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**Valuation Actuary Symposium
September 24- 25, 2009**

Session 26 TS: Introduction to Economic Capital

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Introduction To Economic Capital – Liability Runoff

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Valuation Actuary Symposium
Session 26

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Economic Capital – The Big Picture

In Deciding On A Definition Of EC To Use, Insurers Need To Make A Number Of Key Decisions

- What time horizon to use
- Which measure(s) of risk to use
- Which risks to include
- What level of confidence to target

There Are Also A Number Of Implementation Decisions To Be Made (E.G., Stochastic Vs. Stress Testing Quantification Method) — Consequently, There Are A Large Number Of Possible Ways In Which EC Can Be Defined

Two Fundamental Views On Risk

- Risk of asset cash flows insufficient to meet liability obligations over life
- Risk of possible adverse change in FV of assets and liabilities over one year

Economic Capital – Big Picture

As A Result, Two EC Metrics Have Emerged As The Most Common:

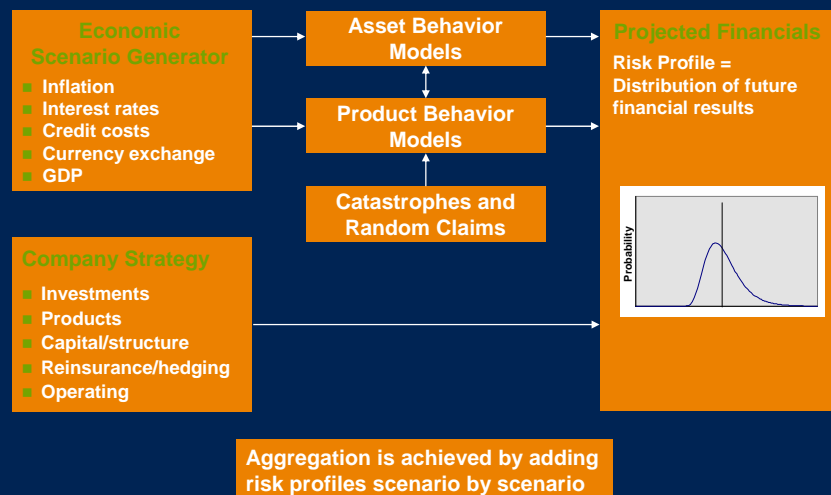
- A liability runoff approach metric
 - The level of total initial assets, less some measure of reserves for liabilities, required to pay all future policyholder benefits at the chosen confidence level
- A one-year mark-to-market approach metric
 - The level of assets, in addition to the market value of liabilities, needed to cover A fall in the market value of net assets over A one-year time horizon at the chosen confidence level

Different Views, But Both Valid –

- Complimentary information – should not rely on single metric
- Can calculate impact of risks, risk-adjusted performance, and diversification benefits under both methods

Liability Runout Approach – Process Overview

With A Liability Runoff Approach, A Real World Stochastic Projection Basis Is Frequently Used



Liability Runoff Approach Metric

EC Is Based On The Amount Of Total Asset Requirement (TAR) Needed To Cover Liabilities At A Required Confidence Level Projected Over The Lifetime Of The Business

- For each scenario examined, the minimum amount of assets required to satisfy all liabilities by the end of the projection is determined
- Scenarios are rank ordered to form distribution of the required TAR amounts
- EC is a function (E.G., CTE) of the distribution of TARs for a given confidence level less some measure of the liabilities

EC Is Derived From The Resulting Distribution Of Total Asset Requirements

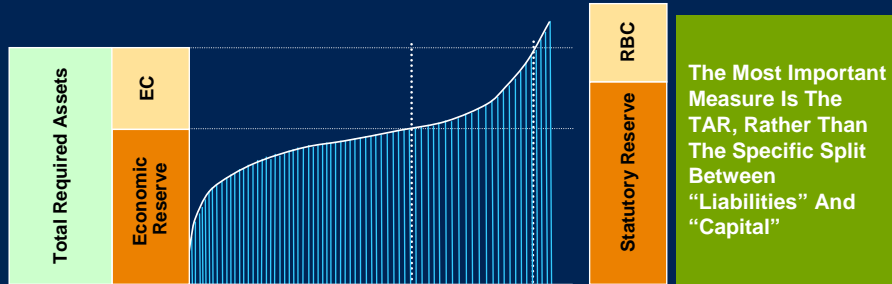


Illustration of Process – TAR Curves

TAR Curves Are Developed For Products:

