# Stress & Reverse Stress from a Macro Viewpoint

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# Stress & Reverse Stress Testing from a Macro Viewpoint

Key Stress Testing Challenges:

1- Dynamic vs. Static Approach to Stress Testing,

2- Partial vs. General Equilibrium,

3- Top-down vs. Bottom-up,

4- Modelling Methodologies: Stress Testing vs. Forecasting/Scoring,

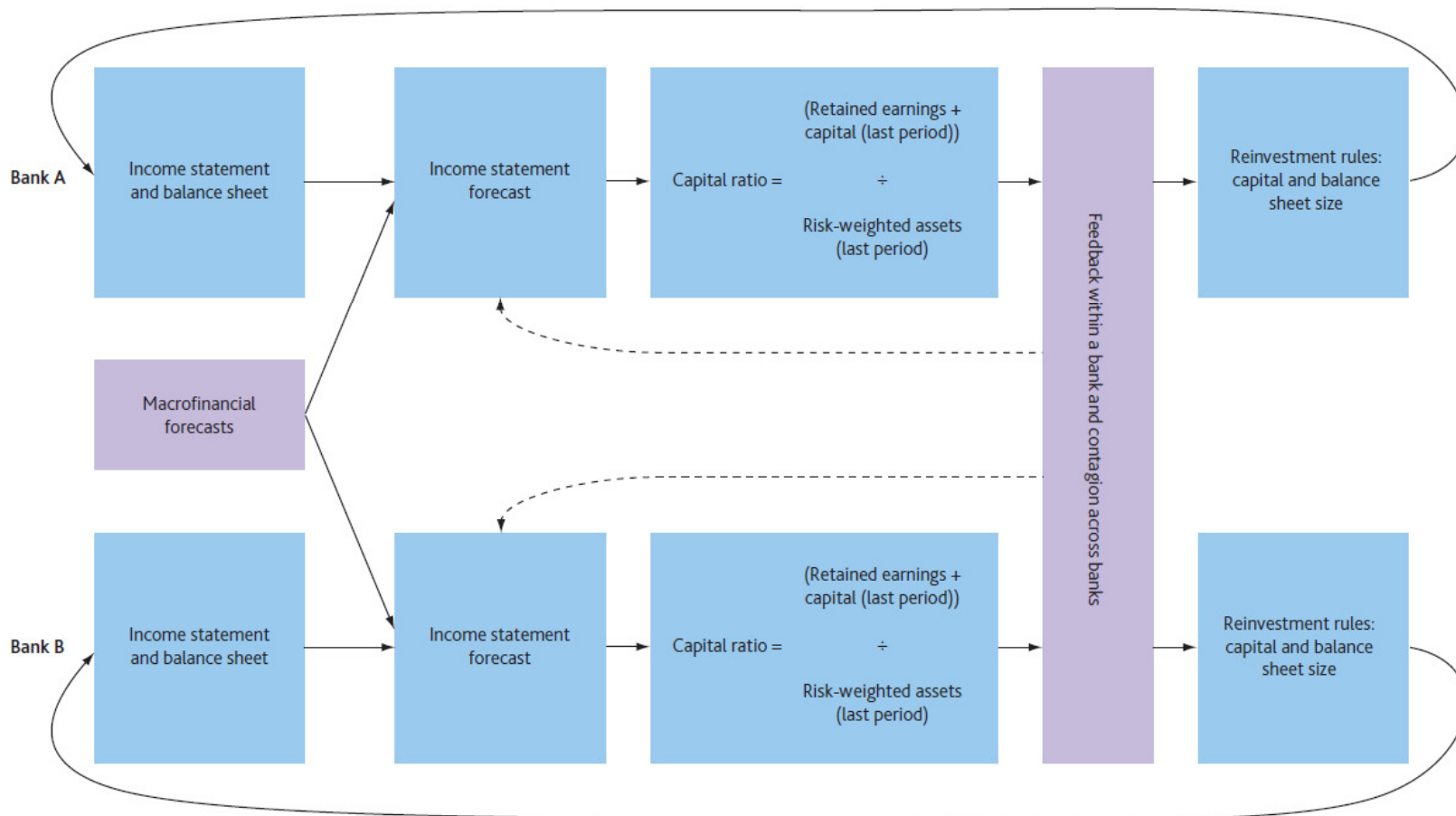5- Quantitative Reverse Stress Testing,

6- Looking beyond Capital & Solvency.

# **Stress Testing:** 1- Dynamic vs. Static Approach
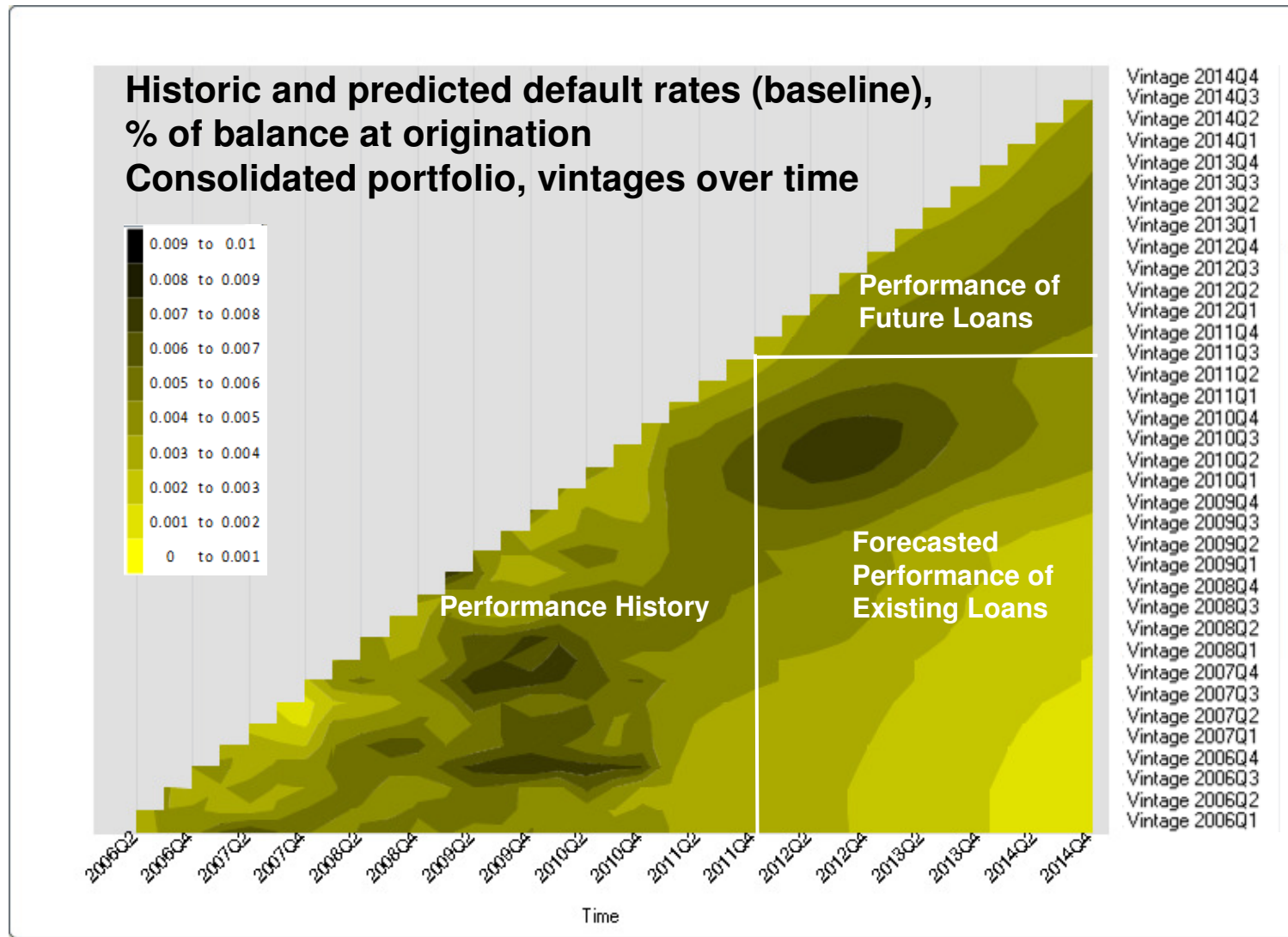
# Stress Testing: 2- Partial vs. General Equilibrium

