

Reverse Stress Testing:

Challenges & Benefits

Presented by:

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Reverse Stress Testing: Introduction & Agenda



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Today's Participants



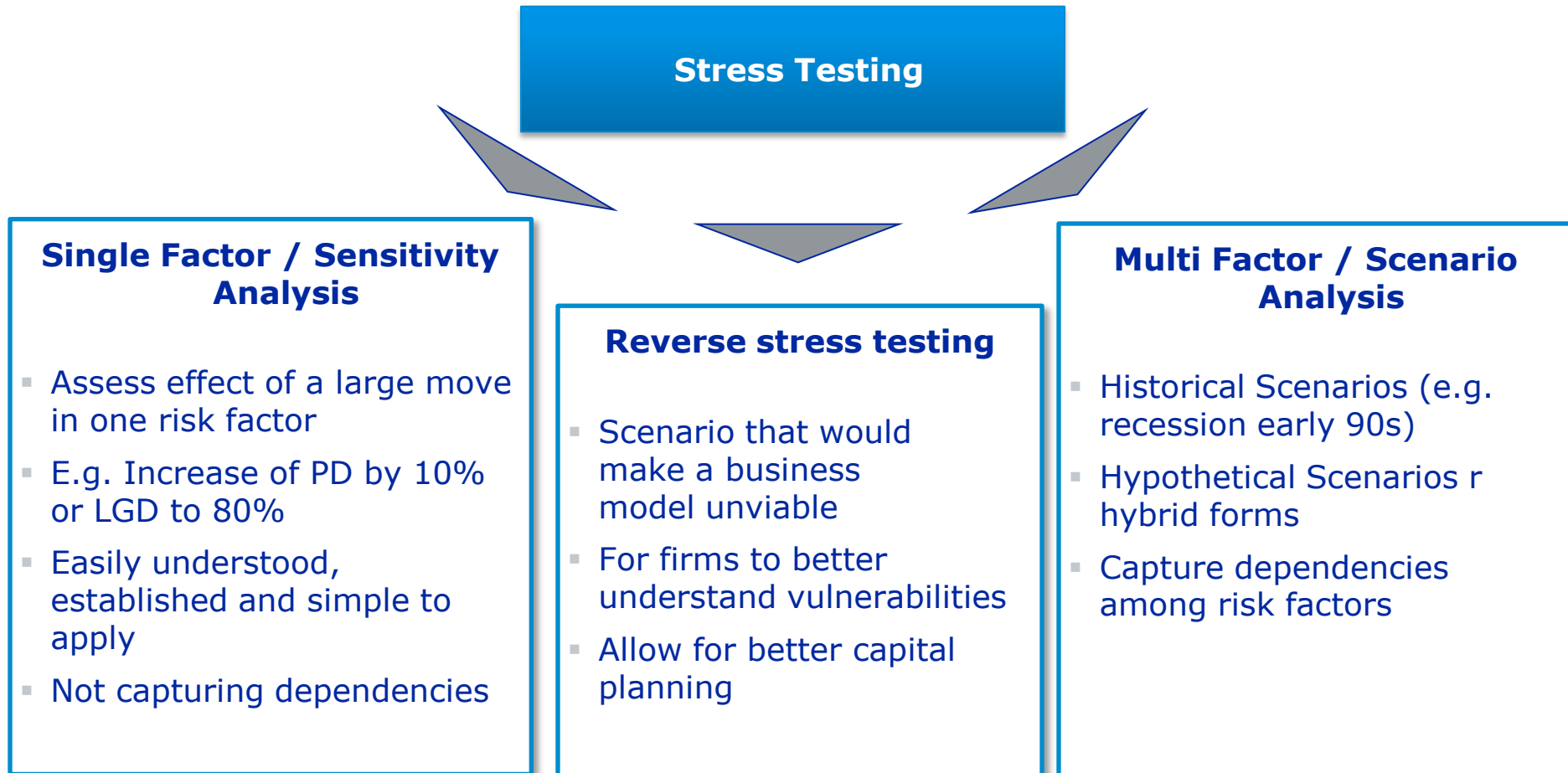
- » Reverse stress testing is a hot topic around the world
- » 700+ registrations from Europe, North and Latin America, the Middle East, Africa and Asia

Today's Agenda

- Types of Stress Testing
- Reverse Stress Testing: Definition and Key Purpose
- Quantitative Approach to Reverse Stress Testing
- Qualitative and Hybrid Approaches to Reverse Stress Testing
- Understanding Key Risks to the Global Economy

Stress Testing

Types of Stress Tests



Reverse Stress Testing

Definition:

Process of identifying the point at which a financial institution's **business model becomes unviable** and then **identifying scenarios** and circumstances that might cause this to occur.

Idea:

Reverse engineering of the risk management process

Think beyond capital/losses/liquidity: **reputation, concentration, loss of confidence**

Purpose:

- Overcome disaster myopia and improves contingency planning
- To be added as a key **Risk Management tool**

Quantitative Reverse Stress Testing

What the Regulator says

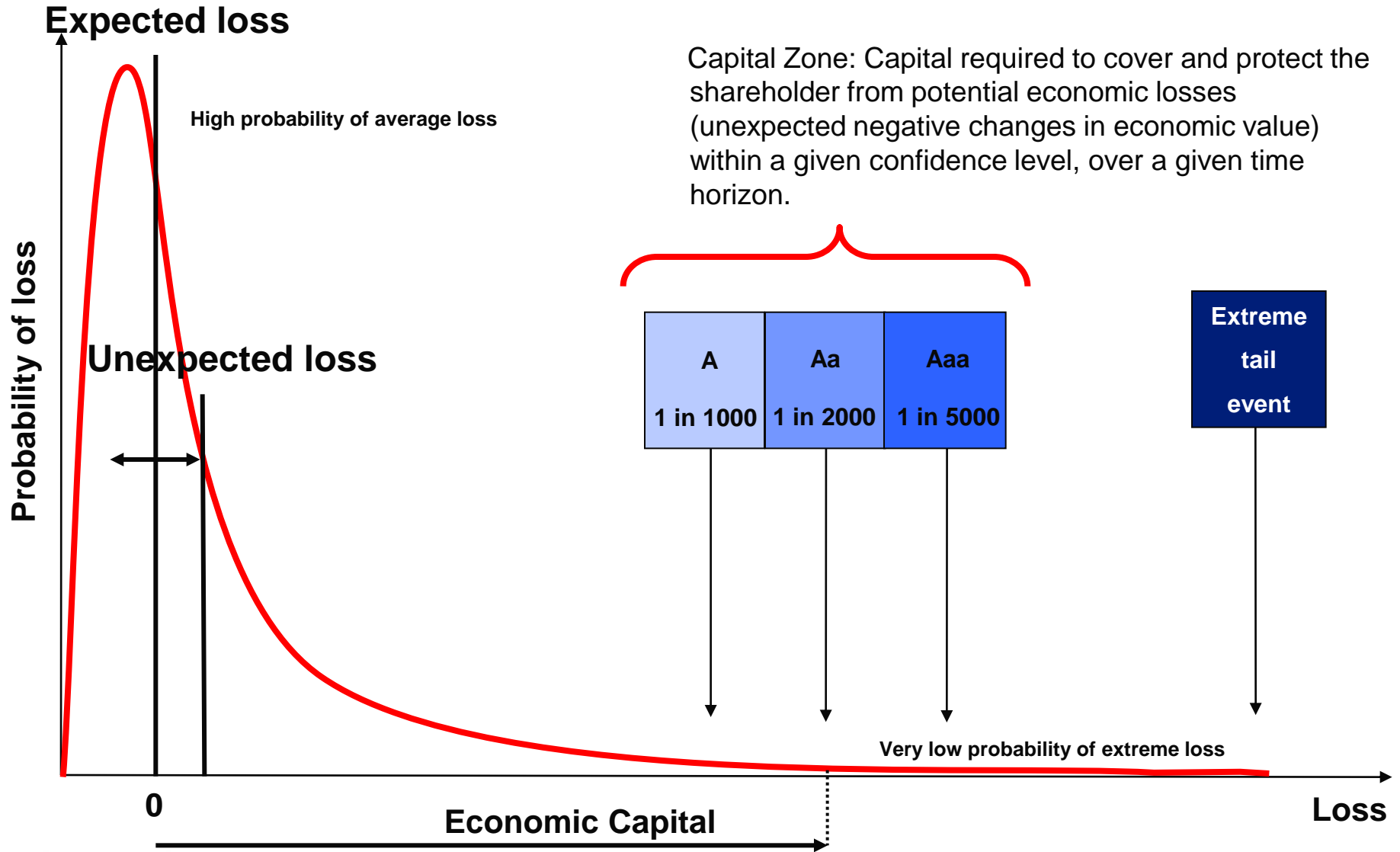
- “We are proposing to introduce a **‘reverse-stress test’** requirement, which would apply to banks, building societies, CRD investment firms and insurers, and would require firms to **consider the scenarios most likely to cause their current business model to become unviable**”
- “A key objective of the reverse stress testing is to **overcome disaster myopia** and the possibility that a **false sense of security** might arise from regular stress testing in which institutions identify **manageable impacts**”
- “Our aim is to ensure that firms more fully explore **‘Tail Risks’** which, if they were to crystallize, would cause counterparties and investors to lose confidence in them, so that a firm is more aware of its business model vulnerabilities when making strategic business decisions, when contingency planning, and when considering its risk management arrangements”

