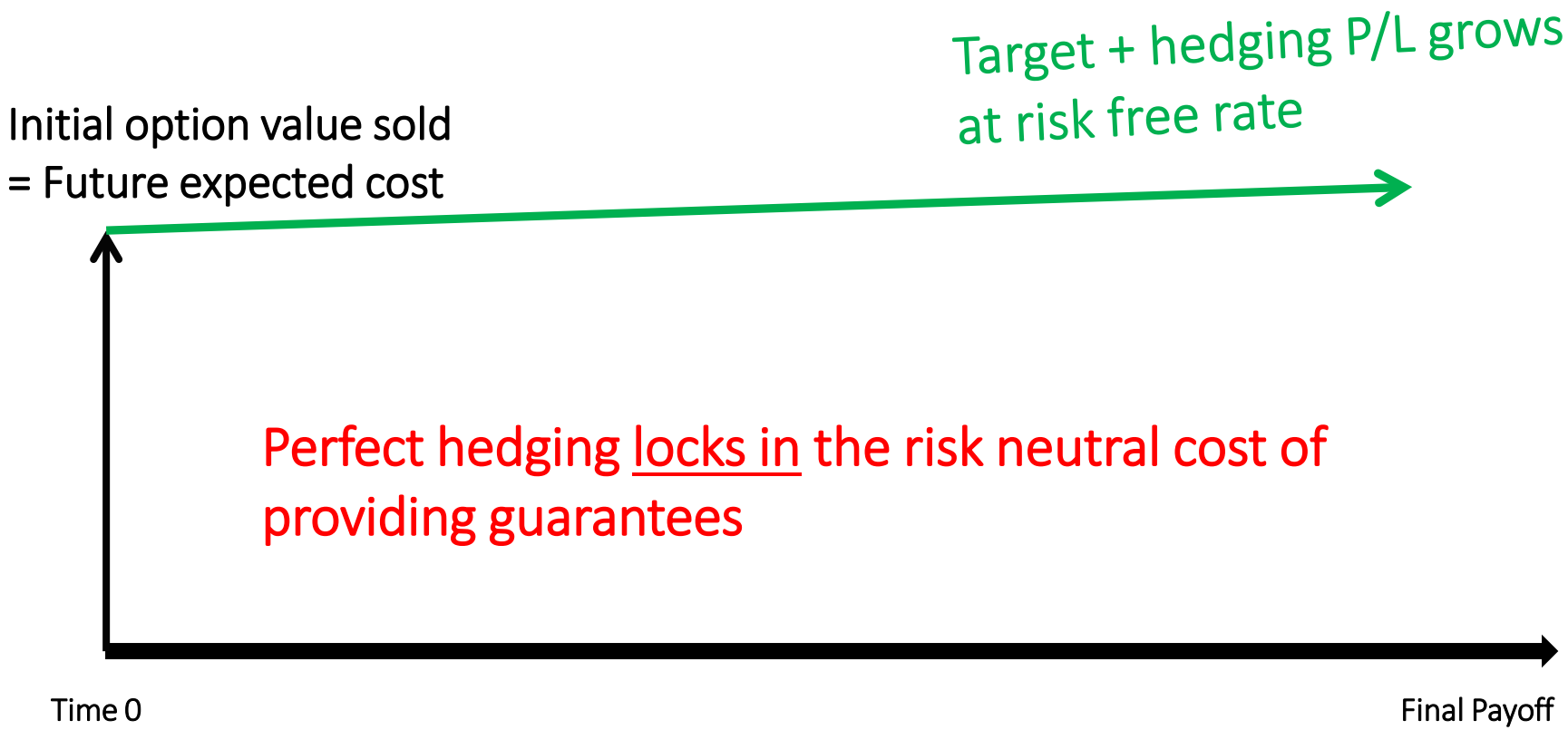
- Two key components
  - #1 Reduce the expected cost of future guarantees – through product designs (the most effective)
  - #2 Reduce the uncertainty of cost of providing actual future guarantee claims – through hedging (sometimes the only tools)



Risk neutral pricing with perfect hedging (Martingale)

Breakage = 0

$$\$Liab^1 = \$Liab^0 (1+r) + \Delta\$Liab - \Delta\$Asset$$



Risk neutral pricing of derivatives

- Applied to derivatives only
- Risk neutral only for the averages
- Use of hedge ratio
- Hedging or not?

