

# Identifying and measuring systemic risk

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# Outline

- Introduction / Definition
- Dimensions of systemic risk
- Measures and macro-prudential instruments
- Practical implementation
  - The ESRB Risk Dashboard
  - Macro stress-testing
  - The usefulness and limitations of early warning models
- Concluding remarks

### *What is systemic risk?*

“The Global Financial Stability Report of the International Monetary Fund (2009) defines systemic risk as **a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and that has the potential to cause serious negative consequences for the real economy.**”

*[Engle et al. (2015), “Systemic Risk in Europe”, Review of Finance]*

# Dimensions of systemic risk

## **1.) Cyclical imbalances**

- One potential source of financial instability stems from the build-up of aggregate financial imbalances over time, i.e. it refers to the cyclical or **time dimension** of systemic risk(s).

## **2.) Structural externalities**

- Another potential threat to financial stability might arise from common exposures and inter-linkages within the financial system, i.e. the structural or **cross-sectional dimension** of systemic risk(s).

# Cyclical imbalances – introduction

- Cycles of “booms” and “busts” in the real economy and the financial sector (e.g. Minsky, 1982)
- Prevailing view before the financial crisis: central banks should not “lean” against growing imbalances, but just “clean up” the aftermath of a collapse
- However: huge potential costs, e.g. estimation by Haldane (2010): global output loss of \$60 - \$200 trillion due to last crisis
- Problem: “paradox of financial instability”, the system seems to look strongest precisely when it is most vulnerable (Borio/Drehmann, 2009)
- Key element: extent to which imbalances are financed by debt instead of equity (Schoenmaker/Wierts, 2011)
- Example: dot-com bubble (2000) <-> U.S. housing market bubble (2007)

# Cyclical imbalances – measures and macro-prudential instruments

- Credit-to-GDP gap -> counter-cyclical capital buffer (Basel III)
  - Loan-to-value (LTV) and debt-to-income (DTI) ratios -> loan loss provisioning and margining requirements
  - Maturity transformation (lending long-term, borrowing short-term) -> liquidity coverage ratio (LCR), net stable funding ratio (NSFR), time-varying liquidity risk charges, reserve requirements, restrictions on foreign lending, etc.
- > More on these measures and instruments in the later sessions of today and tomorrow

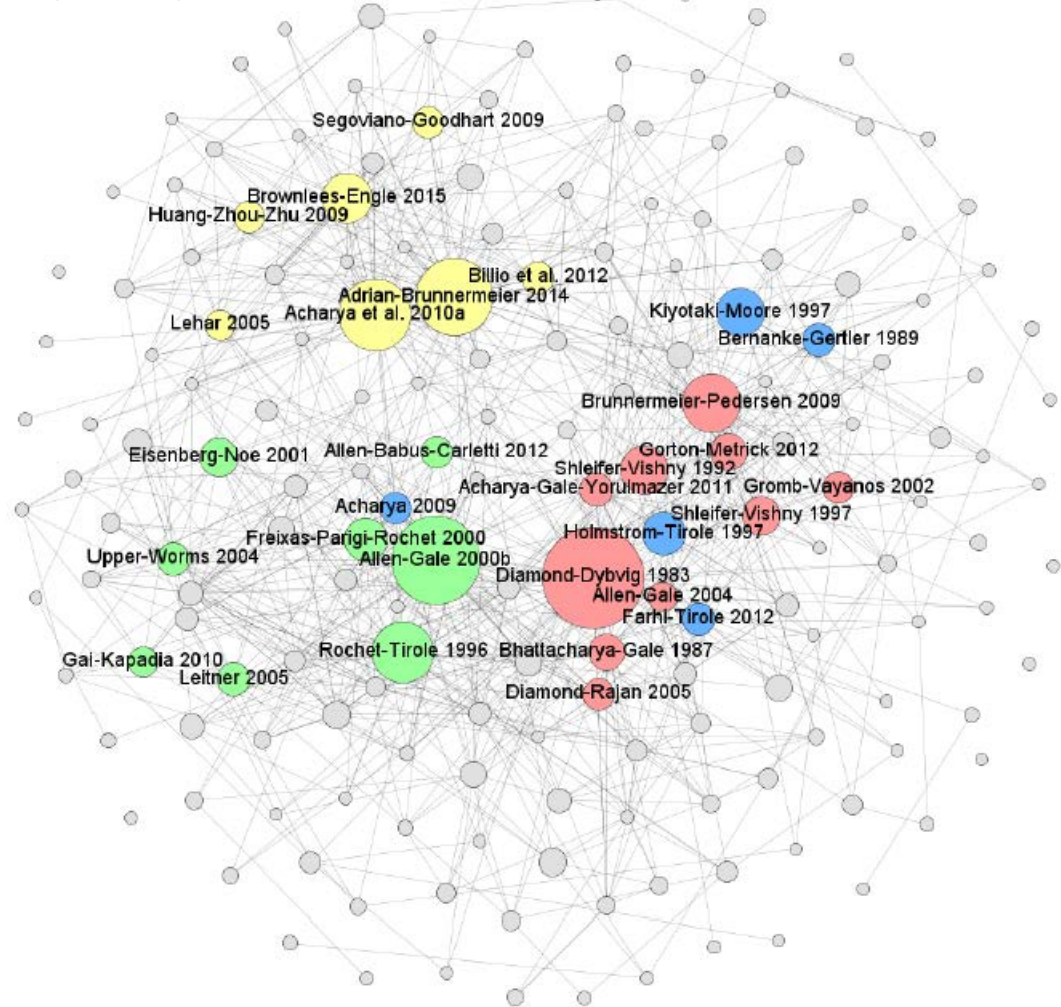
# Structural externalities – measures and instruments