Reverse Stress Testing – Identifying Unmanageable Impacts

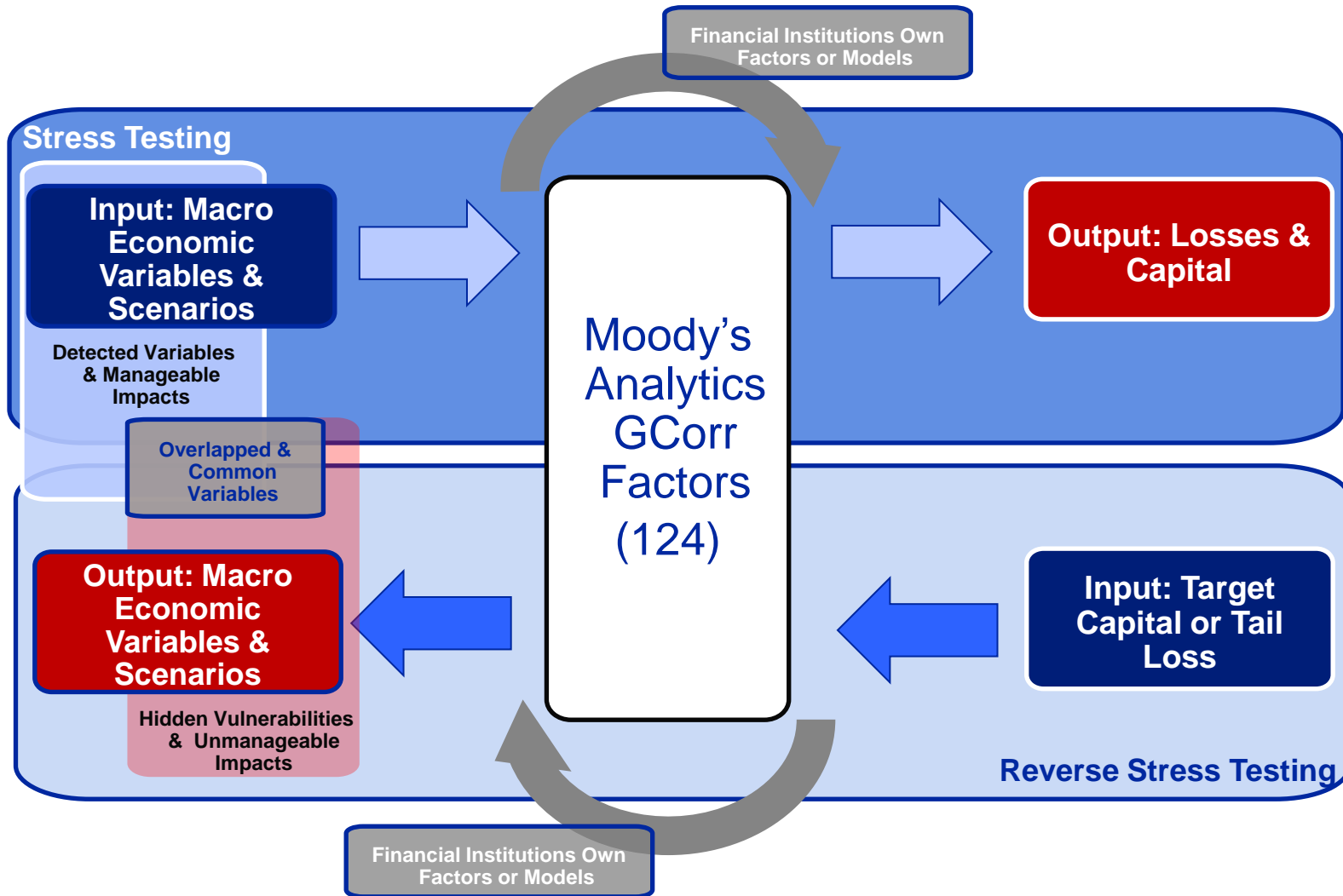
- What losses lead to dropping below a minimum capital ratio X and what events and business lines could cause these losses?
- When a financial institution should be recapitalized under a given (macro) scenario?
- What risk factors drive the losses and their connections with portfolio's performance (e.g. insolvency, bankruptcy...etc.)?
- What are the hidden vulnerabilities of my business model?
- Is there any relationship between the Stress Testing and the Reverse Stress Testing outcomes? Reconciliation?

Moody's Analytics can “**reverse engineer**” via the RiskFrontier™ Trial-by-Trial capability which specific factors could cause the business model to become unviable: **hidden vulnerabilities** and **unmanageable impacts** that are **not detected in the stress testing analysis**

The Portfolio Loss Distribution



Reverse Stress Testing vs. Stress Testing – “The Big Picture”

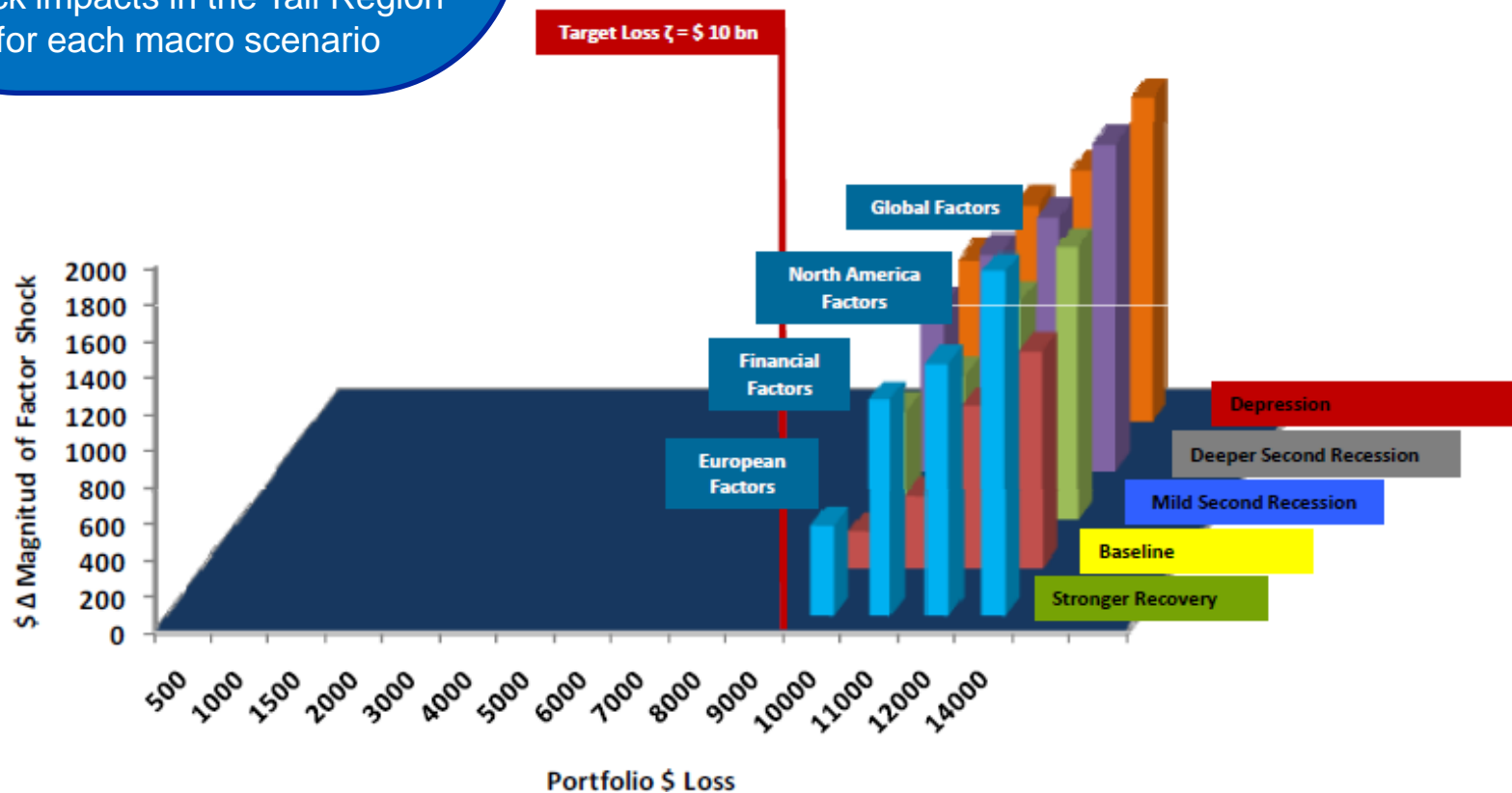


Reverse Stress Testing with RiskFrontier™ – Modeling Steps

- Stage 1:** Definition of the appropriate loss level or some other measure of interest on the balance sheet of the financial institution (e.g. capital ratios)
- Stage 2:** RiskFrontier™ Trial-by-Trial outputs the exact “states-of-the-world” or factor draws that had the most impact on the portfolio Tail Region
- Stage 3:** Once the most reactive factors have been identified from step 2 for each “state-of-the-world” scenario then an analysis is performed to measure the impact of these factors in the portfolio
- Stage 4:** Factors from step 3 are ranked and mapped to macro economic variables according to the combinations for a given target loss/capital in the portfolio
- Stage 5:** Macro economic variables from step 4 are mapped to macro economic variables thus identifying hidden vulnerabilities and overlapping effects