Hedge ratio for derivatives pricing

Risk Neutral

$$\text{H-Ratio} = \frac{\text{PV of claims}}{\text{PV of charges for guarantees}}$$

Risk neutral pricing with perfect hedging (Martingale)

Breakage = 0

$$\$Liab^1 = \$Liab^0 (1+r) + \Delta\$Liab - \Delta\$Asset$$

Target + hedging P/L grows at risk free rate

Initial option value sold
= Future expected cost

Perfect hedging locks in the risk neutral cost of providing guarantees

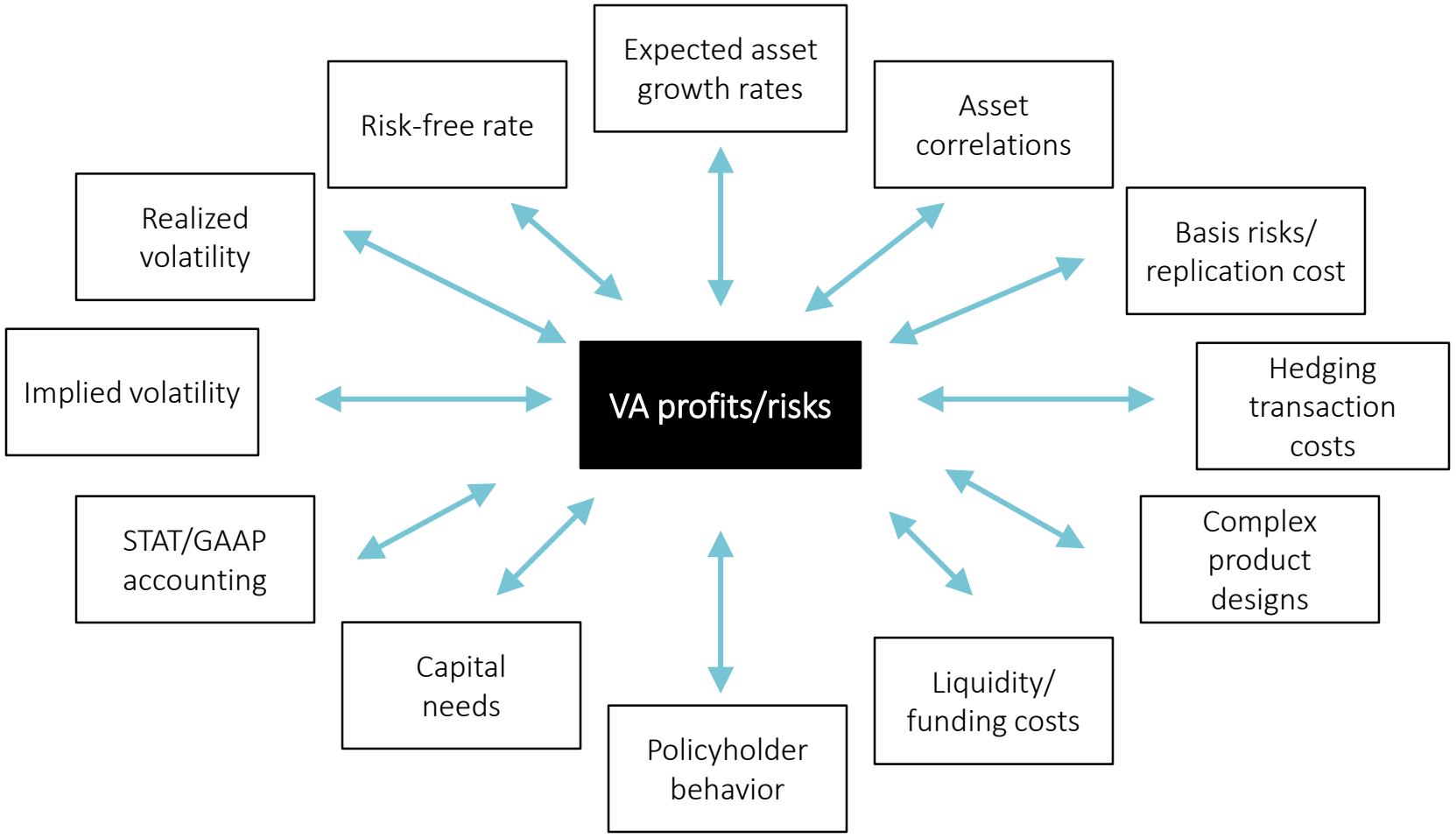
Time 0

Final Payoff

Impact of hedge effectiveness in pricing

- Risk neutral pricing is defined by perfect dynamic hedge
- Without hedging, risk neutral price cannot be locked in
- With hedging, risk neutral might be locked in

