



EUROPEAN CENTRAL BANK

EUROSYSTEM

# **STAMP€: Stress Test Analytics for Macroprudential Purposes**

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The views expressed are those of the author and do not necessarily reflect those of the ECB.

# Overview

- 1 STAMP€ – how did it develop?
- 2 Enhanced 1<sup>st</sup> round impacts – with credit supply dynamics
- 3 2<sup>nd</sup> round feedbacks – real and financial interactions
- 4 2<sup>nd</sup> round feedbacks – contagion within and across financial sectors
- 5 Towards system-wide comprehensive stress-testing – ABM(s)?

## An ECB e-book, staff tools for “macropru ST”



### STAMP€:

#### Stress-Test Analytics for Macroprudential Purposes in the euro area

Edited by Stéphane Dees, Jérôme Henry  
and Reiner Martin

February 2017

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### Macroprudential stress tests: A new analytical tool

Vítor Constâncio

22 February 2017

*The Global Crisis and its aftermath led to greater use of stress tests and to the establishment of macroprudential policy as a new policy area. In this column, ECB Vice-President Vítor Constâncio introduces new suite of analytical tools that support the design and calibration of macroprudential policy. The tools go well beyond the requirements of the traditional solvency stress tests applied to banks, and include a broader set of institutions than just banks, an analysis of the financial cycle, as well as an assessment of systemic risk levels associated with the economic and financial shocks considered in adverse scenarios.*



A A

The Global Crisis and its aftermath led to a greater use of stress tests and to the establishment of macroprudential policy as a new policy area, with the objective being to identify and limit systemic risk. Early identification of risks, supported by thorough surveillance and early warning models to detect potential sources of systemic risk is an essential first

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Vítor Constâncio  
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<http://www.ecb.europa.eu/pub/pdf/other/stampe201702.en.pdf>

### **A new territory: Macroprudential stress tests**

*“The macroprudential function has added a new dimension to stress testing. (...) The underlying framework has to embed spillovers – within the banking sector, to other sectors, including the real economy – also allowing for **banks’ own reactions that can also spillover to other segments** of the economy.”*

**Vítor Constâncio:**

“The role of stress testing in supervision and macroprudential policy”

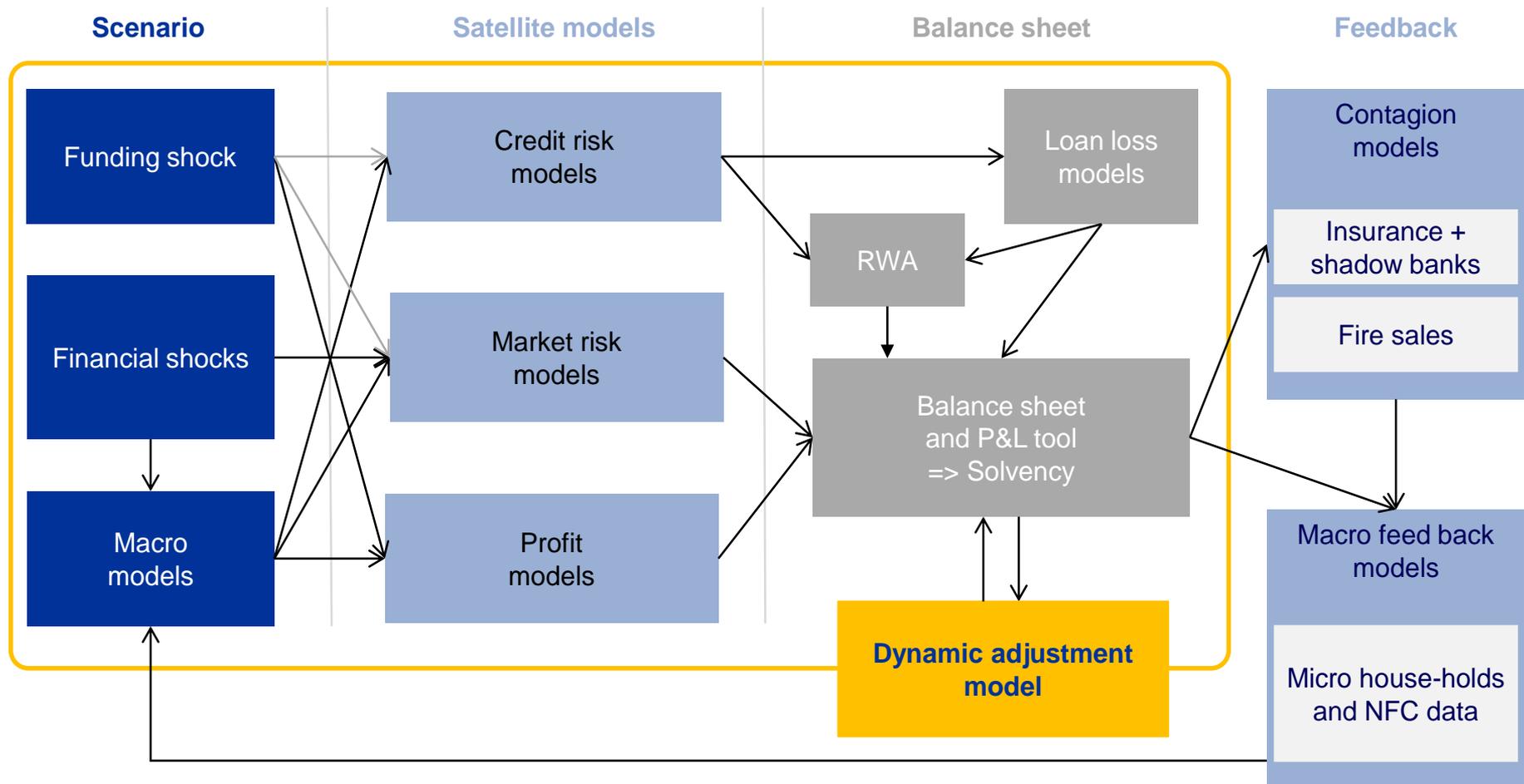
Keynote address by Vítor Constâncio, Vice-President of the ECB,  
at the London School of Economics, **London 29 October 2015**

(see R. Anderson Ed. (2016), *Stress Testing and Macroprudential Regulation: A Transatlantic Assessment*, CEPR Press).