- Baseline is best estimate without any stochastic adjustments
- Individual risk curves developed from applying stochastic adjustments to specific risk element and using baseline assumptions for all other risks
- "All Risks Modeled" TAR curve captures diversification impact among modeled risks

Notes:

- This process presumes integrated modeling of assets and liabilities
- Rank ordering of scenarios is not the same for the respective TAR curves
- Results are very dependent on quality of the assumptions and modeling of risk distributions, policyholder and management optionality, and asset and liability behavior

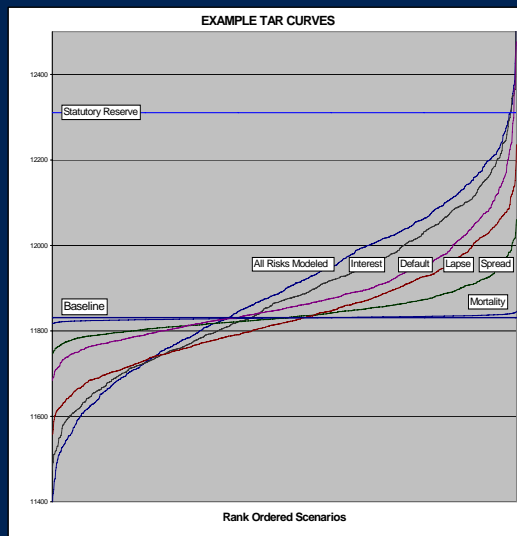


Illustration of Process - Summary EC Metrics

	Economic Reserves CTE(65)	Economic Capital CTE(90)-CTE(65)	Total Asset Requirement CTE(90)
Undiversified (Level 1)			
Baseline (Stochastics Off)	11,831	0	11,831
Attribution			
Interest	246	154	400
Mortality	4	3	7
Lapse	125	97	222
Default	170	134	304
Spread	62	54	116
Total Risk	607	442	1,049
Risk Cov	(296)	(302)	(598)
Net of Cov	311	140	451
Totals	12,142	140	12,282
Diversified (Level 2)			
Baseline (Stochastics Off)	11,831	-	11,831
Attribution			
Interest	151	61	212
Mortality	1	-	1
Lapse	43	11	54
Default	97	66	163
Spread	19	2	21
Total Risk	311	140	451
Totals	12,142	140	12,282

- Metrics for economic reserves, economic capital and the total asset requirement at pre-specified levels are calculated directly from TAR curves

- “Level 1” metrics represent undiversified risks within the product. “Level 2” represents the impact of the internal diversification of risks within the product

Notes:

- TAR curves are further calculated for groupings of products by summing the cash flows of the individual products for each scenario, then repeating the calculation of these metrics

- “Level 3” metrics then represent the aggregate undiversified impact of specific risks across all products, and “level 4” represents the full impact of diversification across all risks and products

Liability Runoff Approach - Variations

In Practice, Different Variations Of The Runoff Approach Exist, Due To Differences In

– Liability Valuation Basis

- Different liability basis results in a different split between liabilities and EC, but total required assets is effectively unchanged
- Popular choices are a statutory, economic or best estimate basis

– Measures Of Interim Solvency

- No solvency check at interim points implicitly allows profits and losses in different time periods to offset each other
- Measures of interim solvency create a more stringent EC requirement; solvency is assessed over interim periods as well as over the entire projection

– Degree To Which New Business Projected

Frequently Implemented Using An Integrated Stochastic Model, Although Other Implementation Approaches Are Possible

Principles-based Approaches To Reserves And Capital Being Adopted In The U.S. By NAIC (E.G., C-3 Phase 2) Use A Liability Runoff Approach (With Statutory Liability Basis And An Assessment Of Interim Solvency)

Liability Runoff Modeling - Value As An ERM Tool

TAR Curves And Metrics Are A Powerful ERM Tool

- Effectively communicates Risk profiles and Diversification impacts
- Tool can be used as the foundation for managing certain risks in an ERM program
- Models can be leveraged directly by Risk Managers for Risk Qualification
 - For example, the model and process are the same as described in the SOA's research paper, *Stochastic Analysis of Long Term Multiple Decrement Contract* for quantifying mortality and lapse risk and reinsurance effectiveness.

