EUROPEAN CENTRAL BANK

EUROSYSTEM

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Policy Messages from the ESCB Macro-prudential Research Network (MaRs)

Keynote Speech at the Centre for Finance, Credit and Macroeconomics
Conference on “Effective Macro-prudential Instruments”
University of Nottingham, 13 November 2014

Introduction: Some concepts

- Macro-prudential policy
  - Oversight/supervision: Public oversight that aims at identifying and containing systemic risks (rather than risks of individual intermediaries or markets)
  - Regulation: Public regulations that aim at maintaining systemic stability
- One definition of systemic risk (ECB 2009): Risk that financial instability becomes so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially
- Can involve all components of financial systems ("horizontal")…
  - Intermediaries (including so-called shadow banks),
  - Markets and
  - Market infrastructures

…and two-way relationship with the economy at large ("vertical")

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Introduction: General overview of MaRs

ESCB network established in 2010 by the General Council

- Mandate: develop core conceptual frameworks, models and tools that provide research support to improve macro-prudential supervision in EU
- Three work streams
  1. Macro-financial models linking financial stability and the performance of the economy (WS1)
  2. Early warning systems and systemic risk indicators (WS2)
  3. Assessing contagion risks (WS3)

Output

- 161 individual research papers (WS1 – 65, WS2 – 51, WS3 – 45)
- 72 ECB Working Papers so far (WS1 – 32, WS2 – 27, WS3 – 13)
- 50 published in journals (WS1 – 21, WS2 – 18, WS3 – 11), including *Journal of Political Economy*, *Journal of Financial Economics*, *Economic Journal*, *Journal of Monetary Economics*
- 3 large joint cross-country projects
- 3 large public conferences: October 2011, October 2012 and June 2014

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Outline

1	Introduction: Concepts and general MaRs overview
2	MaRs messages on macro-prudential regulatory instruments
3	A tool for assessing macro-prudential regulatory instruments: 3D model
4	MaRs messages on macro-prudential and monetary policy interactions
5	Concluding remarks

- Only a very small share of total MaRs work can be shown today, focusing on policy implications from WS1 research that received most support
- Comprehensive summary in **“Report on the Macro-prudential Research Network”** released on the ECB website (http://www.ecb.europa.eu/press/pr/date/2014/html/pr140623.en.html)
- No survey of the outside literature (see report and papers)

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MaRs policy messages on macro-pru regulatory instruments

General insights

- Overall, about 7 different policy instruments considered (loan-to-value (LTV) ratios, (general, sectoral and counter-cyclical) bank capital requirements, leverage caps, liquidity ratios, dynamic loan-loss provisions, limits on foreign currency lending or currency mismatches, and margin requirements on repos)
- Largely based on theoretical research, most found to be effective
- Two papers on general equilibrium models with heterogeneous banks and default (Goodhart et al. 2012a and b)
  - Multitude of market imperfections that contribute to systemic risk require multiple regulatory instruments (5 instruments considered)
  - Combating fire sale externalities is critical for economic performance
  - Best regulatory combination includes (time-invariant) minimum capital requirement, counter-cyclical capital buffer and margin requirement on repos used by shadow banks (against regulatory arbitrage)
  - But indiscriminate combinations of regulations can also be counterproductive

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MaRs policy messages on macro-pru regulatory instruments

Real estate cycles and LTVs

- Mendicino (2012) extends Kiyotaki and Moore (1997)
  - Counter-cyclical LTV more effective than static one
  - Static collateral requirement dampens the effect of credit shocks on output but amplifies the effect of productivity shocks
  - But changing LTVs is politically difficult (e.g. social policies related to housing)
- Gelain, Lansing and Mendicino (2013) DSGE model with housing and adaptive expectations (1997)
  - Generalised collateral requirement with housing value (LTV) and wage income component (debt/loan-to-income limit – DTI/LTI)
  - Similar to time-varying LTV, because unlike housing values wages don’t increase with property bubbles
  - Consider LTV and DTI/LTI regulation together

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MaRs policy messages on macro-pru regulatory instruments

➢ Other regulatory instruments

- Jokivuolle and Kiema (2014) incorporate leverage ratio in Repullo and Suarez (2004)
  - Leverage ratio effective in putting a floor to mistakes in internal ratings-based capital requirements?
  - Increasing ratio (i) enhances safety of banks for which it is binding but (ii) reallocates credit to banks for which it is not binding, augmenting their risk
  - Stabilising effect dominates for relatively low ratio
- Colliard (2014)
  - Leverage ratio may, however, not be the optimal solution to a potential bank moral hazard problem of strategic misreporting of internal ratings-based assessments
  - Preferable solution may be penalties for ex post losses exceeding ex ante assessments

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MaRs policy messages on macro-pru regulatory instruments

➢ Cross-border coordination issues

- Under high financial integration capital regulation limits credit supply at home and abroad, giving rise to a free-rider problem that may need to be addressed through coordination (Dedola, Karadi and Lombardo 2013)
- Even for financial fragmentation national LTVs may give rise to significant international "leakage", if domestic banks can assume new credit risks by buying foreign mortgage-backed securities (Zochowski 2014)
- Evidence that restrictive domestic regulations may induce multinational banks to lower lending standards in foreign markets (Ongena, Popov and Udell 2013)
- Global evidence that domestic macro-prudential policy affecting a particular asset class may lead to bank flows out of the country (Beirne and Friedrich 2014)

- In the European Union LTVs and DTIs/LTIs are not included in the Capital Requirements Directive ("CRDIV") and Regulation ("CRR")
- Implies, inter alia, that the new Single Supervisory Mechanism (SSM) at the ECB cannot coordinate them (for CRDIV/CRR instruments it can tighten)

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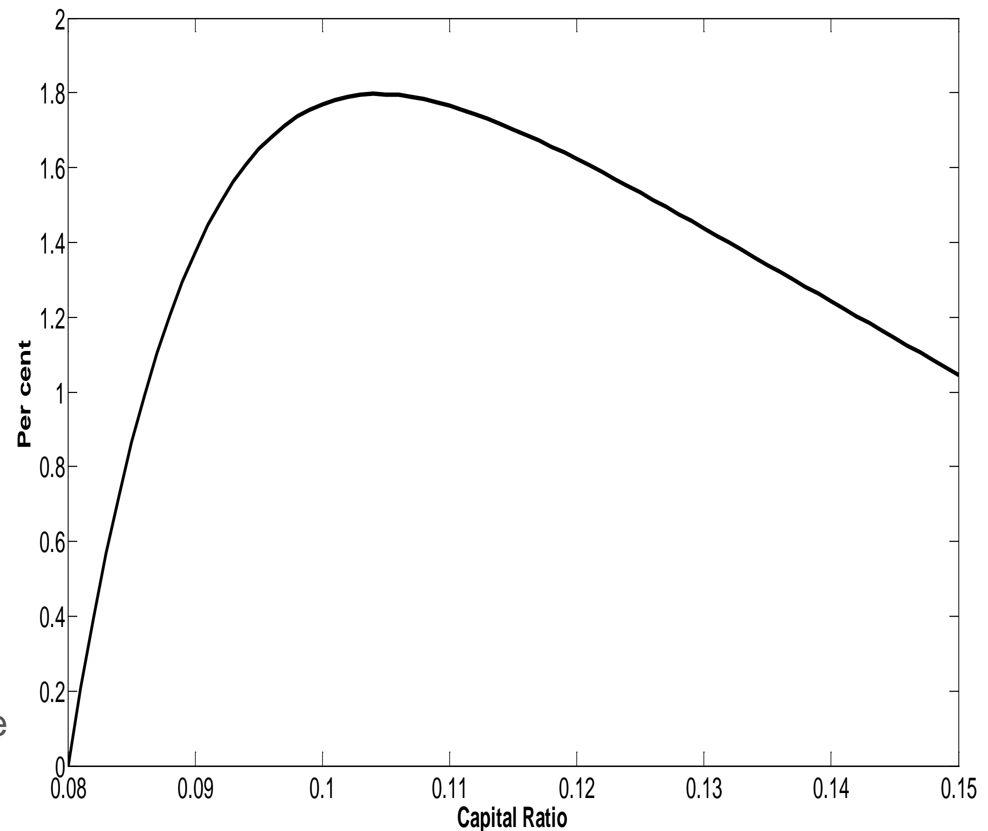
A tool for assessing macro-pru regulatory instruments: 3D model