**STAMP€ has been developed to operationalise this!**

# 1.3 The ECB Top-Down stress test “workhorse” – the basis for STAMP€

## ECB staff toolkit for Systemic Risk analyses (and EBA/SSM/NCA STs)



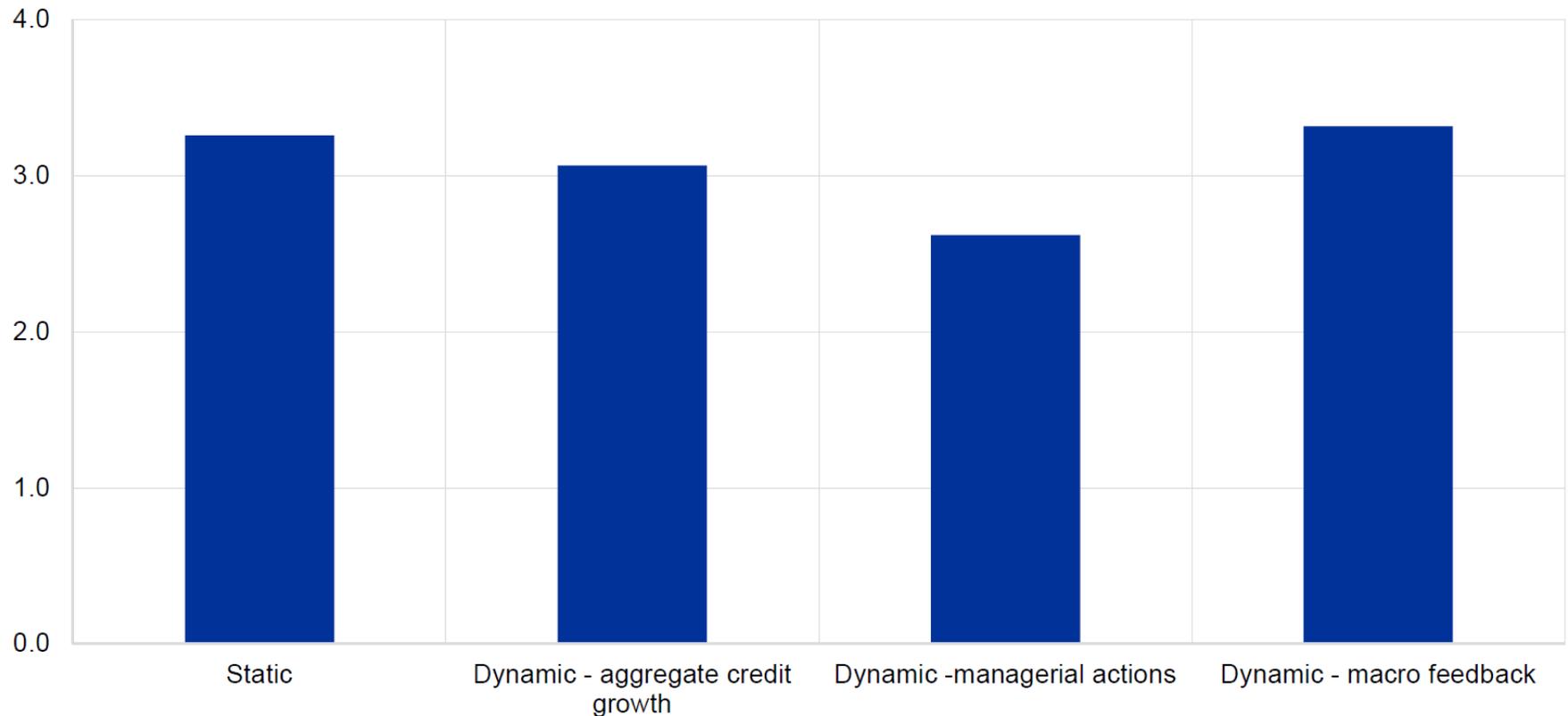
Adapted from Henry and Kok (eds.), ECB Occasional Paper 152, **October 2013**

<https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp152.pdf>

## 2.1 The real-financial “loop”: Sequential effects, via esp. credit channel

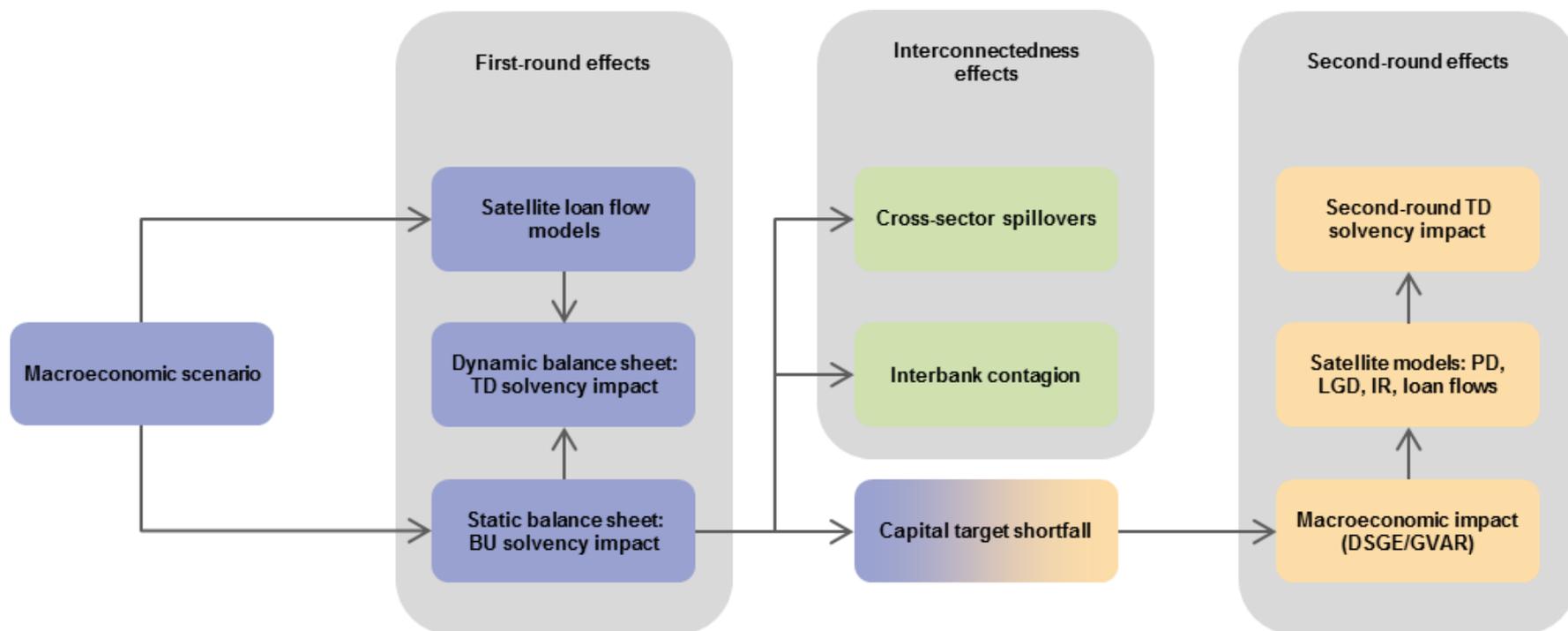
### Dynamic balance sheet and macro-financial linkages, CET1 stress impact (3-step sequence, illustrative results, using mock data)

(CET1 ratio, %)



Notes: The bars represent the aggregate CET1 losses from stress (as a percentage of risk-weighted assets) under the static balance sheet assumption (first bar), a dynamic balance sheet taking into account aggregate credit growth (second bar), a dynamic balance sheet with the optimisation-based adjustment of banks' asset structures (third bar) and macroeconomic feedback with a macro model (fourth bar). These figures, based on 2013 data, are for illustration purposes.

