

# Measuring and Forecasting Financial Stability

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**„Funding Liquidity Risk in a Quantitative Model of Systematic Stability“**

# Funding liquidity risk in a quantitative model of systemic stability

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15/16<sup>th</sup> January 2009

The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or Monetary Policy Committee members.

# Funding liquidity risk in a quantitative model of systemic stability

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# Introduction

- Project under way at the Bank to develop a unified quantitative framework for analysing and assessing risks to the stability of the UK financial system.
- **R**isk **A**ssessment **M**odel for **S**ystemic **I**nstitutions (**RAMSI**).

# Introduction

- RAMSI could be used in internal risk assessment to:
  - Track overall risks in the financial system over time (say, by producing fan charts);
  - Stress testing (resilience to specific scenarios);
  - Identify structural vulnerabilities (what are the sources of tail risk);
  - Policy exercises (how a policy might mitigate systemic risk).

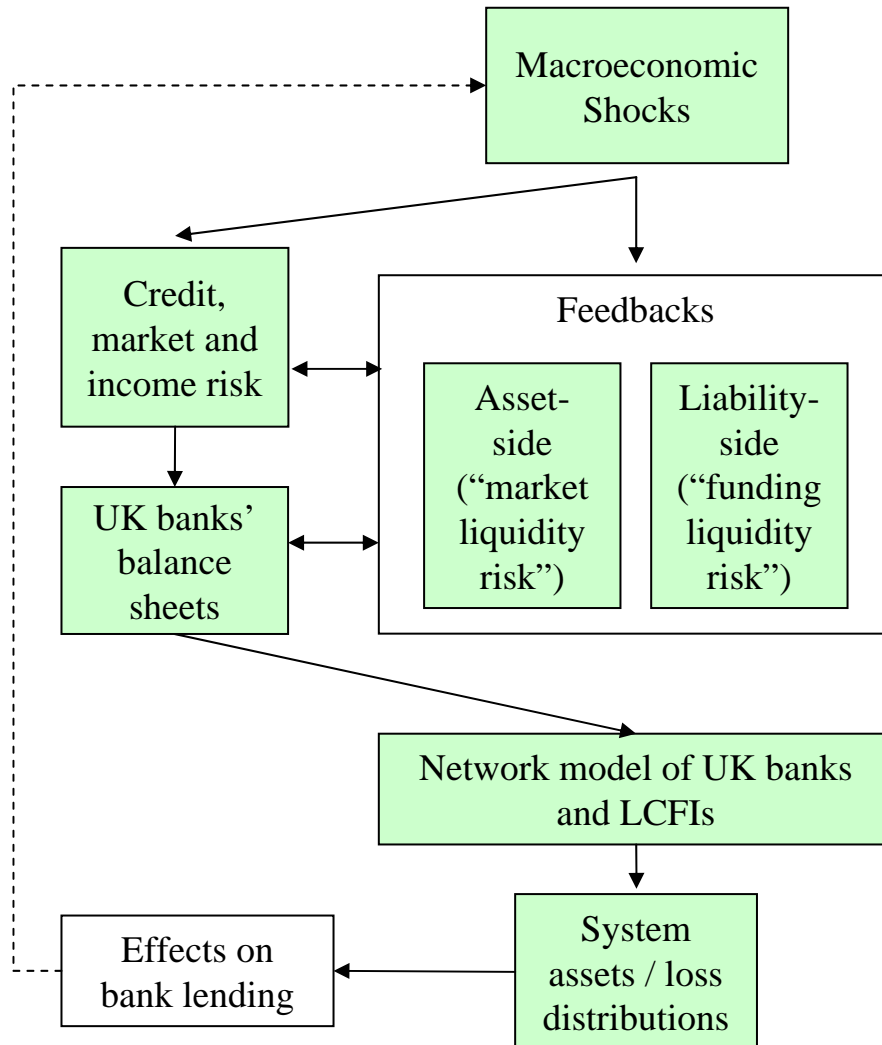
# Introduction

- RAMSI integrates different sources of risk to the core UK banking system.
- Reflected in how banks can fail in the model in different ways:
  - Fundamental (due to credit risk, interest income risk, market risk);
  - Contagion (inter-bank losses, mark-to-market losses caused by asset fire-sales);
  - **Funding illiquidity** (banks lose access to funding);

# Introduction

- Overview of the different parts of the model, with particular focus on funding liquidity risk.
- Simulation results.
- But ... model is only at development stage (further validation to do, numerical results should not be construed as accurate assessments of risks in the UK financial system).

