ERM-2: Introduction to Economic Capital Modeling

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Capital modeling: A key component of a company's overall implementation of risk management

- Today's session focuses on:
  - The role of EC in the broader risk management framework
  - An overview of basic EC concepts
  - Considerations in designing the EC model

Why is EC important?

- Unlike other measures of capital, Economic Capital (EC) captures the combined effect of the various risks and interactions thereof to which an insurer is exposed
- Regulatory bodies continue to encourage the use of EC in capital adequacy assessments
- Rating agencies are adopting EC approaches
- Because EC reflects the risks specific to the insurer, it can be a useful tool in a number of different business contexts (not limited to capital adequacy)
- Both the senior management team and the Board need to be equipped to understand, interpret and utilize the EC model output to inform their decisions

How will EC fit into overall risk management implementation?

A comprehensive risk management program should encompass a broad spectrum of risks and areas of risk management

- Risk management needs to address all sources of risk across the business
- Underlying the risk management framework are finer, more focused risk management processes
- Many companies use a framework that focuses on four key areas of risk:

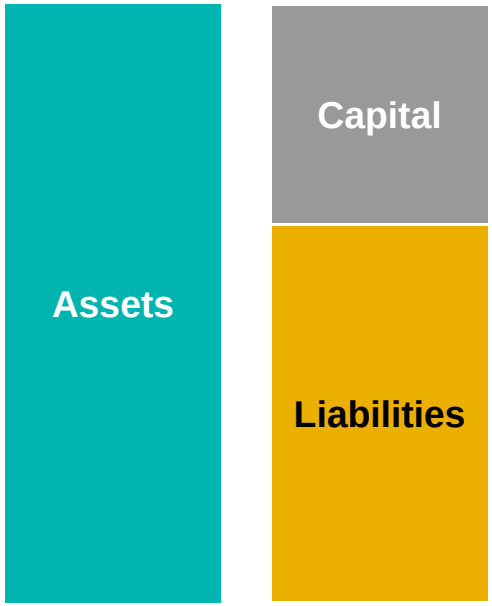
Capital risk	• Material loss of capital • Ratings downgrade
Earnings risk	• Income volatility • Failure to meet plan • Underperformance versus peers
Liquidity risk	• Inability to meet cash calls
Franchise risk	• Damage to reputation • Loss of customers and top-line revenue • Loss of employees/talent/capabilities • Diminished future earnings potential

A single model should not necessarily be used to measure and manage all of these risks

- A one-size-fits-all model may not be appropriate
  - Examples:
    - An earnings model should consider expense ratio risk (i.e., risk of actual expenses being greater than expected), whereas a capital model does not typically include this risk
    - A capital model also does not necessarily forecast cash flows, as would be necessary for an earnings model
    - A capital model is not considered useful for measuring liquidity risk, as holding capital against liquidity risk is largely viewed as ineffective and inefficient
    - Reputation risk can be difficult to quantify and model accurately
- Some insurers have multiple models: e.g., capital model, earnings model, cash flow model
  - Risk assumptions should be consistent across models
- Smaller, less complex insurers may able to use a single financial model for multiple purposes

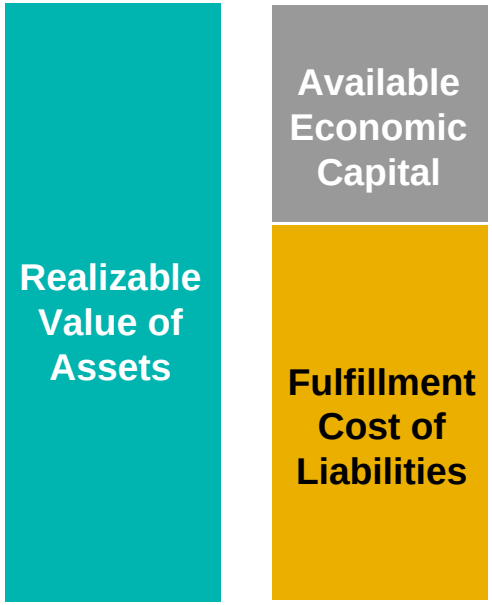
Capital is context dependent: measuring it requires an accounting valuation model

- The *capital (*aka *available capital)* of an insurer is defined as the excess of the value of its assets over the value of its liabilities
- The calculation of an insurer's *available capital* depends on the accounting convention being used, which may vary according to the intended use of the calculation
  - Examples: Statutory, GAAP, Economic
  - Differences in accounting conventions primarily relate to the inclusion of specific types of assets and liabilities and methods for the valuation of assets and liabilities
- Measuring an insurer's *available capital* is relatively straightforward under most accounting conventions