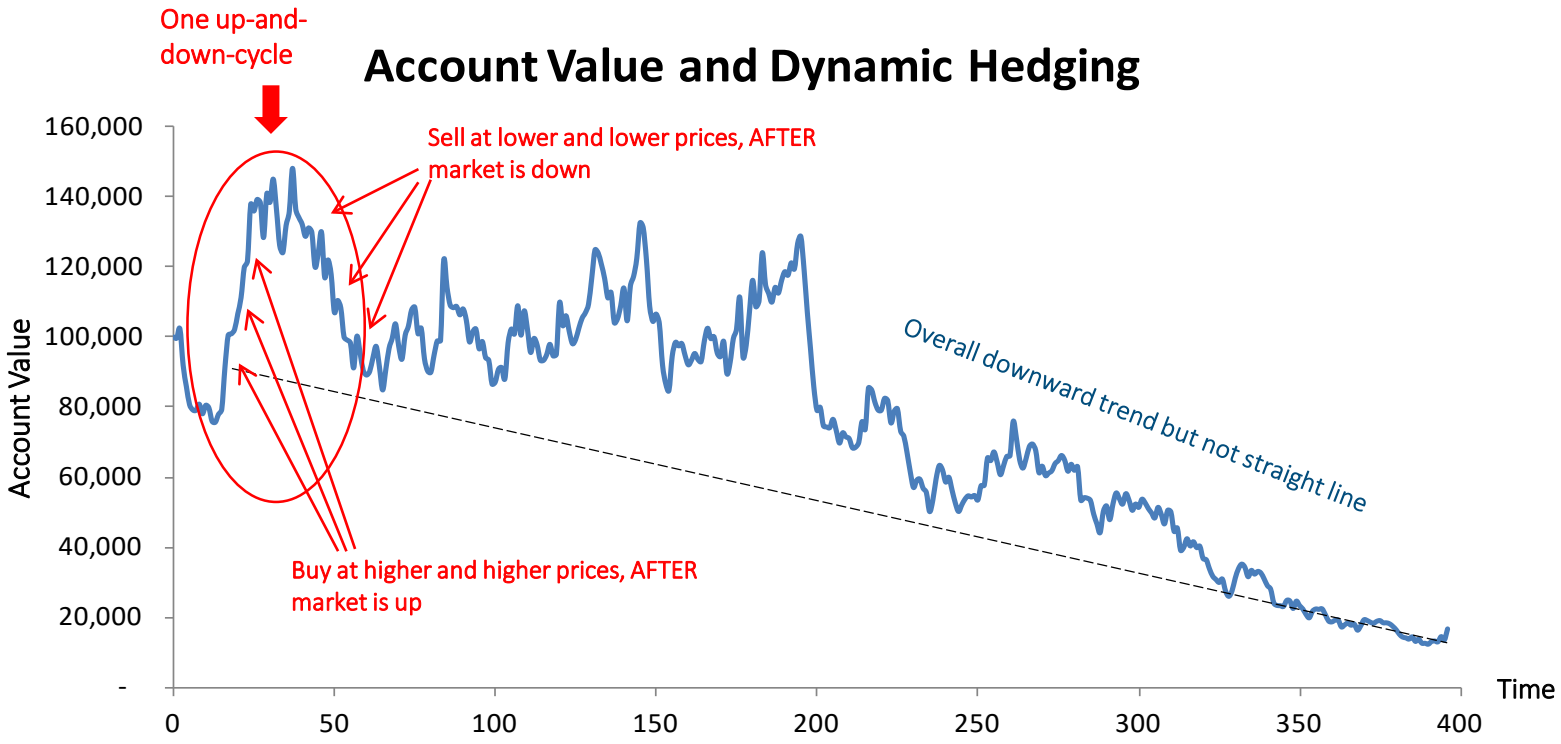
Many factors affecting VA guarantee profits/risks