### The structure of the macroprudential extension (see ECB Macroprudential Bulletin 2/2016, based on EBA/SSM data)

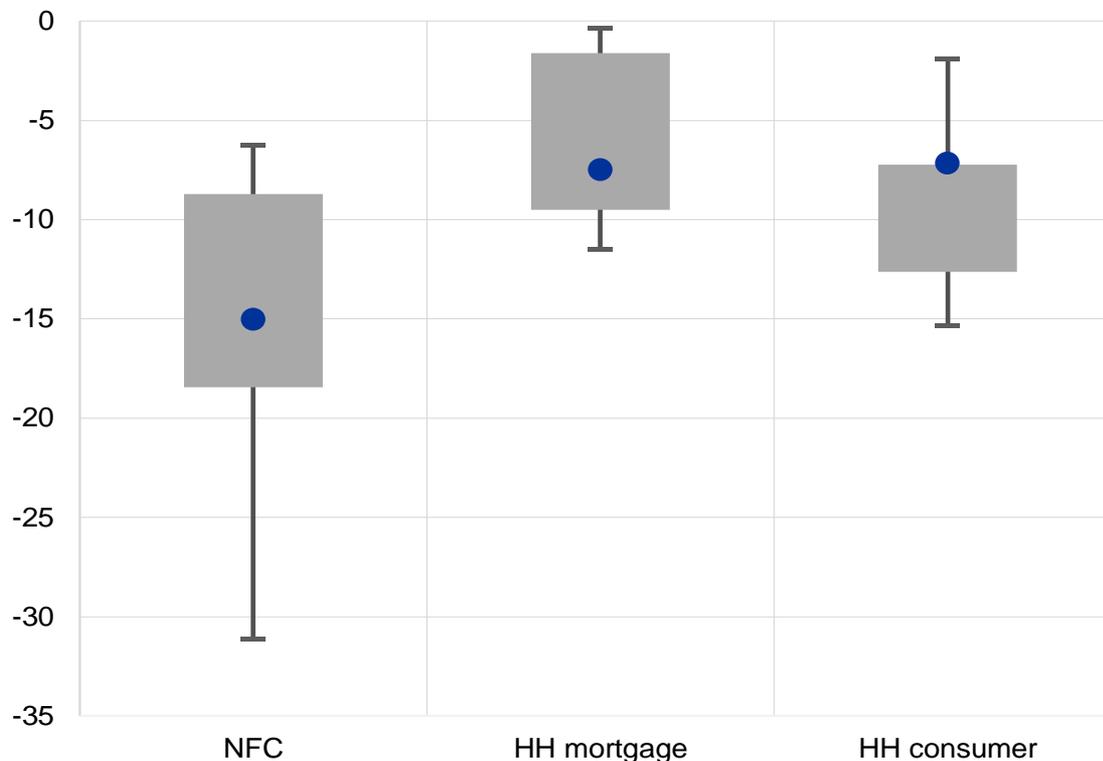


<https://www.ecb.europa.eu/pub/pdf/other/ecbmpbu201603.en.pdf>

## 2.3 1<sup>st</sup> step – make credit consistent with the adverse scenario

# Scenario-conditional changes in total loan flows

(Difference in percentage points between 3-year growth rates, adverse to baseline scenario)

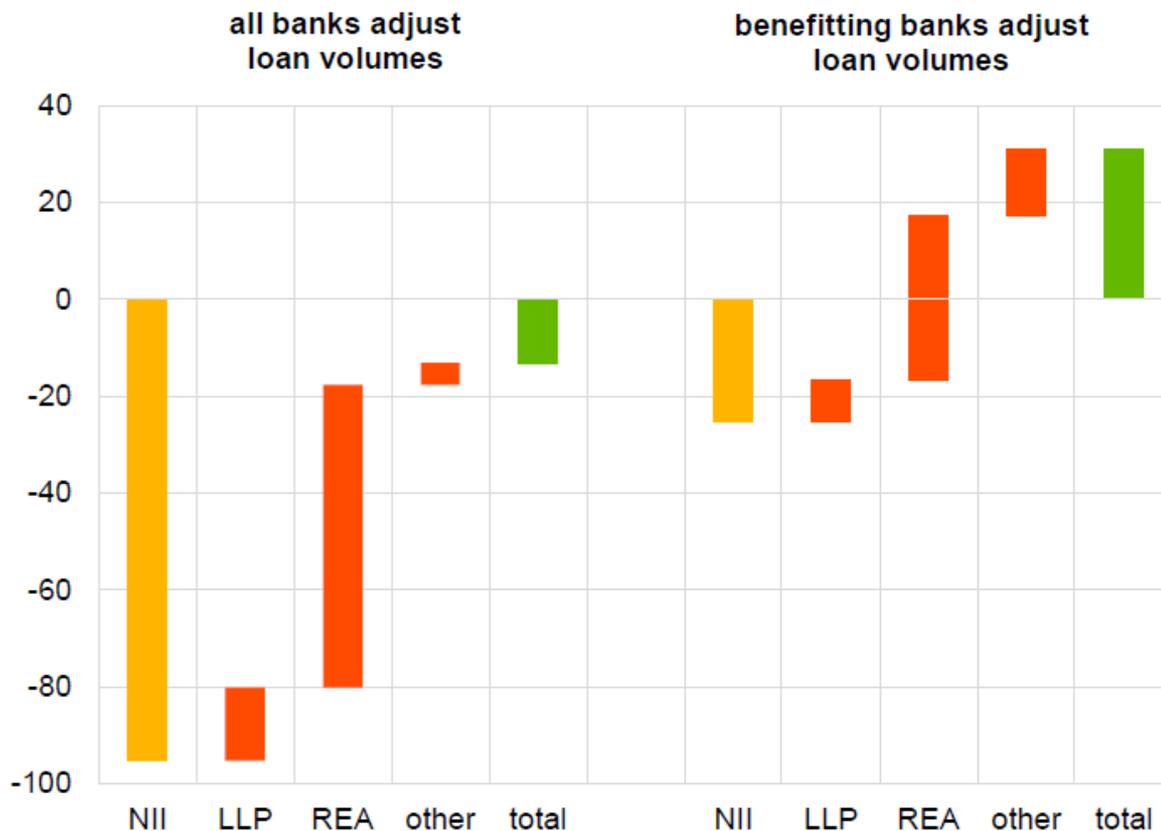


Boxes indicate the interquartile range across EU countries. Dots indicate the EU aggregate and black lines indicate the range between the 10<sup>th</sup> and 90<sup>th</sup> percentiles.