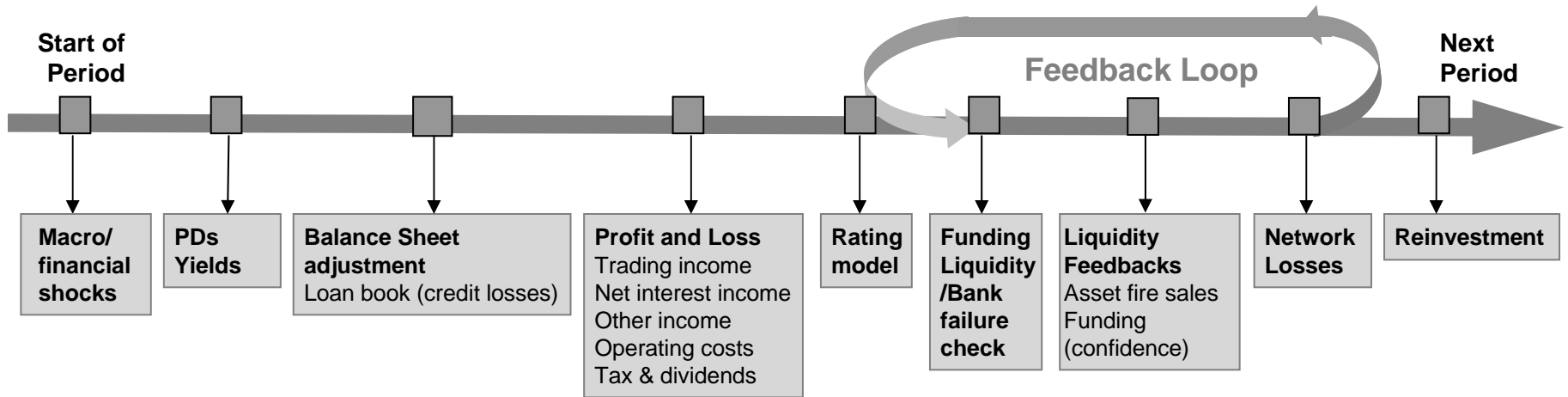
# Model Architecture



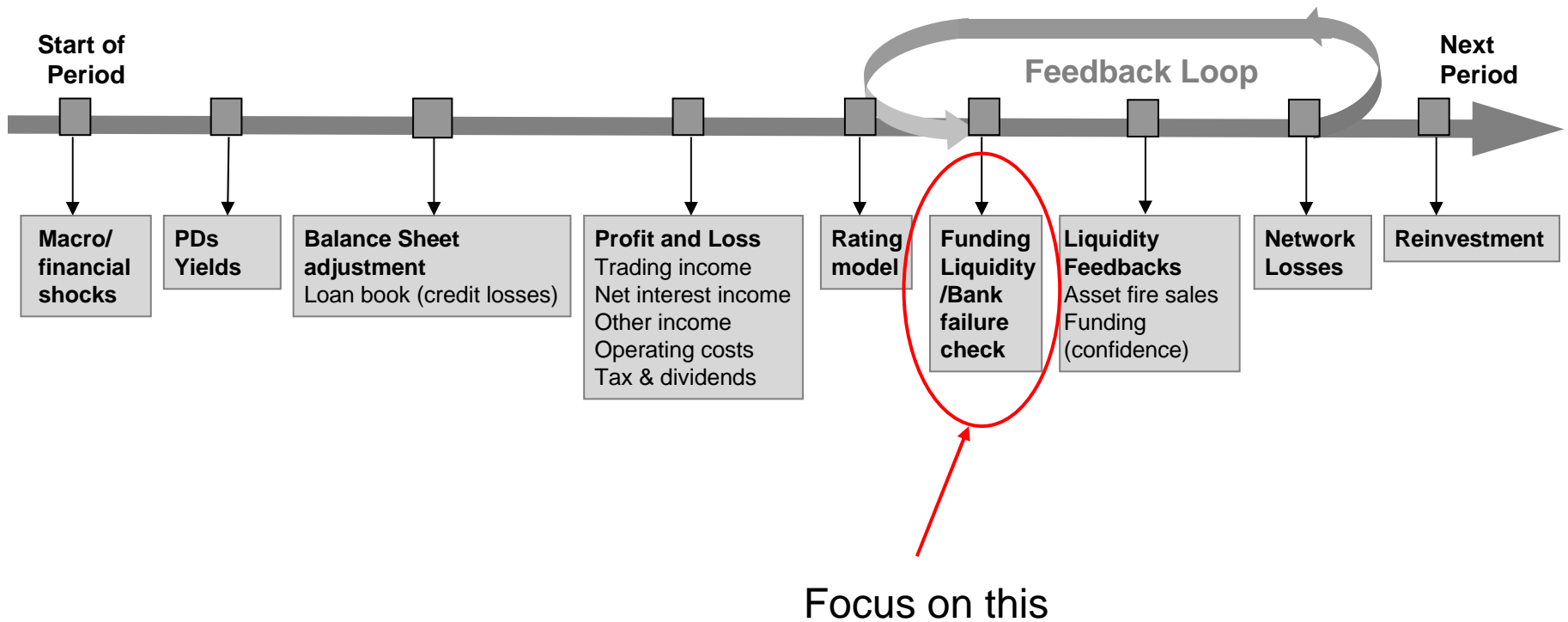
# Balance Sheets

- Bedrock of the model.
- Detailed bank sheets ( $\approx$  400 asset & 250 liability classes; maturity and re-pricing splits; geographical & currency splits).
- Based on published accounts (using rules of thumb to fill in missing data).
- Cover the ten major UK banks (as of the end of 2007).