Example of top-down stress testing approach, Bank of England's RAMSI model



Figure 1 Stylised overview of RAMSI

# **Stress Testing:** 2- Partial vs. General Equilibrium

## Examples of collateral type for RMBS/ABS deals

Illustrative

### RMBS

- » Mortgage rate difference from origination
- » Unemployment rate
- » Employment growth
- » Income growth
- » House price growth
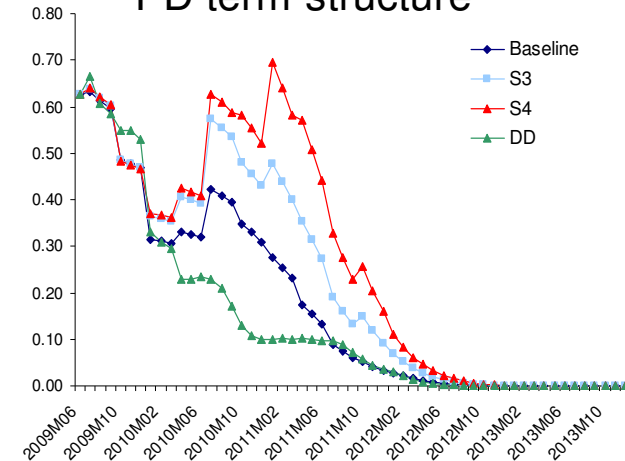- » Home equity

### Auto-Equipment Loan/Lease

- » Interest rates
- » Unemployment rate
- » Commodity/oil prices
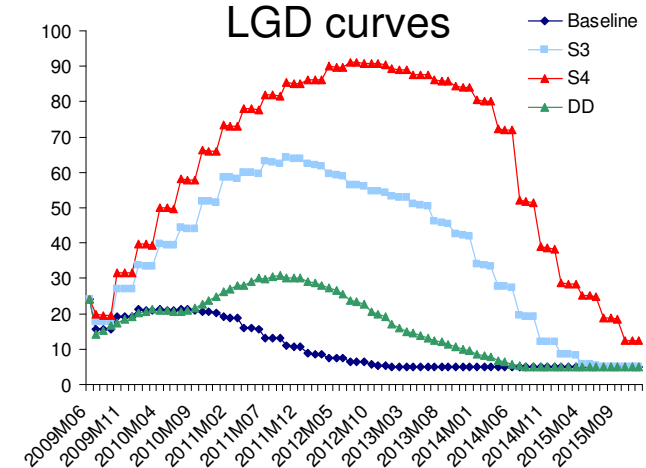- » Price index for used cars

### Small Business Loans

- » Interest rates
- » Unemployment rates
- » Income growth
- » Profits (National Accounts)
- » Share market

PD term-structure

LGD curves

# Stress Testing: 3- Top-down vs. Bottom-up

**Issue**: Loan level model can miss correlations and feedback effects

» Individual performance depends on other loans
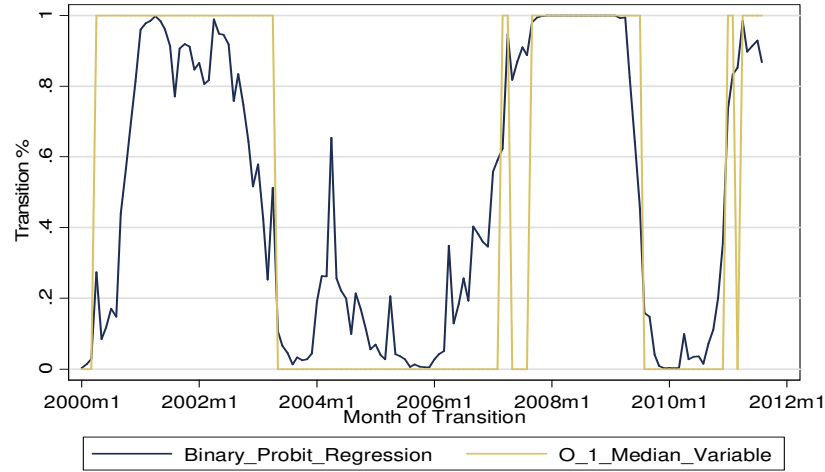
» Difficult to model individuals within a system