- Systemic consequences of a shock depend strongly on structural features of the financial sector (Bank of England, 2011)
  - Macro-prudential instruments should be calibrated with respect to the contribution of each institution to the overall level of systemic risk (Borio, 2011):
    - Adrian/Brunnermeier (2011/2014): CoVaR (conditional value-at-risk)
    - Acharya et al (2010/2012): MES (marginal expected shortfall) -> SES (systemic expected shortfall)
    - Brownlees/Engle (2011/2015): SRISK (conditional capital shortfall index)
    - Huang/Zhou/Zhu (2009/2011): Marginal contribution of a financial firm to the DIP (distress insurance premium) of the financial sector
    - Lehar (2005): ES (expected shortfall) of a firm in case of default
    - Drehmann/Tarashev (2011): CA (contribution approach), rooted in the Shapley value methodology
    - Billio et al (2012): Quantification of the interdependence among financial firms using principal components analysis and Granger-causality networks
    - Segoviano/Goodhart (2009): Distress dependence among banks and stability of the banking system
- > e.g. capital surcharges for systemically important financial institutions (SIFIs)

# Cross-citations of 205 academic articles

[Benoit et al. (Apr 2015), "A Survey on Systemic Risk", Working paper]

- Yellow: systemic risk measures
- Green: contagion
- Red: amplification mechanisms
- Blue: systemic risk-taking





# The ESRB Risk Dashboard

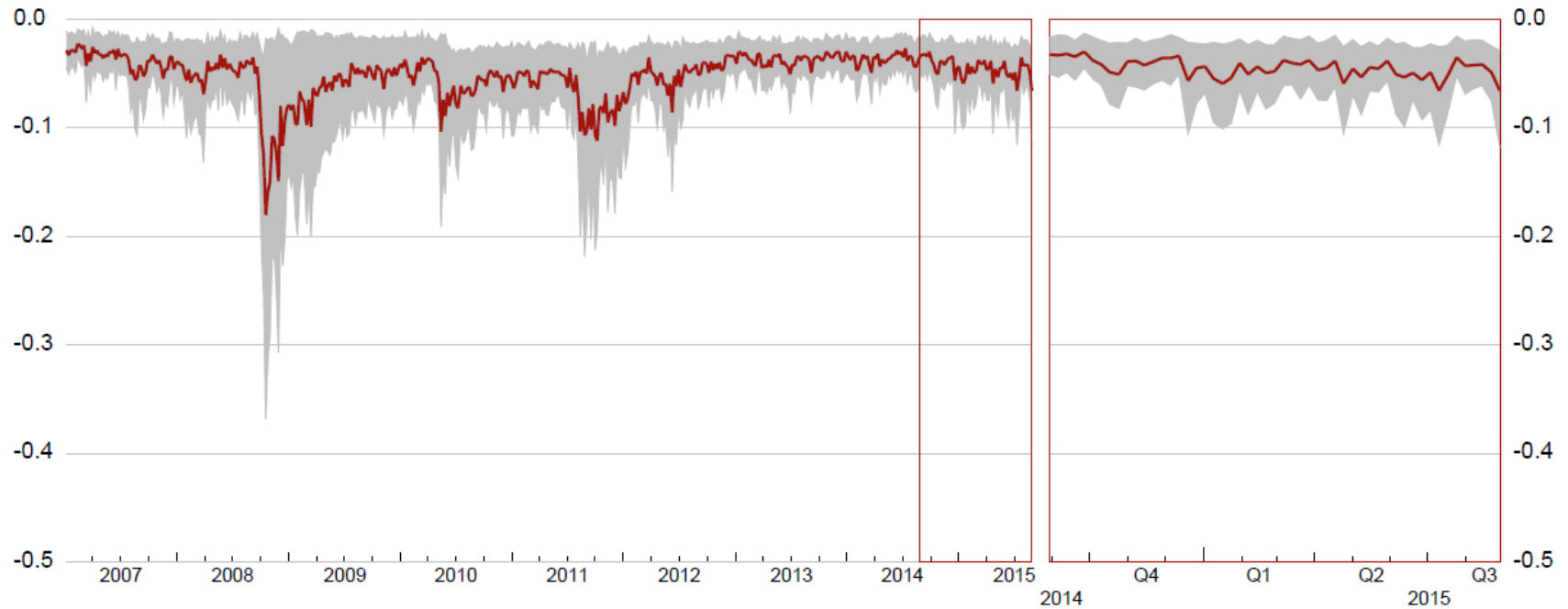
- In 2012: launch of the “ESRB risk dashboard”
- It is a set of quantitative and qualitative indicators to identify and measure systemic risk in the EU financial system
- Currently, it consists of about 70 (external version: 60) measures covering the following areas:
  - Interlinkages and composite measures of systemic risk
  - Macro risk
  - Credit risk
  - Funding and liquidity
  - Market risk
  - Profitability and solvency
- The indicators are published four times a year, together with an overview note which summarizes and reviews the results