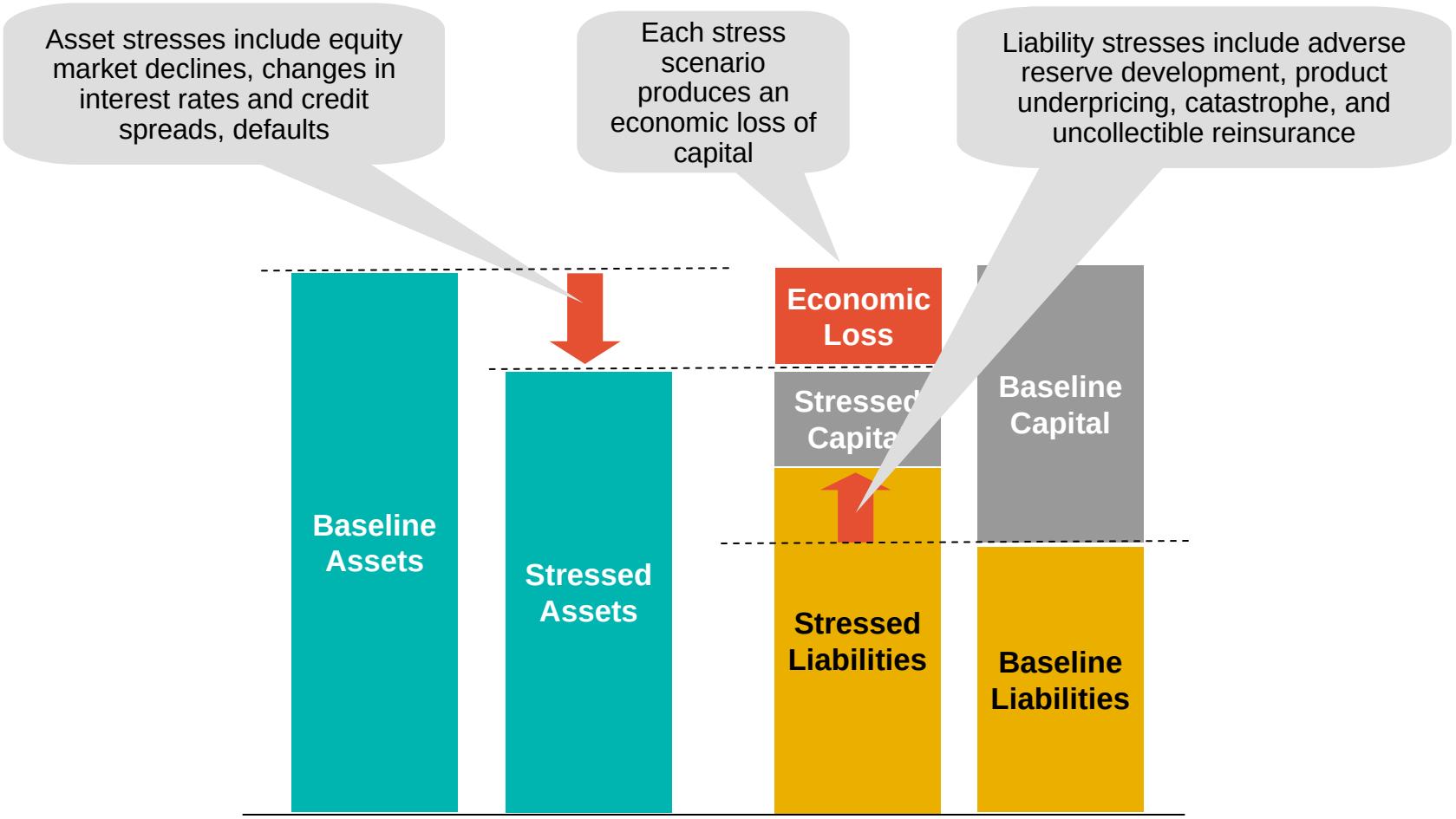


What is “economic capital”?

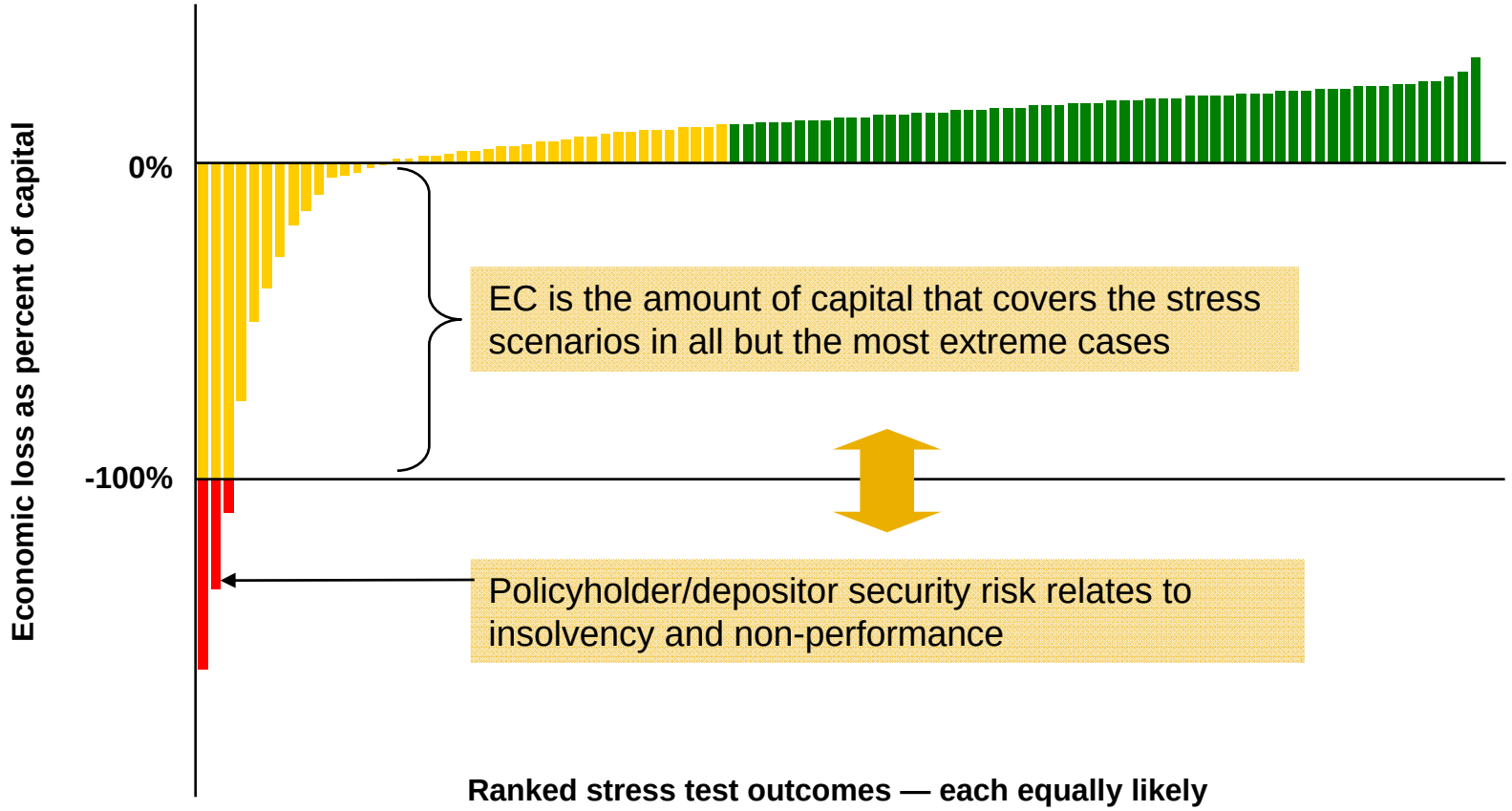
- An insurer’s a*vailable economic capital* is the excess of the realizable value of the company’s assets over the fulfillment cost of its liabilities
- An insurer’s *required economic capital* is the amount of capital that a company needs to provide a reasonable level of security to policyholders, that obligations to them will be met
  - Measurement still reflects realizable asset values and fulfillment costs, but takes into account the risks that asset values could decline and/or fullfillment costs could rise
  - Requires that a security standard be specified
  - Often refered to simply as EC
- The calculation of an insurer’s *required economic capital* can be quite complex