Economic Capital Falls Under The Umbrella Of Economic Modeling

- Economic Modeling (including Integrated Stochastic Modeling) is becoming the basis for quantitative aspects of ERM, Economic Capital, ALM, EV, Cash Flow Testing, Principle-Based Reserves and Capital, and more.
- Investment in building quality models pays dividends as they can be leveraged for many current and emerging applications.
- Fair value and liability runoff economic capital metrics both rely on good cash flow models.

Model Building For EC

Hard Part Of An Economic Capital Program Is Quality Model Building And Risk Definition

- EC measures the impact of risks in the tail with high levels of confidence
- Joint effort with Risk Managers to mathematically specify risk distributions and parameters
- Interactions of Risks, Policyholder Behavior, Management Optionality, Asset Performance and such are all important to EC Modeling
- Risk transfer and mitigation activities in the form of Reinsurance, Securitizations, Guarantees, and such will likely need to be modeled to obtain realistic EC metrics
- Modeling standards may need to be promulgated where there are multiple business units

Other Significant Considerations Include:

- GRID computing
- Modeling assets
- Analysis and audit capabilities
- Many technical issues and decisions

Perspective On EC

No Single “Right” Answer

- EC is a function of the Perspective and Technical Implementation Decisions
- Respective approaches have strong biases in the treatment of risks

EC Is Very Technical, Subjective, and Opaque

- Very difficult to evaluate how good an EC measurement really is
- Layer after layer of assumptions are typically made
- Quality of modeling varies significantly
- Impressive technical language and sophisticated techniques are difficult to evaluate and add to opacity

EC Limits Should Be Appreciated

- No standards, many shortcuts
- Risk of spurious accuracy
- Can only model so many risks
- Ability to model reality (Nassim *Talib's The Black Swan* should be required reading)

Introduction to Economic Capital

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Session 26



Economic Capital - Agenda

Definition

Capital Perspectives & Potential Uses of EC

Defining Risk Events

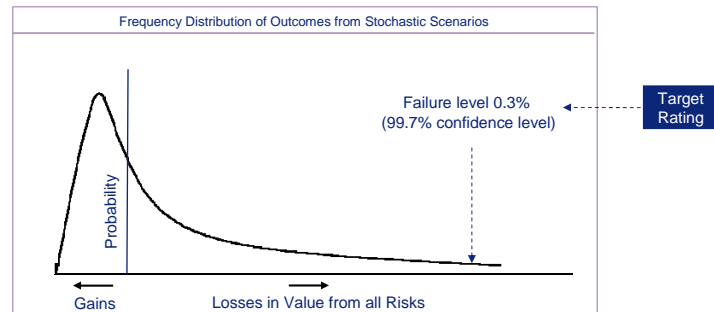
Diversification

Impact of Current Market Environment

Replicating Portfolios

Looking Ahead

Definition of Economic Capital



- Items in **bold** are defined by management and will vary by company
- "The level of capital that results in no more than a **0.3%** chance of failure over a **one-year** time horizon, where failure is defined as losing **100%** of **market value based capital**#"
- # in this case, defined as the excess of the market value of assets over the market consistent value of liabilities

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Capital Perspectives & Potential Uses of EC

- Regulatory Capital
 - Solvency
 - Ability to meet policyholder obligations
- Agency Driven Capital
 - Ability to meet policyholder obligations
 - Ability to meet debt obligations
- Internal Capital
 - Decision making
 - Capital allocation
 - Risk management
 - Compensation
 - Pricing
 - Performance measurement

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Defining Risk Events

- Regardless of choice of method, key to economic capital is defining risk events
- Start with inventory of all risks to which the company is subject
- Determine which of those will be included in EC calculations
- Set desired confidence level (eg 99.5%)
- Develop a distribution of outcomes associated with each risk, and hold capital at desired confidence level

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Diversification

- Determined via correlations embedded in scenarios or correlation matrix applied to stress test results
- Pros and cons of common diversification approaches
 - Correlation matrix
 - Positive – easy to implement, reduced run time
 - Negative – difficult to parameterize
 - Integrated scenarios
 - Positive – provides an integrated solution
 - Negative – increased run time, complex scenario generation
- Most organizations struggle with the allocation of the diversification benefit

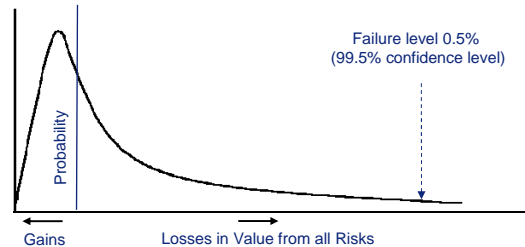
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Characteristics of successful implementations