# The ESRB Risk Dashboard (example: CoVaR measure of 52 banks)

## 1.3 Individual institutions' contributions to overall systemic risk

### a. Banking sector

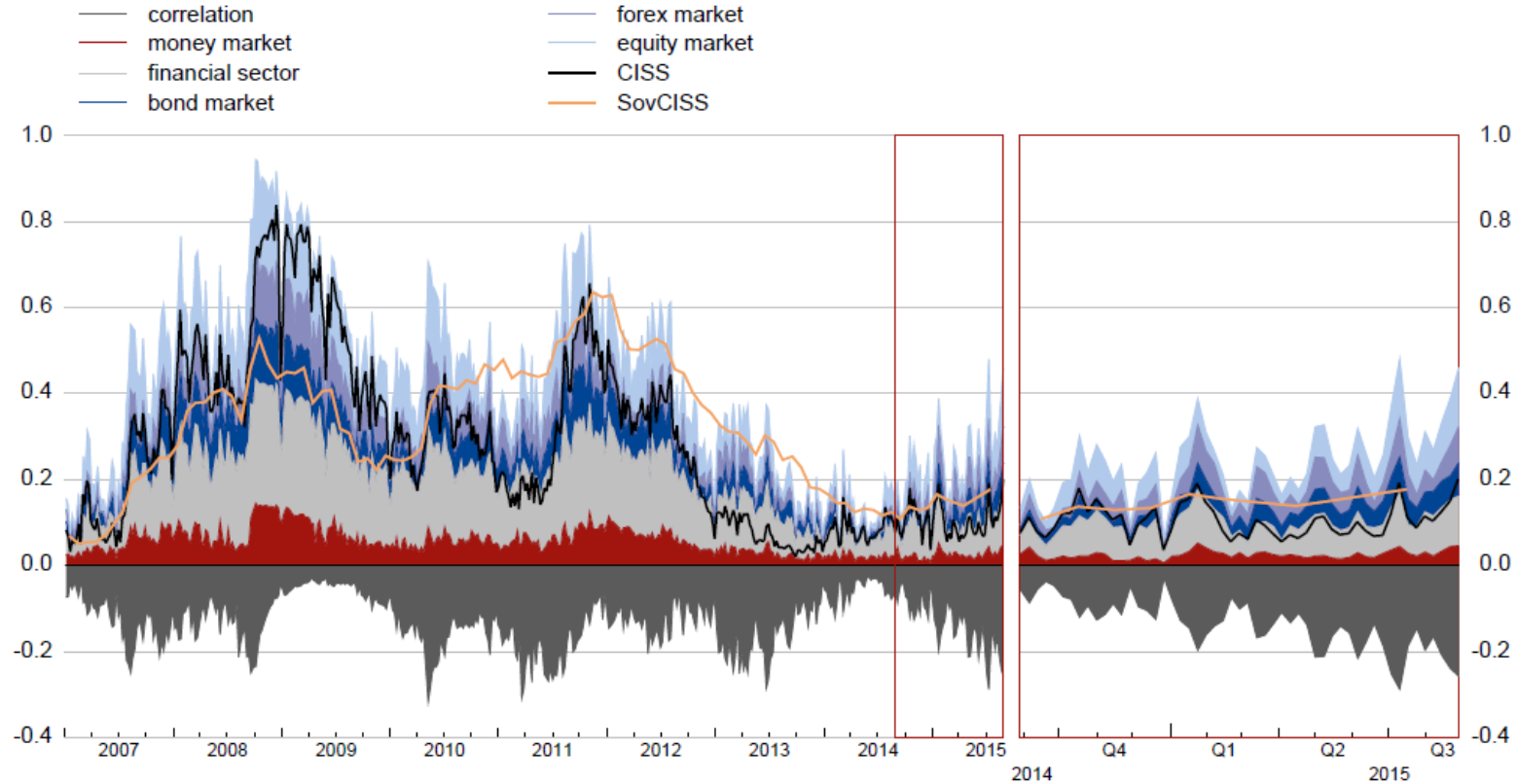
(EU; mean, 5th and 95th percentiles; last observation: 28 Aug. 2015)