# Time-line of events within a quarter

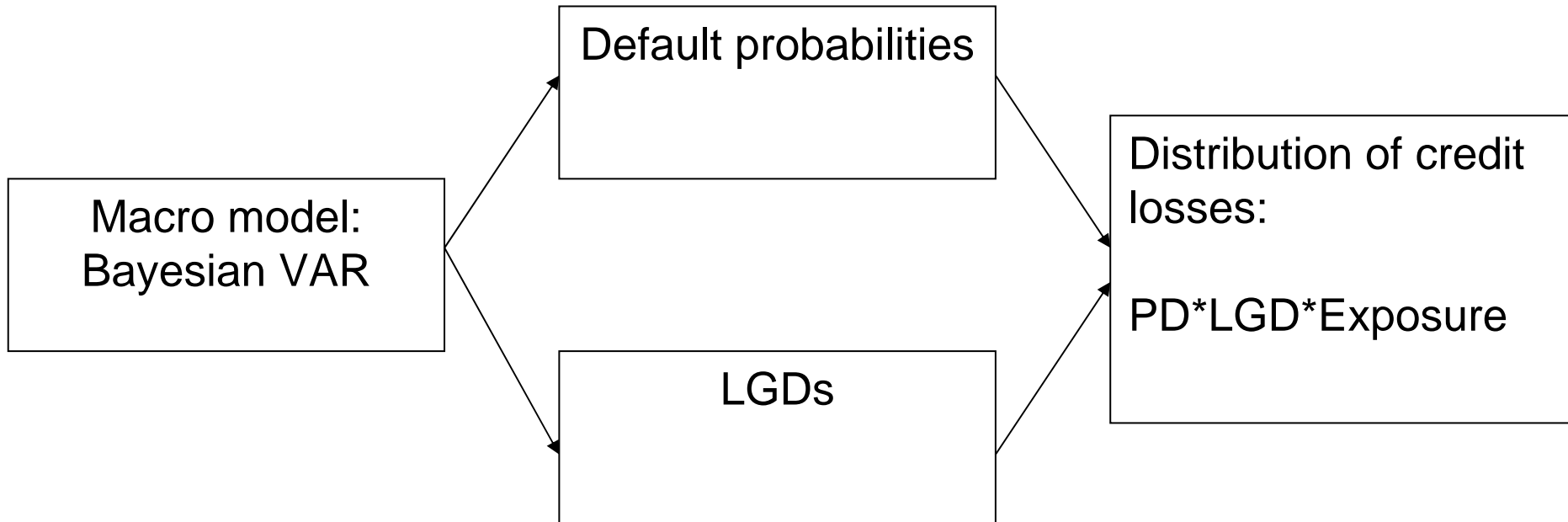


# Time-line of events within a quarter



# Sources of profit and loss

- Credit losses



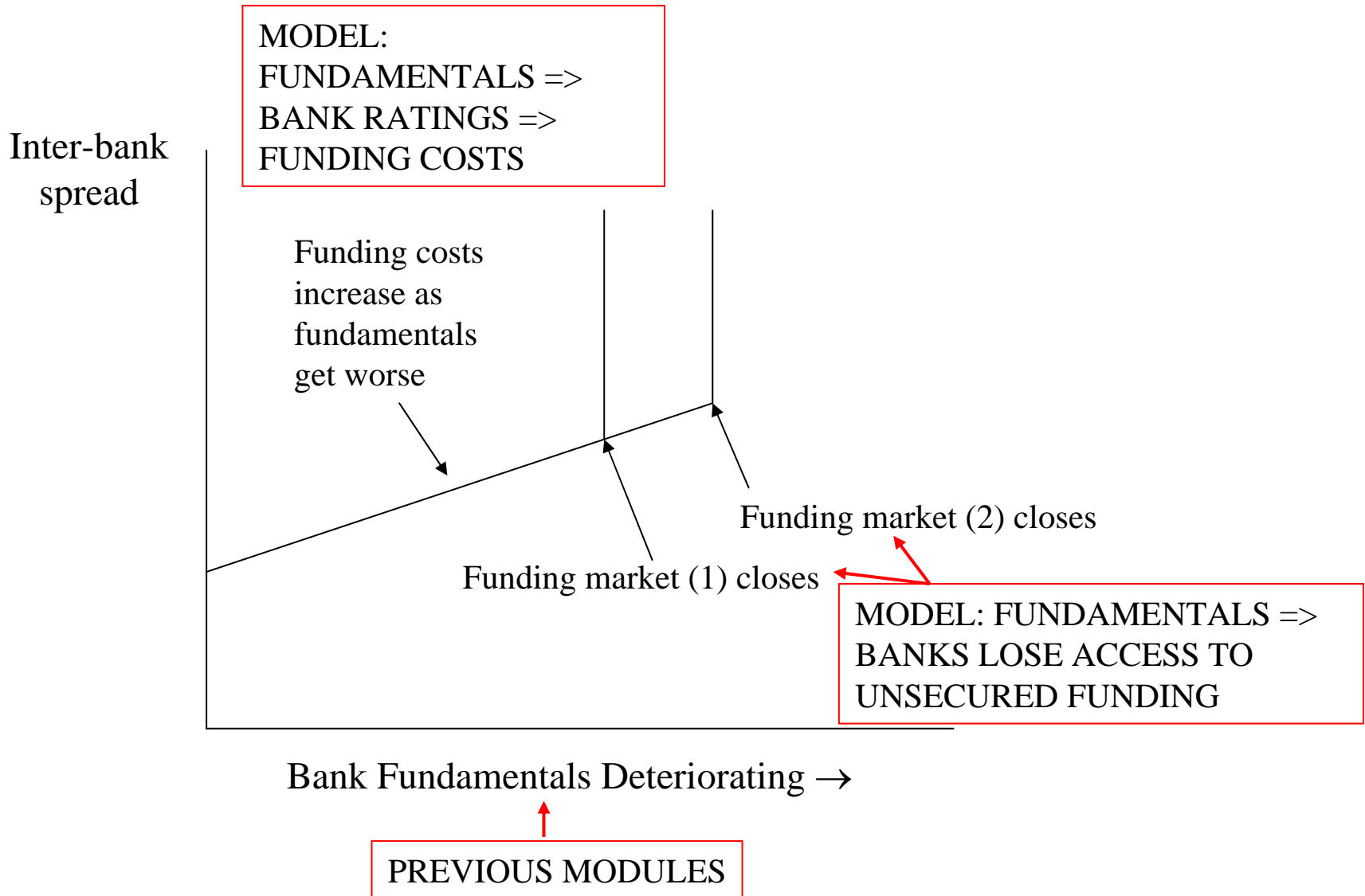
# Sources of profits and losses

- Net interest income; not all assets and liabilities can be re-priced every quarter even if risk-free rates and credit risk change => there can be shocks to NII.
- Trading income, other income (e.g. fees and commissions), and operating costs modelled in a reduced form way.

# Reinvestment

- After profits and losses are realised, banks' balance sheets must be rebalanced.
- Set of mechanical reinvestment rules to achieve rebalancing (e.g. Tier 1 capital ratio).
- No active disinvestment in this version of the model (as a defensive action).

# Funding costs and closure of funding markets



# Bank ratings

- Two steps:
  - 1) Function that maps fundamentals into banks' ratings;
  - 2) Mapping from ratings to credit spreads for banks.
- Endogenous spreads apply to certain sources of wholesale funding.