## 2.4 Deleveraging “good” loans can have overall negative income effects

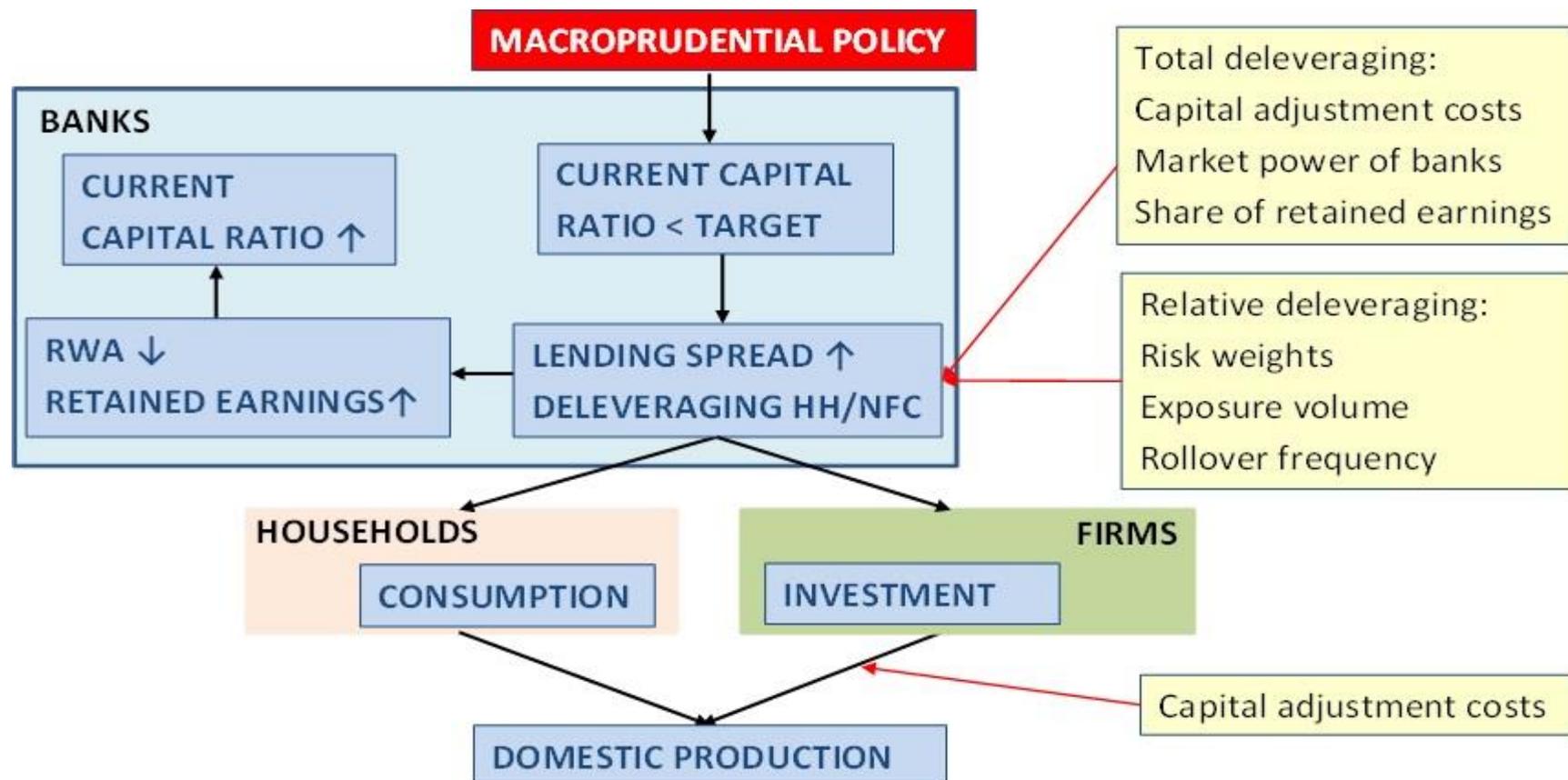
### Contributions to the difference in CET1 ratios between static balance sheet and loan reduction

(basis points of the aggregate CET1 capital ratio)



Notes: NII – net interest income, LLP – loan loss provisions, REA – risk exposure amount, other – factors other than NII, LLP and REA.

## Transmission channels - from a required CET1 ratio to domestic demand

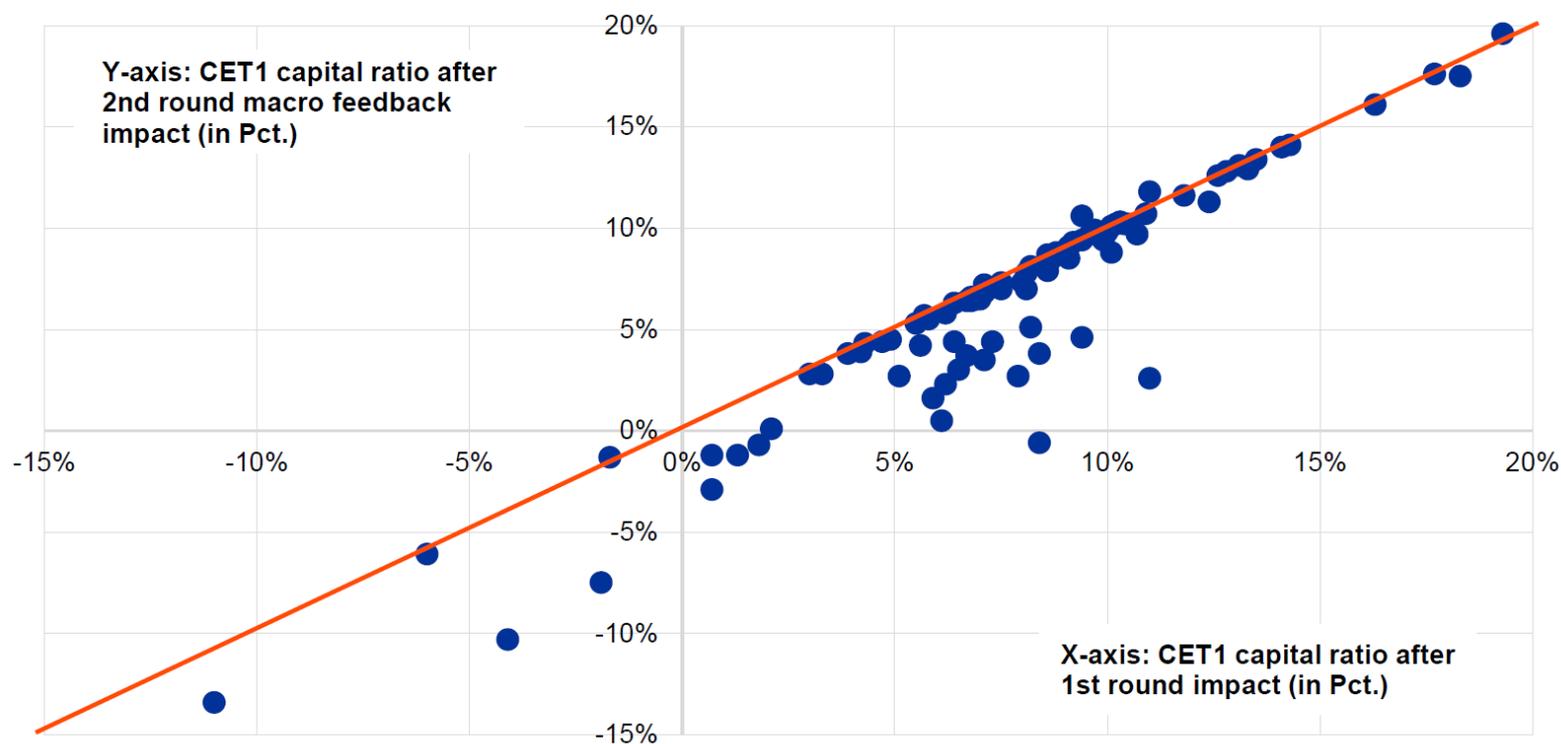


Based on Darracq-Pariès et al. (2011), “Macroeconomic propagation under different regulatory regimes: Evidence from an estimated DSGE model for the euro area” *International Journal of Central Banking*

## 3.2 Individual reactions to shortfalls can be self-defeating in aggregate

**Lower loan growth leads to lower GDP etc., affecting banks' risk parameters and their income P&L accounts.**

**First-round losses** under the adverse vs. **second round losses**  
(i.e. including the macroeconomic impact of deleveraging)



Simulation based on Darracq Pariès et al. (2011).