Reverse Stress Testing with RiskFrontier™ – Step-by-Step

1. Using the RiskFrontier™ Trial-by-Trial capability –given a target loss ζ – we are able to identify and quantify in \$ terms different shock impacts in the Tail Region for each macro scenario



Reverse Stress Testing with RiskFrontier™ – Step-by-Step

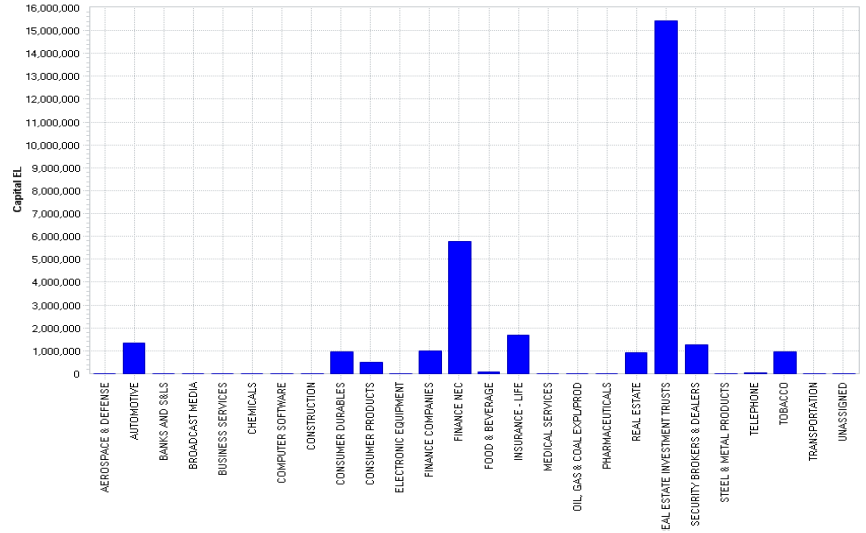
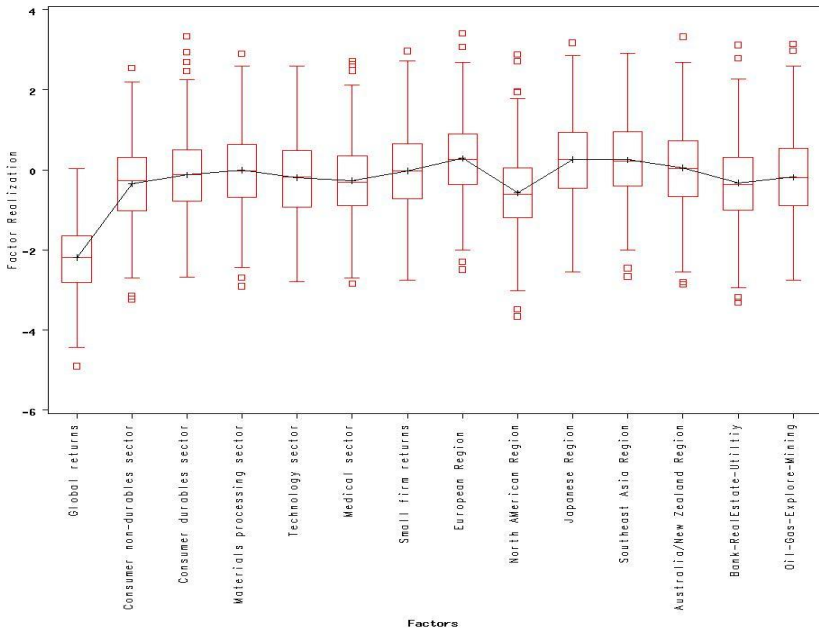
2. RiskFrontier™ overlapping Analysis reveals hidden vulnerabilities & macro variables in the portfolio and firm's stress testing analysis

Overlapping Analysis & Hidden Variables		Reverse Stress Testing Factors Contribution Analysis (Target Capital ζ = 10 bps)			
		Global Factors	North America Factors	Financial Factors	European Factors
Stress Testing Macro Variables	US Unemployment Rate	55%			5%
	VIX Index			10%	
	HP Single Family Home Price				
	SP500 Index		32%		
Portfolio Sensitivity to Shocks		55%	32%	10%	5%

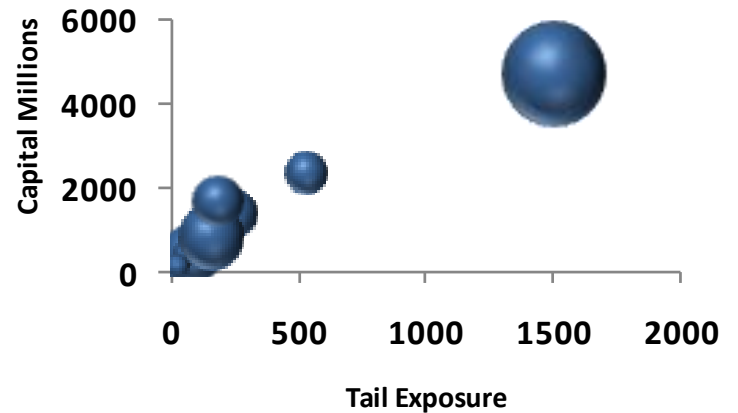
Reverse Stress Testing with RiskFrontier™ – Step-by-Step

3. Strategic Decision Making Analysis: Factors and Macro scenarios that will make the business and/or portfolio unviable (e.g. M&A, macro shock...)

Boxplot of Portfolio 10bps Tail – Factor realizations

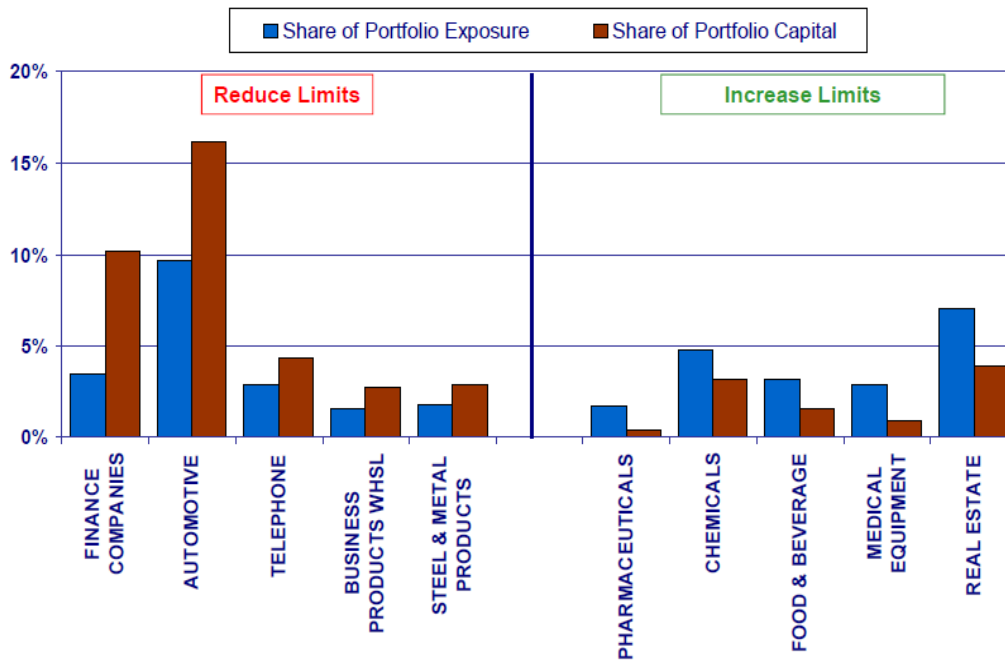


Tail Risk Analysis



Reverse Stress Testing with RiskFrontier™ – Step-by-Step

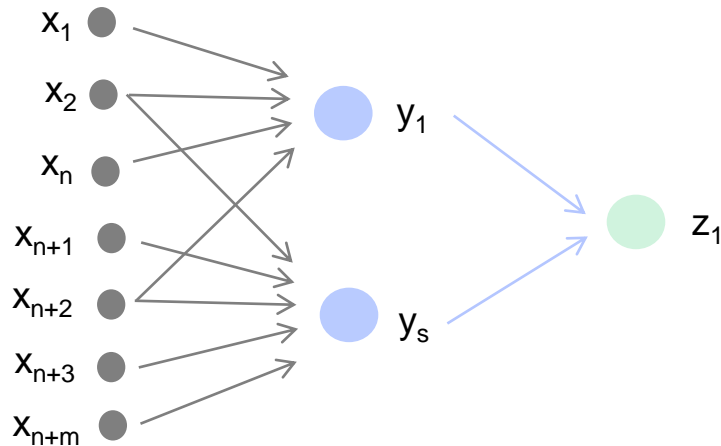
4. Moody's Analytics Reverse Stress Testing Reports help senior management to put in place capital contingency plans and to develop the firm's risk appetite, business strategy and risk limits