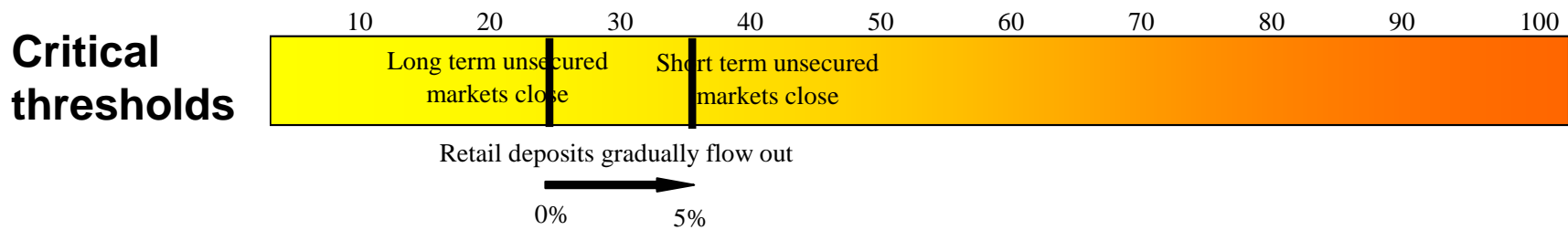
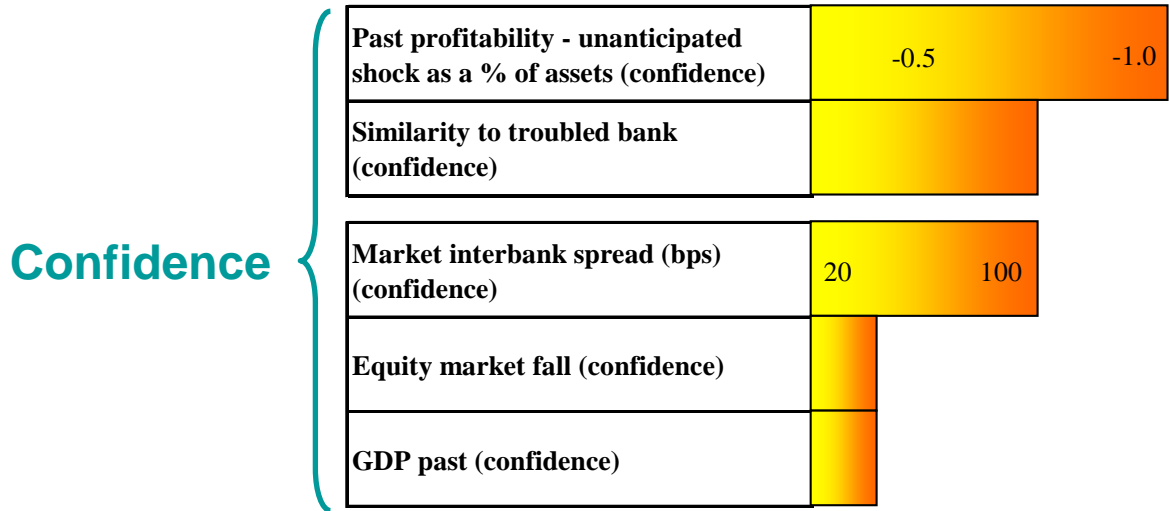
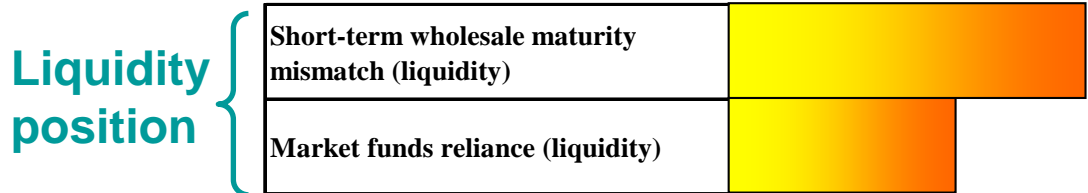
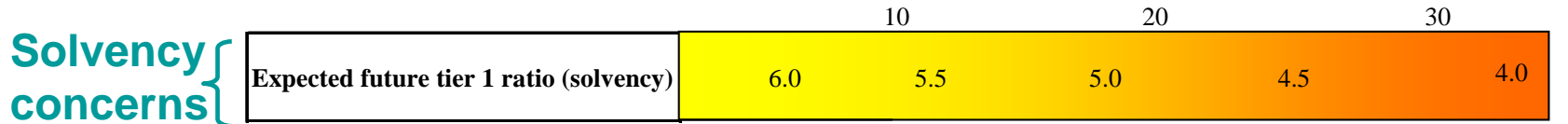
# Closure of funding markets

- Use a 'Danger Zones' approach.
- Banks' access to funding summarised by a danger zone score.
- Scores change quarter-to-quarter.
- Reflect banks' solvency, liquidity positions, and confidence or beliefs about banks' health.
- A way to incorporate our judgements on the factors that matter in funding liquidity crises.

# Closure of funding markets

- Closure is difficult to model because of dependence on imperfectly observable beliefs and because liquidity crises are rare events.
- Calibrated the framework to a small number of crises including Northern Rock and Continental Illinois.

# The Danger Zones



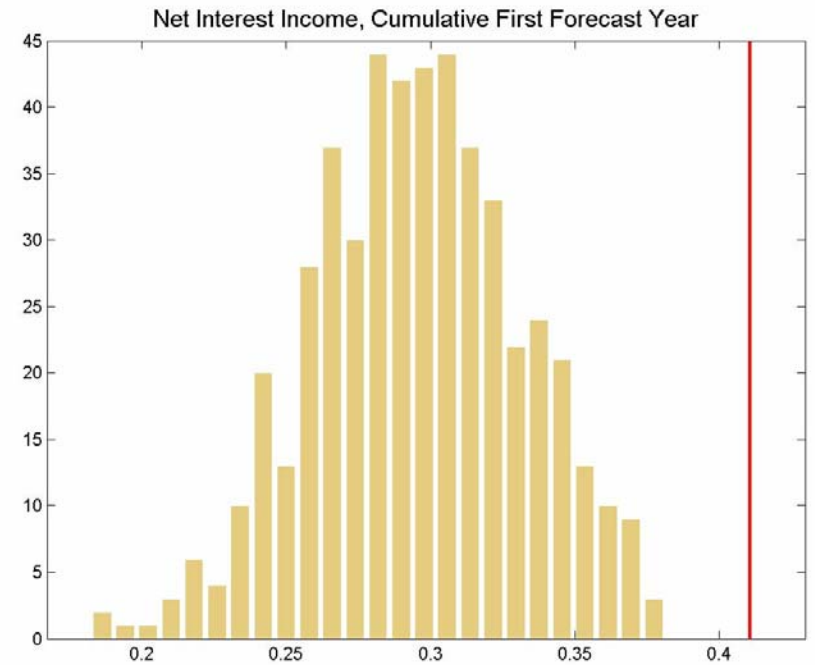
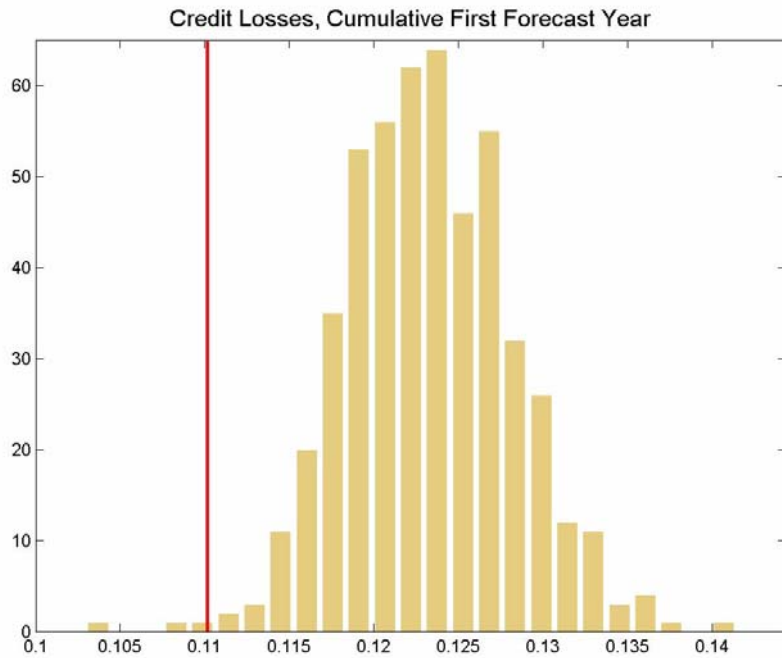
# After bank failure

- Other banks incur losses on inter-bank exposures. The network is cleared using Eisenberg and Noe algorithm.
- Failed banks sell assets => at fire-sale prices => other banks suffer market-to-market losses.
- Obviously these losses can feedback into further funding liquidity problems.