# The ESRB Risk Dashboard (example: CISS indicator)

## 1.1 Composite indicator of systemic stress

(Last observation: 28 Aug. 2015)



# Macro stress-testing – introduction

- Stress tests assess the resilience of **individual financial institutions** or the **financial sector as a whole** to extreme but plausible events (e.g. GDP decrease, inverse term structure)
  - **Microprudential perspective**: analysing institutions individually
  - **Macroprudential perspective**: analysing entire financial sectors
- Since 2003, the Bundesbank has been conducting **regular stress tests** for the German financial system

# Macro stress-testing – bottom-up vs. top-down

Macro stress-tests can be **bottom-up** (EBA/ECB: EU wide stress testing by ), **top-down** (Deutsche Bundesbank: Financial Stability Report, BoE: RAMSI) or a **combination** of the two approaches.

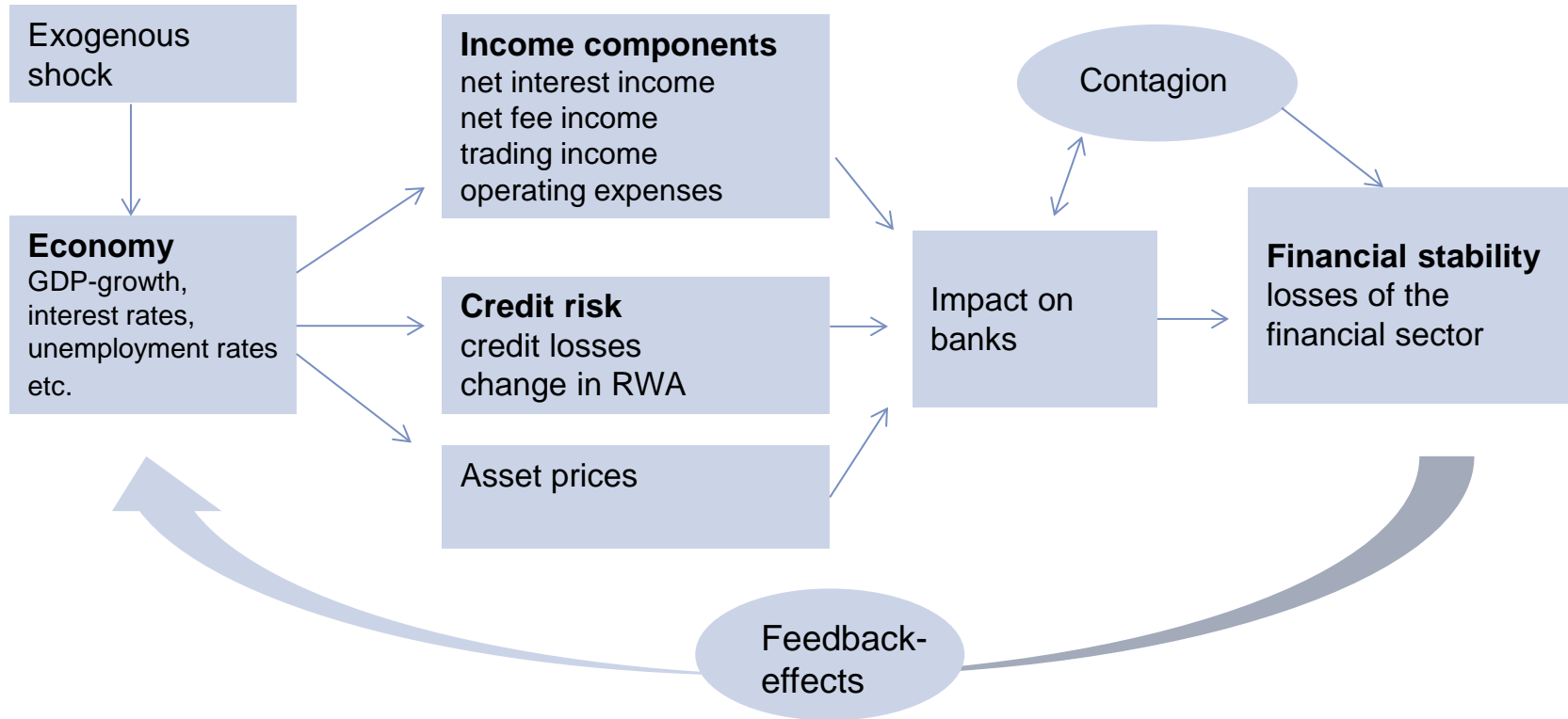
## Top-down Approach

- Supervisory authority calculates risk figures based on data from supervisory reports
- Broader perspective of the banking system:
  - Feedback effects from the financial system to the economy
  - Contagion