➤ **Joint cross-country project for a macroeconomic model with financial instability, capturing the benefits and costs of regulation**

- Financial instability: central role of default (**bank default**, firm default, HH default – 3D)
- Sources of systemic risk
  - Imbalances (over-lending due to excessive bank risk-taking)
  - Aggregate shocks (amplified through bank capital reduction and higher bank funding costs)
  - Some interbank contagion (through bank funding costs)
- Present focus on capital adequacy policies
  - Steady state capital requirements
  - Counter-cyclical capital buffers
- Higher capital requirements
  - Correct risk-taking incentives: reduce excessive lending and defaults
  - Tighten credit supply

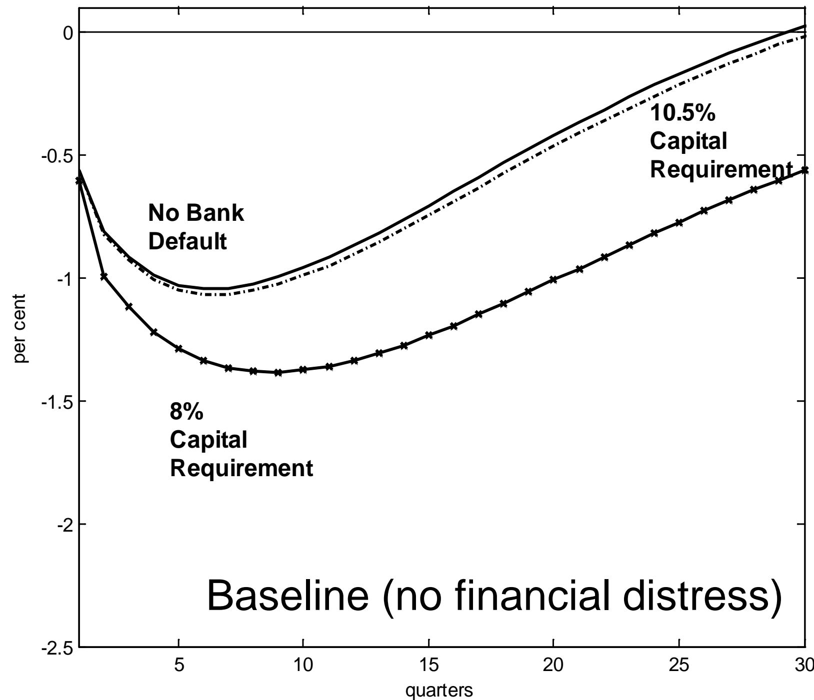


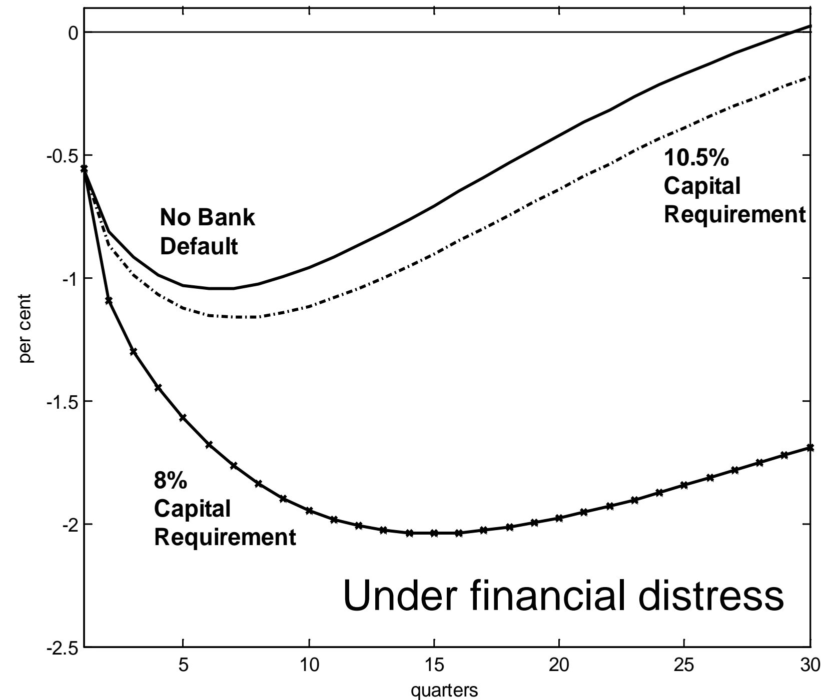
Source: Clerc (BdF), Derviz (CNB), Mendicino (BdP), Moyen (Bundesbank), Nikolov, Stracca (both ECB), Suarez (CEMFI) and Vardoulakis (ECB and Fed Board, 2014).

A tool for assessing macro-pru regulatory instruments: 3D model

➢ **Influence of bank capital, defaults and "distress" on shock propagation (impulse response functions)**

Effects of a persistent reduction in home prices and firm valuations on GDP





- Higher capital requirements (10.5%)
  - Make the macroeconomy more robust to large shocks
  - Almost identical to removing the effects of bank default
- Lower capital requirements (8%)
  - Leave the macroeconomy very vulnerable to large shocks
  - Significant amplification through financial distress

Source: Clerc (BdF), Derviz (CNB), Mendicino (BdP), Moyen (Bundesbank), Nikolov, Stracca (both ECB), Suarez (CEMFI) and Vardoulakis (ECB and Fed Board, 2014).

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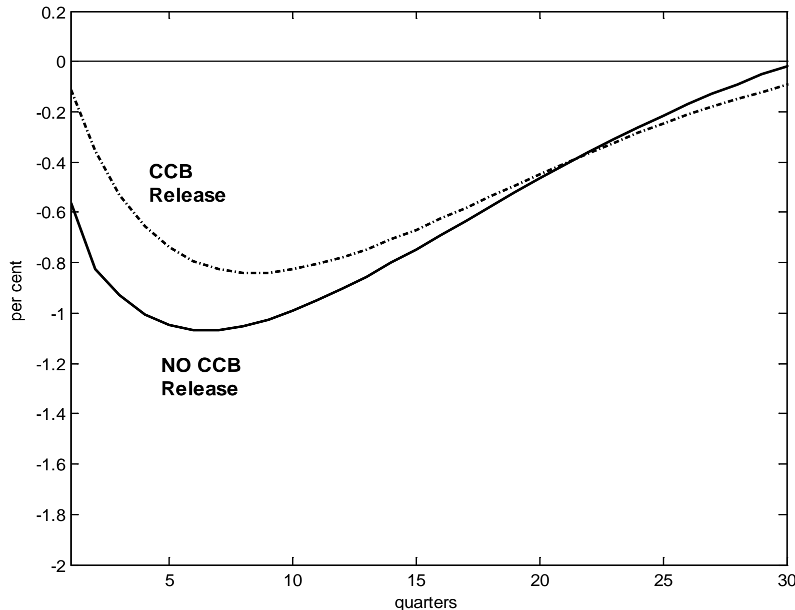
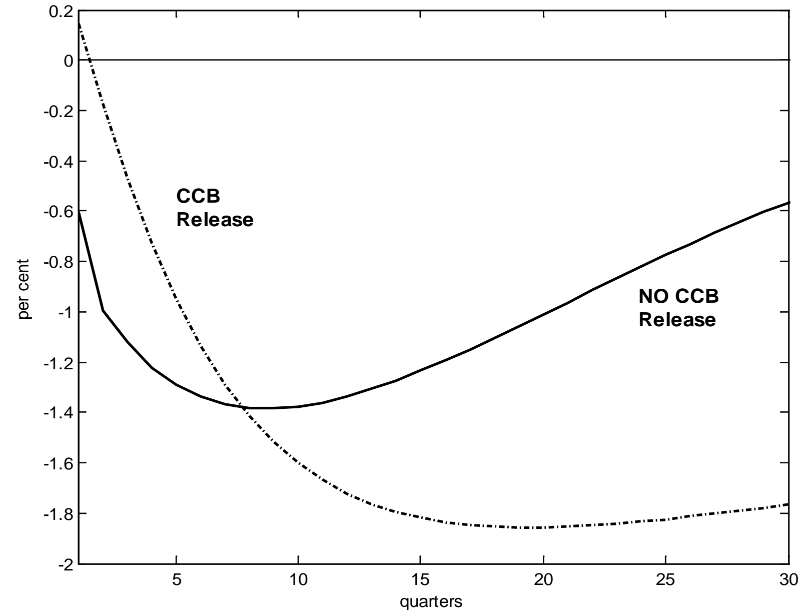
A tool for assessing macro-pru regulatory instruments: 3D model

➢ Release of a counter-cyclical capital buffer and shock propagation (impulse response functions)

Effects of a persistent reduction in home prices and firm valuations on GDP





- Higher capital requirements (10.5%)
  - CCB release attenuates shock propagation for the first 1.5 years
- Lower capital requirements (8%)
  - CCB release attenuates shock propagation early on
  - But when capital becomes too low excessive defaults may also worsen the situation

Source: Clerc (BdF), Derviz (CNB), Mendicino (BdP), Moyen (Bundesbank), Nikolov, Stracca (both ECB), Suarez (CEMFI) and Vardoulakis (ECB and Fed Board, 2014).