- ✓ Strong management sponsorship
- ✓ Disciplined methodology development
- ✓ Disciplined approach to implementation
- ✓ Leveraged technology
- ✓ Established production process
- ✓ Communication

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ICA and Solvency II

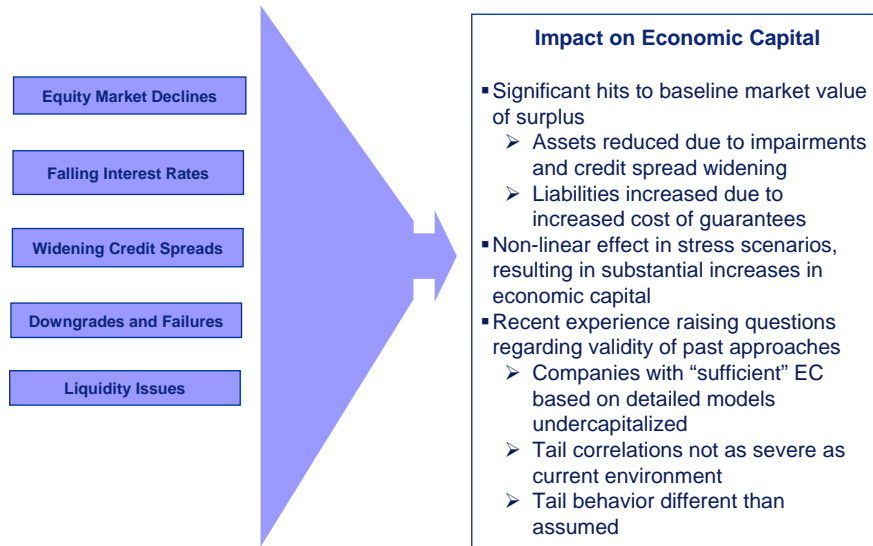


The level of capital that results in no more than a **0.5%** chance of failure over a **one-year** time horizon, where failure is defined as losing **100%** of **market value based capital**"

Item	ICA	Solvency II
Value of liabilities	Best estimate, no risk margin	Best estimate plus risk margin based on CoC approach
Capital Requirement	Based on 99.5%	SCR: Based on 99.5% MCR: Based on lower threshold ORSA: Based on company's risk appetite
Risks Included	All material risks	Market, insurance, credit, operational
Approach	Two pillar (quantitative and governance)	Three pillar (quantitative, governance, and disclosure)

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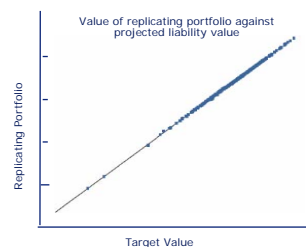
Impact of Current Market Environment



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Replicating Portfolios

- Portfolio of assets which can be used to replicate the behaviour of life insurance liabilities under different economic scenarios
- Once a replicating portfolio of assets has been found, then under a wide range of economic conditions, the value of the replicating portfolio equals the value of the liabilities
- The RP can then be used as to estimate the MVL when market conditions change without time consuming model re-runs
- This enables companies to quickly recalculate liabilities, balance sheets, capital requirements and embedded values:
 - As economic conditions change
 - Under "what ifs" and specific scenarios
 - To project market consistent balance sheets



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Replicating Portfolios

Sample liability features and behaviors and candidate assets

	Features and Behaviors	Candidate Assets
Basic Cash Flows	<ul style="list-style-type: none"> Fixed cash flows Investment index-linked cash flows Credited rate based on bond yields Longevity related 	<ul style="list-style-type: none"> Zero coupon bonds Equity / property total return index Bond total return index Life table amortizing bonds, mortality swaps
Embedded Guarantees	<ul style="list-style-type: none"> Guaranteed accumulation values Participation in investment profit upside (ex EIA) Guaranteed minimum credited rates Guaranteed annuity rates, GMIB Guaranteed reinvestment terms on future premiums Ratchets / non-negative reversionary bonus 	<ul style="list-style-type: none"> Equity put options Equity call options Bond put option, American style or Bermudian swaption Vanilla swaptions, quanto swaptions Forward start options Cliquet / lookback options
Dynamic Policyholder behaviour	<ul style="list-style-type: none"> Option take-up rates depend on moneyness Lapse rates increase in high markets Lapse rates increase in low markets Equity fund lapse rate depends on interest rates Premium persistency dependent on option value 	<ul style="list-style-type: none"> Power law options Up and out options Down and out options Outside barrier options Compound options (options on options)