## Bottom-up Approach

- Scenarios are pre-defined by the supervisory authority
- Banks calculate these scenarios based on their own methodology and data
- Results are collected, aggregated, and analysed by the supervisory authority
- Disadvantages
  - Inconsistencies across banks due to differences in risk models
  - No feedback effects/ no contagion

# Macro stress-testing – general overview of top-down stress testing



# Macro stress-testing

## Top-down stress test at Deutsche Bundesbank (I)

### 1. Macroeconomic scenarios:

- Stress scenarios should be severe, but plausible. We use: NiGEM, structural vector autoregressions (SVAR) or historical events to generate stress scenarios.
- Baseline scenario: often forecasts (Deutsche Bundesbank, OECD World Economic Outlook)

### 2. Satellite models: Link between macroeconomic scenario and Banks' P&L sheet

Income Component	Small Banks	Large Banks
Interest Income	panel regression	panel regression
Interest Expenses	panel regression	panel regression
Fee Income	panel regression	panel regression
Trading Income	-	quantile analysis
Operating Costs	panel regression	panel regression
Credit losses	panel regression model for mortgage losses	panel regression model for mortgage losses

# Macro stress-testing

## Top-down stress test at Deutsche Bundesbank (II)

### 3. Adjusting risk-weighted assets: for banks that use IRB models for the credit risk

$$RWA_{t,i} = RWA_{0,i}^{credit} \cdot \frac{RW(pd_t)}{RW(pd_0)} + RWA_{0,i}^{other}$$

- $pd_t$  = median probability of default for customer loans in quarter t
- $RW(.)$  = Basel II function for risk weights

### 4. First-round results: aggregated losses, regulatory capital ratios, bank defaults



# Macro stress-testing

## Top-down stress test at Deutsche Bundesbank (III)

### 5. **Second-round effects:** cascade (round-by-round) algorithm for large banks

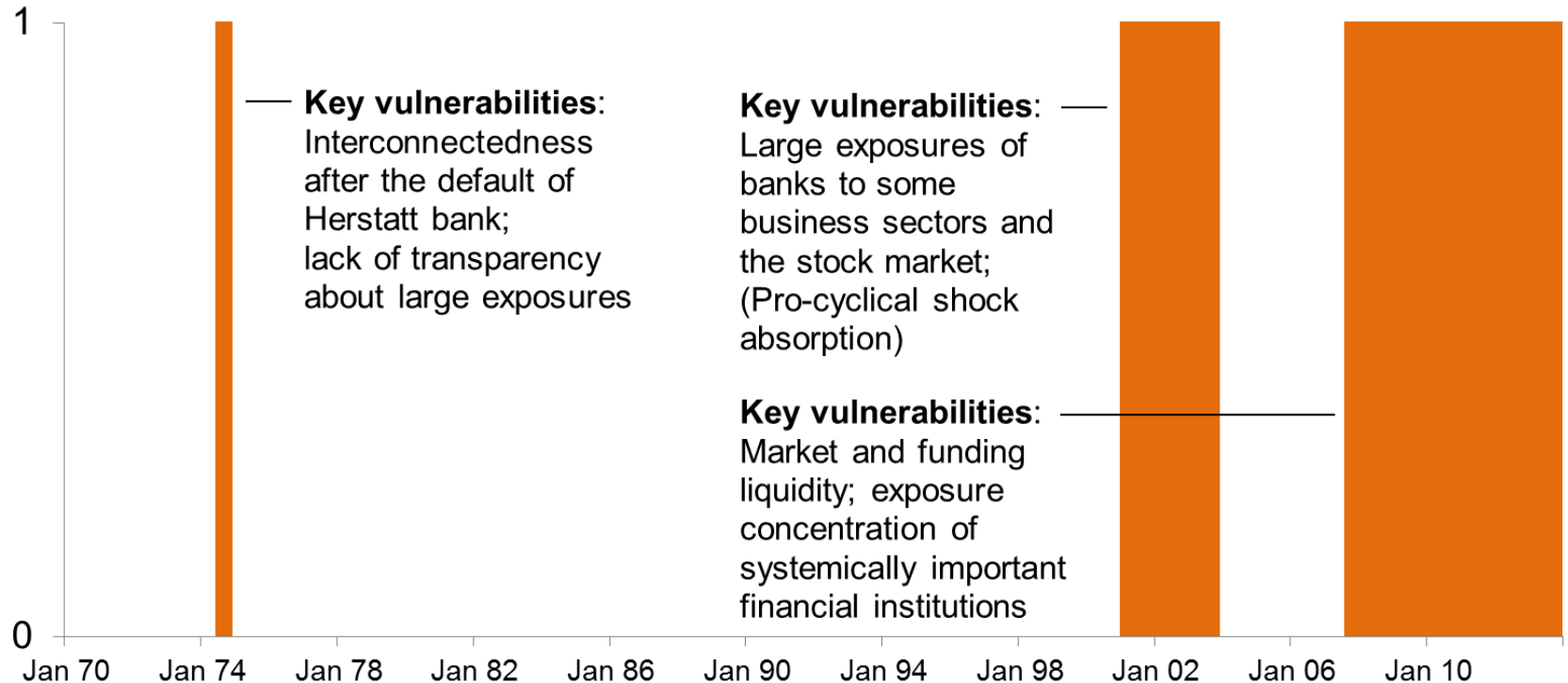
- Main idea: if a bank's tier 1 ratio is below 6 %, calculate losses for connected banks
- This process is repeated until no further bank fails