Required EC is measured by “stress-testing” the economic balance sheet



To calculate EC we must compile the economic losses from all of the stress tests



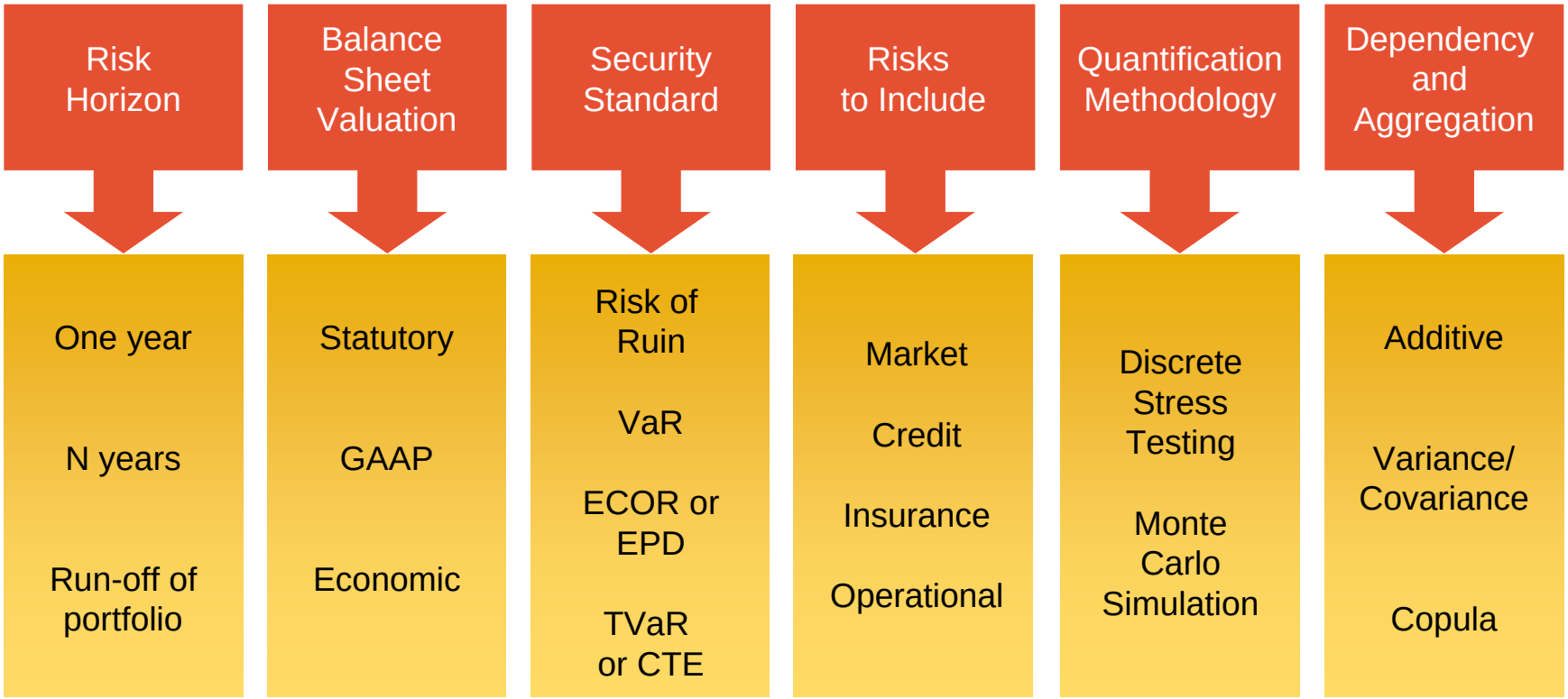
- In the model EC is varied, up or down, until the chosen security standard is just met