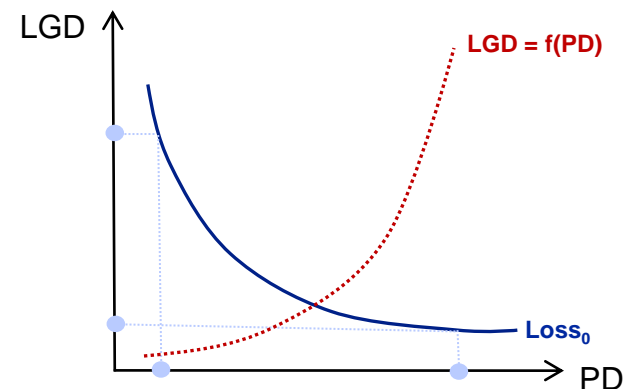
	Amount	As a Proportion of MTM Exposure
No. of Exposures	1886	
No. of Expired Exposures	68	
No. of Counterparties	988	
No. of Exposures Exclu...	68	
Commitments	616,963,700,000	
Book Exposure	616,963,700,000	
MTM Exposure	659,247,928,290	
Total Spread Revenue	11,094,725,542	168.3 bp
Expected Loss	5,157,629,337	78.2 bp
Expected Spread Reve...	5,937,096,205	90.1 bp
Unexpected Loss	12,407,535,833	188.2 bp
Capital	53,425,219,911	810.4 bp
Expected Shortfall	63,770,278,501	967.3 bp
Sharpe Ratio		47.85 %
RORAC		15.99 %
Vasicek Ratio		11.11 %

Reverse Stress Testing: Mathematical Challenges

The math behind reverse engineering of risk modeling

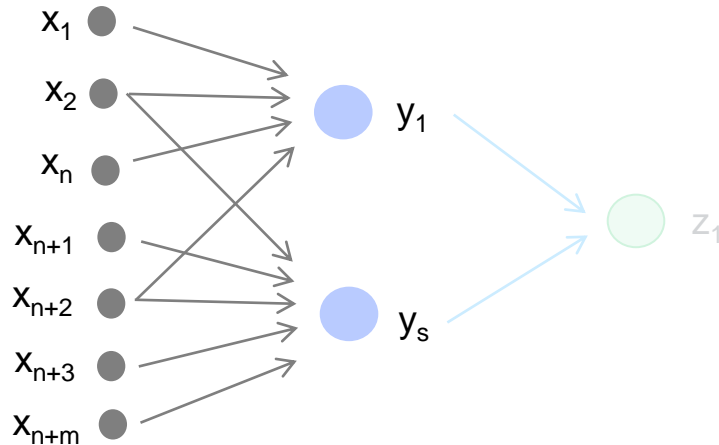


But $z_1 \rightarrow \{y_1, y_2, \dots, y_s\} \rightarrow \{x_1, x_2, \dots, x_{n+m}\}$
opens the door to **multiplicity**



Reverse Stress Testing: Mathematical Challenges

The math behind reverse engineering of risk modeling



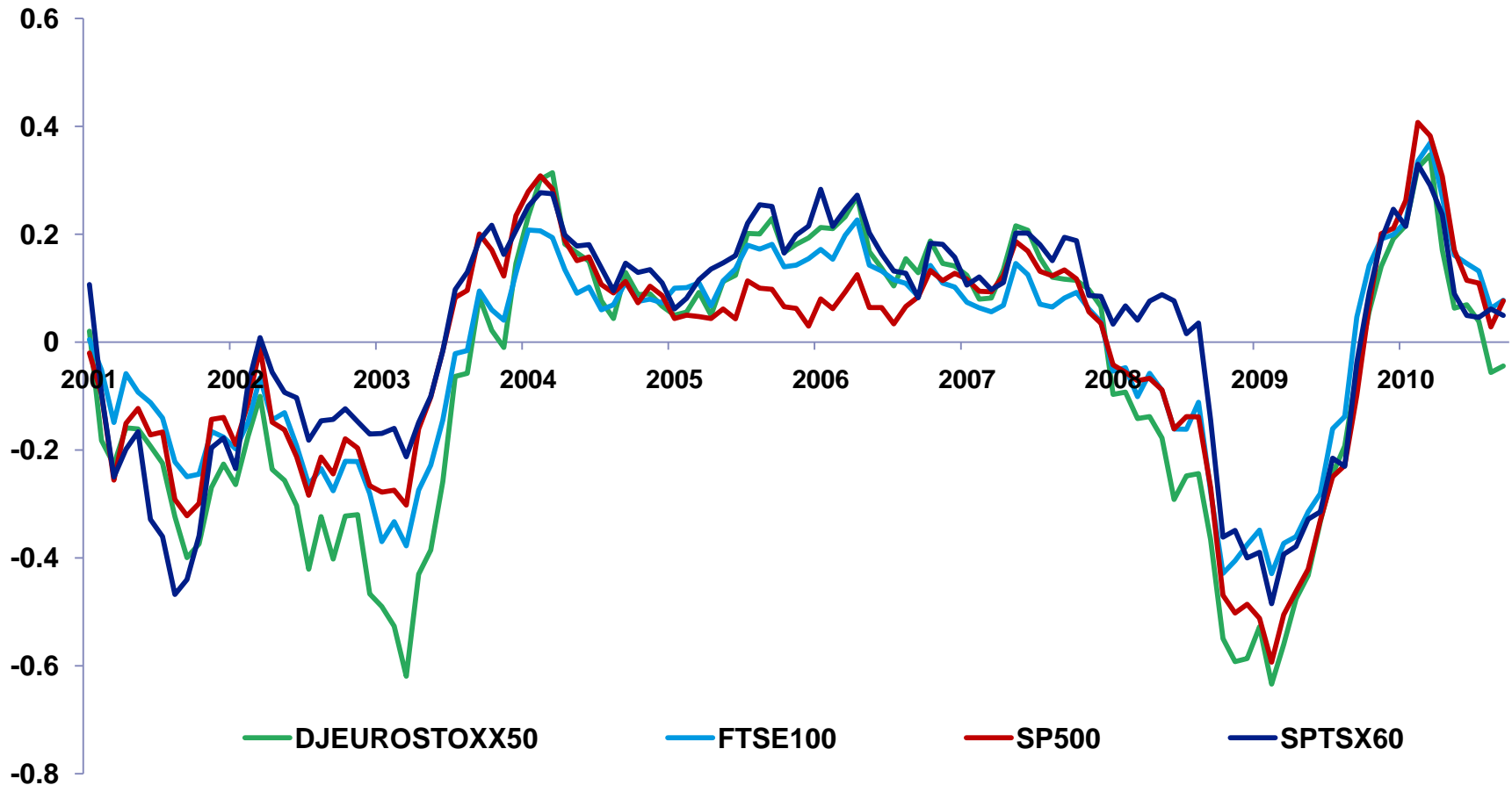
From PD, LGD, Correlation and other Risk Parameters to Consistent Macro and Capital Market Scenarios:

Multiplicity is still an issue!
Identification problems to be dealt with.
Reducing the dimension of the Macro Scenarios (factor analysis) could match the two dimensions

Squeeze Box Approach to Stress Testing

Consider year-on-year log-returns of 4 major indices at monthly frequency:

DJEuroStoxx 50, FTSE 100, S&P 500, SPTSX60 (Jan 01 – Sep 10)



Squeeze Box Approach to Stress Testing

Return correlation is strong and growing...

	DJEuro Stoxx 50	FTSE 100	S&P 500	SPTSX 60	
DJEuro Stoxx 50	1				2001-2010
FTSE 100	0.98	1			
S&P 500	0.94	0.95	1		
SPTSX 60	0.91	0.91	0.93	1	

2001-2005

2006-2010

	DJEuro Stoxx 50	FTSE 100	S&P 500	SPTSX 60
DJEuro Stoxx 50	1			
FTSE 100	0.99	1		
S&P 500	0.92	0.92	1	
SPTSX 60	0.87	0.87	0.92	1

	DJEuro Stoxx 50	FTSE 100	S&P 500	SPTSX 60
DJEuro Stoxx 50	1			
FTSE 100	0.98	1		
S&P 500	0.96	0.97	1	
SPTSX 60	0.94	0.94	0.95	1

Squeeze Box Approach to Stress Testing

How to capture this communality?