### 6. **Results:** aggregated losses, regulatory capital ratios, bank defaults

- Main stress drivers: credit losses and trading income (large banks)
- Interest income: seems to be a more stable income component, but low interest environment will continue to put interest margins (of small banks) under pressure

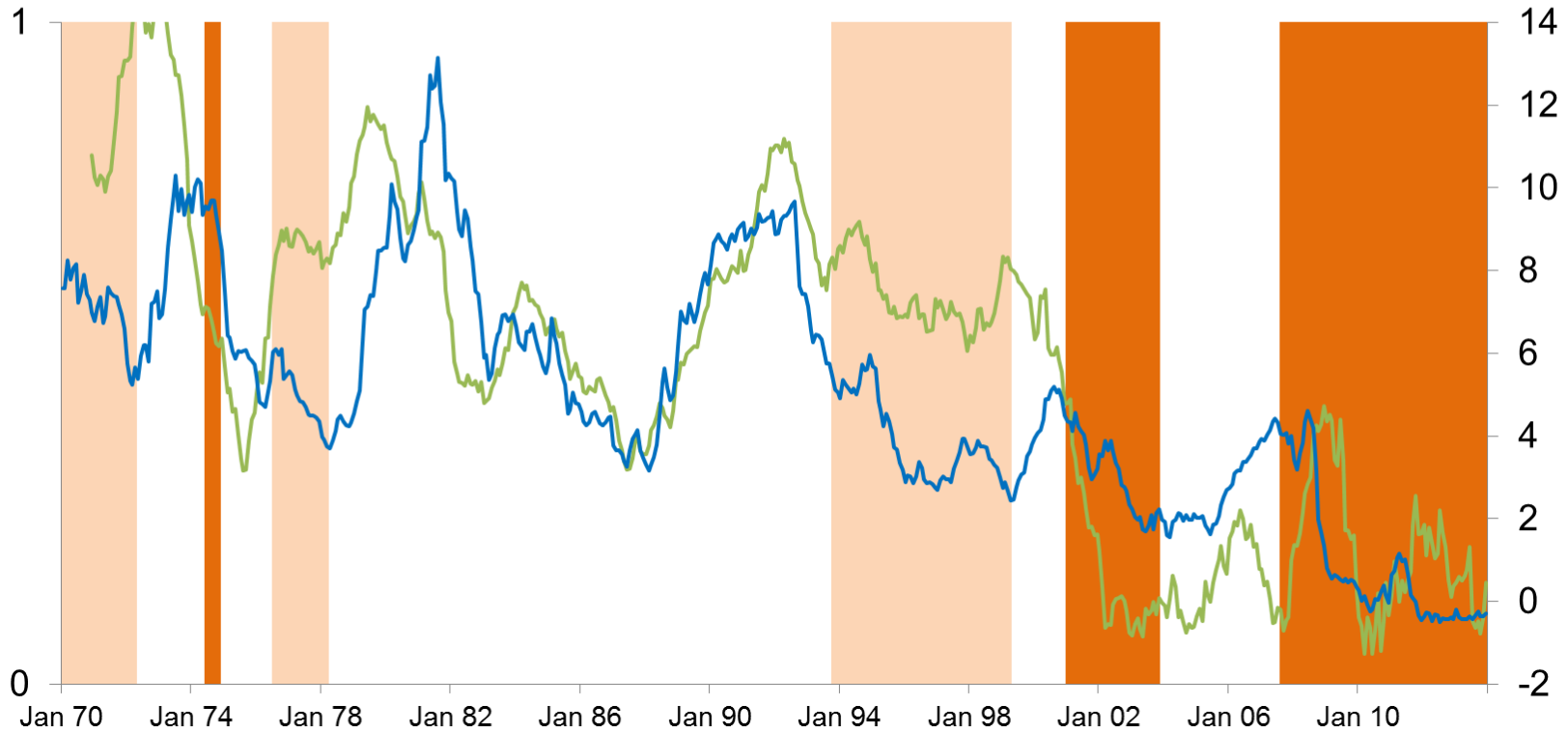
# The usefulness and limitations of early warning models (I)