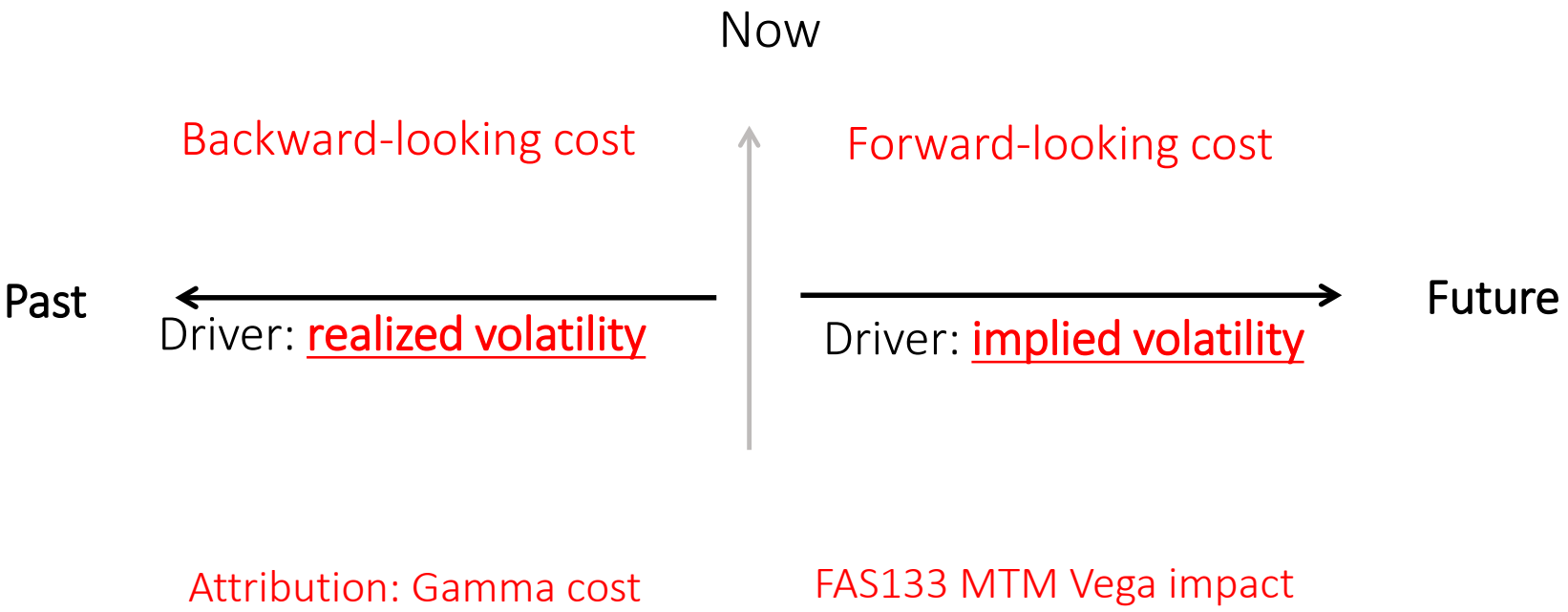
These are some of the most exotic, super-long dated, and hybrid derivatives ever created!

Dynamic hedging boils down to gamma risk

- Higher realized volatility increases cost of dynamic hedging program
  - Hedge cost increases during periods when underlying funds moves sharply, resulting in elevated transaction costs and increased "buy-high-and-sell-low" round trip trades
  - Volatility drives cost of options
  - Dynamic hedging "premium" is spent gradually over the duration of the contract