Principal components (PC) analysis

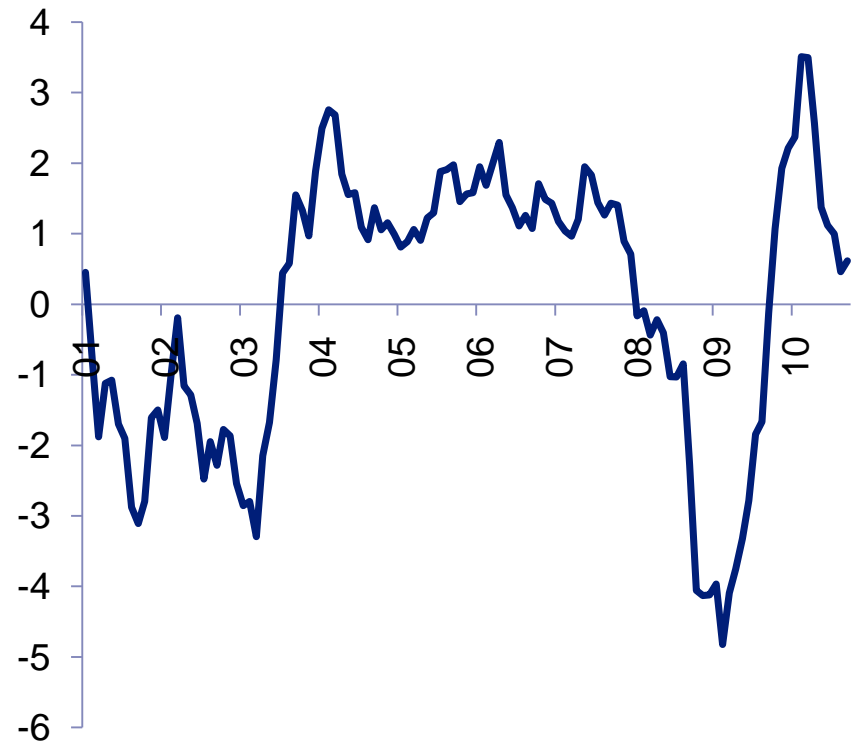
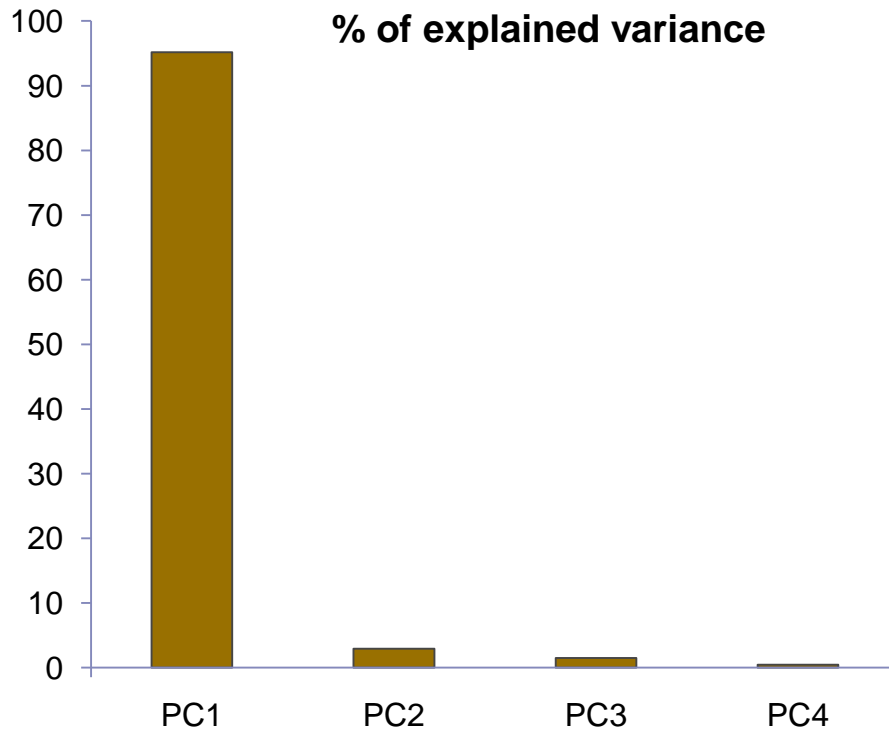
- From our 4x4 correlation matrix we extract 4 eigenvalues
- To each eigenvalue corresponds an eigenvector
- Eigenvectors, which are orthogonal by construction, capture non-overlapping pieces of information
- Starting from eigenvalues and eigenvectors we can build PC scores and PC loadings

What do we want to achieve?

- A single PC capturing most of the covariance across the 4 stock indices:
a **Global Equity Factor**

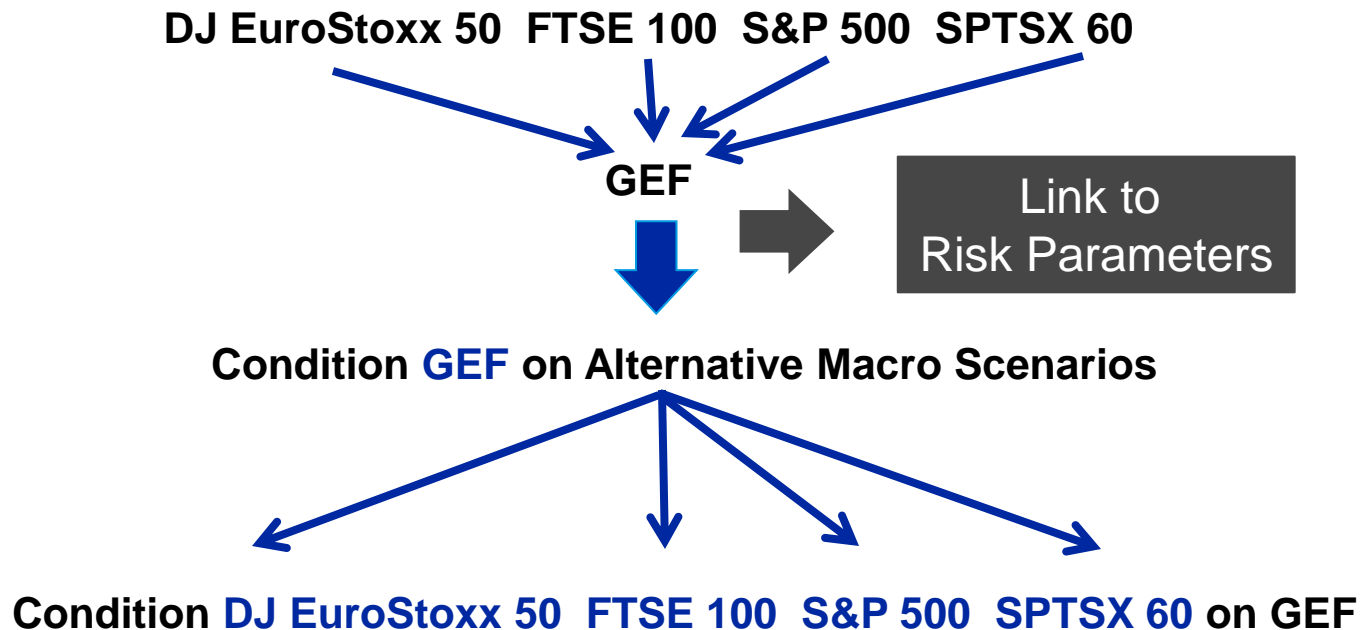
Squeeze Box Approach to Stress Testing

The PC 1, or **GEF**, captures most of the variance in equity returns



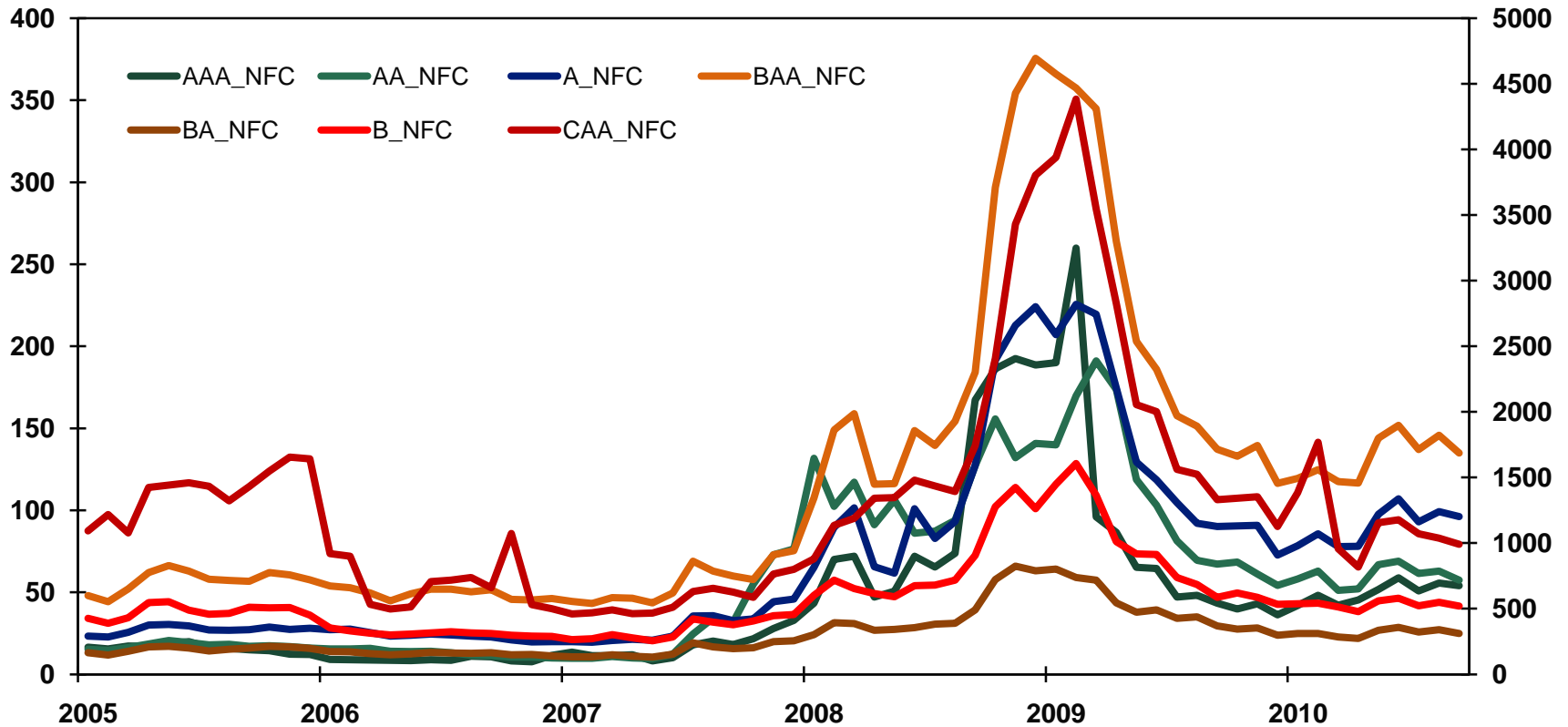
Squeeze Box Approach to Stress Testing

- 1- **Model the GEF** conditional on different macroeconomic scenarios
- 2- **Link GEF with Risk Parameters:** PD, LGD, Correlations, etc
- 3- **Condition our original stock indices on the GEF forecasts** to get predictions across alternative scenarios.