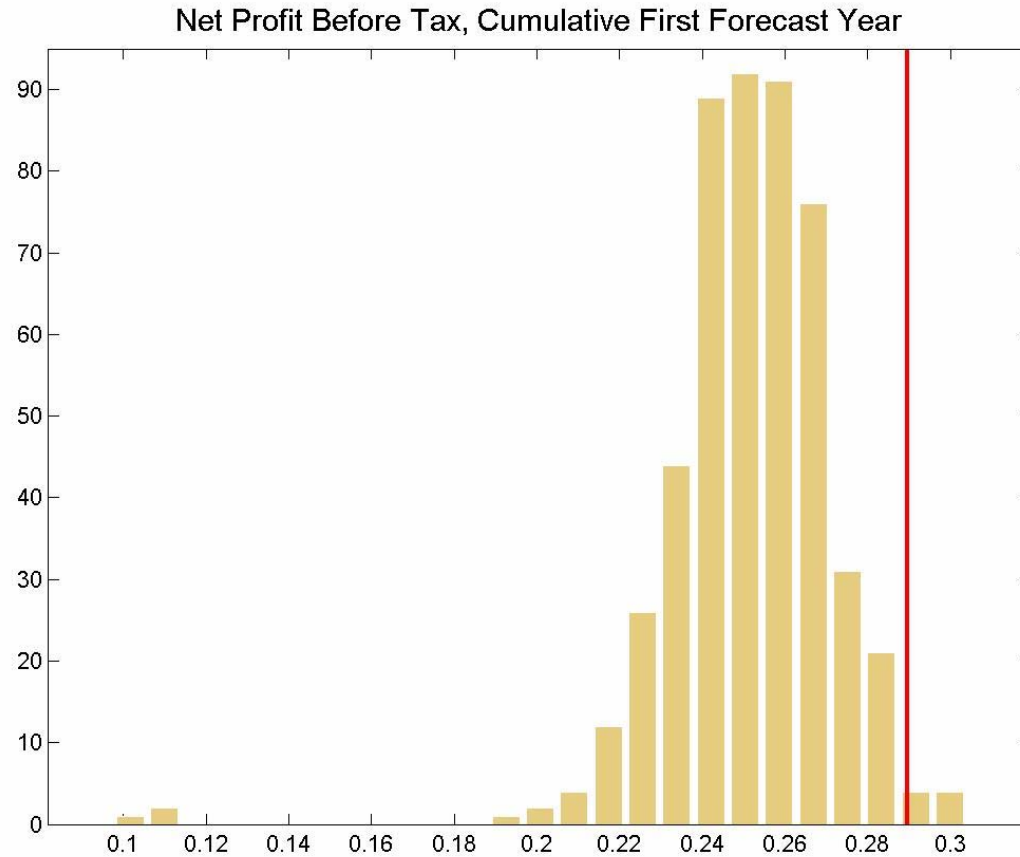
# Simulation results

- 2007Q4 as the baseline.
- 500 random draws (from the BVAR) in Q1. 12 quarters per draw.

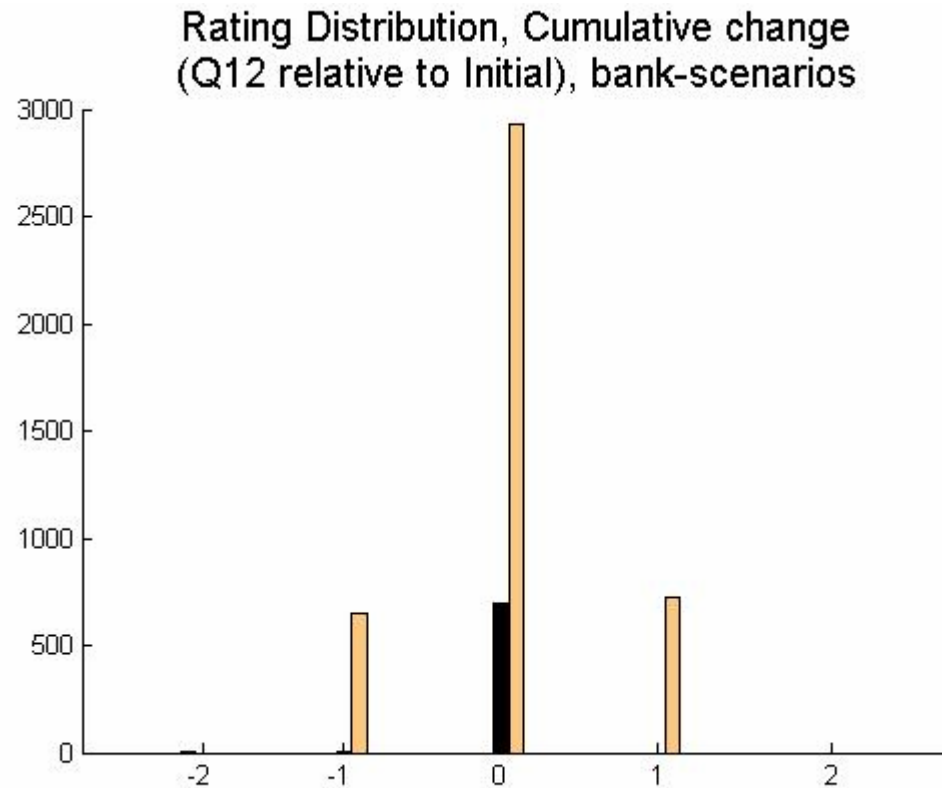
# Credit losses and Net Interest Income relative to '07 capital