Risk models could miss the forest for the trees

– Why not model the forest, model the trees and then make sure the tree model agrees with forest projections?
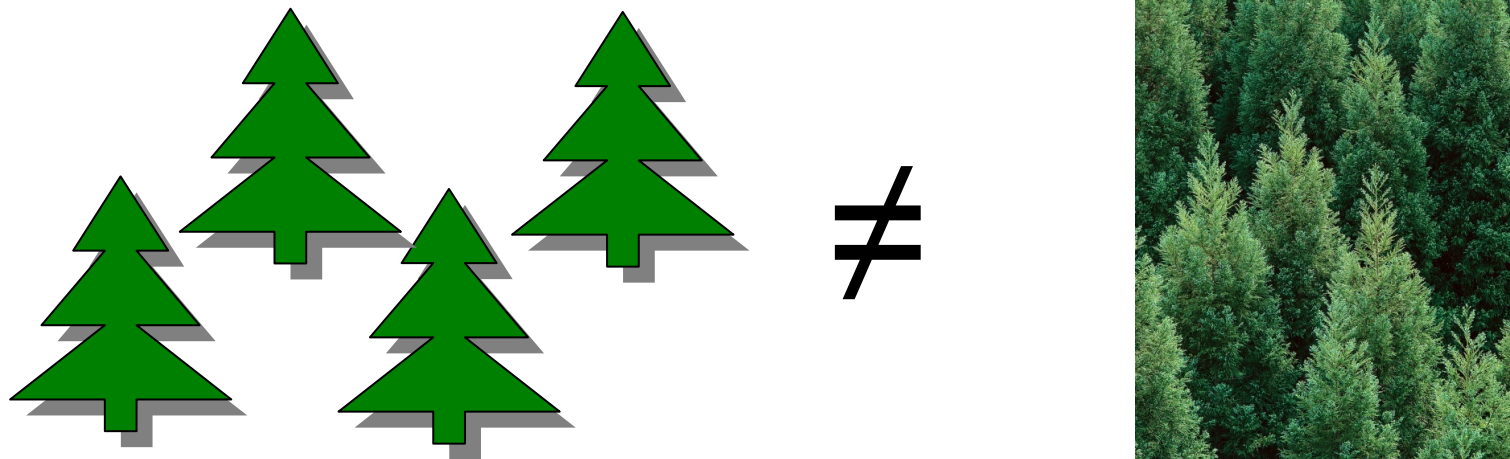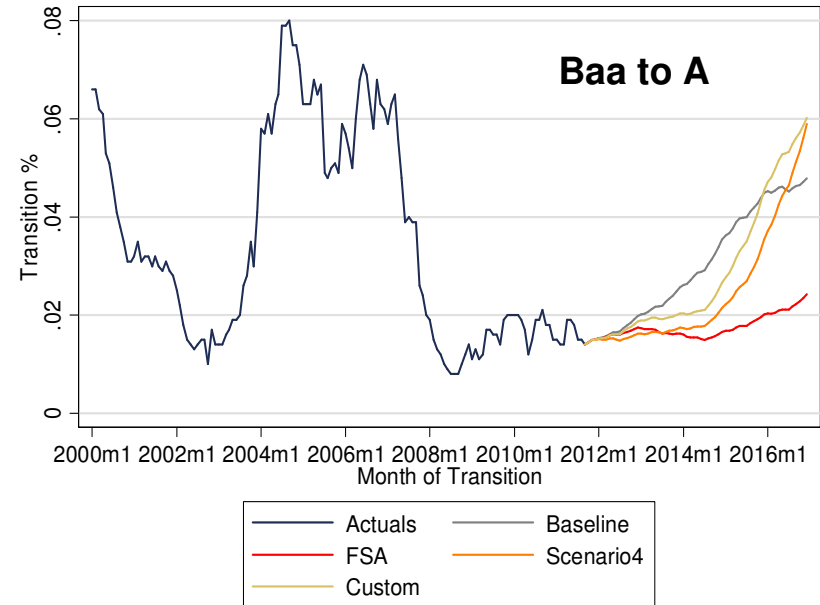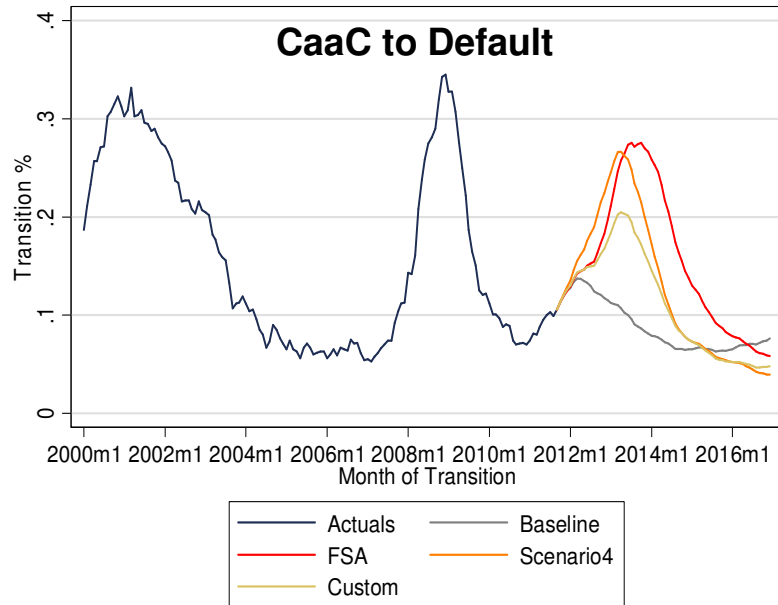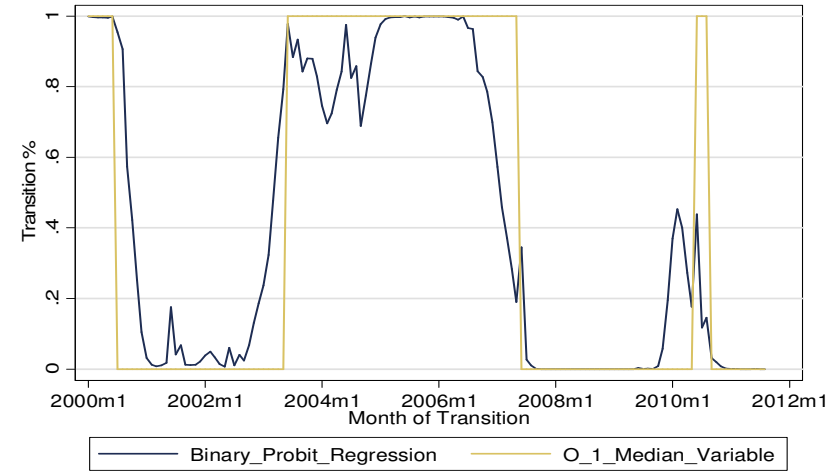
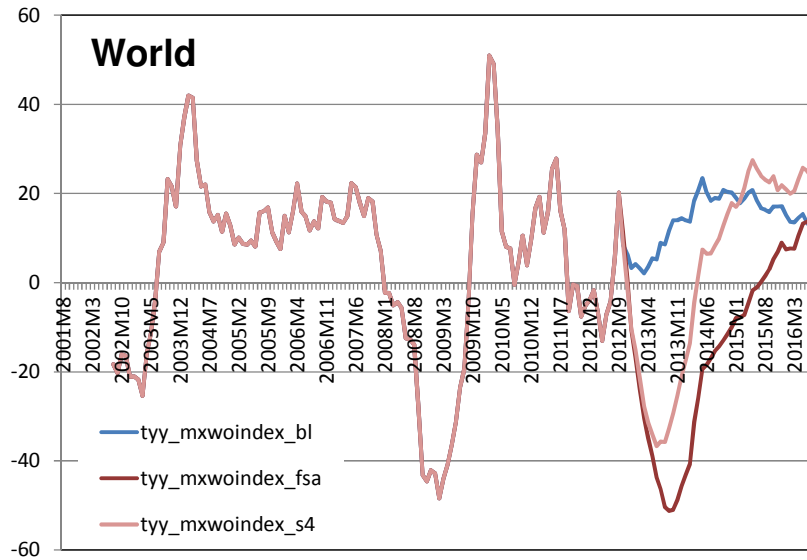# Stress Testing: 4- Modelling Methodologies