## 3.3 2<sup>nd</sup> round effects – via a Semi-structural MCS-GVAR model

### The equation system:

$$x_{it} = a_i + \sum_{p_1=1}^{P_1} \Phi_{ip_1} x_{i,t-p_1} + \sum_{p_2=0}^{P_2} \Lambda_{i,0,p_2} x_{i,t-p_2}^{*,C-C} + \sum_{p_3=0}^{P_3} \Lambda_{i,1,p_3} y_{i,t-p_3}^{*,C-B} + \sum_{p_4=0}^{P_4} \Lambda_{i,2,p_4} z_{i,t-p_4}^{*,C-CB} + \sum_{p_5=0}^{P_5} K_{i,p_5} v_{t-p_5} + \varepsilon_{it}$$

$$y_{jt} = b_j + \sum_{q_1=1}^{Q_1} \Pi_{jq_1} y_{j,t-q_1} + \sum_{q_2=0}^{Q_2} \Xi_{j,0,q_2} x_{j,t-q_2}^{*,B-C} + \sum_{q_3=0}^{Q_3} \Xi_{j,1,q_3} y_{j,t-q_3}^{*,B-B} + \sum_{q_4=0}^{Q_4} \Xi_{j,2,q_4} z_{j,t-q_4}^{*,B-CB} + \sum_{q_5=0}^{Q_5} E_{j,q_5} v_{t-q_5} + \omega_{jt}$$

$$z_{lt} = c_l + \sum_{r_1=1}^{R_1} \Gamma_{lr_1} z_{l,t-r_1} + \sum_{r_2=0}^{R_2} \Psi_{l,0,r_2} x_{l,t-r_2}^{*,CB-C} + \sum_{r_3=0}^{R_3} \Psi_{l,1,r_3} y_{l,t-r_3}^{*,CB-B} + \sum_{r_4=0}^{R_4} \Psi_{l,2,r_4} z_{l,t-r_4}^{*,CB-CB} + \sum_{r_5=0}^{R_5} T_{l,r_5} v_{t-r_5} + \tau_{lt}$$

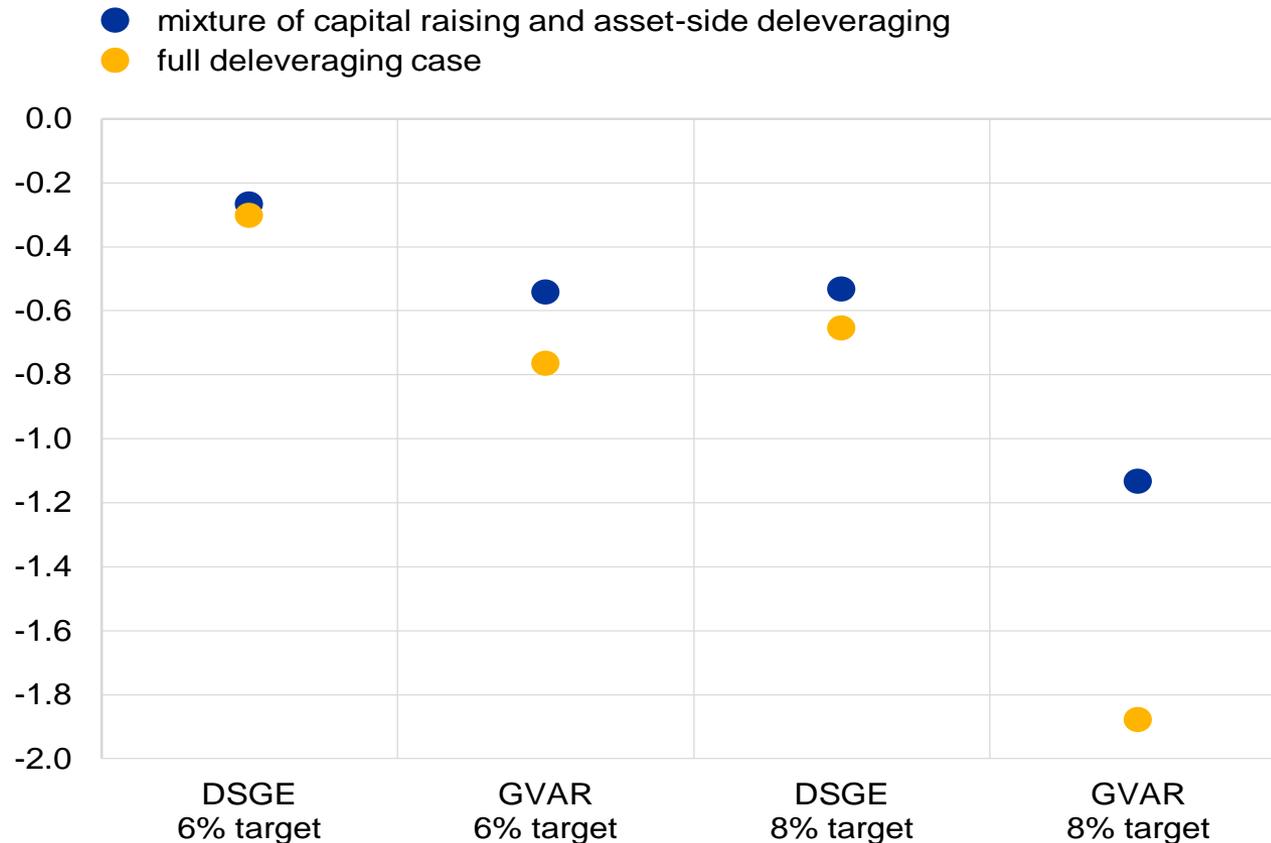
Equations for **countries**, banking sectors, and **central banks** with exclusion restrictions

- **Bank-specific variables y's**: credit, leverage, lending rate, deposit rate, PD
- **Strategy 1** – identified negative credit supply shock (loans down, lending rates up)
- **Strategy 2** – shock leverage directly consistent with the capital ratio shortfall