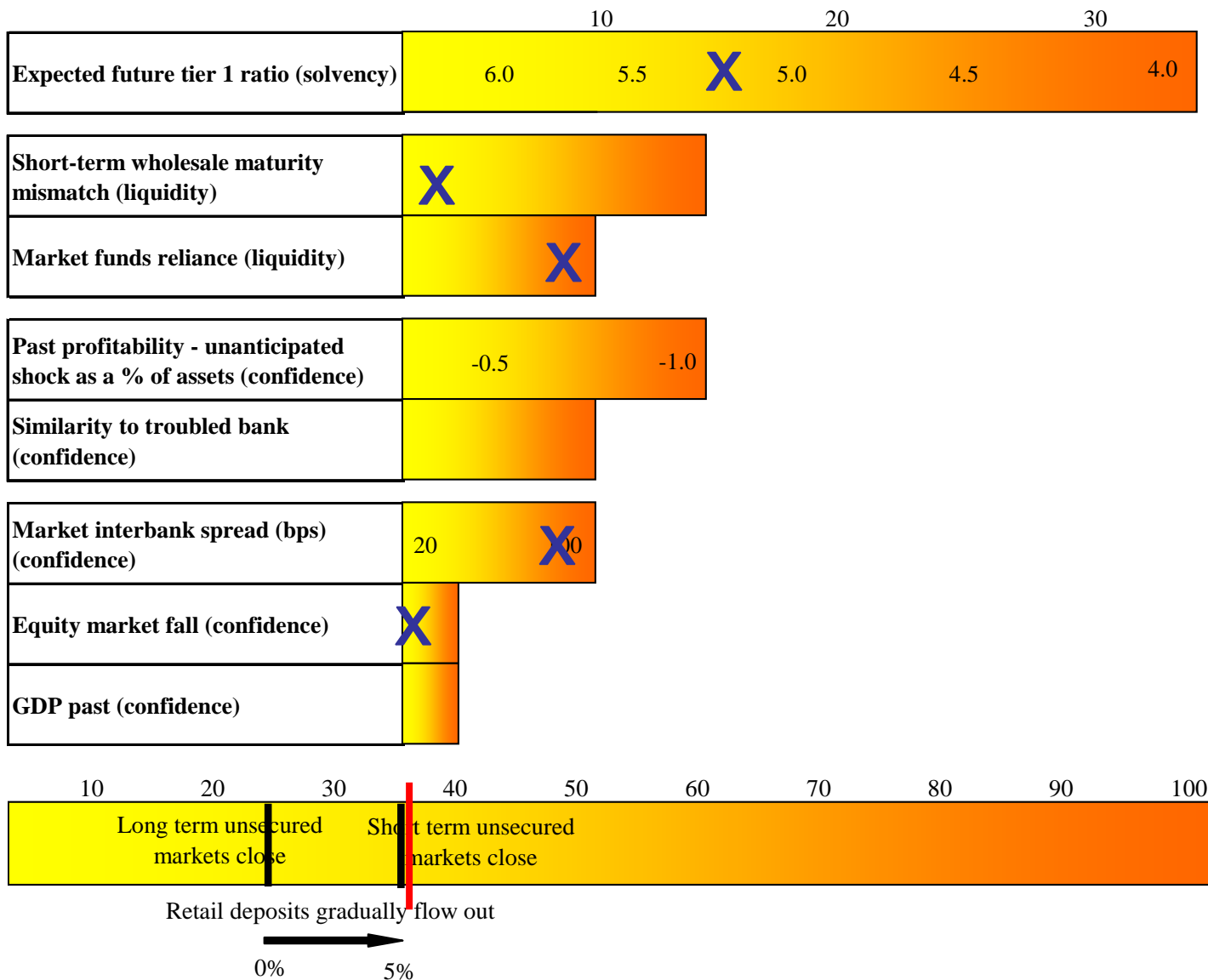
# Net profits before tax



# Change in ratings



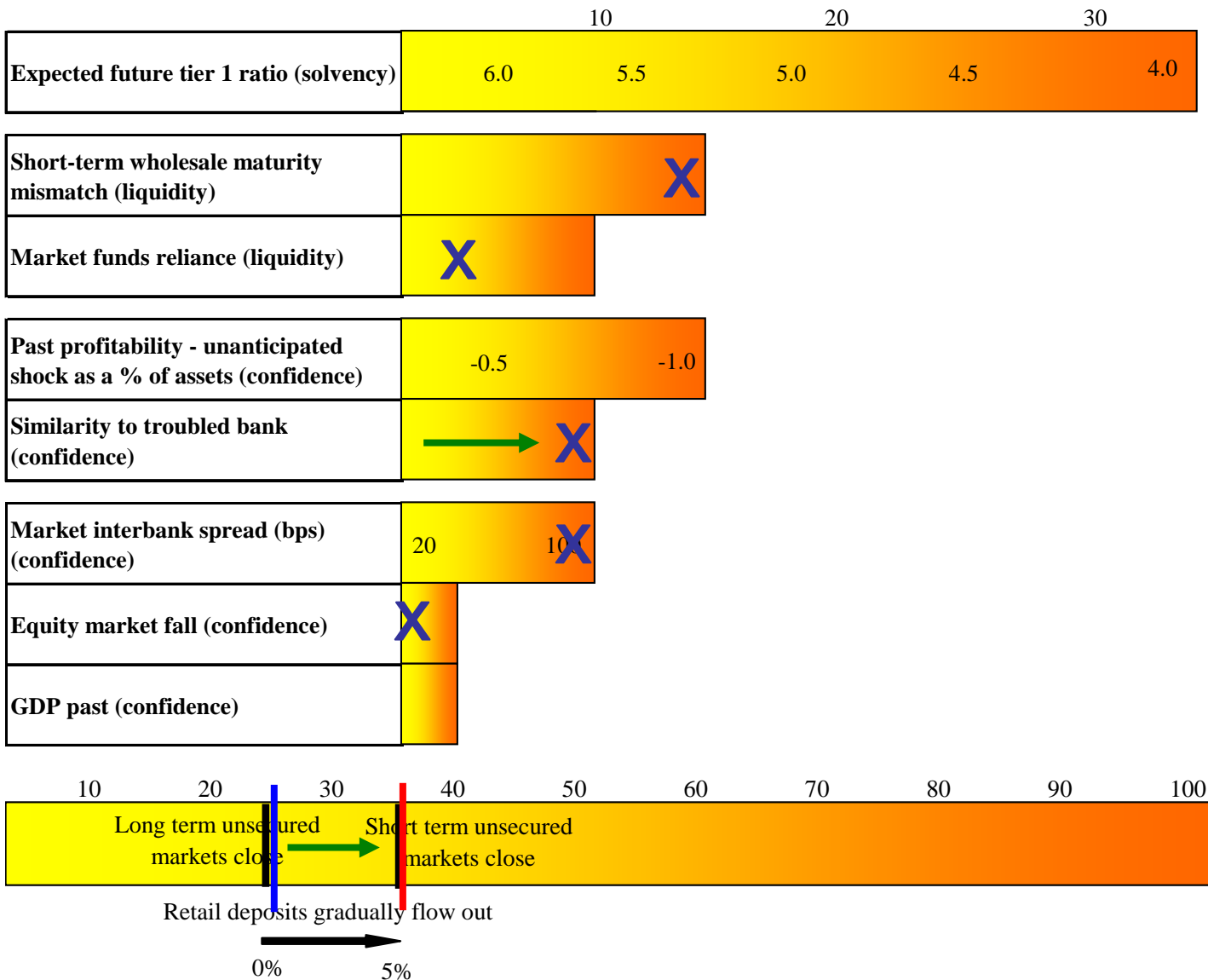
# DZ scores in a tail realisation: bank default