## ■ Periods of financial instability

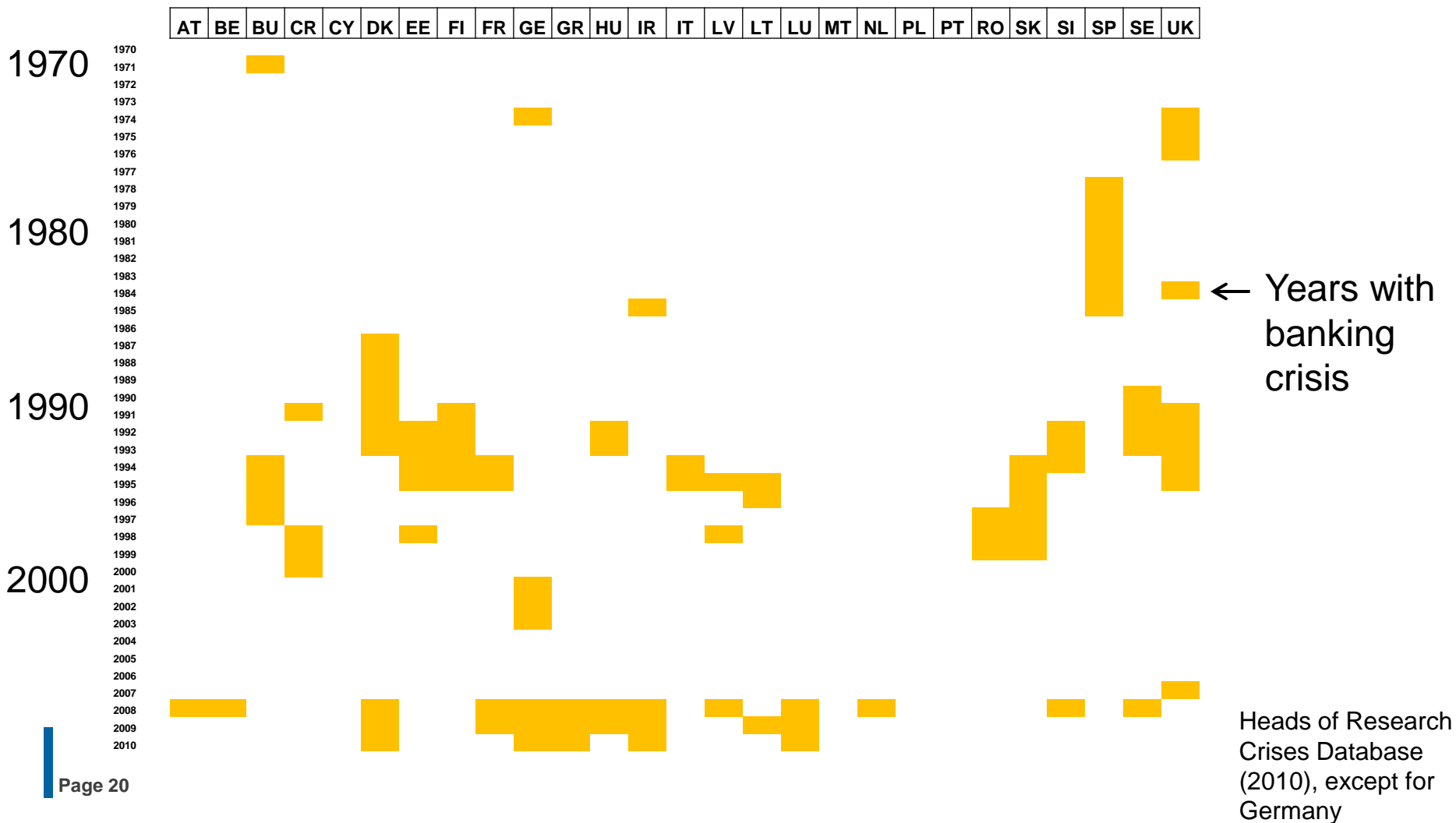


# The usefulness and limitations of early warning models (II)

- Periods of financial instability in Germany
- Periods with high domestic credit growth and declining interest rates
- Bank credit to domestic firms and households, annual rate of change, (r.h.s)
- German government bill yield, 1 year maturity (r.h.s)