Squeeze Box Approach to Stress Testing

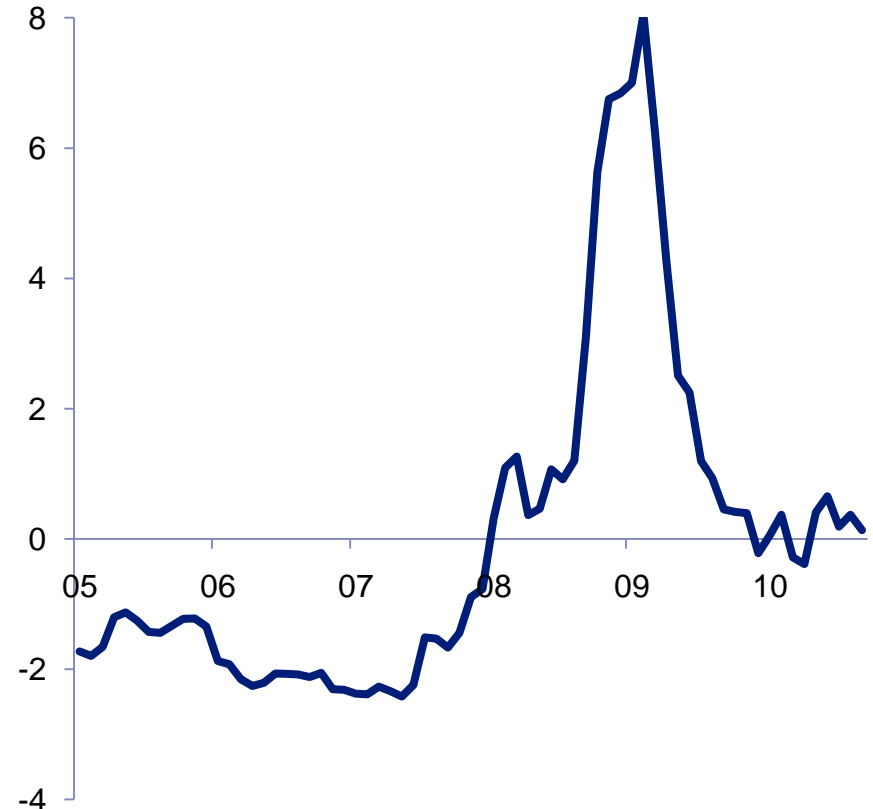
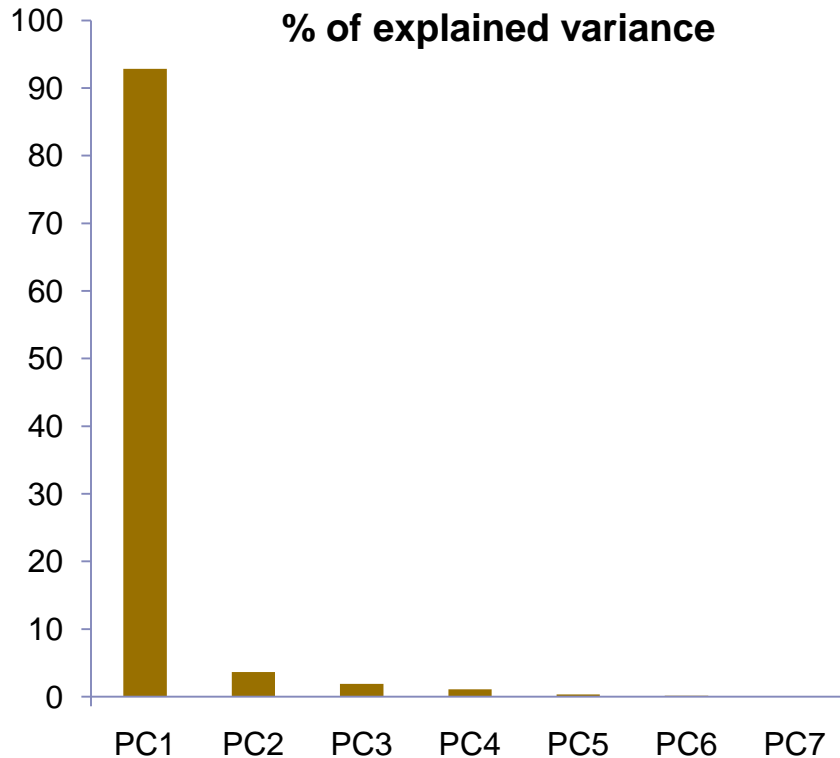
We can use the same approach for forecasting **CDS spreads** for, e.g., global non-financial corporates for Moody's rating buckets (Aaa, Aa, A, Baa, Ba, B, Caa).



Source: Moody's Analytics, Capital Market Research Group

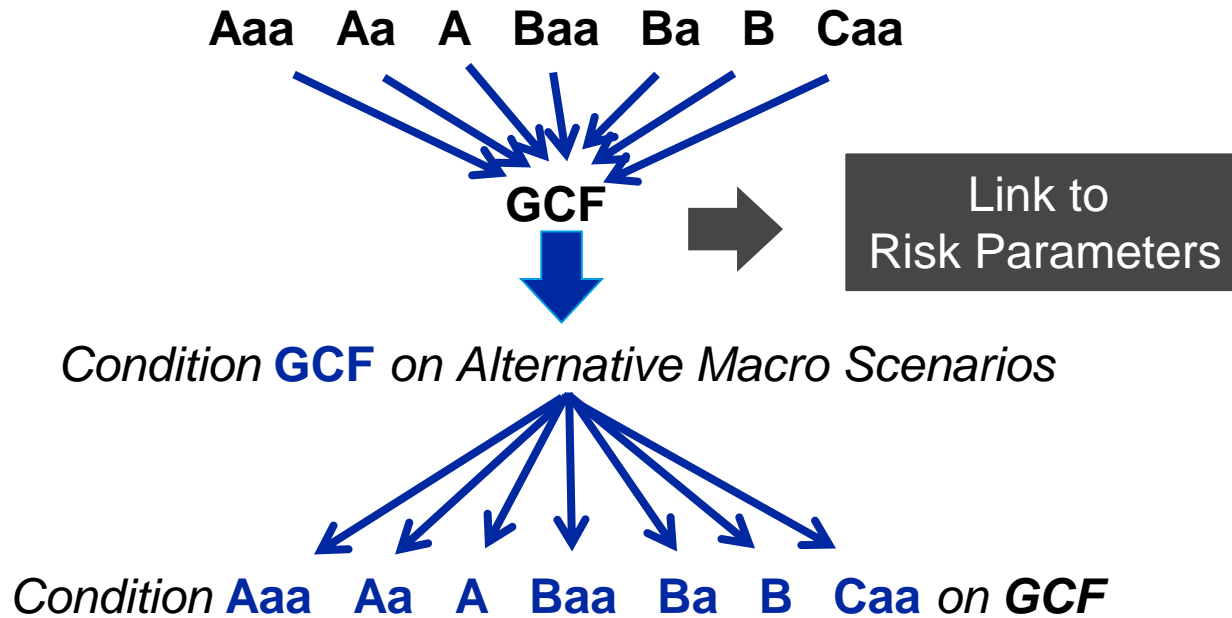
Squeeze Box Approach to Stress Testing

We now call PC1 **Global Credit Factor**



Squeeze Box Approach to Stress Testing

Hence, we can model the **GCF** conditional on different macro scenarios.