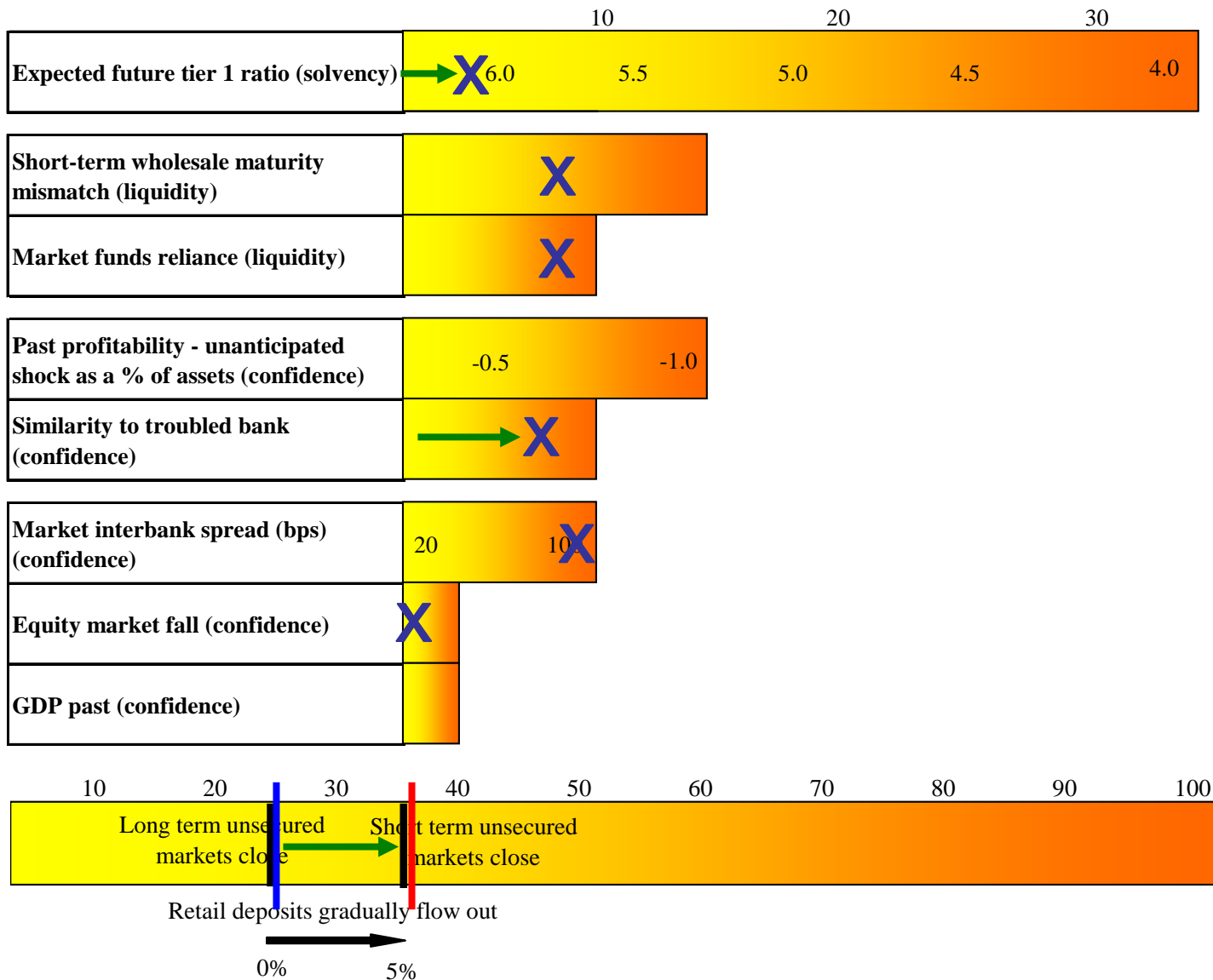
# Simulation results

- Other features of the tail realisations include:
  - Inter-bank losses aggravate the fragility of banks further;
  - In some realisations there are multiple and sequential bank failures due to short-term funding markets closing to them.

# Second bank failure



# Third bank failure



# Summary

- RAMSI is being developed at the Bank as an integrated model for analysing and assessing risks to UK financial stability.
- Funding liquidity risk is a key trigger for bank failure in the model, making the system potentially more fragile.
- Closure of funding markets is modelled using a 'Danger Zone' approach.
- In the future, consider modelling banks' access to secured funding and allow for 'safe banks' to receive liquidity inflows during crises.

**Additional slides**

# Stylised balance sheet and income statement

ASSETS	LIABILITIES
Loans to banks	Deposits from banks
Loans to customers	Customer accounts
Trading portfolio assets	Trading portfolio liabilities
AFS investments	Debt securities
Derivatives	Derivatives
Reverse repo	Repo
	Capital

## INCOME STATEMENT

Net interest income

Fees and commissions

Trading income

Other income

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**Total operating income**

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Operating expenses

Impairments

- On loan book

- On AFS book

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**Profit before tax**

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Tax

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**Profit after tax**

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Dividends

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**Retained earnings**

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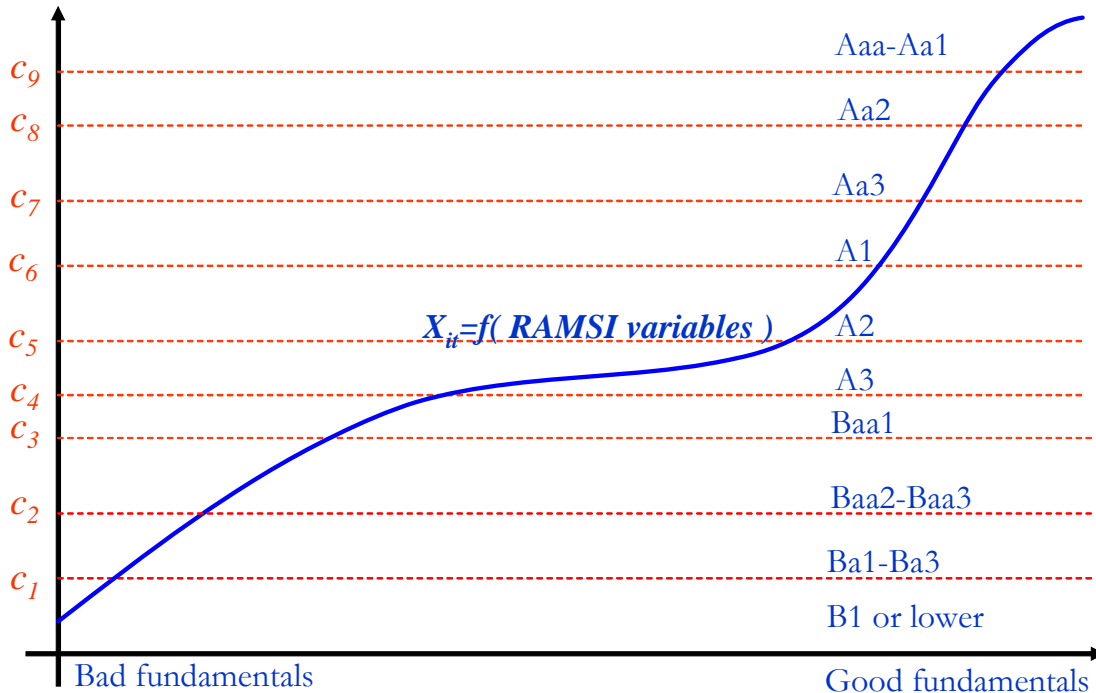
# BVAR variables