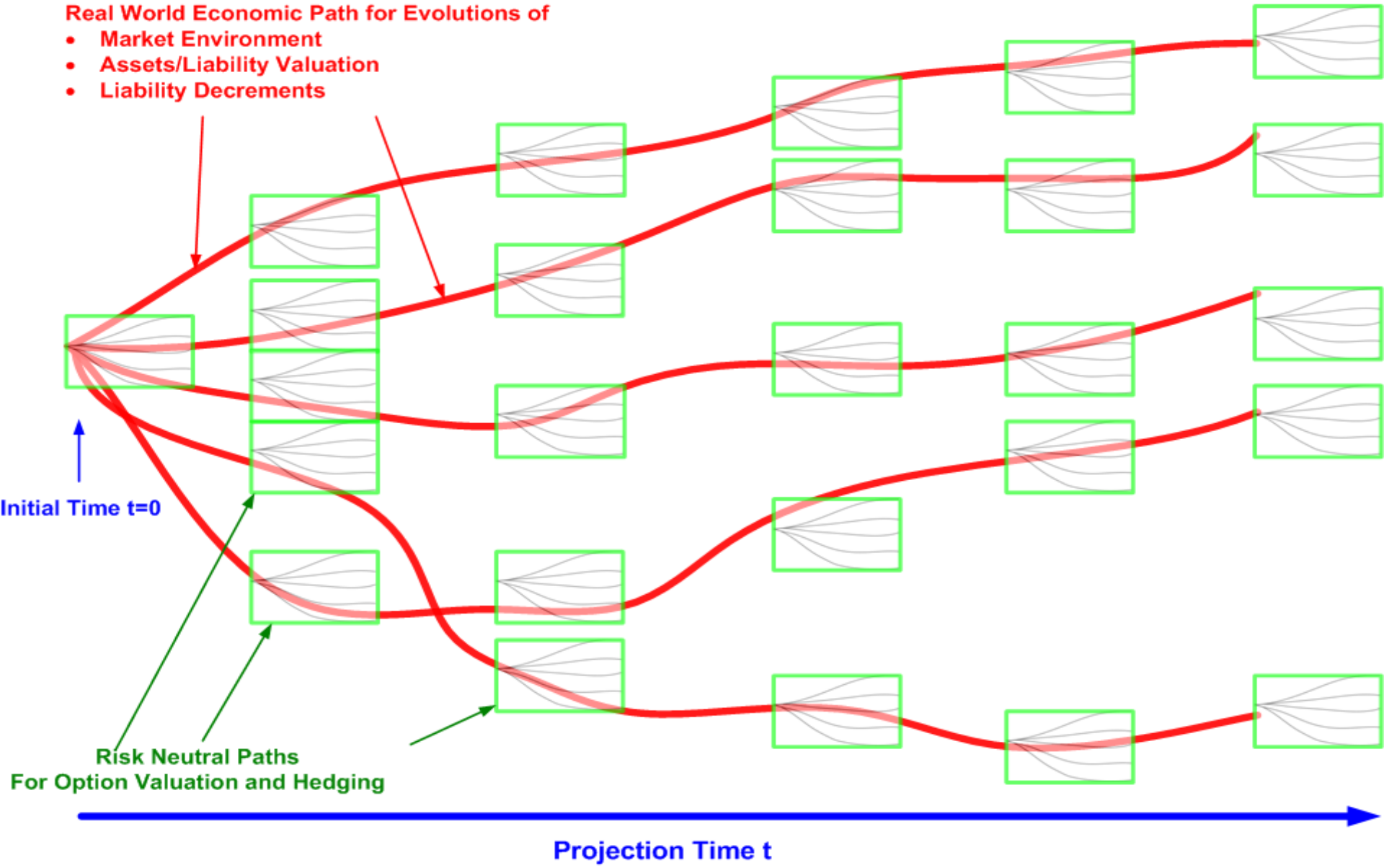


Impact of “volatility” on option value



This is the art and science of hedging attribution of Gamma, Theta, and Vega

Hedging Program Financial Projections – A Stochastic On Stochastic System



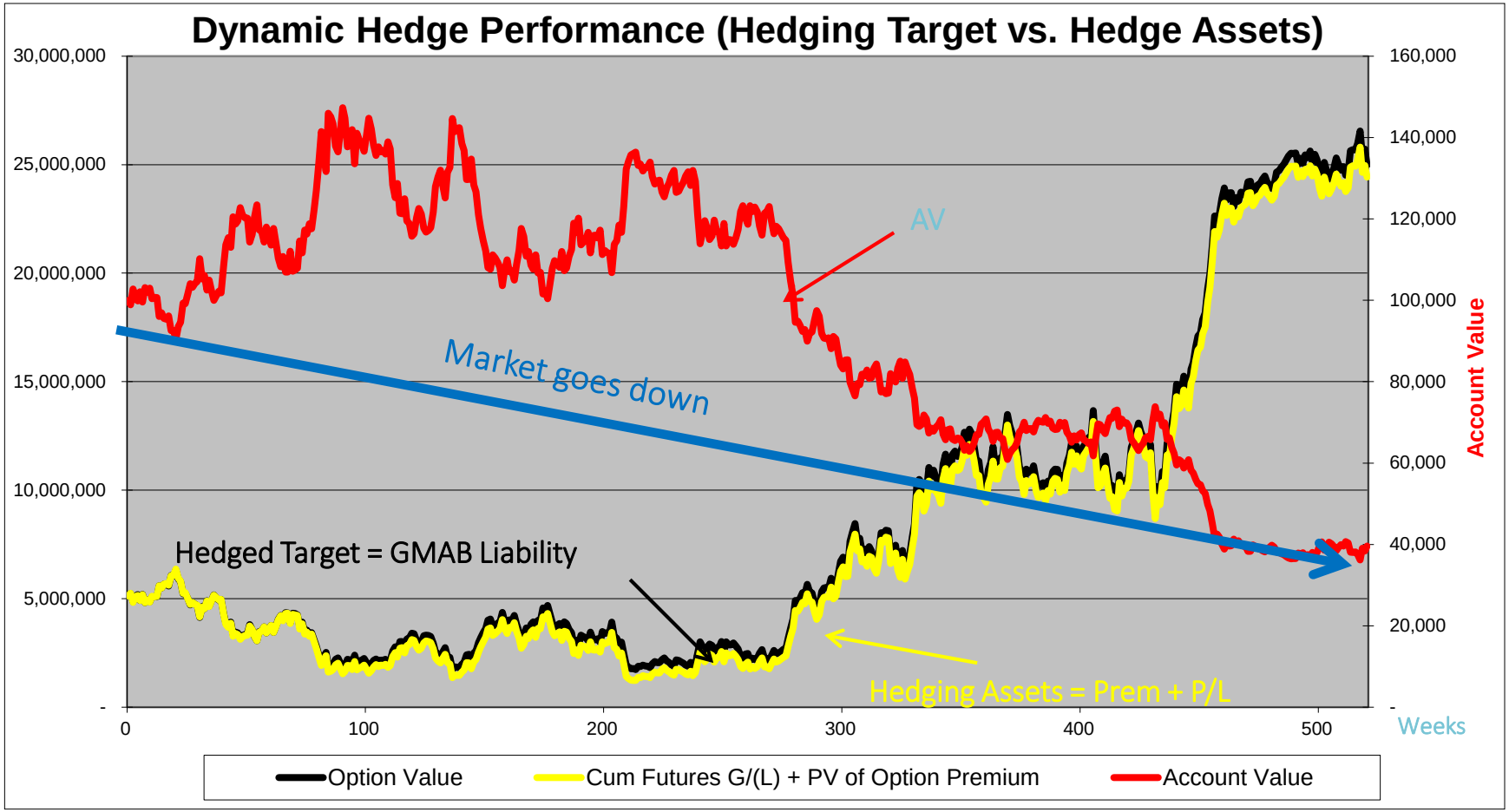
Two ways to view a dynamic hedging program: #1 Cash account

- Cash account approach
  - Asset and liability accounts, including interim cash flows and interest rate accruals
  - Asset starts with initial option price premium
  - Liability starts with Marked-to-Market value of time zero risk neutral expected claims
  - In perfect hedging under Black-Scholes conditions, assets (including hedging G/L) = liabilities at all time
  - Updated value at liability account is always matched by the opposite amount at asset account
  - In imperfect environment, hedge breakages reduce hedge effectiveness