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Looking Ahead

- US companies continue movement to a market-consistent approach
- Significant focus on quality of models
- Increased use of management “dashboards” to enable users of EC results to understand drivers and analysis of change
- Reevaluation of methods used to determine shock events
 - History alone insufficient
 - Judgment required via “panel of experts”/survey approaches
 - Correlation assumptions will continue to be a challenge
- Increased use of stochastic versus stress test methods
 - Will further drive need for robust, high quality, well controlled models
- Potential for pullback from rating agencies on use of internal models

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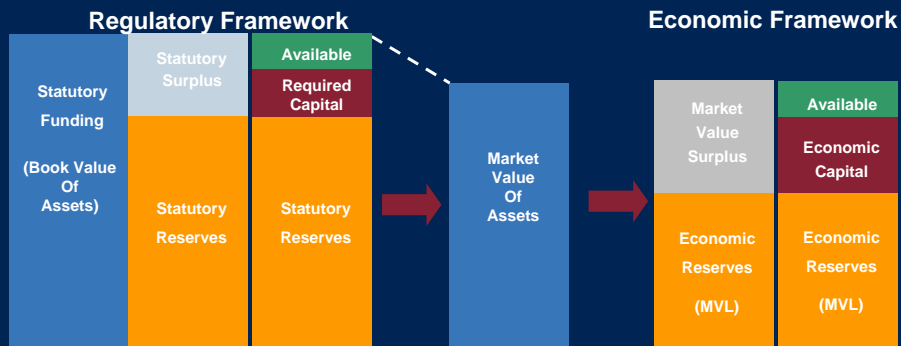
Introduction to Economic Capital – Fair Value

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EC Framework Provides Alternative Views

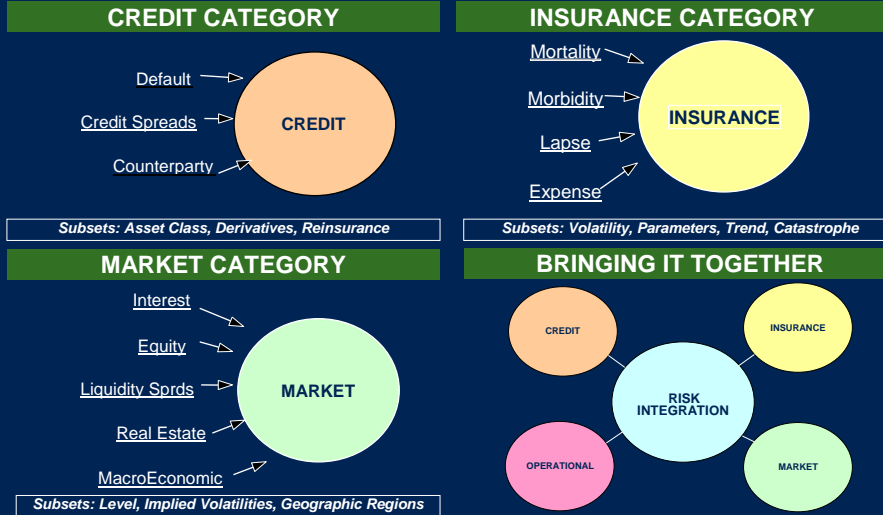


Is There Enough Surplus To Support Risks?

New Terminology:

- Required Capital (Statutory) → Economic Capital
- Statutory Reserves → Economic Reserves (MVL)
- Market Value Surplus (MVS) = MVA (Assets Backing Required Funding) – MVL