UK	US	EA	World
Real GDP	Real GDP	Real GDP	Real oil prices
CPI inflation	CPI	CPI	Real world equity price index
£ERI	3-m T-Bill rate*	3-m T-Bill rate*	
Real FTSE All Share	10-yr govt bond rate*	10-yr govt bond rate*	
3-m T-Bill rate*			
3-yr govt bond rate*			
10-yr govt bond rate*			
Unemployment*			
Real house prices			
Real comm. prop. prices			
Income gearing*			
Corporate lending*			
3-month LIBOR spread*			
10-yr corporate spread*			

# Other income and costs

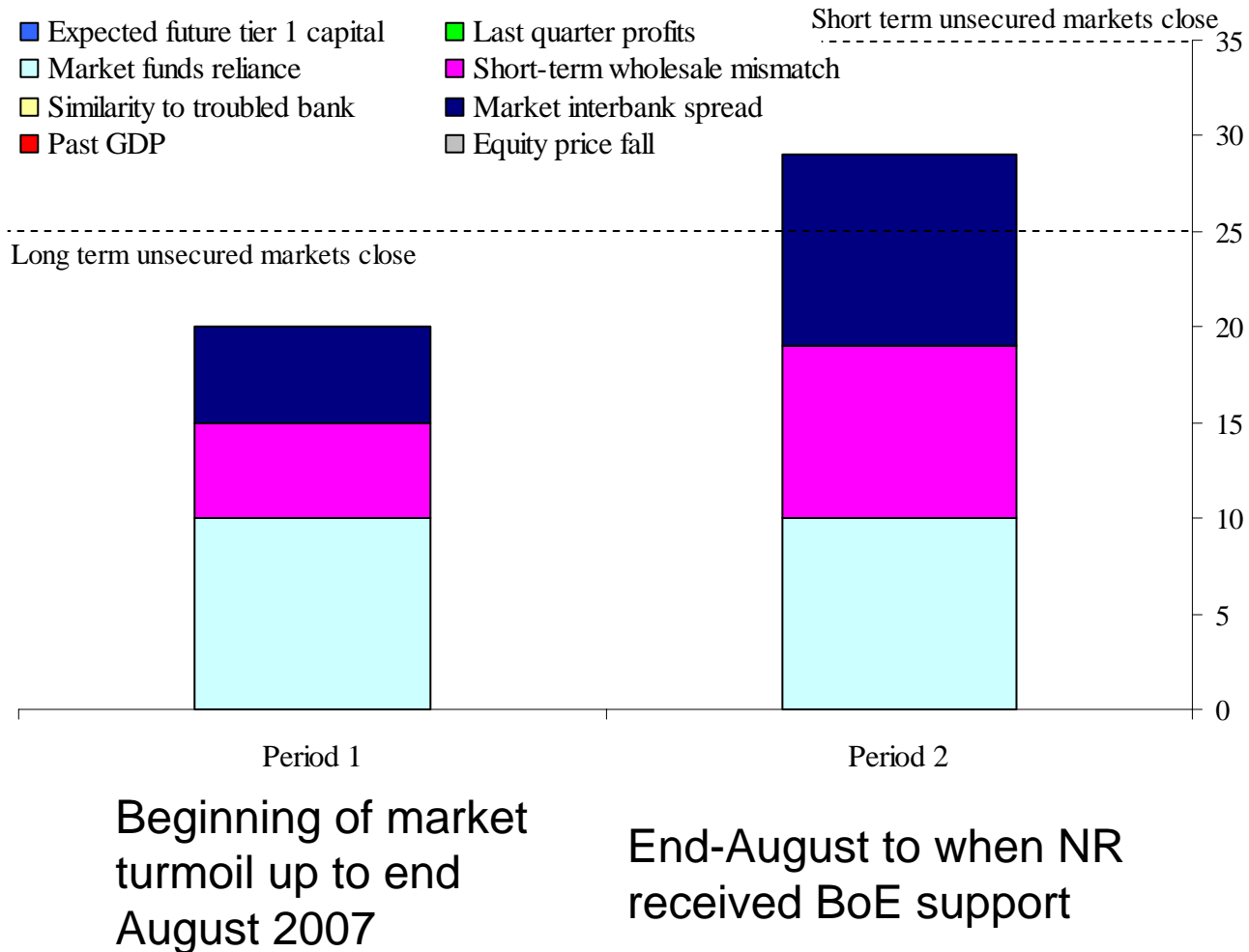
- Simple estimated equations
- Non-interest income excluding trading income:
  - Pro-cyclicality: Based on empirical evidence from US data, fees and commissions are found to be strongly pro-cyclical.
  - Bank-specific determinant: 2007 levels of non-interest income used as a base for forecasts.
- Operating expenses:
  - Banks target cost / income ratios.
  - But banks are unable to immediately adjust expenses given a significant drop in operating income (i.e. there is some stickiness to operating expenses).

# Ratings Model



- Rating index function  $f()$  and cut-off points ( $c_j$ ) estimated using a RAMSI-friendly version of Pagratis and Stringa (2008).
- In every simulation, realised values of RAMSI variables determine  $f$ . Rating assigned to banks depending on the max cut-off point  $c_j$  that is crossed by  $f$  (e.g. A1 if  $c_6 < f(\text{RAMSI}_i) < c_7$ ).

# Case studies: Northern Rock



# Case studies: Continental Illinois