Binary (Probit) Model Downgrade

Binary (Probit) Model Upgrade

CaaC to Default

Baa to A

# Stress Testing: 4- Modelling Methodologies

**Equity Forecasts, Annual Returns**



World

Legend:
- tyy_mxwoindex_bl
- tyy_mxwoindex_fsa
- tyy_mxwoindex_s4

**Equity Forecasts, Annual Returns**



US

Legend:
- tyy_spxindex_bl
- tyy_spxindex_fsa
- tyy_spxindex_s4

**Equity Forecasts, Annual Returns**
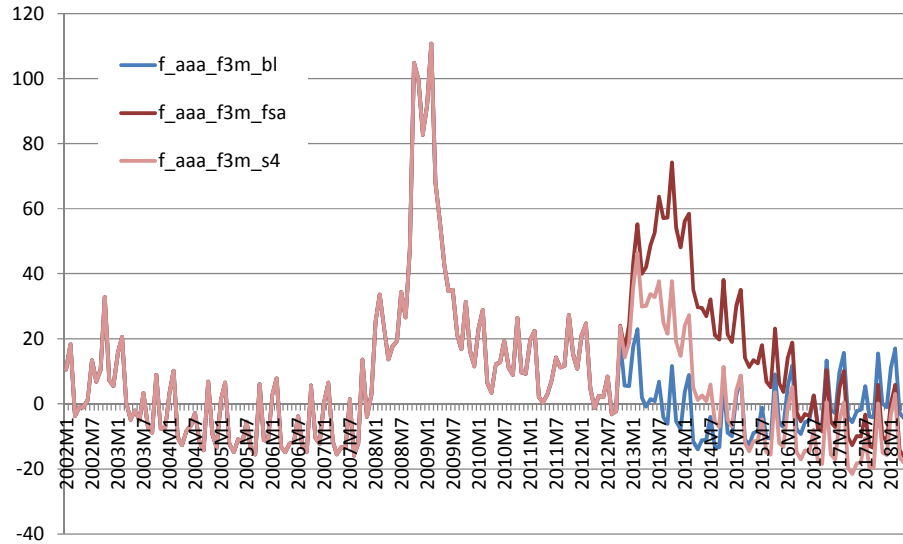


UK

Legend:
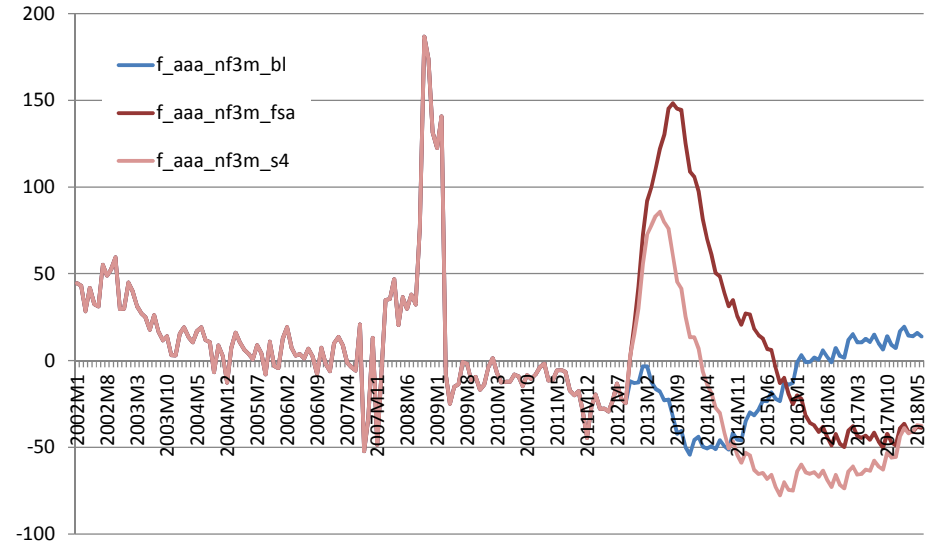- tyy_ukxindex_bl
- tyy_ukxindex_fsa
- tyy_ukxindex_s4
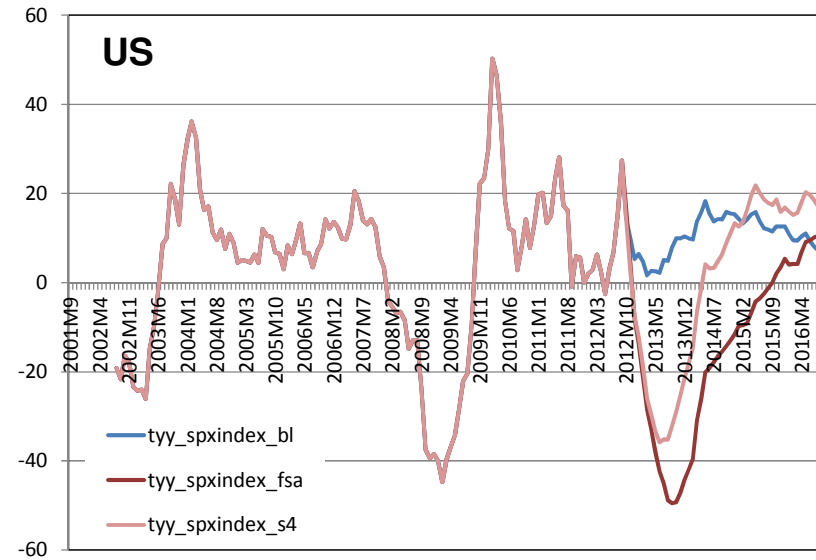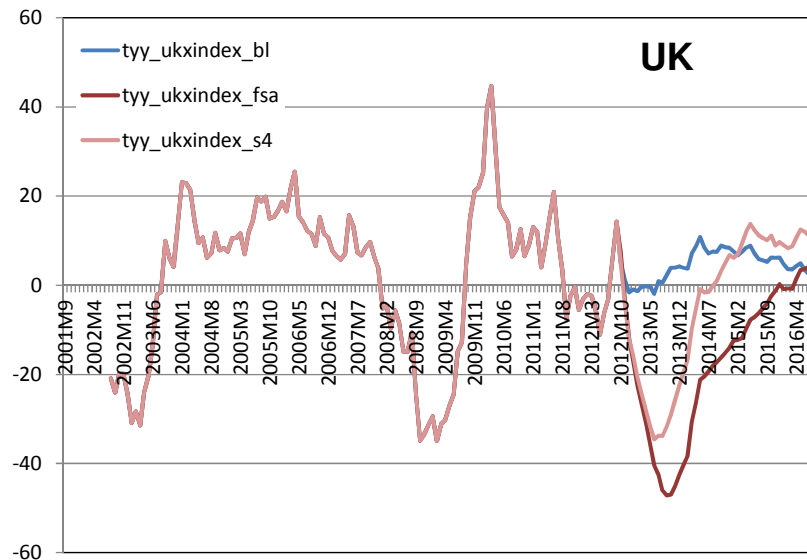
Equity Indexes, annual growth rate
History and forecasts

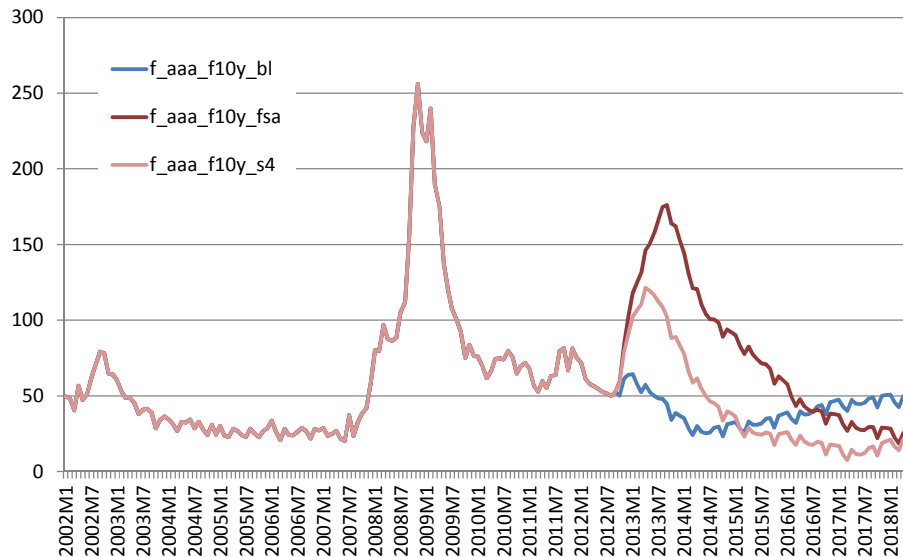# **Stress Testing:** 4- Modelling Methodologies