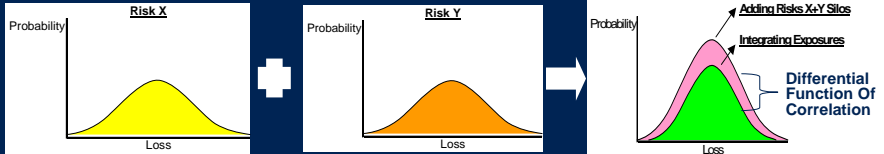
Risk Universe



2

Viewing Risk Holistically

Leveraging Natural Offsets Enhances Risk Profile



Holistic Views Of Risk May Demonstrate Favorable Profile

	Prod A	Prod B	Prod C	Prod D	Prod E	<i>Integrated Products</i>
Investments						
Credit	X	X	X	X	X	<i>Credit Total</i>
Interest	X	X	X	X	X	<i>Interest Total</i>
Equity			X		X	<i>Equity Total</i>
Claims						
Mortality	X	X	X	X		<i>Mortality Total</i>
Longevity	X	X	X			<i>Longevity Total</i>
Morbidity		X		X		<i>Morbidity Total</i>
Unemployment	X	X		X	X	<i>Unemploy Total</i>
Integrated Risks	<i>A Total</i>	<i>BC Total</i>	<i>C Total</i>	<i>D Total</i>	<i>E Total</i>	<i>Enterprise Total</i>

3

Principles Of Fair Value EC Framework

- Consistent With Solvency II Principles
- EC Assessed From Stressing Total Economic Balance Sheet
- Stress Assesses Impact To Market Value Surplus (MVS) Over One Year
- $MVS = \text{Market Value Assets} - \text{Market Value Liabilities}$
- Market Value Assets (MVA) Is Generally Known
- Market Value Liab (MVL) Reflects Fulfillment Cost Of Liability Obligations
- Fair Value EC is:
 - The Additional Assets Over MVL Needed To Be Economically Solvent In 1 Year At Some Confidence
 - Loss (Risk Exposure) in Economic Value From a Catastrophic Event Within 1 Year
- EC Often Assessed:
 - Through Real World, Risk-Integrated, Stochastic Scenarios
 - Confidence Level Extremely High (99.5% - 99.95%)

4

Explaining 'One Year' Risk Horizon

- EC Is Potential Impact To MVS Over One Year
- $MVS = \text{Market Value Assets} - \text{Market Value Liabilities}$
- Impact To MVS Requires Full Run Off Of Lifetime Cash Flows

Scenario Path Assumption Under 'One Year' Risk Driver Shocks

Risk Driver	1 st Yr Scenario Path	Remaining Yrs Scenario Path
Market/Credit	Extreme Market/Credit Shock	Forward Curve Relative To Shock
Insurance-Normal Volatility	Random Fluctuation Shock	Returns To Best Estimate
Insurance-Catastrophe	Catastrophic Shock	Returns To Best Estimate
Insurance-Incorrect Baseline	Assumption Misestimate Shock	Shock Persists For Product life

5

Market Consistent (MC) Concepts

- Uses MC Assumptions To Predict Future
- MC Assumptions Aligned With Market Perception Of Risk

Example:

- The Price Of A Security Is Set In The Market (\$100)
 - $PV(\text{Cash Flows}) @ \text{Discount Rate} = \100
 - Two Ways Of Aligning Assumptions With The Market
 - 1) Cash Flow Assumptions = Best Estimate; Solve For Discount Rate
 - 2) Discount Rate = Risk-Free Return; Solve For Cash Flow Assumptions
 - Method 2) Gives Rise To MC Assumptions
- MC Valuation Is All About Pricing With MC Assumptions
 - Using MC Assumptions Aligns Valuation With Market

6

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Value Concepts In Capital Markets

	"VALUE"	CASH FLOWS (YEARS)				
		1	2	3	4	5
Borrowing \$100 To Pay Stream Of Liability Cash Flows	=	5.25	5.25	5.25	5.25	105.25
Buy Treasury	(\$1.08)					
Asset Principal/Interest		5.00	5.00	5.00	5.00	105.00
Market Expectations Of Defaults		-	-	-	-	-
Asset Cash Flows		5.00	5.00	5.00	5.00	105.00
Income		(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Buy Corporate	(\$1.08)					
Asset Principal/Interest		6.50	6.50	6.50	6.50	106.50
Market Expectations Of Defaults		(1.50)	(1.50)	(1.50)	(1.50)	(1.50)
Asset Cash Flows		5.00	5.00	5.00	5.00	105.00
Income		(0.25)	(0.25)	(0.25)	(0.25)	(0.25)

- Market Prices Reflect That Every Investment Has The Same Risk-Adjusted Cash Flow
- On Average, No Free Lunch Exists...Times That Beat Market Expectations Will Be Offset By 'Market Corrections'
- The Value Of Any Asset, Today, Is The Same

7

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Principles Of Market Value Of Liabilities