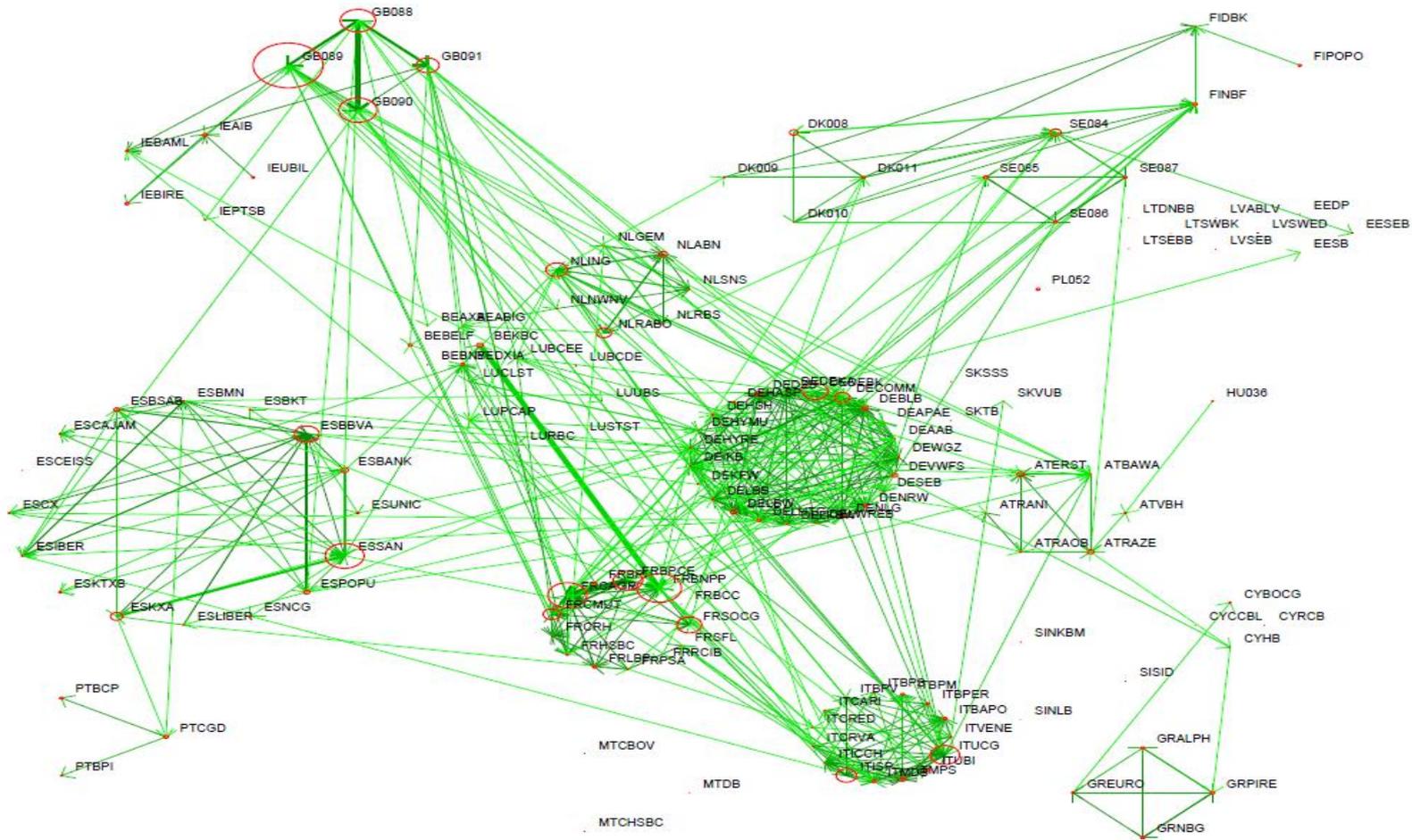
See Semmler et al. (2017), "Destabilizing effects of bank overleveraging on real activity - An analysis based on a Threshold MCS-GVAR" Macroeconomic Dynamics, forthcoming.

# Impact of possible banks' responses on GDP

(Percentages, deviation from baseline levels, end-2018)



## An EU banking system “topography” (2-tier structure with domestic (local) and global cores)

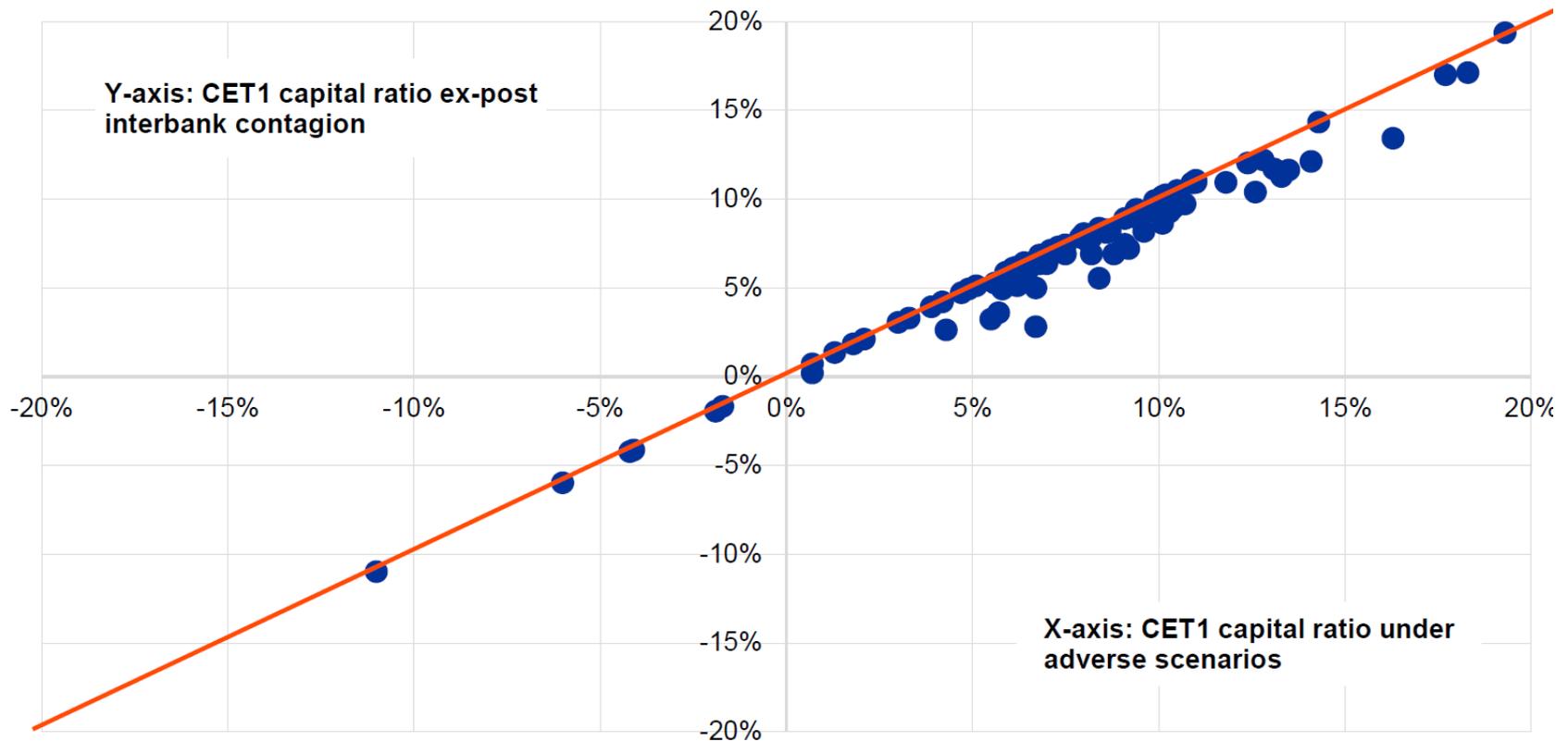


See Hałaj and Kok (2013), “Assessing interbank contagion using simulated networks,” *Computational Management Science*, Springer, vol. 10(2).

## 4.2 Estimating contagion – within the banking sector

# Capital impact of a cascade of defaults combined with asset devaluation

### First-round losses vs. second round losses with interbank contagion



Source: Henry and Kok, Eds., ECB Occasional Paper No. 152, October 2013.

Note: X-axis: end-2014 CET1 capital ratio under the adverse scenario (99th percentile); Y-axis: CET1 capital ratio ex-post interbank contagion (99th percentile).