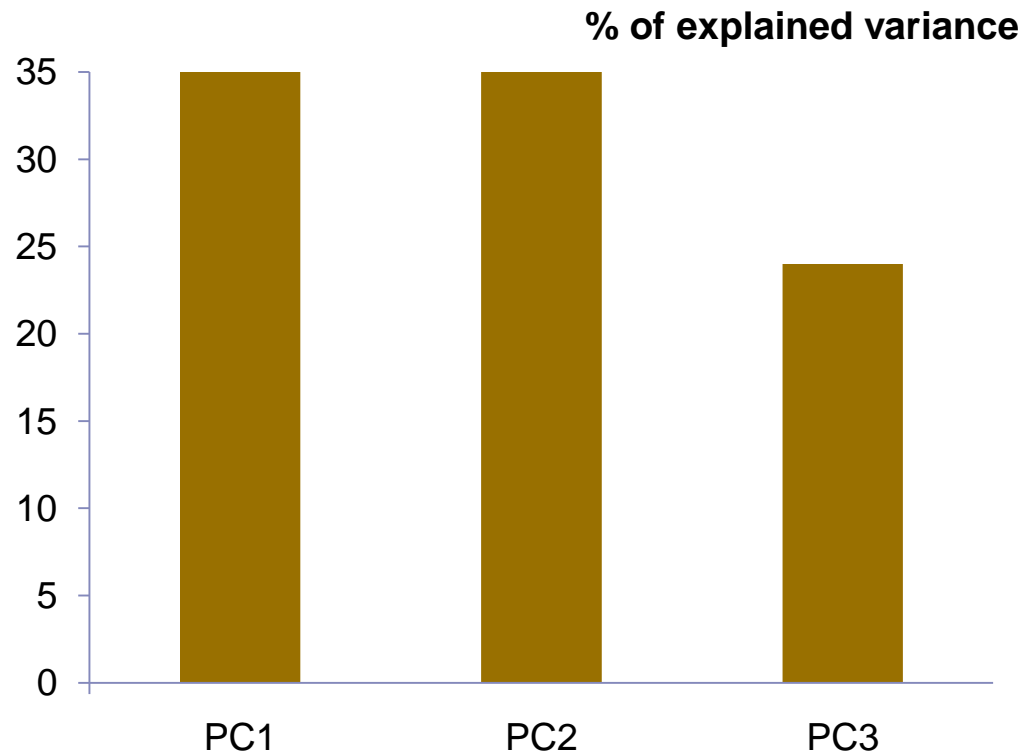
Squeeze Box Approach to Stress Testing

Challenge to model pure macroeconomic series:

MONETARY
CYCLE
Inflation

CREDIT
CYCLE
Rates

REAL BUSINESS
CYCLE
Econ Activity



Qualitative and Hybrid Reverse Stress Testing

Qualitative Approach to Reverse Stress Testing

Beyond standard macroeconomic and financial stressed scenarios:
Reputation, Concentration, Loss of Confidence, Organizational Risks

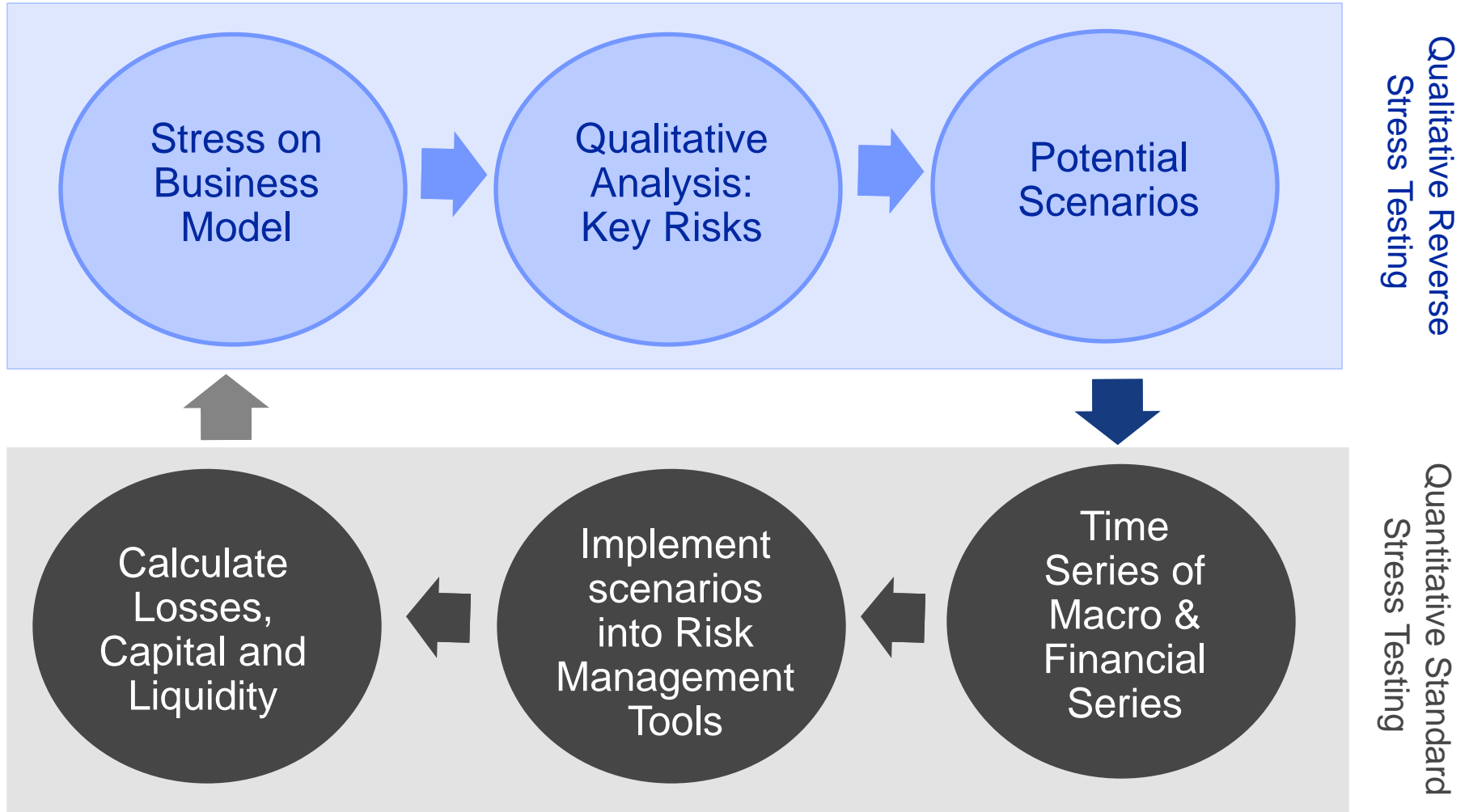
Purpose:

- Think through and write down contingency plans for such events
- Get Senior Management involved
- Smaller institutions can concentrate more on qualitative analysis rather than reverse engineering the risk models

Difficulties:

How to define these events?
Likelihoods?

Hybrid Approach to Reverse Stress Testing



Today's Key Risks to the Global Economy

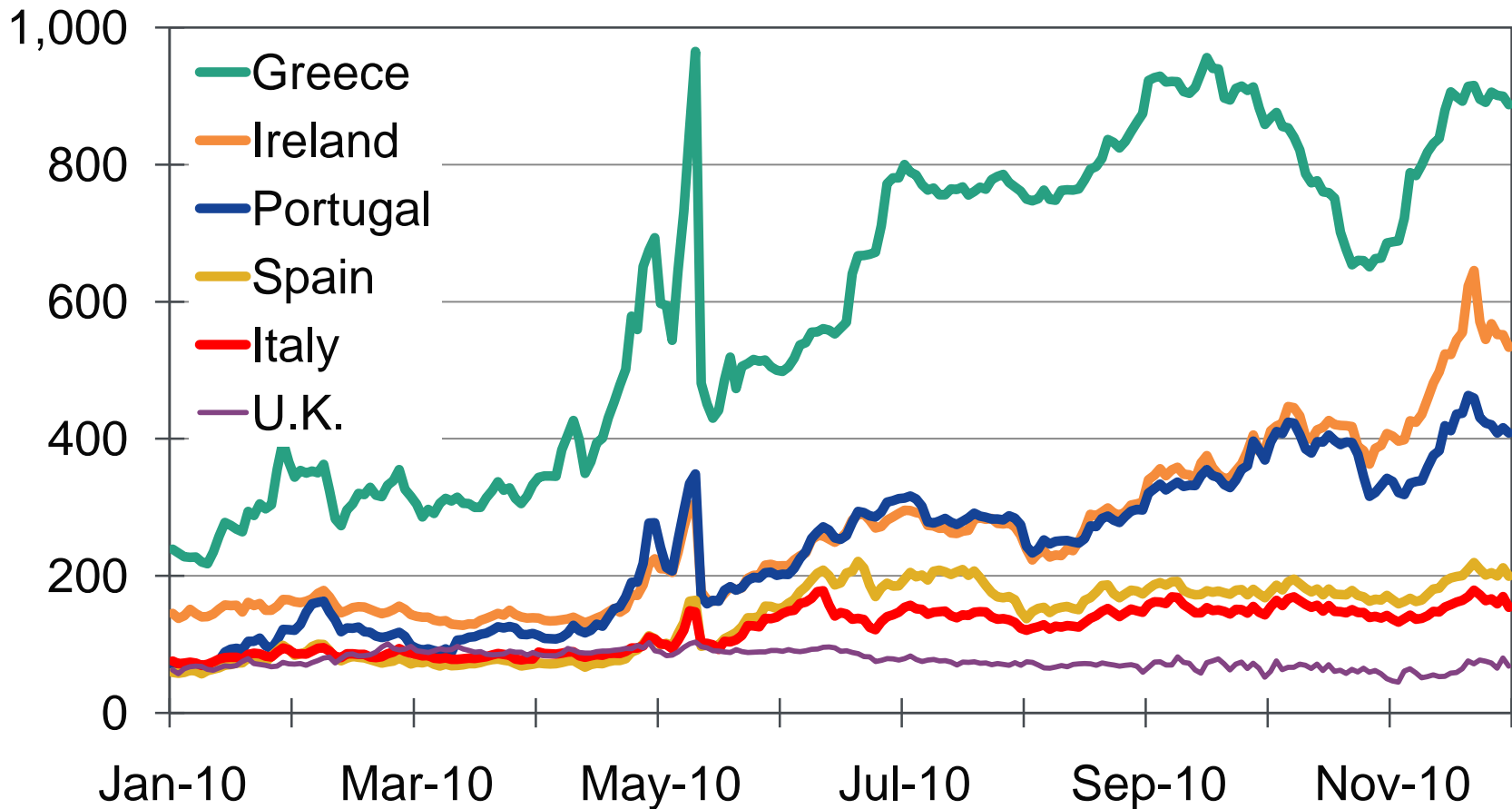
Top Global Economic Threats

Based on expected value of global economic loss

- » European Sovereign Debt and Banking Crisis
- » Deflationary Trap in U.S.
- » Global Protectionism and Currency Wars
- » Chinese Hard Landing
- » Crashing Commodity Price Bubble
- » Runaway Global Inflation
- » Terrorist Attack
- » U.S. Fiscal Crisis and \$ Crash