Companies that are implementing EC models believe they can use them to help make decisions

- Is my capital adequate to support the current business plan?
  - Will I have excess capital that is not deployed into the business?
  - Do the profits I expect to generate provide an adequate return?
  - Are there changes to the plan that would put me in a better position?
- Which risks are creating the greatest need for capital, and am I doing enough to mitigate those risks?
  - Is there a more effective design for my reinsurance program?
  - Should I make greater use of hedging against market or economic risks?
- How much capital is each business and product using?
  - How should I allocate capital so that the cost of capital can be appropriately included in product prices?
  - Are products and businesses generating adequate returns on the capital they are using?
  - Should I grow or shrink businesses, based on their expected returns on capital?

While best practices are emerging, there is still not "one right way" to measure EC

Six Key Methodological Elements that Must be Decided



The approach taken should reflect the circumstances of the company and management's preferences and objectives, as well as best practice

EC model design considerations — risk horizon

- Two emerging alternatives

Run-off of Portfolio	• Projects asset and liabilities into the future, until all liabilities have been settled • Fundamental question being asked is, “Can I meet all of my obligations as they come due, in most circumstances?” • Essentially a cash flow testing approach • Requires multi-year scenarios as to market and economic conditions • Typically includes one additional year of business
One-year Horizon	• Projects balance sheet one year into the future • Fundamental question being asked is, “What might happen to the values of my assets and liabilities?” • Essentially a trading approach; assumes that risk position can be (at least partially) exited at the end of the year • Requires “market values” for liabilities • Typically includes losses from coverage provided during the year

To see the differences between the two risk horizons, consider the risks associated with investing in a corporate bond

- Ten-year investment grade bond

Run-off of Portfolio	• Buy-and-hold strategy • What is the likelihood that the bond will default at any point over the ten years to maturity? • Fluctuations in market value along the way are not a concern
One-year Horizon	• Trading strategy • How might changes in interest rates and credit spreads over the next year affect the market value of the bond? • What is the likelihood that the bond will default or suffer a downgrade in the next year? • Defaults and changes in market value beyond one year are not a concern

There is a (slowly) emerging consensus favoring the one-year risk horizon

	Proponents	Detractors
Run-off of Portfolio	• Consistent with illiquidity of policy liabilities ("buy-and-hold") • Doesn't require market values of liabilities • Doesn't actually require balance sheets	• Intractable technical problem: How do you combine different businesses, with different run-off durations?
One-year Horizon	• Consistent with real-world solvency regulation • Only need to specify what might happen over the next year • Simpler and more transparent	• Assumption that current risk position can be exited is open to question

EC model design considerations — balance sheet valuation

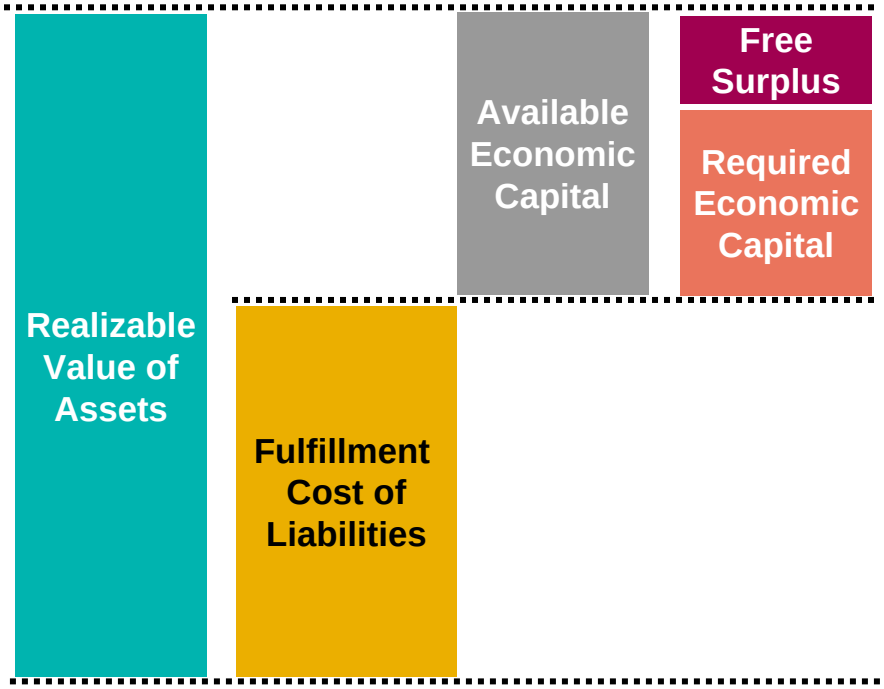
- Two emerging alternatives, with a slight preference for economic

Statutory	• Value all assets and liabilities using statutory regulatory valuation scheme
	  ◦ Assets at amortized cost or market
	  ◦ Loss reserves at nominal value
	• Rationale is that this is the legal basis on which regulators will judge whether you are insolvent or not

Economic	• Value all asset and liabilities using a market-consistent economic valuation framework
	  ◦ Assets valued at market
	  ◦ Loss reserves and unearned premium reserve at present value using risk-free rate, plus a market-value margin that compensates holder for taking risk
	• Rationale is that, in a distressed circumstance, external audiences will look to market values to determine viability