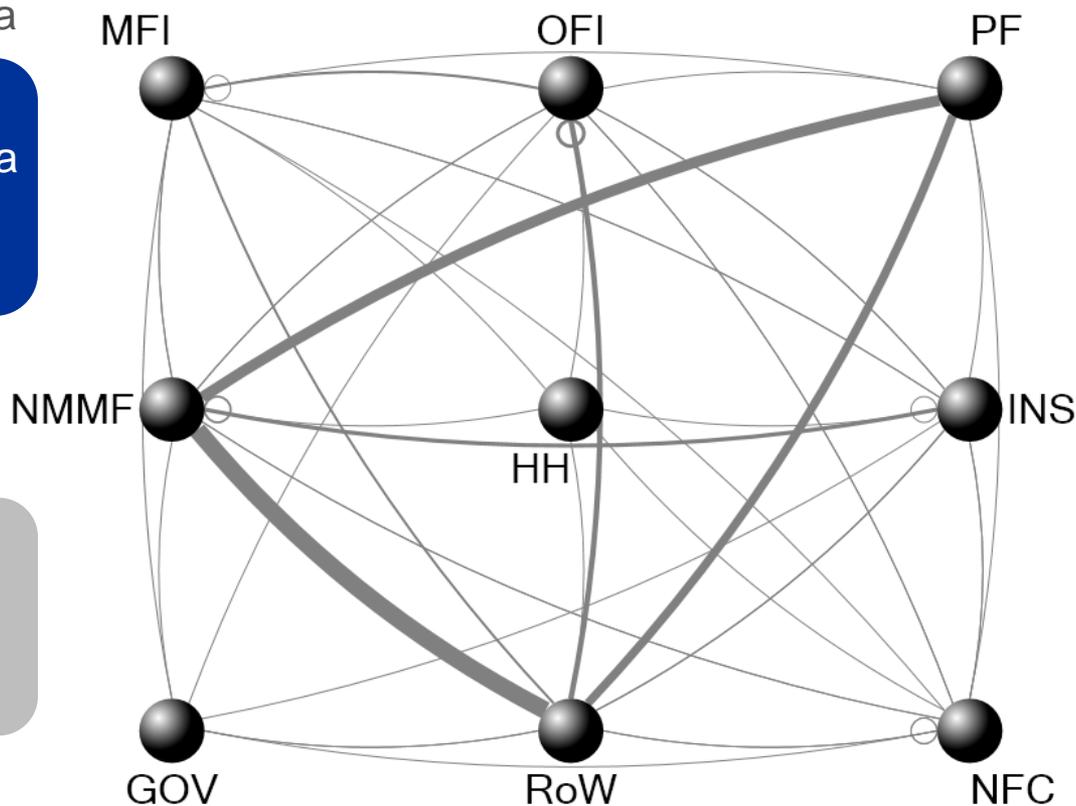
### Cross-sectoral interconnectedness via FoF

Flow-of-Funds data

Sectors interconnected via 'Who-to-whom' accounts

Initial shock

Bank capital depletion



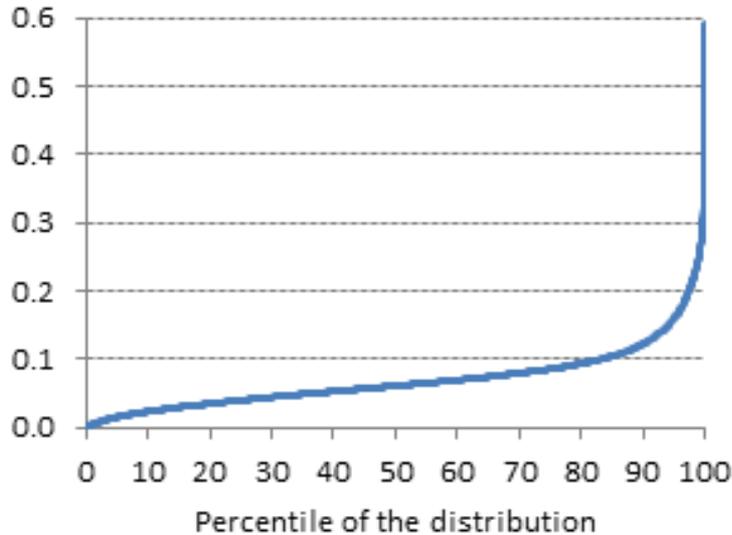
Iterative algorithm

1<sup>st</sup> round: Market value of bank equity decreases

2<sup>nd</sup> round (iterative): Loss of equity transmitted to sectors holding equity

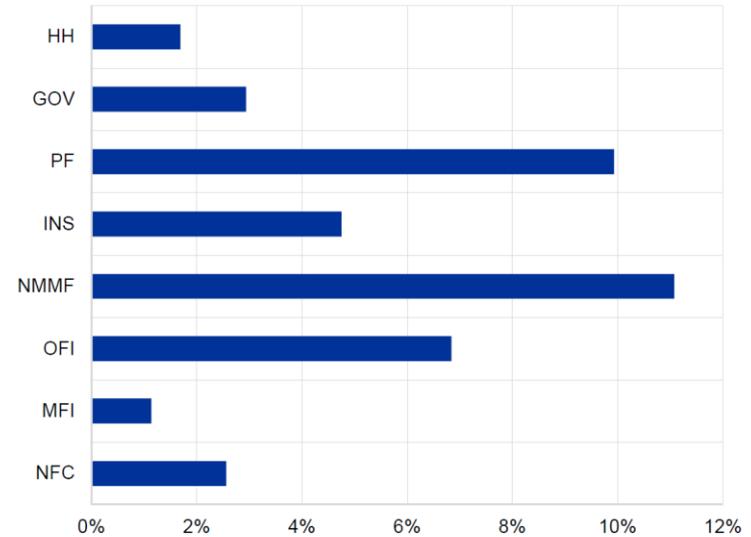
### Direct interbank contagion

X-axis: percentile of the distribution; Y-axis: bank losses on interbank exposures to banks falling below 6% CET1



### Cross-sector spillovers

Losses triggered by reduction in market value of bank equity in % of total financial assets)

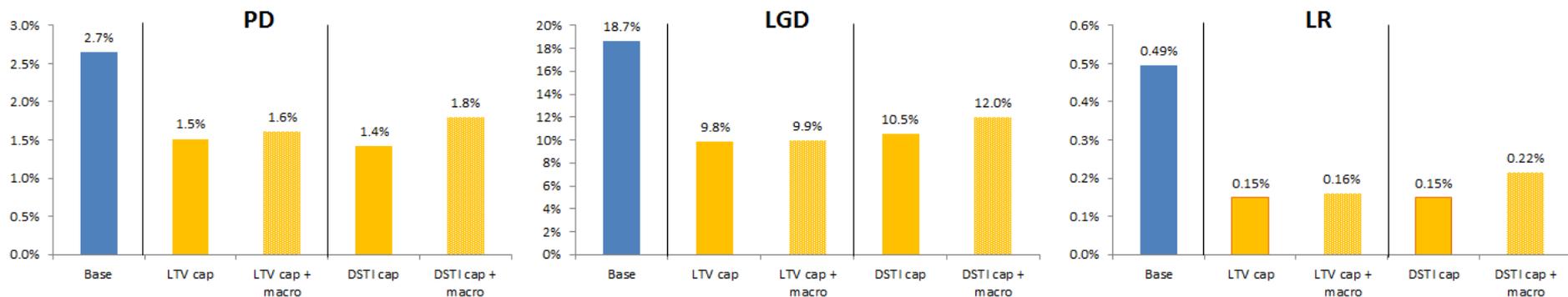


- **Systemic risks arising from interconnectedness usually appear to be contained** further analysis needed on price contagion and funding stresses
- **Interbank contagion** related to direct bilateral exposures remains immaterial, below 10 basis points for most “simulated” interbank networks
- **Investment funds** and **pension funds** most strongly affected by spillovers from reduction in market values of bank stocks