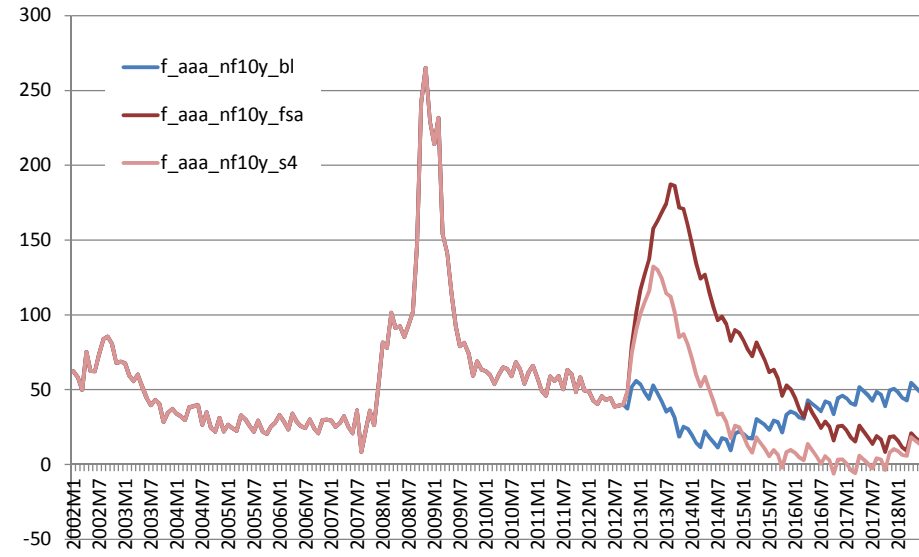Corporate Spread, Aaa Financials, 03m
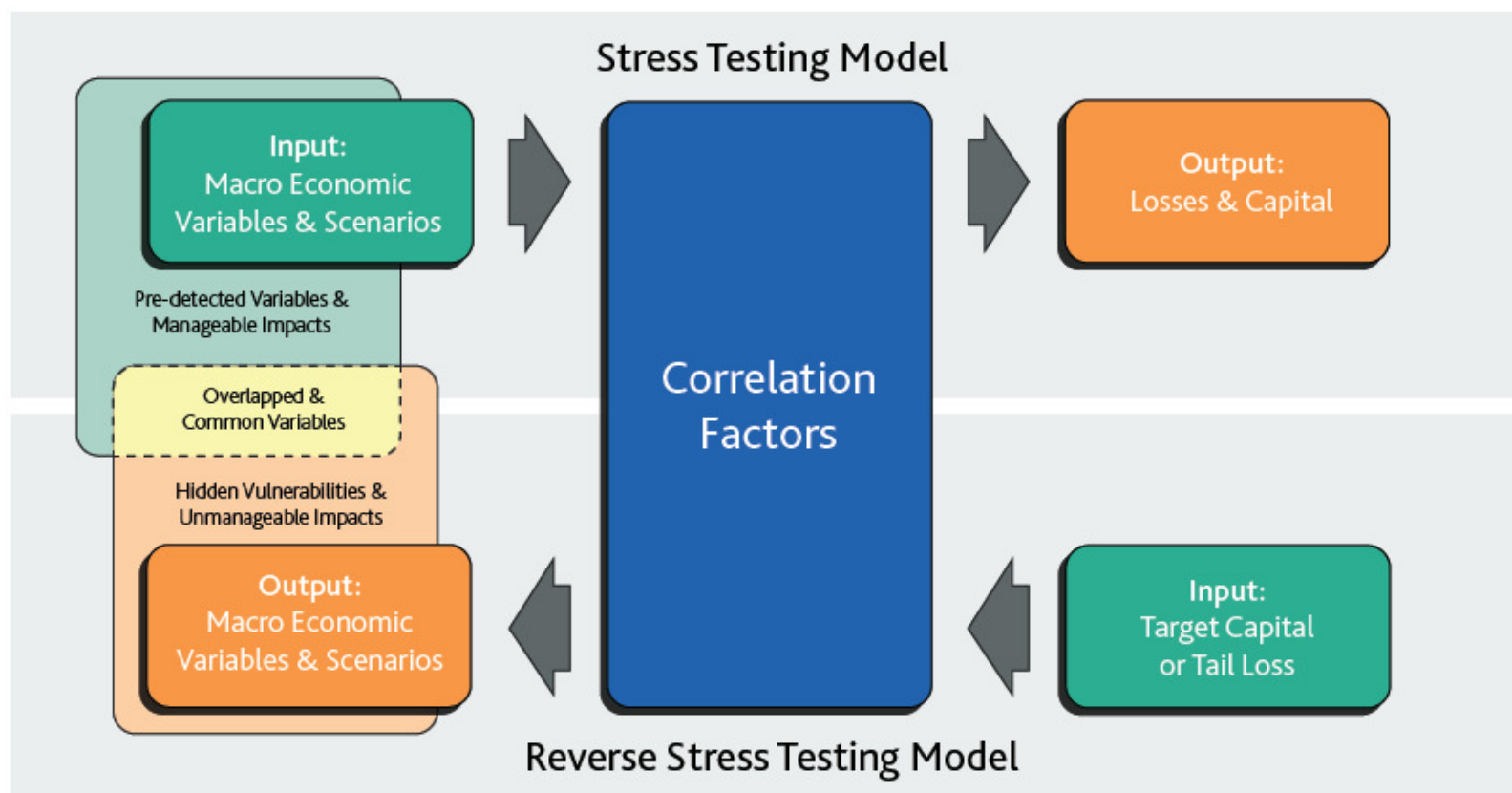Corporate Spread, Aaa Non-Financials, 03m
Corporate Spread, Aaa Financials, 10y
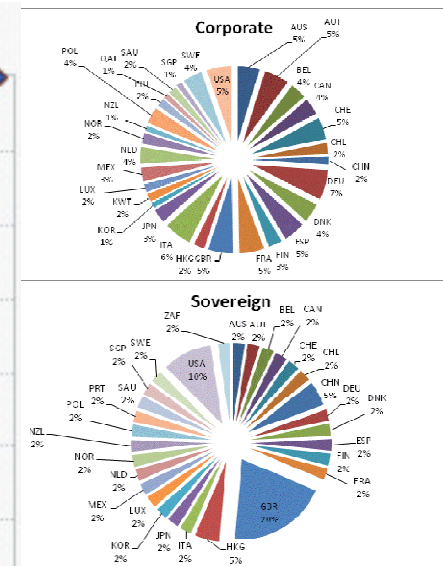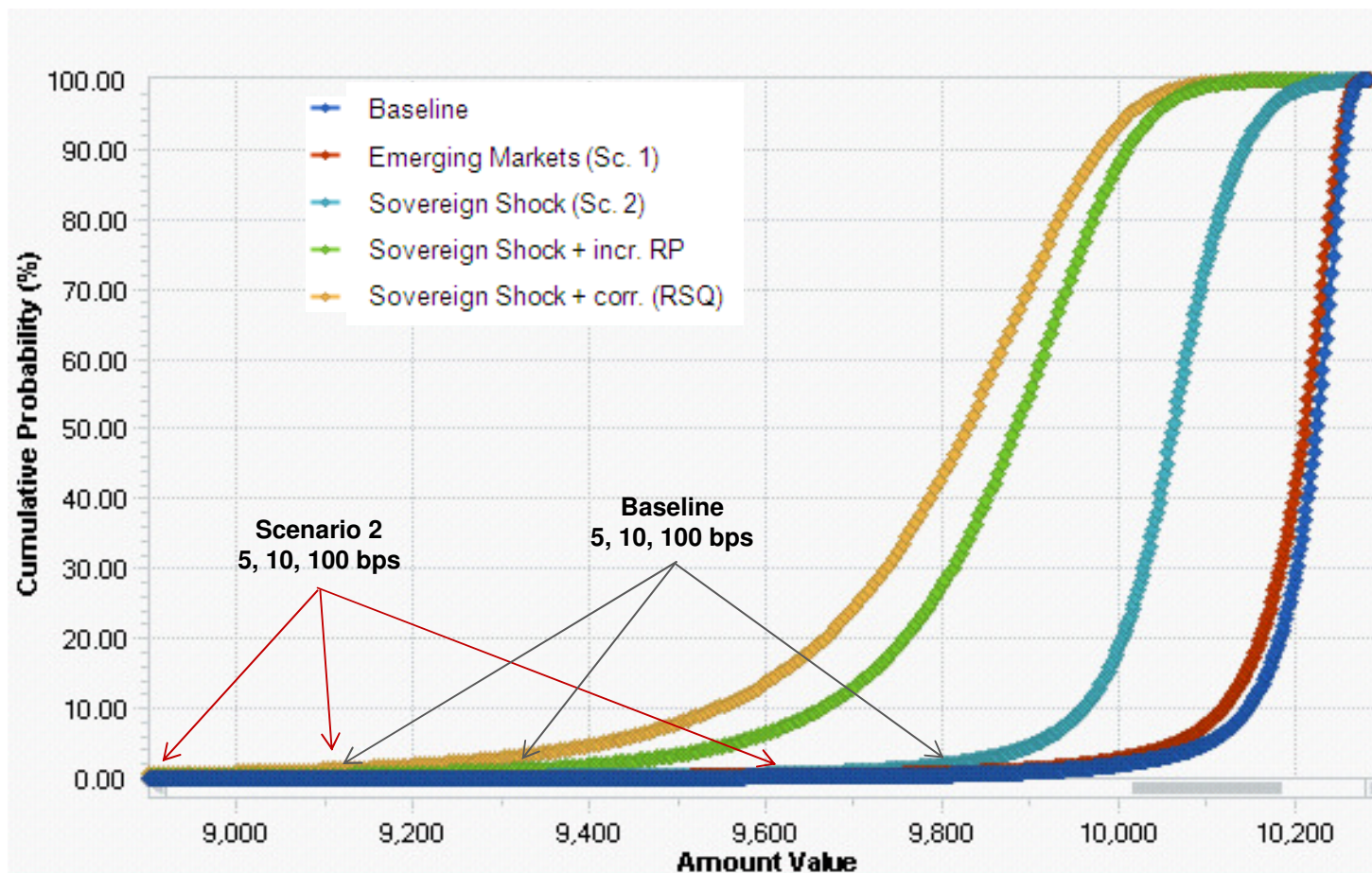Corporate Spread, Aaa Non-Financials, 10y