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MaRs messages on macro-pru and monetary policy interactions

- Not yet based on new macro models with financial instability, which still need to be extended to monetary policy
- Three contributions build on Iacoviello and Neri's (2010) DSGE model with housing and financial frictions
- Angelini, Neri and Panetta (2014) study the implications of joint or independent setting of interest rate (monetary) and (time-varying) capital (macro-prudential) policy for macroeconomic stability
  - "Cooperative" solution: Both policies jointly and optimally chosen
  - "Non-cooperative" solution: Both policies chosen independently
    - Central bank stabilises inflation and output volatility, taking macro-pru as given
    - Macro-pru authority stabilises the loan-to-output ratio, taking monetary policy as given
    - May lead to conflicting policies involving excessive instrument volatility
    - For financial or housing shocks the benefits of macro-pru are sizeable
    - For supply shocks macro-pru has only modest benefits over monetary policy

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MaRs messages on macro-pru and monetary policy interactions

- Beau, Clerc and Mojon (2012) estimate DSGE model for the euro area to analyse which effects monetary and macro-pru policies have on price stability

  - 4 policy regimes, depending on
    - whether or not monetary policy/the interest rate rule factors in financial stability considerations and
    - the existence or not of a macro-pru authority leaning against credit developments
  - Results
    - Policy regime is immaterial for inflation dynamics
    - Best combination for maintaining price stability after asset price or credit supply shock is an independent macro-prudential policy leaning against credit growth and a monetary policy focused on price stability

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MaRs messages on macro-pru and monetary policy interactions

- Lambertini, Mendicino and Punzi (2013) introduce expectations-driven housing cycles
  - Taylor-type monetary policy rule is not optimal, but an interest rate rule that also responds to financial variables improves welfare
  - Welfare comparison of a macro-prudential policy varying LTVs counter-cyclically and an interest rate rule taking financial factors into account
    - Borrowers benefit from more stable supply of credit under the LTV policy
    - Lenders (banks) benefit from more stable consumption under the interest rate rule directly responding to credit

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Concluding remarks 1

- Talk has highlighted the policy conclusions from MaRs WS1 research that received most support
- Focus on regulatory instruments and their interaction with monetary policy
- Nevertheless, still caution justified w.r.t. conclusions derived mainly from single or few models (many theoretical) and in a relatively new field
- Also, primary targets of MaRs WS1 were to undertake relatively fundamental research developing new macro models with serious characterisations of financial instability (major developments not shown today, except 3D model) and not necessarily to make strong policy recommendations as yet
- The analytical basis for macro-prudential policy is improving, including through MaRs, but still needs to go much further (so that also stronger policy conclusions can be drawn from a multiplicity of models)

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Concluding remarks 2

- The emerging new models need to be used more widely in the economics profession and to have this change need to be taught (at least in graduate studies) at universities (additional “paradigm”?)
- But new macro-prudential policy field will not develop if policy makers are not bold in starting to use the available instruments when needed (theory/science rarely leads practice in economics)
- Outside empirical literature on how macro-pru instruments can be effective is increasing (see Claessens, Ghosh and Mihat 2014, Crowe et al. 2013, ESRB 2014 or Kok et al. 2014 for overviews)

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Background Slides

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Ultimate sources of systemic risk

SPECIAL FEATURES OF THE FINANCIAL SYSTEM

Information intensity of financial contracts

Balance-sheet structures of inter-mediaries

High degree of connected-ness

MARKET IMPERFECTIONS

Incomplete markets

Asymmetric and imperfect information

Externalities

Public good character of systemic stability

Multiple equilibria

Powerful feedbacks and amplification: Non-linearities/ regime changes

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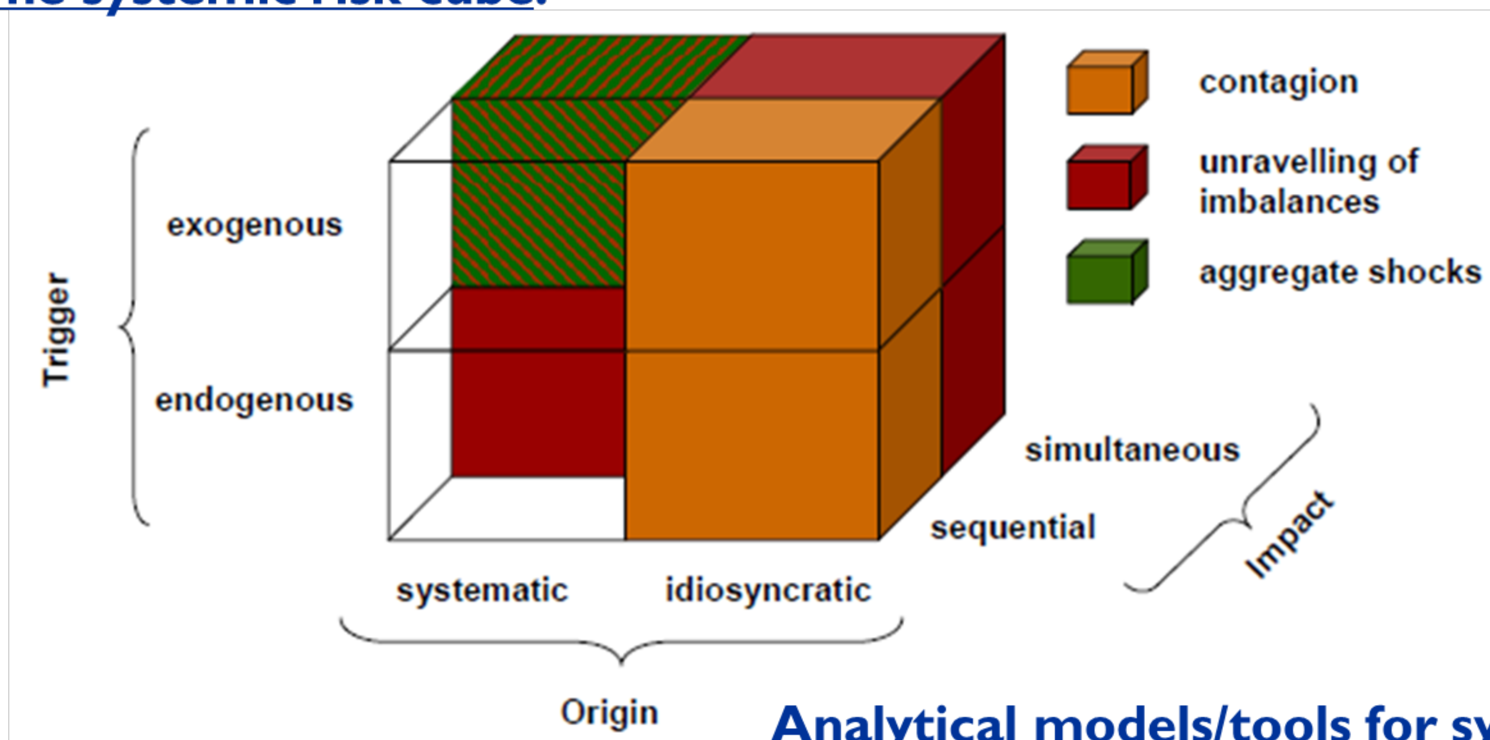
Forms of systemic risk and analytical approaches

The systemic risk cube:



Analytical models/tools for systemic risk:

- SR 1: Contagion – Contagion and spillover models
- SR 2: Endogenous build-up and unravelling of widespread imbalances – Early warning indicators and models
- SR 3: Aggregate shocks – Macro stress testing models

Source: Based on de Bandt, Hartmann and Peydró (2010) and ECB (2009 and 2010).