Dynamic replications

– Whether or not market goes up or down

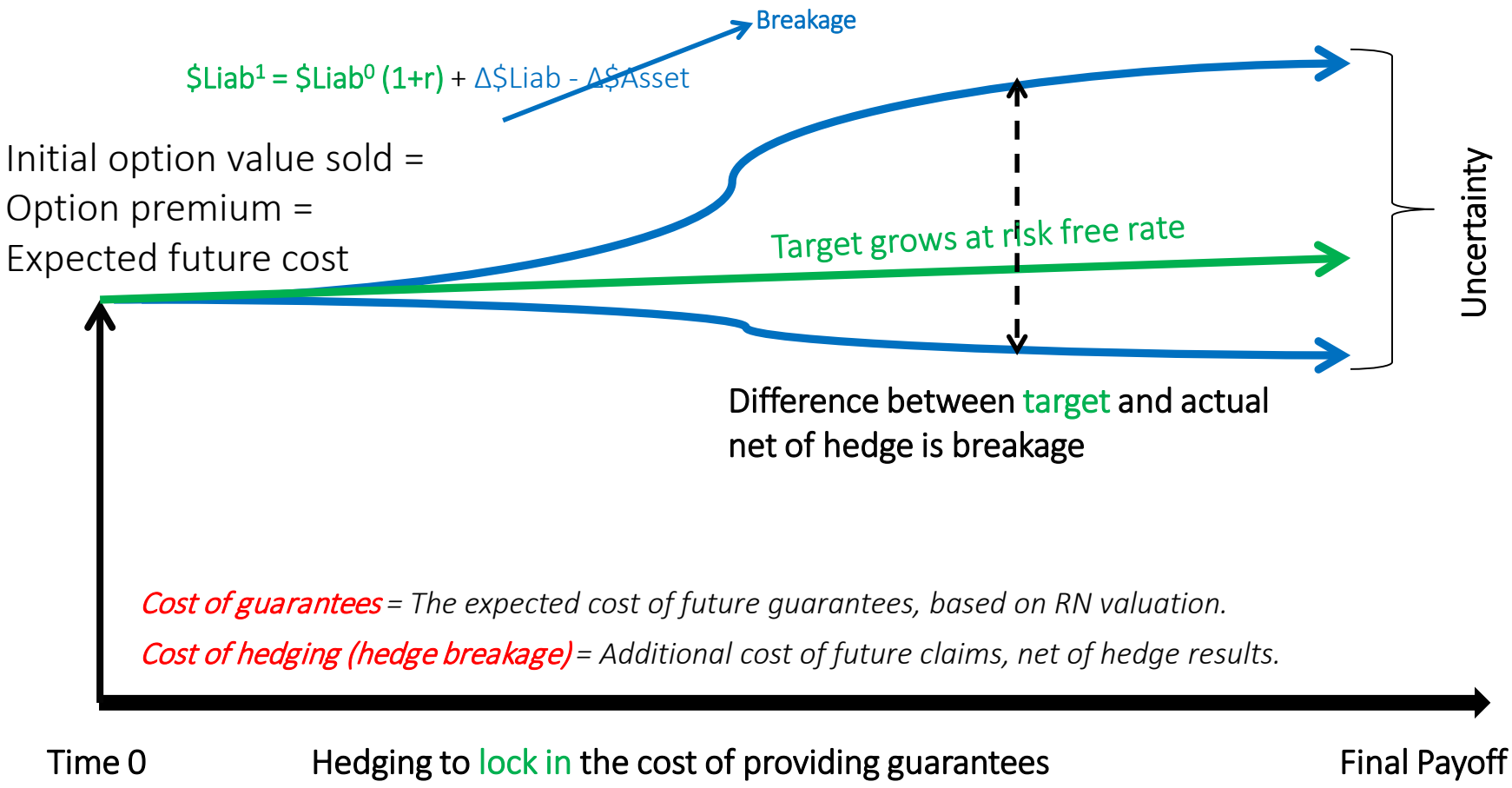
- Example of a derivatives block with $5M option value
  - Two paths of market performance of replicating strategies
  - Whether or not market goes up or down – the hedging is to track against the change in liability with small net P/L



Two ways to view a dynamic hedging program: #2 Martingale

- Martingale approach
  - Liability account plus hedging G/L
  - Liability starts with Marked-to-Market value of time zero risk neutral expected claims (= option premium)
  - In perfect hedging under Black-Scholes conditions, liabilities + hedging G/L stay the same all the time
  - All values in all times grow at risk free rate, or PV to time zero at initial value
  - In imperfect environment, hedge breakages reduce hedge effectiveness

Derivatives Martingale pricing is validated via dynamic hedging



What is the relationships between pricing and hedging?