The economic balance sheet is prepared on a market-consistent basis

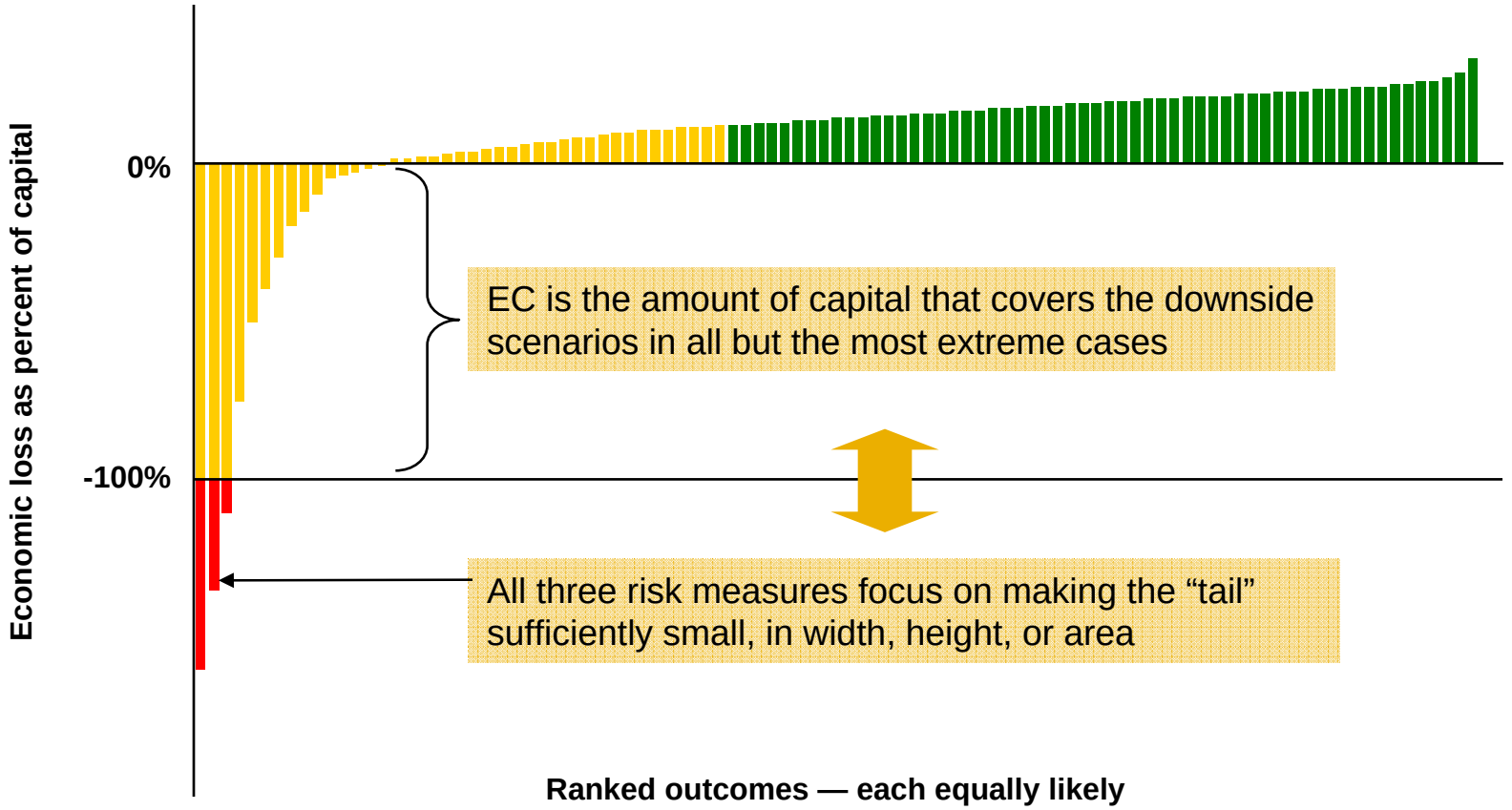
- Realizable values of assets are typically their market values, net of tax costs/benefits
- Fulfillment cost of liabilities is typically the present value of the expected payments, plus a market-value margin, net of tax benefits/costs
  - The market value margin compensates the holder of the liabilities for the risk associated with them
  - Market value margin would be required in any arms-length transfer of the liabilities (entity taking them over would want a return on them)



EC model design considerations — security standard

- In the context of EC, risk = failure, insolvency, unsatisfied policyholder obligations (default on depositor obligations for a bank)
  - EC is set so that failure risk is reduced to an acceptable minimum (a security standard)
- Various measures of failure risk
  - VaR ("Value-at-Risk")
    - Amount of capital needed to reduce **probability of failure** to acceptable target
    - For example, probability of unsatisfied claims = 1%
  - ECOR ("Economic Cost of Risk") or EPD ("Expected Policyholder Deficit")
    - Amount of capital needed to reduce **expected cost of failure** to acceptable target
    - For example, expected unsatisfied claims = .5%
  - TVaR ("Tail Value-at-Risk") or CTE ("Conditional Tail Expectation")
    - Amount of capital needed to cover **expected cost of failure above selected probability target**

All three risk measures are ways of measuring the "smallness of the tail"



Emerging best practice is to use either VaR or TVaR risk measures

- Advantages of VaR
  - Easy to interpret: probability of ruin
  - “Who cares how dead you are?”
  - Widely used, common in insurance and banking
  - More credible to model
- Advantages of TVaR
  - Considers both probability and severity of failures
  - Technical advantage of coherence; important when allocating capital

EC model design considerations — security standard

- One way to set the level of the security standard is by reference to bond default statistics