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MaRs management structure

Chair: Philipp Hartmann, ECB

Work Stream 1 Coordinators:

Laurent Clerc, BdF
Philipp Hartmann, ECB

Work Stream 2 Coordinators:

Carsten Detken, ECB
Kateřina Šmídková, CNB

Work Stream 3 Coordinators:

Paolo Angelini, BdI
Simone Manganelli, ECB

Consultants:

Professor Xavier Freixas,
Universitat Pompeu Fabra
(2010-2012)

Professor Javier Suarez,
CEMFI, Madrid
(2012-2014)

Consultant :

Professor Hans Degryse,
Katholieke Universiteit Leuven
(2012-2014)

Secretaries:

Angela Maddaloni, ECB, 2010-2011
Kalin Nikolov, ECB, 2011-2012
Fiorella De Fiore, ECB, 2012-2013
Gerhard Rünstler, ECB, 2013

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MaRs research questions

Work Stream 1	How can financial instability be represented in an aggregate economic model?
	How does widespread financial instability affect the real economy?
	What are the main transmission channels of financial instability at the aggregate level?
	What role is played by nonlinearities, amplification and feedback effects?
	What are the cumulative effects of the two-way interaction between financial instability and the performance of the economy at large, including the build-up and unravelling of financial imbalances?
	How can the leverage cycle be described theoretically and empirically?
	How can these models help understand the causes and features of the recent financial crisis?
	How can models help identify the appropriate macro-prudential policies to maintain systemic stability?
Work Stream 2	What are the key macro-prudential early warning indicators for groups of countries with relatively similar financial structures in the European Union?
	How can the different indicators be aggregated at the EU level?
	What are the best early indicators of widespread imbalances, asset price bubbles, credit booms and over-indebtedness?
	What are the best indicators of current systemic stress or instability?
Work Stream 3	How large are cross-border bank contagion risks compared to domestic risks?
	How significant are the risks of spillovers between different types of intermediaries?
	Is bank contagion risk significantly enhanced when feedback effects are taken into account?
	Can one distinguish between contagion risk, as one form of systemic risk, and the unravelling of imbalances, the Minsky-Kindleberger type of systemic risk?

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General achievements of MaRs

- Further clarified important **concepts**
- Developed several **structural models** incorporating financial instability into macroeconomics (perhaps main challenge of economics today)
- Proposed a variety of novel **empirical approaches** to
  - **measure widespread financial instability and identify its origins**
  - assess its (often non-linear) interaction with the economy at large and
  - warn about the risk of financial crises
- Started to assess a wide range of **regulatory instruments** proposed for macro-prudential policy
- Developed a number of **analytical tools** for supporting policy
- Put new (European) **data sources** at work

→ Material progress in developing the analytical foundations of macro-prudential policies

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Macro models with financial instability developed by MaRs 1

➢ Structural/theoretical

- Aoki and Nikolov, 2012, Bubbles, banks and financial stability, *ECB Working Paper*, No 1495 – non-linear dynamic general equilibrium model with banks holding asset bubbles and multiple equilibria
- Boissay, 2011, Financial imbalances and financial fragility, *ECB Working Paper*, No 1317 – non-linear static general equilibrium model with excessive wholesale funding of financial intermediaries and multiple equilibria
- Boissay, Collard and Smets, 2013, Booms and systemic banking crises, *ECB Working Paper*, No 1514 – non-linear calibrated dynamic general equilibrium model with banks' wholesale funding leading to boom-bust cycles
- Clerc, Derviz, Mendicino, Moyen, Nikolov, Stracca, Suarez and Vardoulakis, 2014, Capital regulation in a macroeconomic model with three layers of default, ECB, *Mimeo*. – calibrated dynamic general equilibrium model with bank, firm and household default and multiple financial frictions
- Dewachter and Wouters, 2013, Endogenous risk in a DSGE model with capital constrained financial intermediaries, *National Bank of Belgium Working Paper*, No 235 – integrating the He and Krishnamurthy approach in non-linear calibrated DSGE model
- De Walque, Pierrard and Rouabah, 2010, Financial (in)stability, supervision and liquidity injections: A dynamic general equilibrium approach, *Economic Journal*, 120(549) – dynamic general equilibrium model with an interbank market and a bank default

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Macro models with financial instability developed by MaRs 2

➢ Structural/theoretical (cont.)

- Goodhart, Kashyap, Tsomocos and Vardoulakis, 2012, Financial regulation in general equilibrium, *Banque de France Document de Travail*, No 372 – non-linear static general equilibrium model with bank default and shadow banking

➢ Empirical

- Hartmann, Hubrich, Kremer and Tetlow, 2012, Melting down: Systemic financial instability and the macroeconomy, ECB, *Mimeo.* – non-linear vectorautoregression model incorporating systemic financial instability

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WS1: Selected research highlights…

➢ Research progress

- Several approaches incorporating financial instability in macroeconomic models
  - Perhaps main challenge in economics today (brief survey Hartmann et al. 2013)
  - Imbalances for bank assets and liabilities (liquidity!, see next slides)
  - Economy behaves fundamentally differently at systemic instability (incl. non-linearities, see example on slide 4 and in background slides)
  - Recessions more severe in crises where bank credit plays important role
  - Modelling financial instability rather than frictions makes material difference for macroeconomy
- Shadow banking/securitisation, expectations about real-estate prices (e.g. no rational expectations) and foreign currency loans amplify credit and leverage cycles
- Cross-country spillovers from regulator policies may be material

➢ Analytical tools

- Macroeconomic model for assessing macro-prudential regulatory policies (see later slide 10 and background slides)
  - Developed by staff from 4 NCBs, ECB and MaRs consultant
  - Shared across the ESCB
- Non-linear empirical model for assessing macro impact of financial crises (slide 4)
  - Nowcasting states of systemic fragility, scenario analyses and, may be, forecasting

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WS1: …and selected insights for policy

➢ Macro-prudential policy

- Multitude of market imperfections that contribute to systemic risk require multiple regulatory instruments:
  - Key to diminish fire-sale risk
  - Regulatory arbitrage may require capital requirements to be combined with margin requirements on repos
- But indiscriminate combinations of regulations can also be counterproductive
- Countercyclical loan-to-value ratios (LTVs) more effective than static ones (politically complex, but perhaps generalised collateral limit could help)
- Advisable to consider LTVs and debt-to-income limits (DTIs) together
- Regulatory policies may need to be coordinated across financially integrated countries (roles of Single Supervisory Mechanism, ESRB), also for instruments outside EU legislation (LTVs, DTIs!)
- Interaction with monetary policy

- Descriptive work by the CGFS, ESRB and IMF on macro-prudential policy instruments

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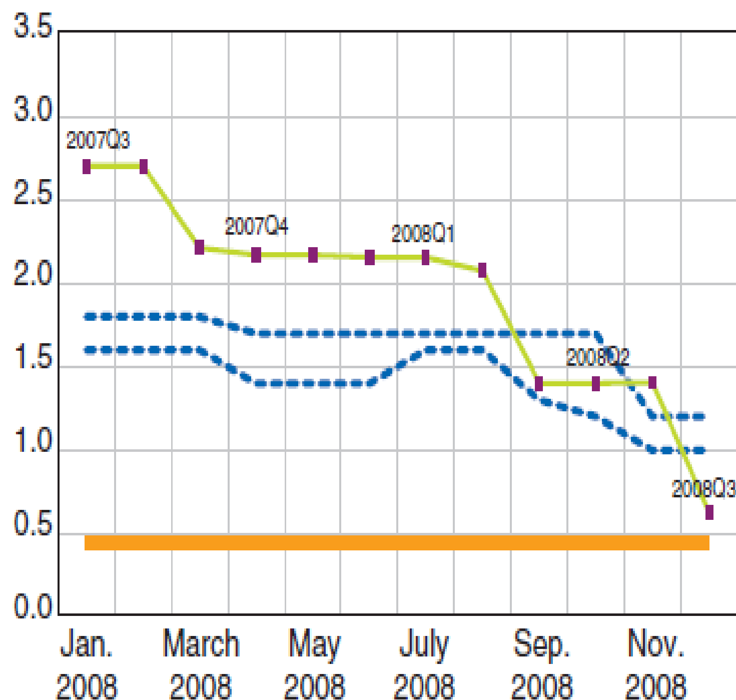
What can we gain from macro-prudential research?