Europe's Sovereign Problems Boil Over

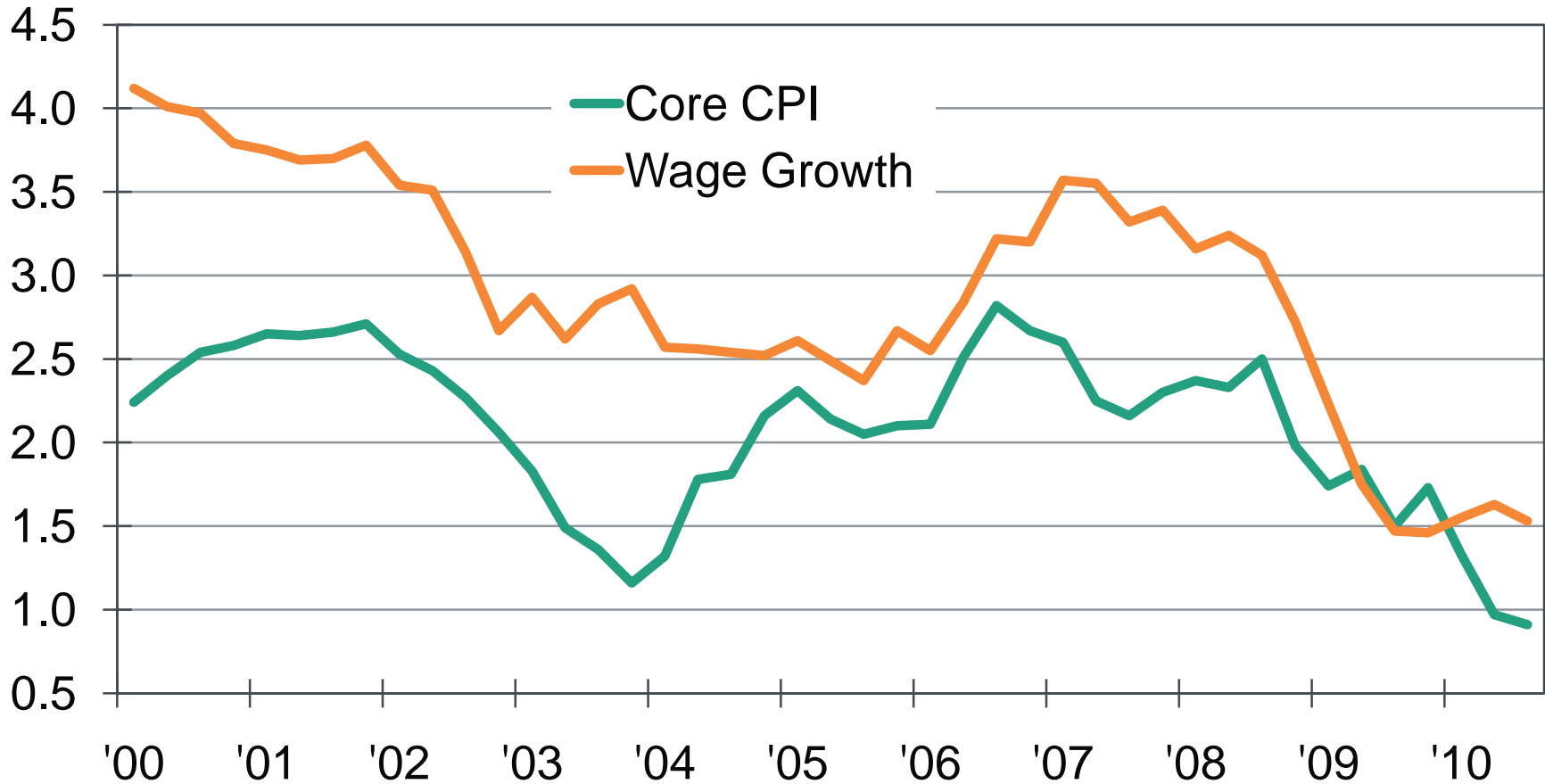
Spread between 10-year sovereign and German bunds, bp



Sources: Bloomberg, Moody's Analytics

Deflationary Forces Overwhelm U.S. Economy

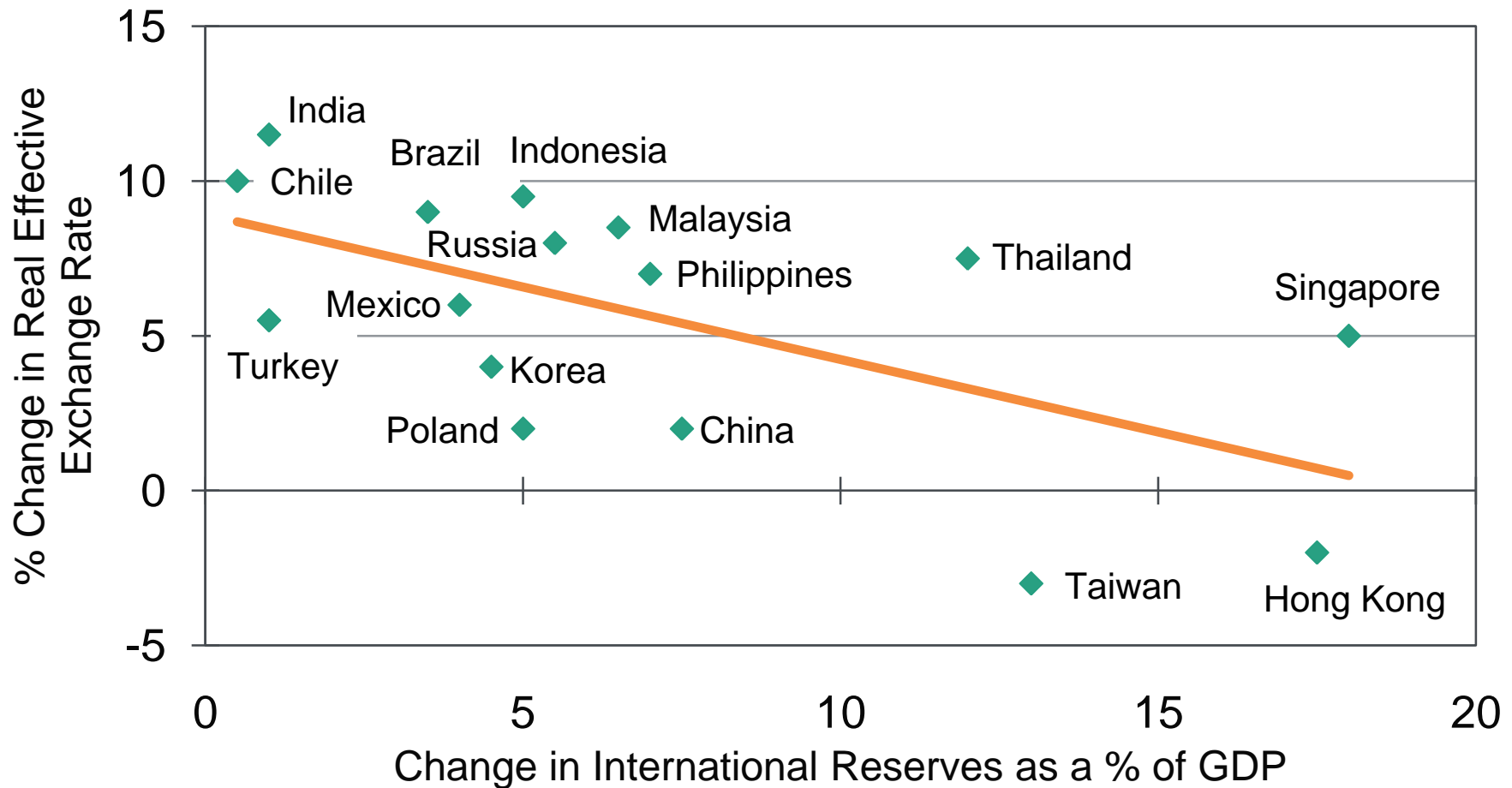
% change year ago



Sources: BLS, Moody's Analytics

Currency War Intensifies

9/09 – 9/10



Sources: Bloomberg, Moody's Analytics

Concluding Remarks

- Reverse Stress Testing represents a challenge to risk management traditional thinking.
- Pushes management to think about multiple business risks, beyond capital, liquidity and losses.
- Its application and practical advantages yet to be tested. Is it here to stay?
- Started in the UK and other European countries; if successful it could expand to the global economy.
- Combination of quantitative and qualitative analysis to be expected

Q&A Session

Thank you!

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