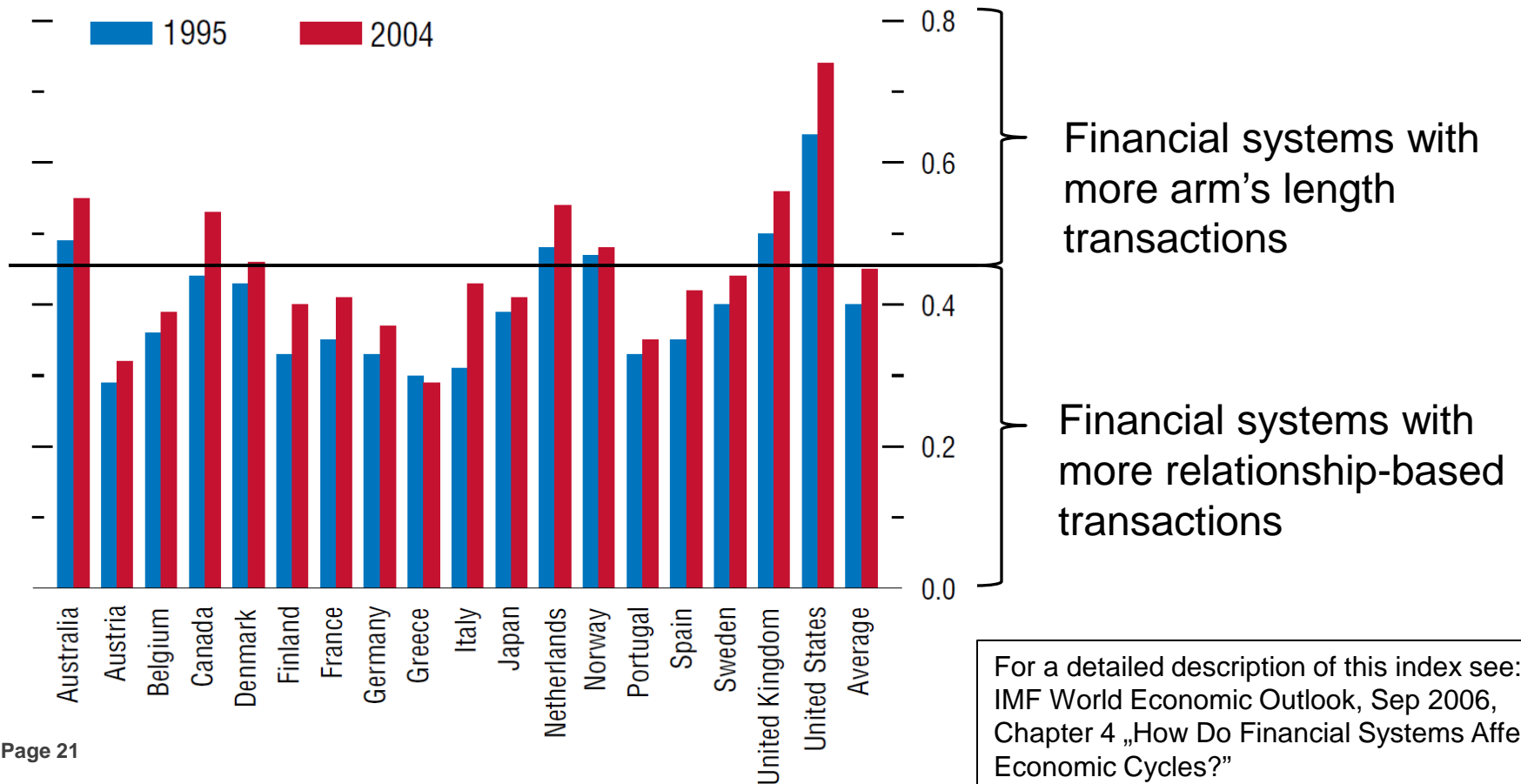


# The usefulness and limitations of early warning models (III)



# The usefulness and limitations of early warning models (IV)

## The IMF's Financial Index (WEO 2006)



For a detailed description of this index see:  
IMF World Economic Outlook, Sep 2006,  
Chapter 4 „How Do Financial Systems Affect  
Economic Cycles?“

## Concluding remarks

- A proper identification and measurement of systemic risk(s) is crucial to develop appropriate macro-prudential tools
- Different dimensions and characteristics have to be considered and addressed accordingly
- Since the financial crisis, a lot of progress has already been achieved
- However, in several areas some further research is needed, e.g. to develop suitable advanced early warning models to serve as a basis for meaningful macro-prudential measures
  
- Thank you for your attention!