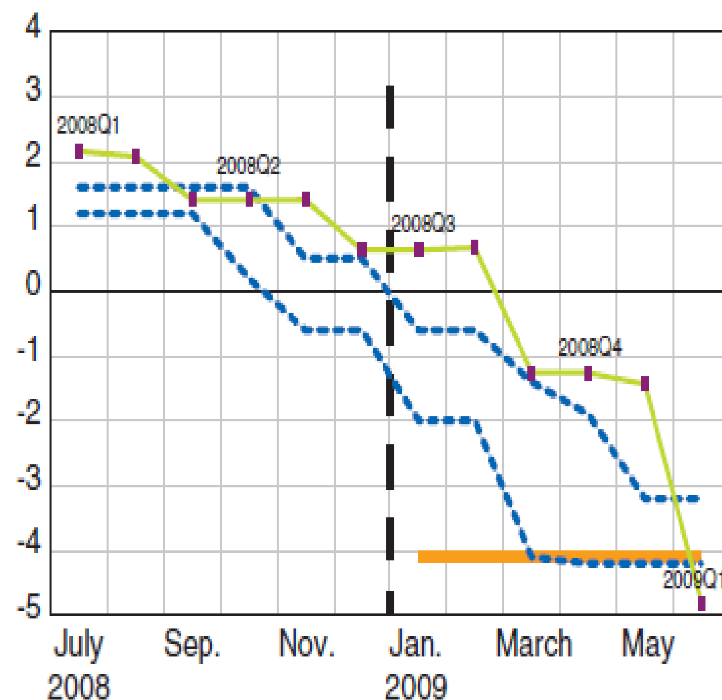
Real time euro area GDP growth forecast errors and coincident growth releases

(%)

a) For 2008



b) For 2009



Source: Trichet (2011).

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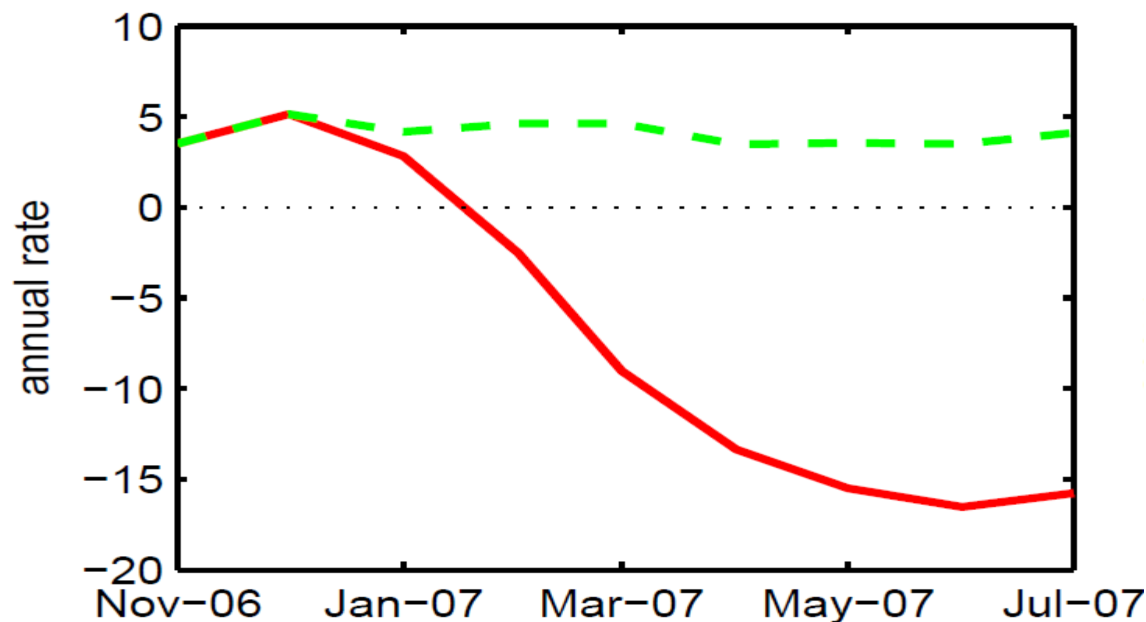
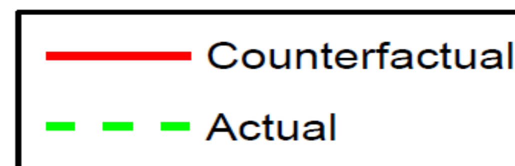
What can we gain from macro-prudential research?

➢ Non-linear impact of widespread financial instability on growth

- Bayesian vectorautoregression model with output growth, inflation, interest rate and credit growth allowing feedback effects between all variables (monthly data, 1987-2010)
- Incorporate Composite Indicator of Systemic Stress (CISS) in it (see slide 13)
- Add Markov-Switching/regime changes in parameters and error variances (see also background slides)



Scenario in January 2007:
What would have been the growth outlook for the euro area if systemic instability had hit?
•Large increase of CISS (to 0.7)
•Fundamental regime change in the macroeconomy



- One caveat: This scenario not "out of sample", but possible in the future

Source: Hartmann, Hubrich, Kremer and Tetlow (2012).

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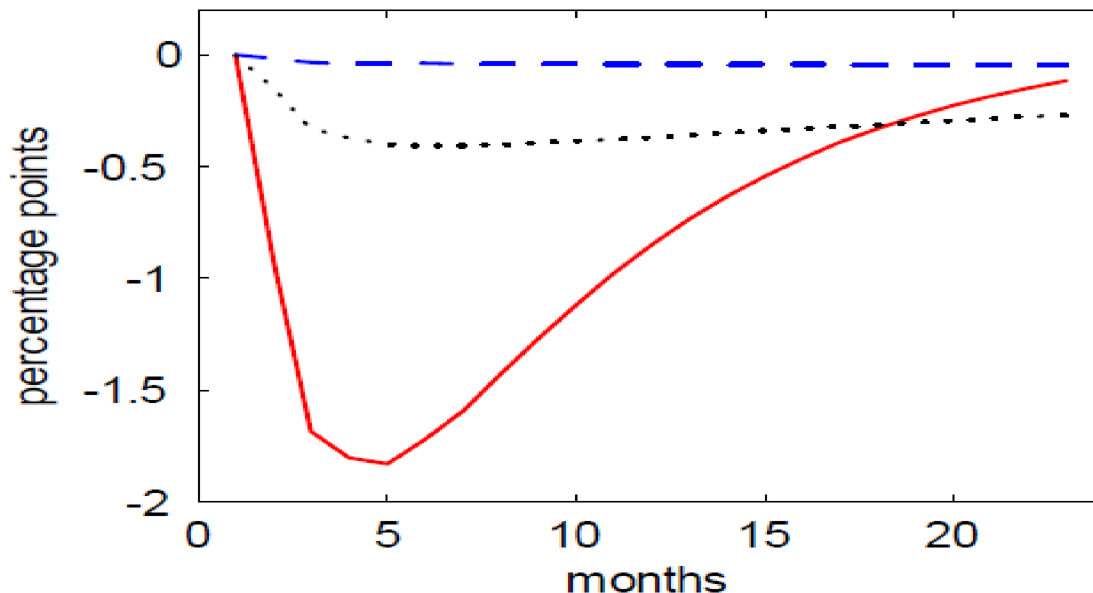
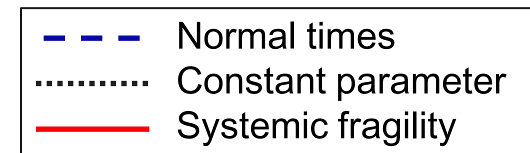
➢ Non-linear impact of widespread financial instability on growth

- Take Bayesian vectorautoregression model with output growth, inflation, interest rate and credit growth allowing feedback effects between all variables
- Incorporate our Composite Indicator of Systemic Stress (CISS) (see slide 13) in it
- Add Markov-Switching/regime changes in parameters and error variances



Impulse response functions of a one standard deviation shock in the CISS on output in different regimes (monthly euro area data, 1987-2010)



- Nowcasting states of systemic fragility, scenario analyses and, may be, forecasting

Source: Hartmann, Hubrich, Kremer and Tetlow (2012).