Every repricing can be attributed into three components

Market drivers	Luck
Assumptions	Bet
Product design	Actions

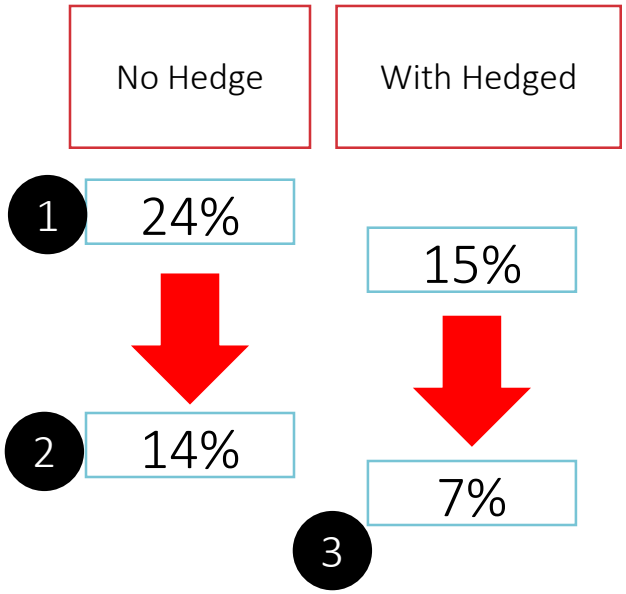
Pricing sensitivity and hedging

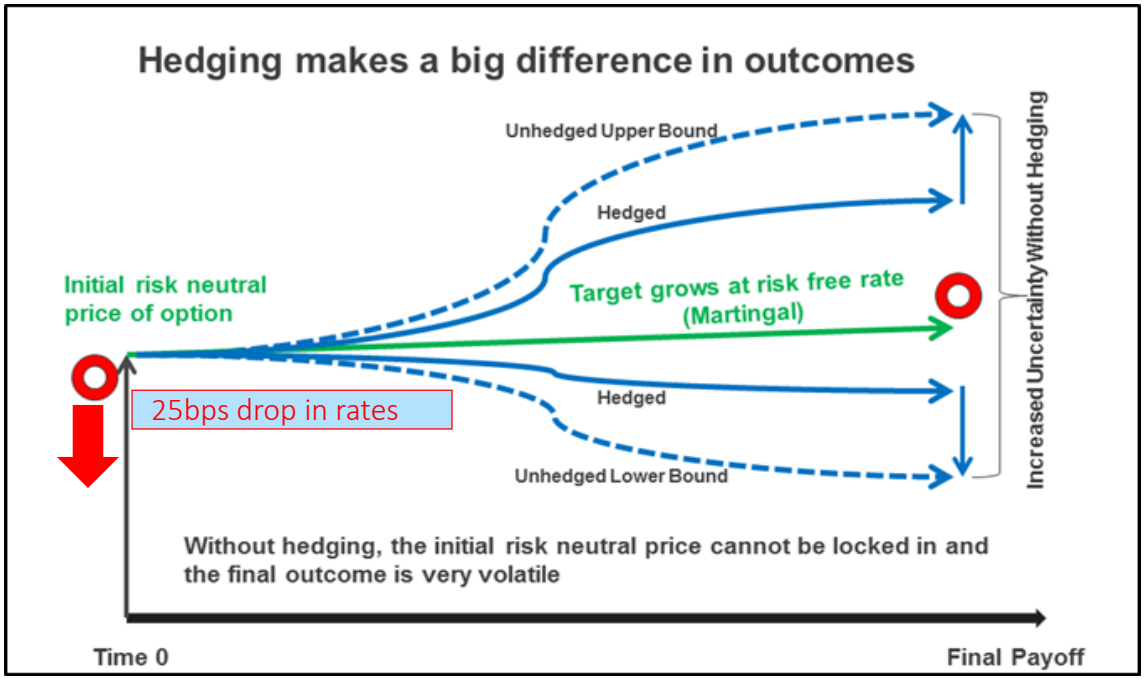
- Hedging (after products are sold) is NOT to cure the already low rate environment

When policies are issued at lower rates, hedging only locks-in the profitability at the lower level (e.g. interest rate hedging is to prevent future interest rate drop)

1. Profitability before market crash
2. Profitability after 25 bps swap rate shock down
3. Profitability after locking-in the shocked swap rate

Profitability (hypothetical case)





VA risk management best practice – integrated risk management

- Two key components
  - #1 Reduce the expected cost of future guarantees – through product designs
  - #2 Reduce the uncertainty of cost of providing actual future guarantee claims – through hedging