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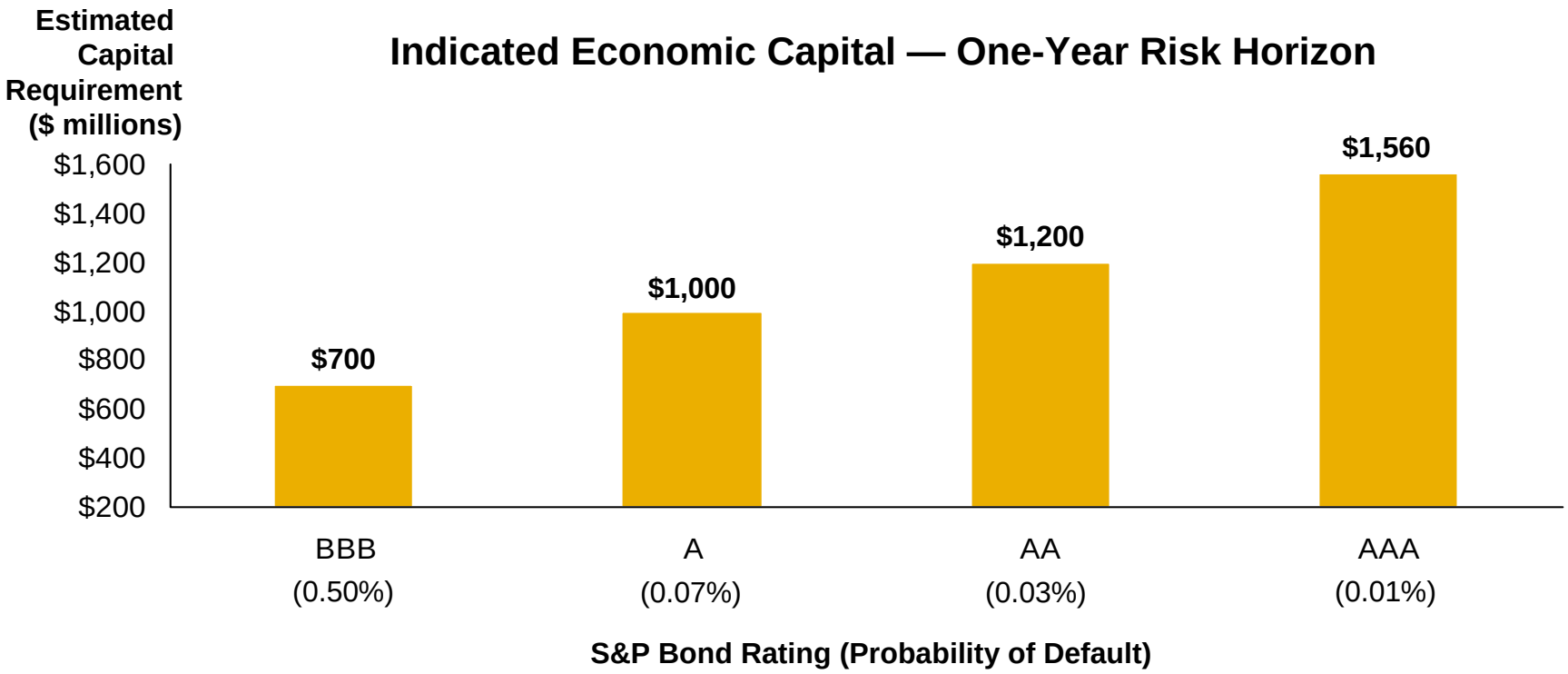

Other methodological issues

- Risks to include
  - Most companies are focusing on key insurance and market risks
  - Reinsurer counterparty credit risk is also often a priority
- Quantification methodology
  - Most companies are using Monte Carlo (i.e., stochastic) simulations
- Dependency and aggregation
  - Adding results is tantamount to assuming that all bad things happen at once (obviously conservative)
  - Best approach is to use Monte Carlo simulations with Copulas, so that aggregation reflects appropriate diversification benefits
  - Limits on fungibility of capital between legal entities must also be recognized in aggregation

Building an EC Model

Basic construct of an economic capital model

Risk factors:

Examples: Interest rates, credit spreads, claim liability estimation, product pricing, inflation, customer retention, hurricane, pandemic, IT failure, market conduct

- Specify stress values for each risk factor, and associated probabilities
- Specify dependency structure across risk factors

Risk portfolios (assets and liabilities):

Examples: Equities, investment-grade corporate bonds, personal auto claim liabilities, workers compensation claim liabilities

- Specify loss functions that describe how each portfolio responds to movements in risk factors

Aggregate Economic Losses:

Losses in capital value due to all combinations of risk factors — with associated probabilities

Required Economic Capital:

Capital sufficient to sustain all but the most extreme stress scenarios — set at selected security standard

The EC model is designed to reflect all key risks and the company's specific business structure

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A defined set of risk factors:

- By market
  - Interest rates
  - Credit spreads
  - Equity market
  - Inflation
- By product
  - P&C reserving
  - P&C pricing
  - Life longevity
  - Policy lapses
- Catastrophe
  - Wind
  - Earthquake
  - Pandemic
- Operational
- …

The portfolio of risks within a defined business structure:

- Commercial Business
  - Commercial property
  - Workers compensation
  - Excess liability
  - Investments
- Personal Business
  - Auto
  - Homeowners
  - Investments
- Life Business
  - Traditional
  - Unit-linked
- Bank Business
- …

- Level of granularity is limited only by the ability to specify the risks and inter-dependencies
- Economic capital will be allocated to each defined risk factor and business portfolio