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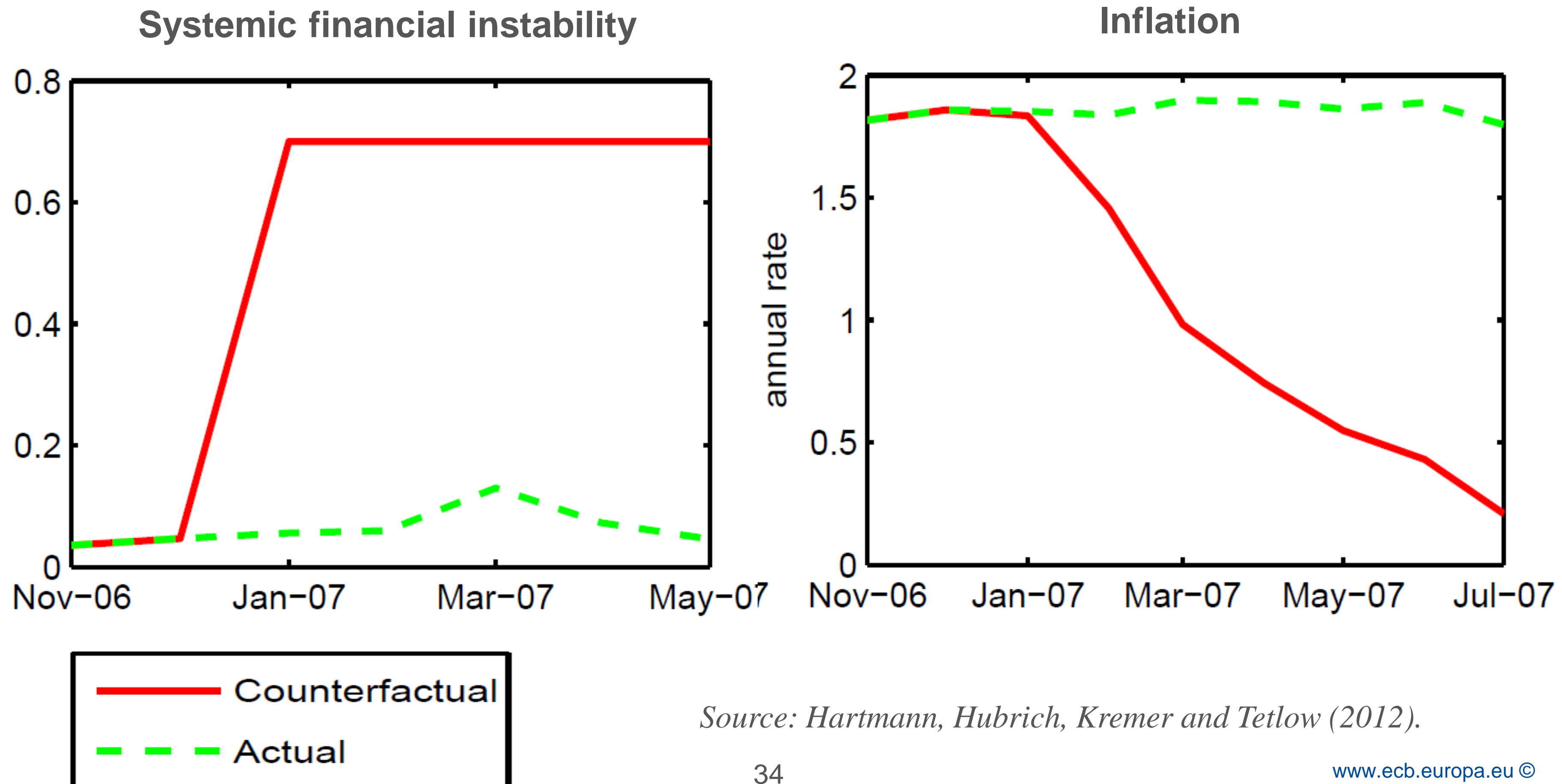
➢ Non-linear impact of widespread financial instability on inflation

- Markov-switching Bayesian vectorautoregression model with CISS from slides 4 and 34
- January 2007 scenario: Large increase of CISS and fundamental regime change to a state of “systemic fragility” (until June 2007)

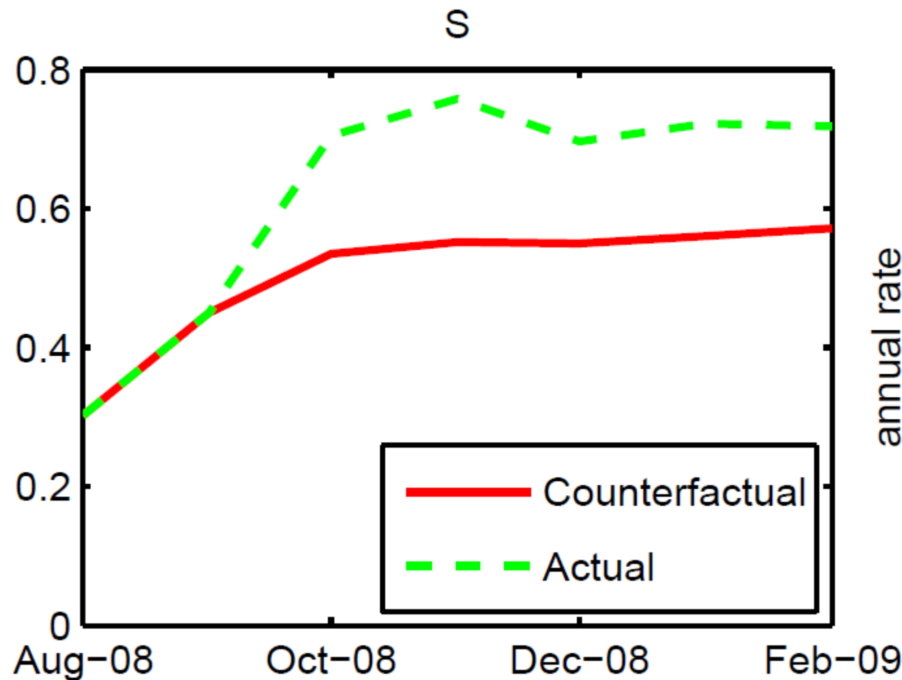


Source: Hartmann, Hubrich, Kremer and Tetlow (2012).

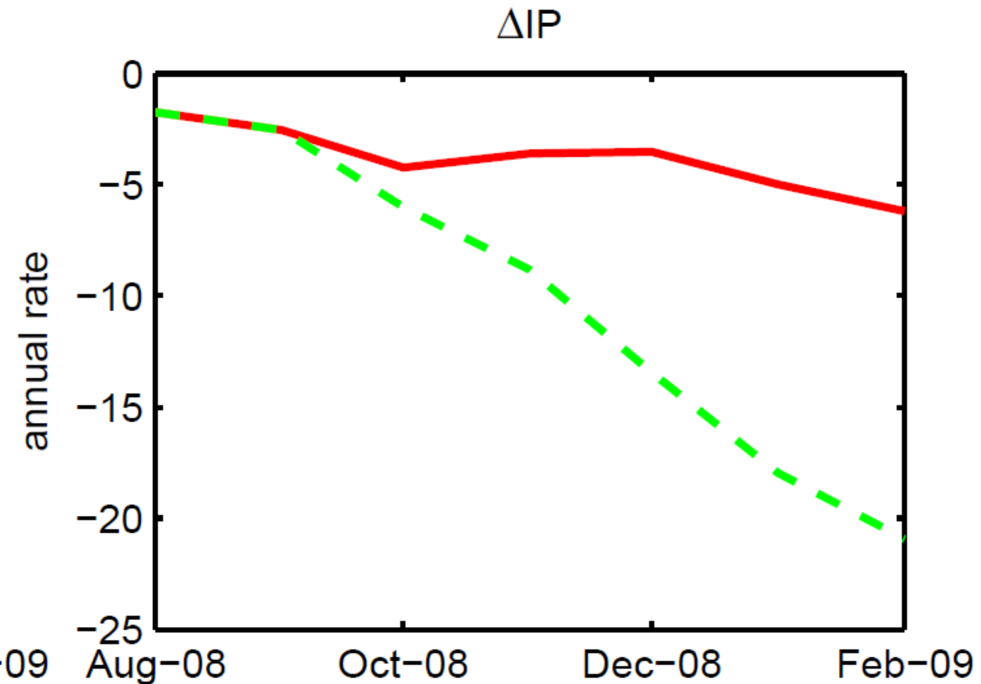
➢ Non-linear impact of widespread financial instability on growth

- Markov-switching Bayesian vectorautoregression model with CISS from slides 4 and 34
- October 2008 scenario: Fundamental regime change from state of “systemic fragility” to tranquil times (until February 2009)

Systemic financial instability



Output growth



Source: Hartmann, Hubrich, Kremer and Tetlow (2012).