- Without Traded Market Prices, Economic Valuation Techniques Used

- Where Possible, Liability Value = Value Of Capital Market Hedges
- If No Market Hedge Exists, Apply 'Market Value Margins' (MVM)

- Market Value Margins Is Margin Over Best Estimate Assumptions
- Assess Lifetime Capital Cost To Hold Additional Risk Margins
- Market Value Margins Analogous To Mark-To-Model Adjustment

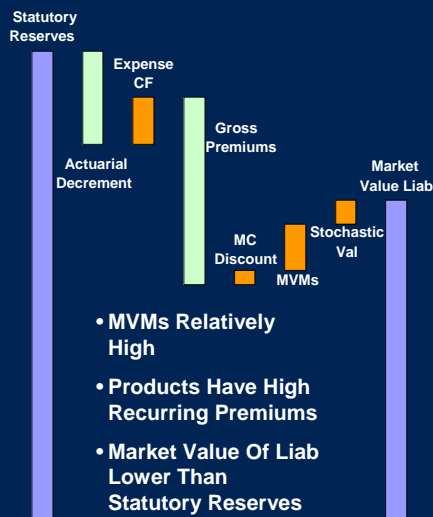
Risk	Ability To Observe Hedges <==High.....Low ==>
Interest/Equity	X
Credit/Spreads	X
Mortality/Morbidity	X
Home Price Appreciation	X
Unemployment	X

- Market Value Liab = Base Value + Market Value Margins

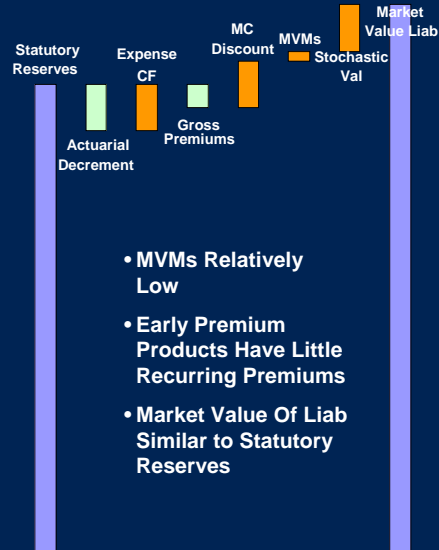
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Reconciling Stat/Econ Reserves Generically

Example 1

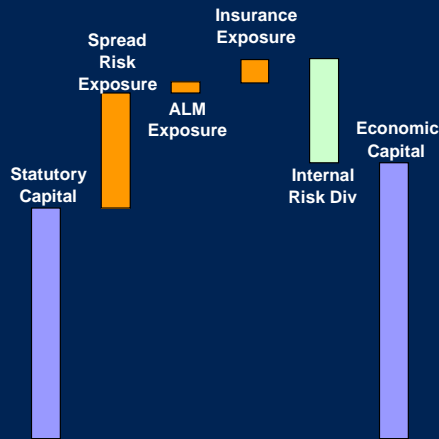


Example 2



9

Reconciling Stat/Econ Capital Generically

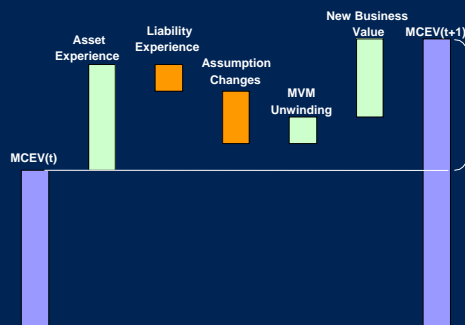


- Spread Exposure Material Risk From Economic Solvency Perspective
- Statutory Capital Has Limited ALM Exposure On Products With Insurance Risks
- Statutory Capital Has Limited Insurance Exposure On Retirement Income Products
- Risk Diversification Is Assessed Internally And At Any Product, Geographic, Or Enterprise Level

10

Fair Value EC Is Value Oriented Framework

- Market Consistent Embedded Value (MCEV) Represents Shareholder Value
- $MCEV = MVS = \text{Market Value Assets} - \text{Market Value Liab}$
- MCEV Is Value Of Liquidation At Market Value
- Economic Earnings = Growth In MCEV (excluding Dividends/Infusions)
- Economic Earnings Represents Value Added Contributions



Economic Earnings

- Market Value Profit Or Loss
- Investment Earnings Recognized When Earned
- Attributable To Inforce Growth And New Issues
- Excludes Dividends Or Infusions

11