### Integrated Dynamic Household Balance Sheet model

- Micro-macro model relating individual households and macro data
- Balance sheet data, cash flow, debt and collateral for 60,000+ households (150,000+ members) from 15 EU countries (HFCS).
  - **Stress testing / sensitivity**, conditional on scenarios.
  - **Impacts of (borrower-based) macroprudential policy**

#### Impact on households PDs, LGDs, LRs (1st and 2nd round)



See Gross and Población (2017), “Assessing the efficacy of borrower-based macroprudential policy using an integrated micro-macro model for European households”, *Economic Modelling*, Vol. 61.

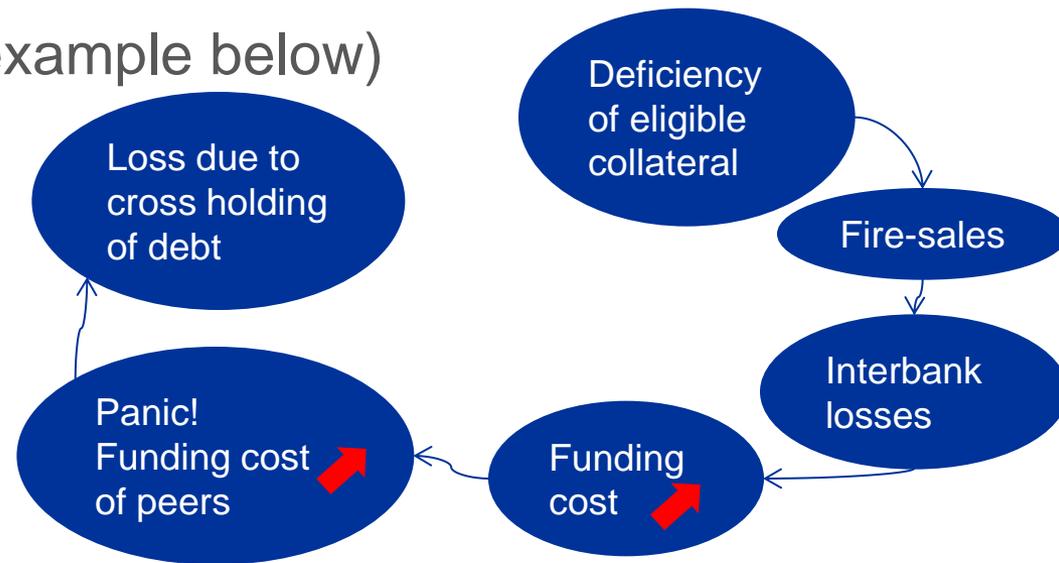
### Liquidity Stress-Tests: an Agent-Based Modelling approach, connected to solvency

1. Banking system interrelations, static or changing over time
2. Shocking the system or part thereof (at any stage below)
3. Shock transmission (one example below)

4. Shock impacts on both:

- **Liquidity**
- **Solvency**

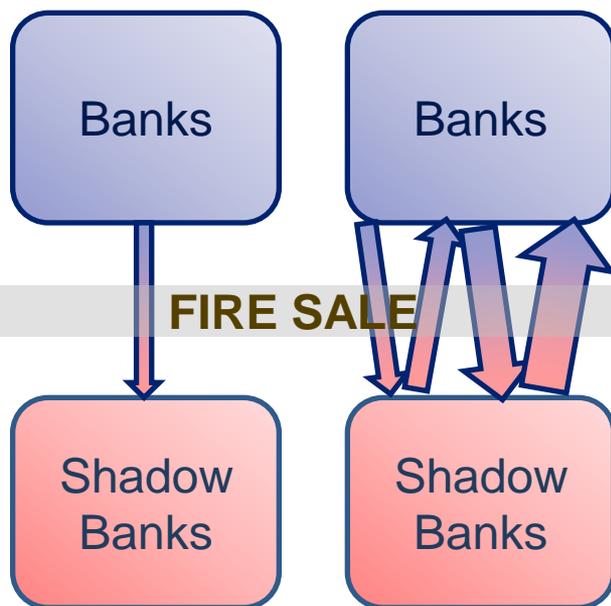
With interdependencies



**Collateral / Central Bank *and* others (funds, insurers...) [WIP]**

### Simulating fire sales in an Agent Based Model

Stricter requirements on banks might add fuel to the fire-sale of a marked to market (systemic) security

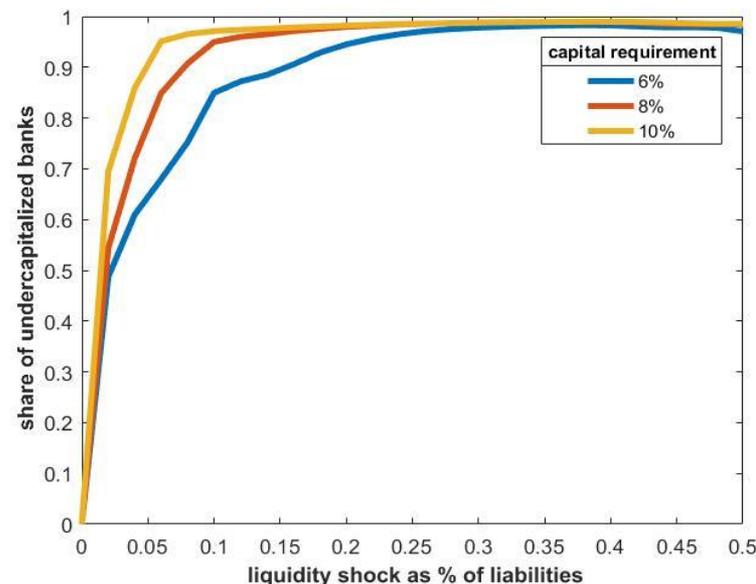


Fire sale due to exposures to common assets via mark-to-market pricing

Higher capital requirements  
➔ more rigid banking sector



Shocks amplified further through stronger fire sales by shadow



## 1. STAMP€, ECB e-book

- A 'living' infrastructure developed for macroprudential analyses
- A stand-alone projection tool, conditional on any chosen scenario
- Dynamic balance sheets and some other amplification + feedbacks

## 2. Need to refine dynamic balance sheet approach

- Shift to refine bank behaviour (e.g deleveraging – pecking order)
- Implications to be specified in detail (eg for NPLs – cure etc. / Credit supply)

## 3. Need to go beyond banks and beyond solvency

- Cooperation with EIOPA on **Insurers / Pension Funds** and ESMA on **CCPs**
- Integrate **Liquidity Stress-Tests**, time dimension and crisis vs. stress issues
- Connect with the rest of the wider financial sector – System-Wide ST