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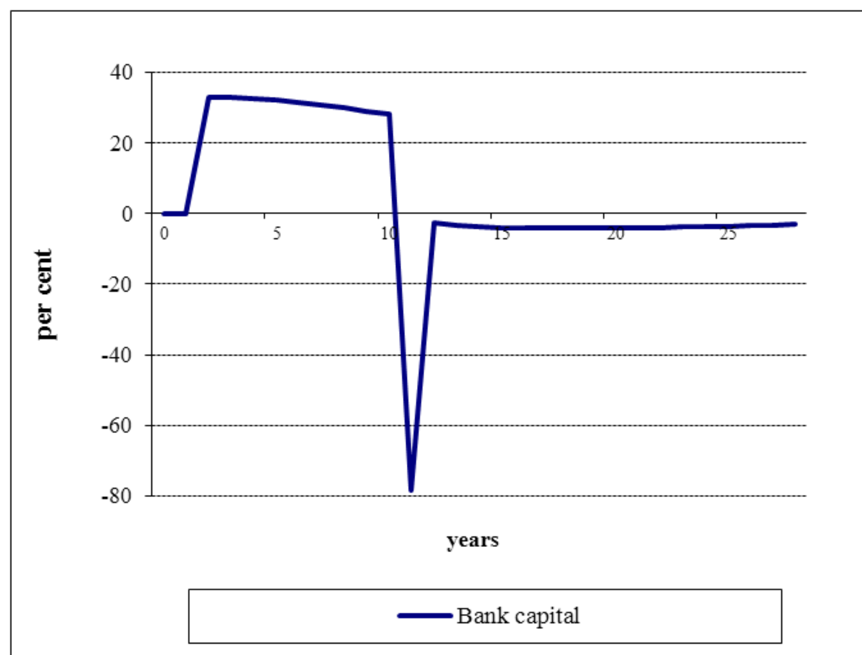
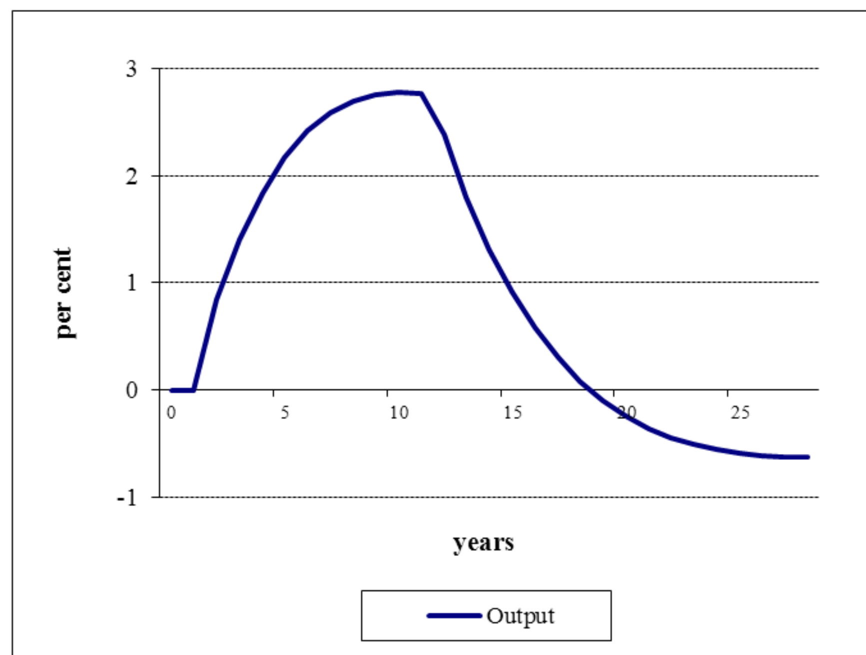
WS1: Macroeconomic model with boom-bust cycles 1

➢ Build-up and unravelling of imbalances via banks' asset side

- Calibrated dynamic stochastic general equilibrium model with banks that can hold a bubble asset like in the rational bubbles literature and face occasionally binding capital constraints
- Credit constraints of firms and banks decrease interest rates and lead to "search for yield"
- Banks start to hold "zero-dividend" asset in pure expectation that its value will appreciate





- Crisis driven by (exogenous) switch between multiple equilibria (non-linearity), one where the zero-dividend asset has value and one where it has not

Source: Aoki and Nikolov (2012).

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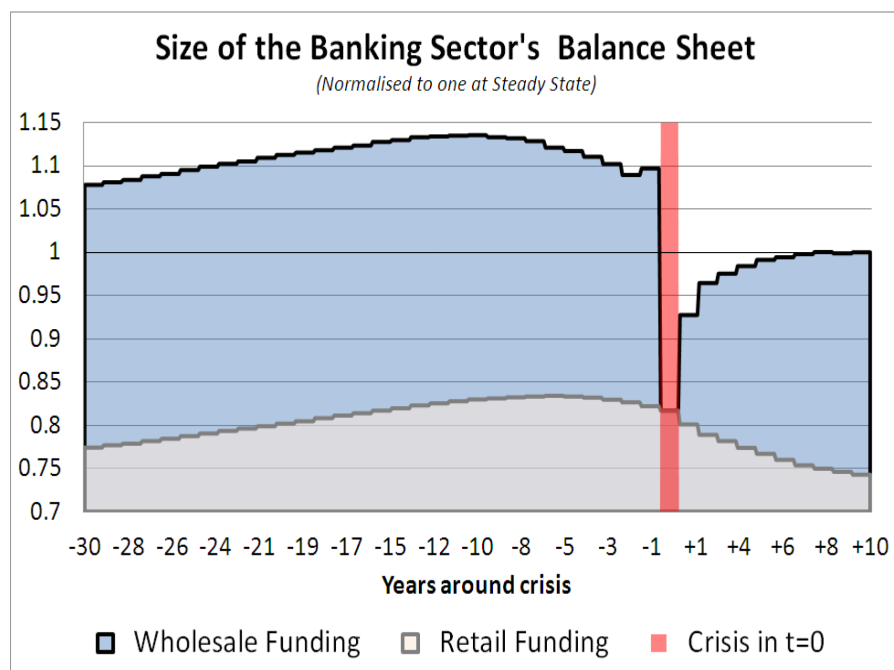
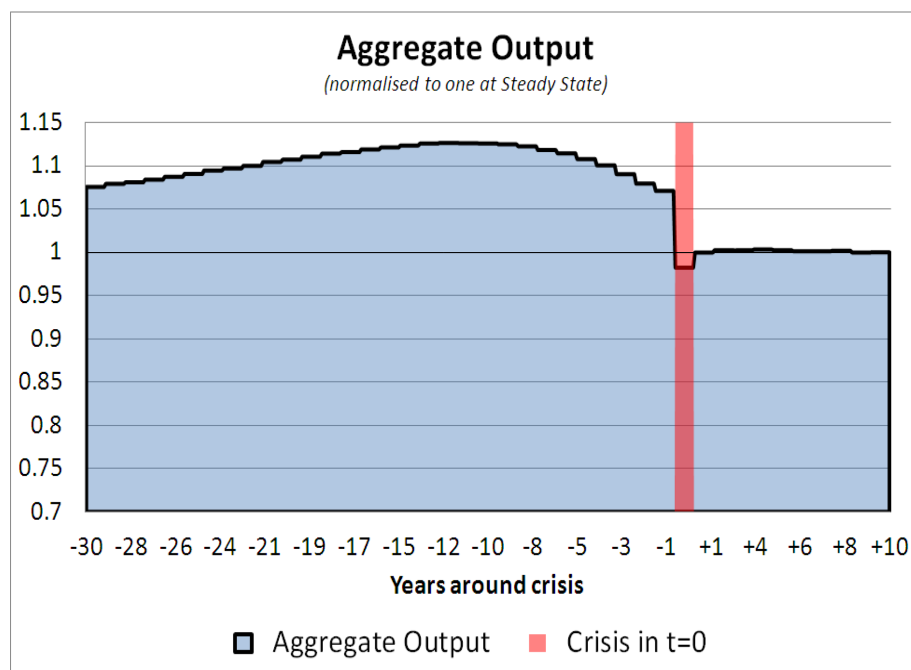
WS1: Macroeconomic model with boom-bust cycles 2

➢ Build-up and unravelling of imbalances via banks' liability side

- Calibrated real business cycle model with banks of different ability to choose borrowers (asymmetric information)
- Positive productivity shock creates demand for loans, banks take wholesale funding and grow
- Less proficient banks enter until trust breaks down and the interbank market freezes





- Crisis driven by breakdown of wholesale funding (non-linearity)

Source: Boissay, Collard and Smets (2013).