A company should start by establishing its own hierarchy of risk factors, and prioritize their inclusion in the model

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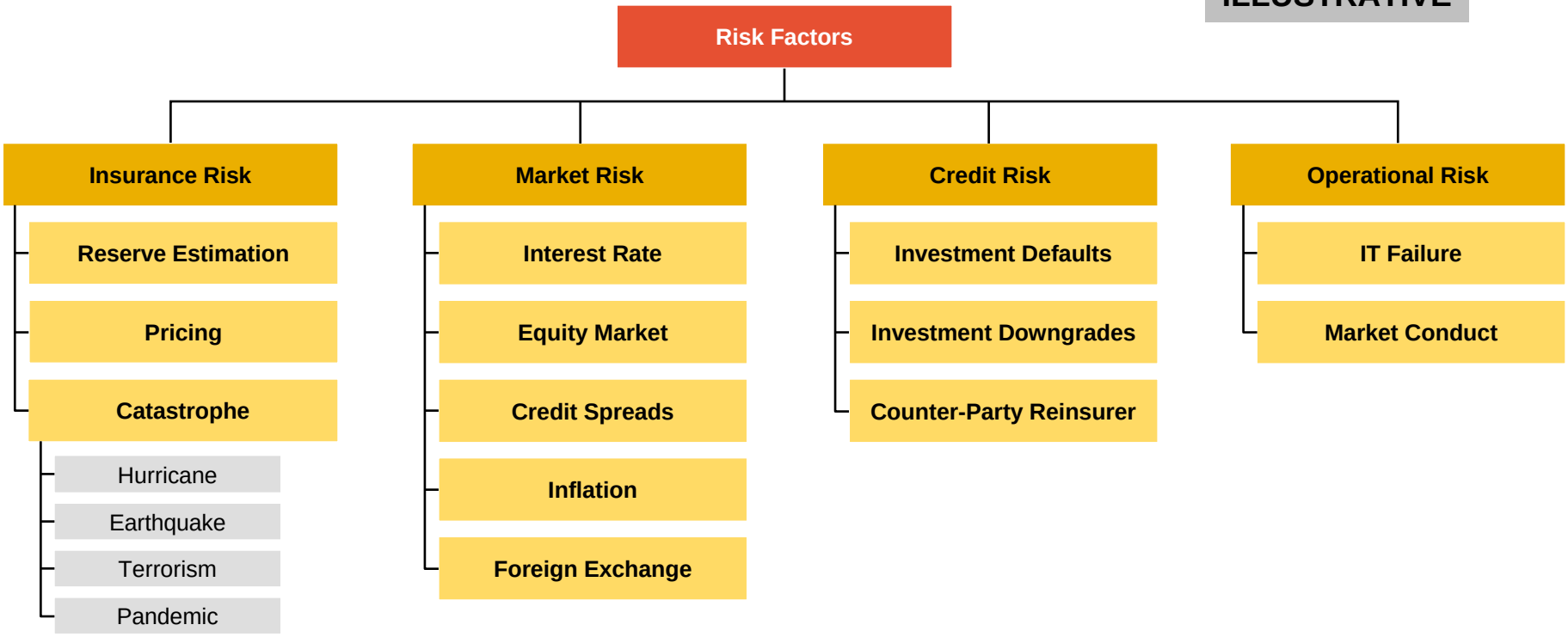


Risk factors — insurance risk

- Insurance risk factors capture the principal types of insurance risk:
  - Reserve risk — potential adverse development on reserves held for previous policy periods, due to misestimation of liabilities
    - Typically modeled using stochastic methods — validated with history
  - Pricing risk — potential underwriting losses for the current year, due to mispricing of product
    - Can use loss ratio distribution models or frequency/severity models, or make inferences from reserve risk models — validated with history
  - Catastrophe risk
    - Typically uses vendor-provided catastrophe models
- Dependency across insurance risk factors and with market risk factors

Risk factors — market risk

- Market risk is a measure of the potential loss in value resulting from changes in market variables, such as:
  - Interest rates
  - Credit spreads
  - Equity market indices
  - Inflation rates
  - Foreign exchange rates
- Extensive body of academic research on historical behaviors, coupled with financial economic theory
  - Banks made the mistake of extrapolating short-term volatility to long-term behaviors

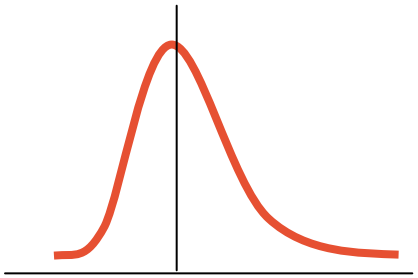
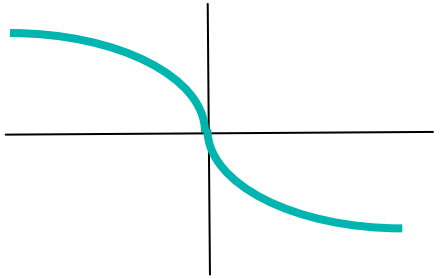
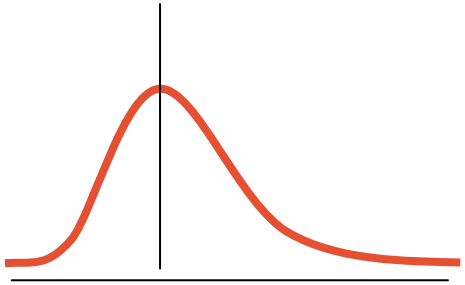
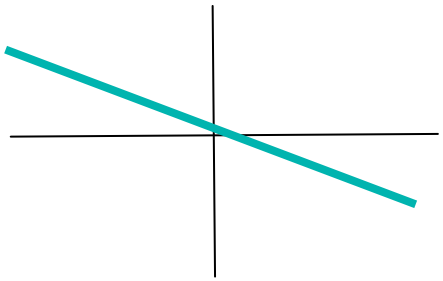
Risk factors — credit risk