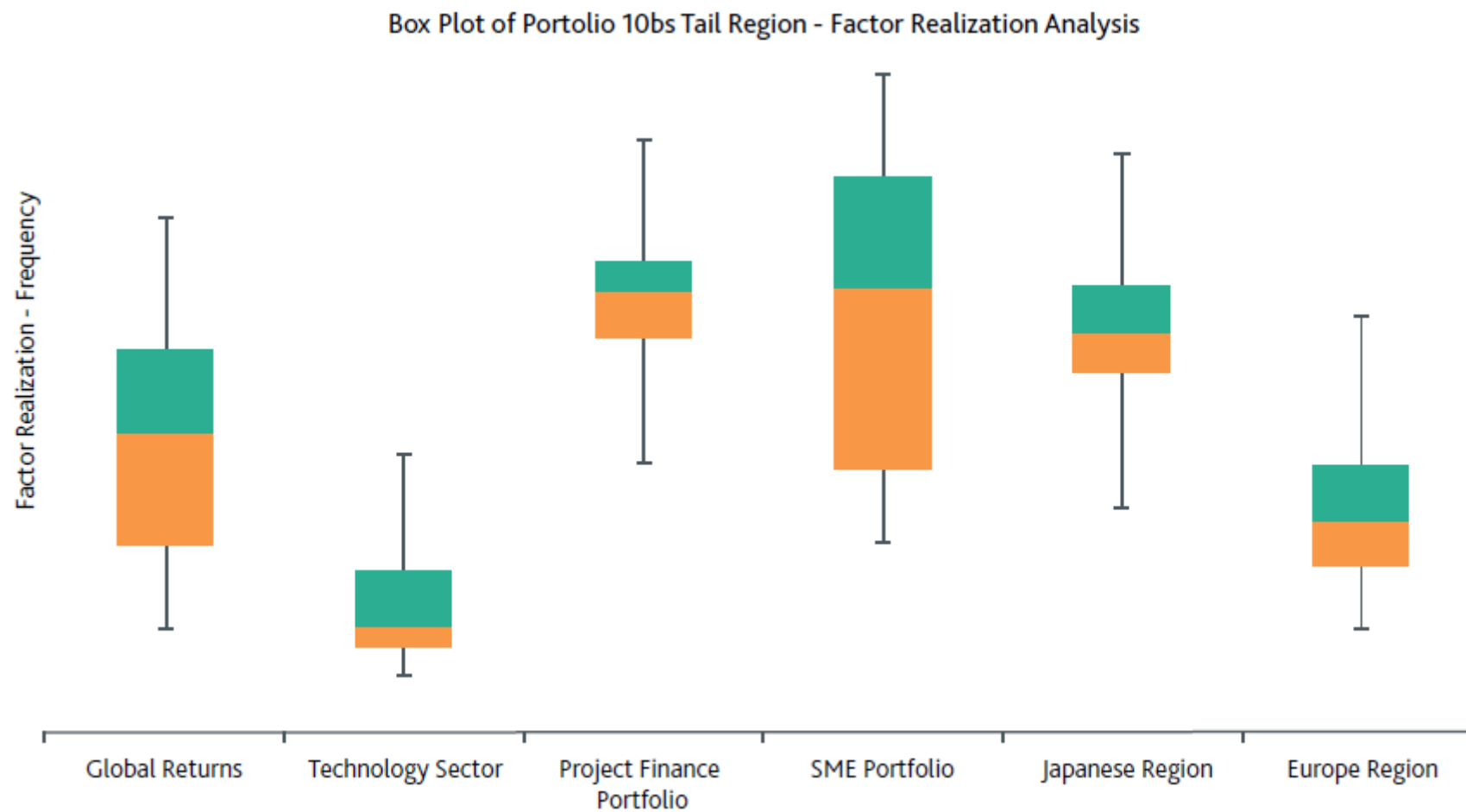# Stress Testing: 5- Reverse Stress Testing

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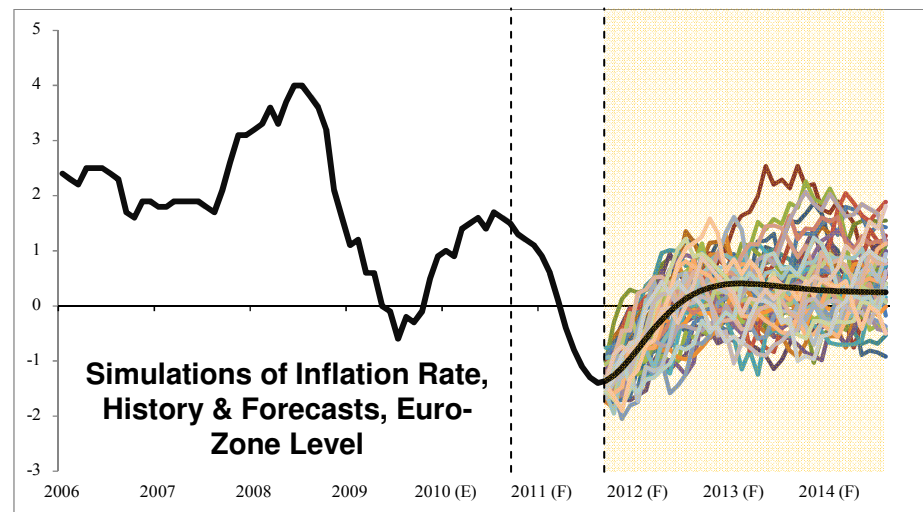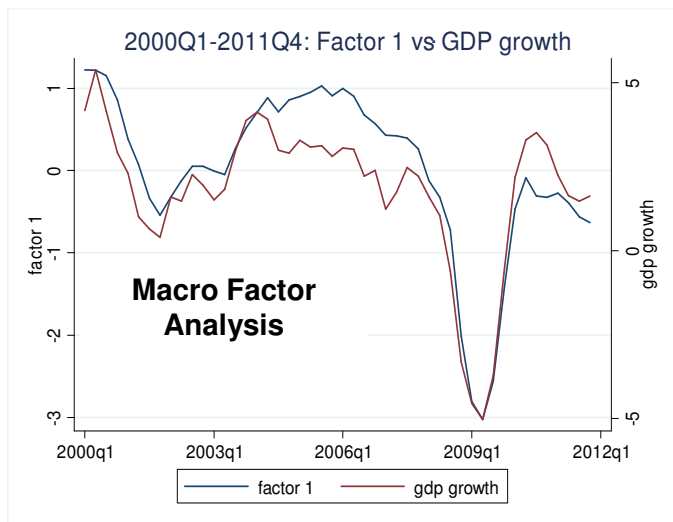## Portfolio Expected Values – Defining Severity