- Credit risk measures the potential loss in value arising from credit events, including:
  - Default risk on major investment holdings
  - Downgrade risk on major investment holdings
  - Default risk of counter-party reinsurers
  - Default risk of premium receivables from key accounts
- Typically modeled using rating agency default/downgrade models

Risk factors — operational risk

- Operational risk is the risk of loss resulting from inadequate or failed internal processes, personnel and systems or from external events
- Can be explicitly modeled or assessed qualitatively, and may or may not lead to a capital charge
- Possible approaches to modeling include:
  - Add-on model, which aggregates expected costs for various operational risks (requires assumed degree of correlation and confidence level)
  - Stochastic model based on scenario analysis
    - Parameterization requires input from risk managers and other knowledgeable staff to understand and assess risks

For example, suppose we only had two risk portfolios, each subject to only two risk factors

Risk Factors	Risk Portfolios
Interest Rate **Probability of interest rate change from current level (Bp)**  **-100 0 +100**	**$15M of Treasury Bonds** **Change in value as a function of interest rate changes** 
Claim Liability Estimation **Probability of estimation error (%)**  **-10% 0 +10%**	**$10M of Auto Loss Reserves** **Change in value as a function of reserve error percent** 

Calibration of loss functions can be based on individual stress tests or a stochastic model

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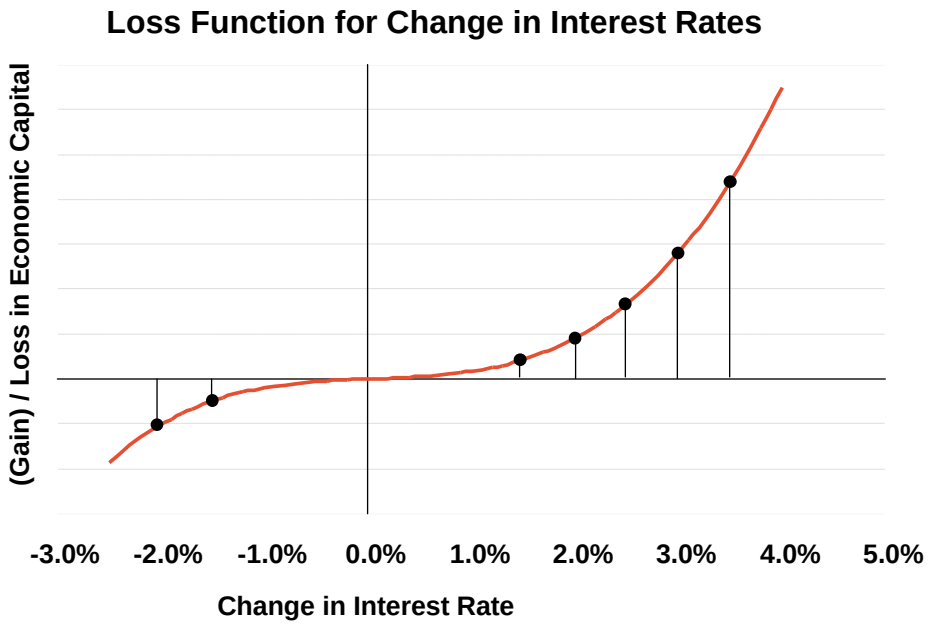
- Detailed portfolio models can be used to measure the economic losses due to changes in each risk factor
  - Exploits higher resolution of detailed models to retain accuracy
- In addition to looking at the impact of individual risk factors, the loss functions must also capture key interactions between risk factors
  - This is very relevant when two risk factors interact to compound losses
    - — Catastrophe losses and reinsurance counterparty defaults



Each level of stress is assigned a probability and a value

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Illustrative Table of Selected Stresses

Target Financial Strength Rating	Confidence Level Equivalent	Equity Value Stress	Interest Rate Stress	Loss Reserve Misestimation
AAA	0.05%	-50%	+/- 200bps	+50%
AA	0.1%	-40%	+/- 150bps	+35%
A	0.2%	-35%	+/- 120bps	+25%
BBB	0.5%	-30%	+/- 100bps	+20%

- Probabilities and stress values reflect research and judgment of experts

Dependency structure between risk factors must be specified, and results must be aggregated across all risks and businesses to calculate overall EC

- Dependency defines the extent to which bad things are likely to happen at once
  - Convenient metric is correlation
    - 0% means no dependence
    - 100% means perfect dependence
  - Simplest approach is to add EC derived from each piece
    - Assumes 100% correlation — very conservative
- Dependency isn't constant across situations
  - When the U.S. equity market goes down a little, the UK market moves independently
  - When the U.S. equity market goes down a lot, the UK market usually also goes down
  - When the U.S. equity markey is in free fall, the UK market almost always does the same
- Copulas are usually used to capture the dependency structure
  - Complex mathematically, but not too hard to understand
  - Degree of "correlation" varies
    - What is it at 50th percentile?
    - What is it at 99th percentile?
- One-year risk horizon makes aggregation much easier
  - Only way to effectively aggregate Life and P&C results