# Stress Testing: 5- Reverse Stress Testing
## Analyzing Factors' Realizations Across Tail Events



Box Plot of Portolio 10bs Tail Region - Factor Realization Analysis

# Stress Testing: 5- Reverse Stress Testing

## Linking Factors' Realizations to Macro Scenarios



2000Q1-2011Q4: Factor 1 vs GDP growth

Macro Factor Analysis

Standard Alternative Scenarios
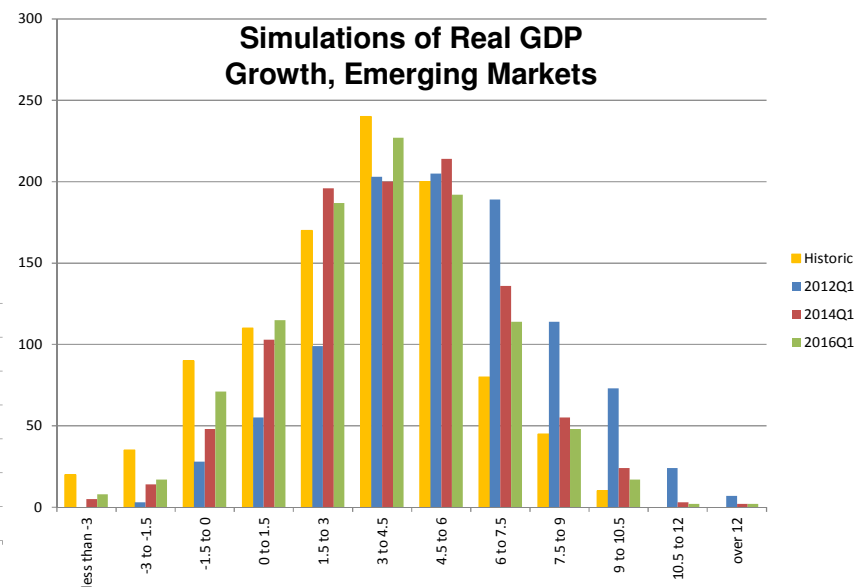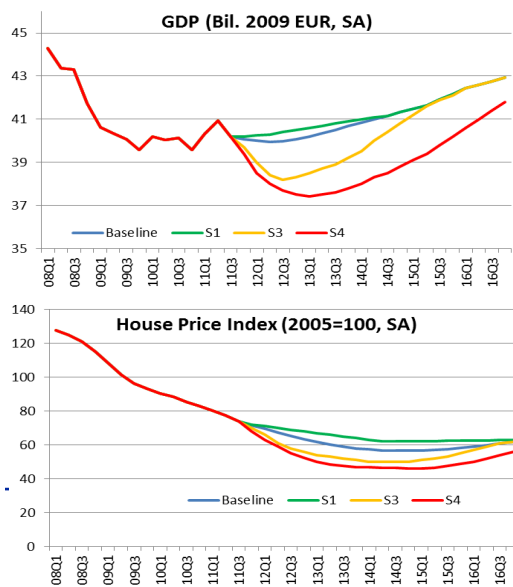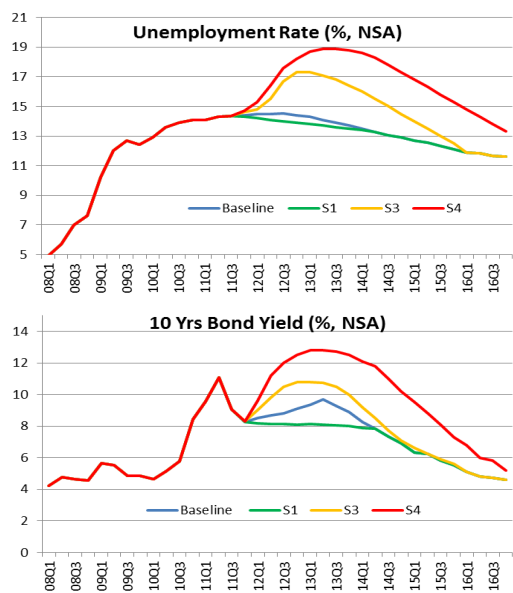


Simulations of Inflation Rate, History & Forecasts, Euro-Zone Level



Unemployment Rate (%, NSA)



GDP (Bil. 2009 EUR, SA)



10 Yrs Bond Yield (%, NSA)



House Price Index (2005=100, SA)



Simulations of Real GDP Growth, Emerging Markets

# **Stress Testing:** 5- Reverse Stress Testing

## **Linking Factors' Realizations to Macro Scenarios**

### **UK factor analysis – 21 macroeconomic series**

```
Factor analysis/correlation          Number of obs     =      48
    Method: principal factors        Retained factors  =      14
    Rotation: (unrotated)            Number of params  =     203
```

| Factor | Eigenvalue | Difference | Proportion | Cumulative |
|--------|-----------|-----------|-----------|-----------|
| Factor1 | 9.58311 | 5.68839 | 0.4995 | 0.4995 |
| Factor2 | 3.89472 | 2.17554 | 0.2030 | 0.7025 |
| Factor3 | 1.71918 | 0.32750 | 0.0896 | 0.7921 |
| Factor4 | 1.39168 | 0.42675 | 0.0725 | 0.8646 |
| Factor5 | 0.96493 | 0.34703 | 0.0503 | 0.9149 |
| Factor6 | 0.61790 | 0.18001 | 0.0322 | 0.9471 |
| Factor7 | 0.43789 | 0.15421 | 0.0228 | 0.9700 |
| Factor8 | 0.28368 | 0.07129 | 0.0148 | 0.9847 |
| Factor9 | 0.21239 | 0.06647 | 0.0111 | 0.9958 |
| Factor10 | 0.14592 | 0.08320 | 0.0076 | 1.0034 |
| Factor11 | 0.06272 | 0.02724 | 0.0033 | 1.0067 |
| Factor12 | 0.03548 | 0.01399 | 0.0018 | 1.0085 |
| Factor13 | 0.02149 | 0.01927 | 0.0011 | 1.0097 |
| Factor14 | 0.00222 | 0.00844 | 0.0001 | 1.0098 |
| Factor15 | -0.00622 | 0.00523 | -0.0003 | 1.0095 |
| Factor16 | -0.01145 | 0.00397 | -0.0006 | 1.0089 |
| Factor17 | -0.01542 | 0.00627 | -0.0008 | 1.0081 |
| Factor18 | -0.02169 | 0.00980 | -0.0011 | 1.0069 |
| Factor19 | -0.03149 | 0.01253 | -0.0016 | 1.0053 |
| Factor20 | -0.04402 | 0.01326 | -0.0023 | 1.0030 |
| Factor21 | -0.05728 | . | -0.0030 | 1.0000 |

LR test: independent vs. saturated: chi2(210) = 1443.70 Prob>chi2 = 0.0000

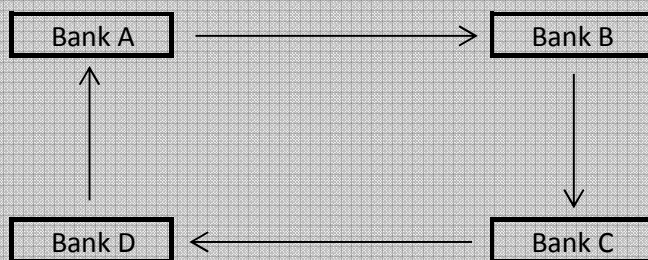### **UK Factor Analysis – Top 5 Factors**
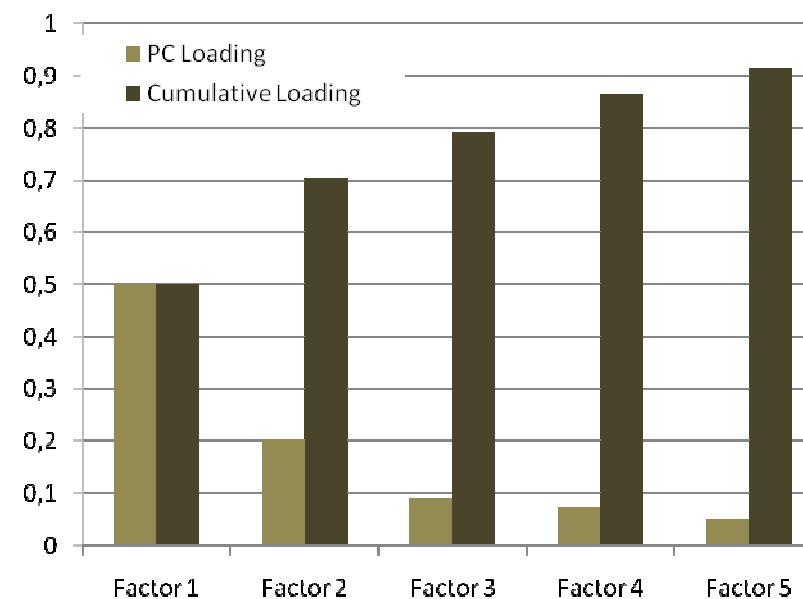


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ANALYTICS

# Stress Testing: 5- Reverse Stress Testing

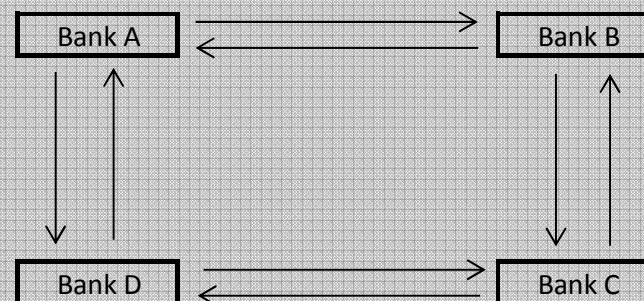## Linking Factors' Realizations to Macro Scenarios, UK Top Factors



UK, 2000-2012: Factor 1 vs GDP growth

UK, 2000-2012: Factor 2 vs Growth in Employment

UK, 2000-2012: Factor 3 vs Inflation

UK, 2000-2012: Factor 3 vs Monetary Policy rate

UK, 2000-2012: Factor 4 vs M1 (growth rate)

UK, 2000-2012: Factor 5 vs Home Price growth (lagged)
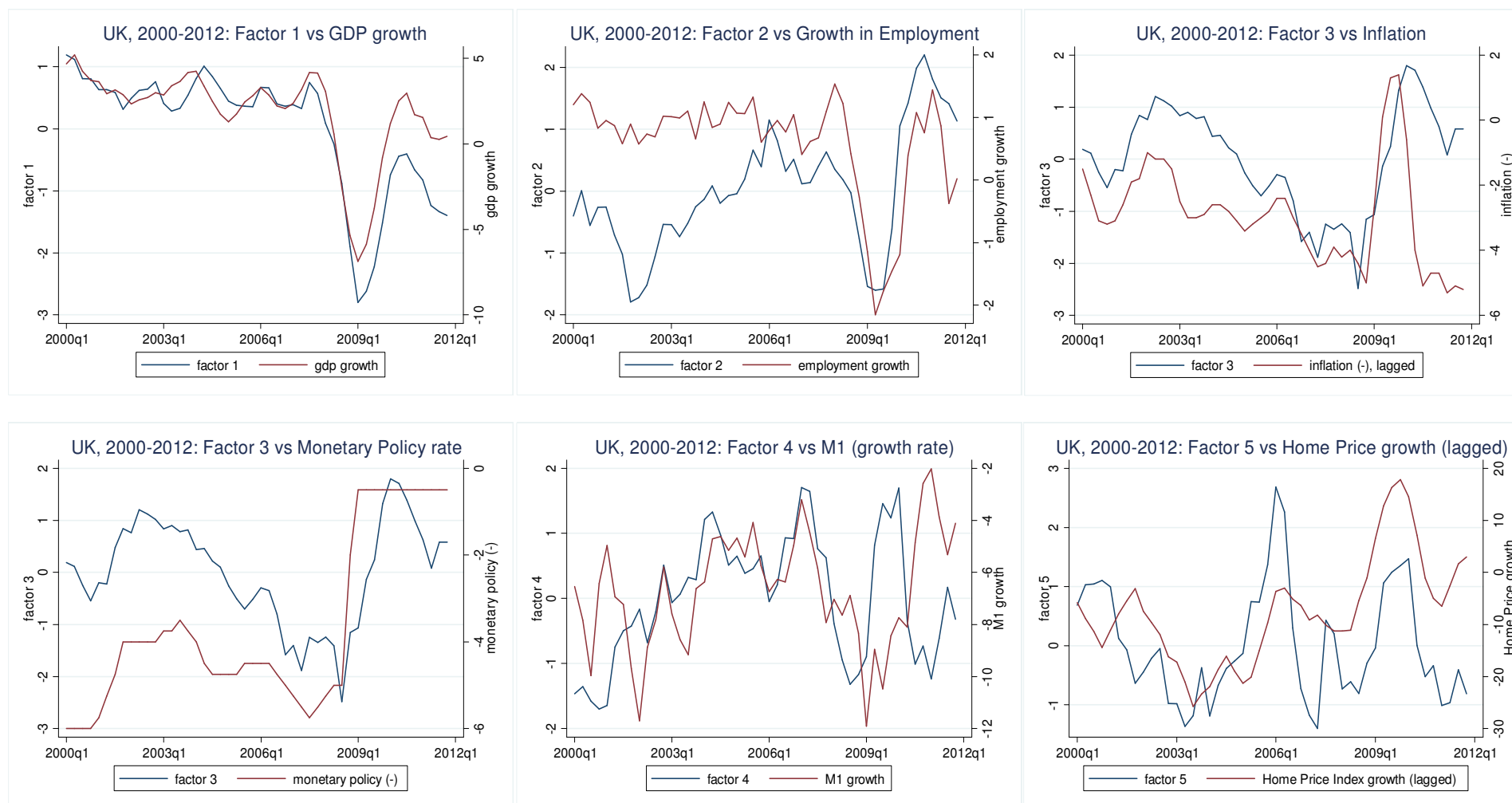
# Stress Testing: 6- Looking beyond Capital & Solvency



**Case 1: Incomplete Markets**

Bank A → Bank B → Bank C → Bank D → Bank A

**Case 2: Complete Markets**

Bank A ⇄ Bank B, Bank A ⇄ Bank D, Bank B ⇄ Bank C, Bank D ⇄ Bank C

**Case 3: A Hybrid Market Structure**

Bank B1 ← Bank B2 ← Bank B3 ← Bank B4

Bank A1 ⇄ Bank A2

Bank A3 ⇄ Bank A4

Bank B5 → Bank B6 → Bank B7 → Bank B8
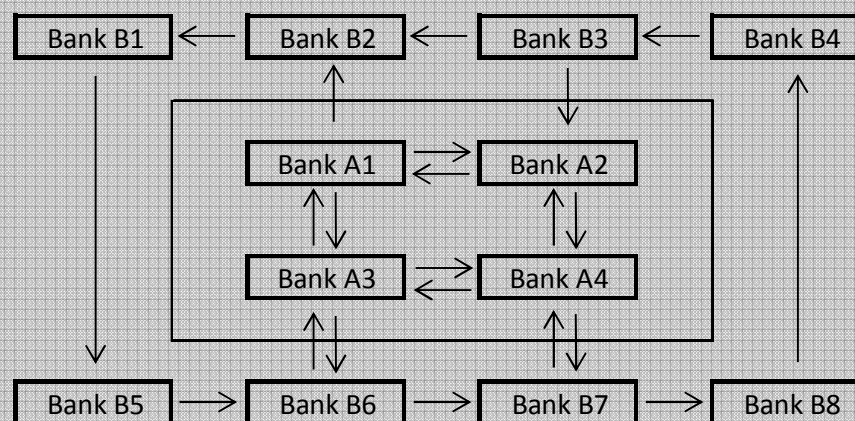
# **Stress Testing:** 6- Looking beyond Capital & Solvency

(1) If a **small institution fails**, other peripheral banks are likely to suffer asset-liability mismatches. But the systemic risk involved is not as high. Large institutions should be able to absorb the original shock and stop the domino effects once it enters the core banking area.

(2) If the shock is to one of the **large financial institutions**, there is a secondary effect through the overall health of the financial economy that could put all institutions under tremendous pressure.

Though the core banking sub-sector is complete (bi-directional flows), the fact that it is highly concentrated poses severe challenges to the banking sector as a whole. It is not so much a direct domino effect between, say, Bank A1 and Bank A2, but an ***indirect contagion risk***: (2.a) Bank A1 affects the overall economy (as it is a big financial institution whose failure can put pressure on the local financial and labor markets), (2.b) the economy affects Bank A2 as an external shock, (2.c) Bank A2's failure worsens the economic picture even more, (2.d) the economy affects Bank A3, etc.



P&L Rate, Total Assets



P&L Rate, Total Liabilities

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