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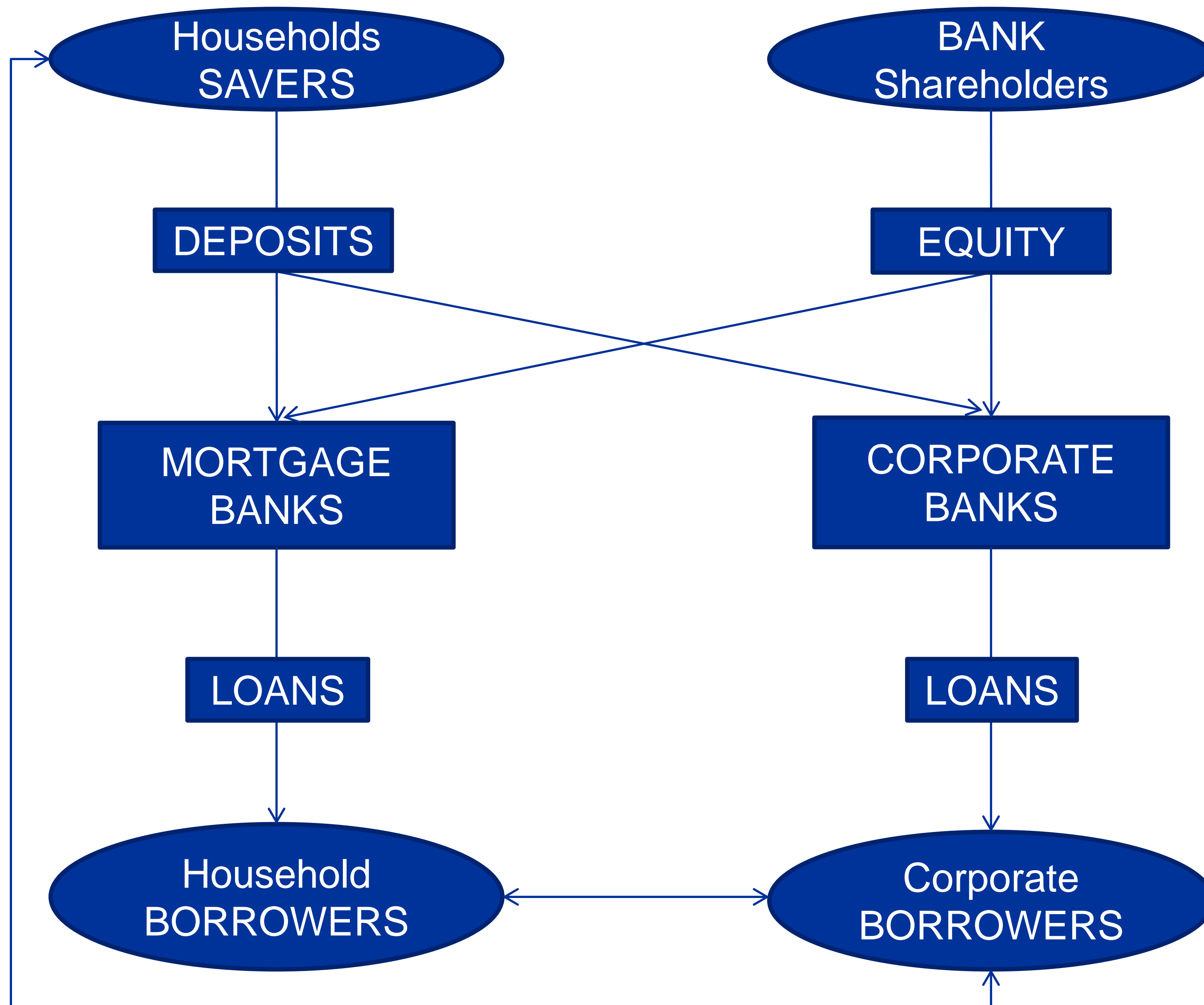
WS1: Structure of the 3D model



Source: Clerc (BdF), Derviz (CNB), Mendicino (BdP), Moyen (Bundesbank), Nikolov, Stracca (both ECB), Suarez (CEMFI) and Vardoulakis (ECB and Fed Board, 2014).

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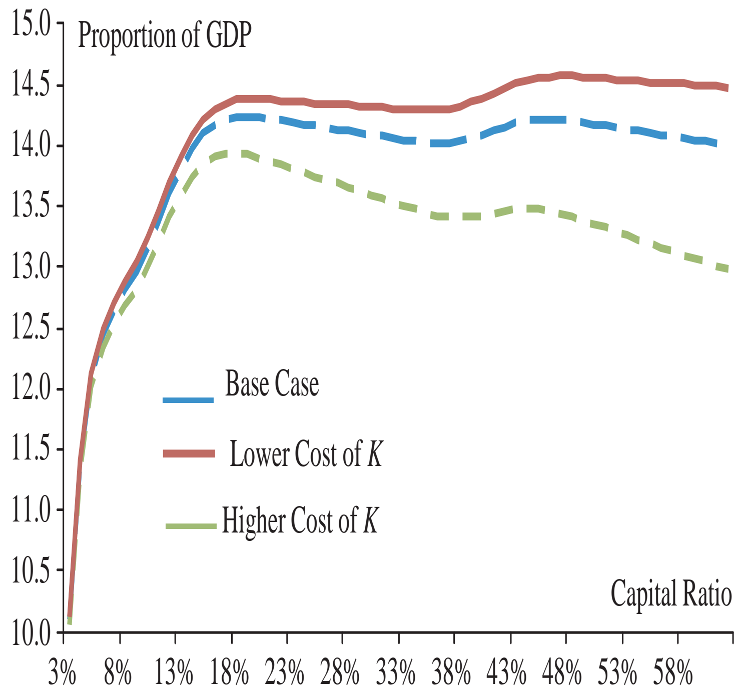
WS1: Comparison of "welfare" measure by Miles et al. with 3D

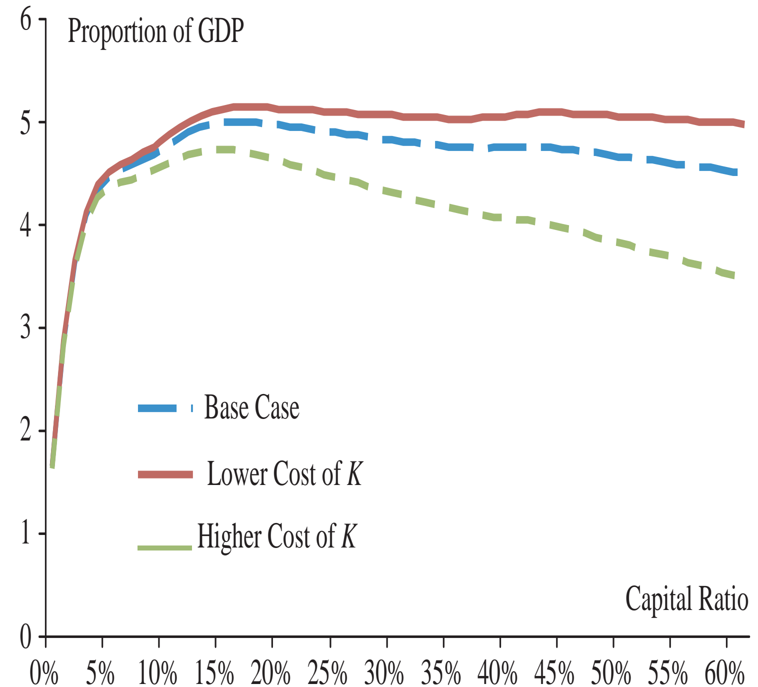
➢ Qualitatively similar conclusions for steady state/medium to long term

- Sizable social benefits of increasing bank capital from low levels
- Limited social costs of relatively high bank capital levels
- Caveat: Transitional costs of increasing capital not captured

Financial crises have permanent GDP effect



Financial crises have transitory GDP effect



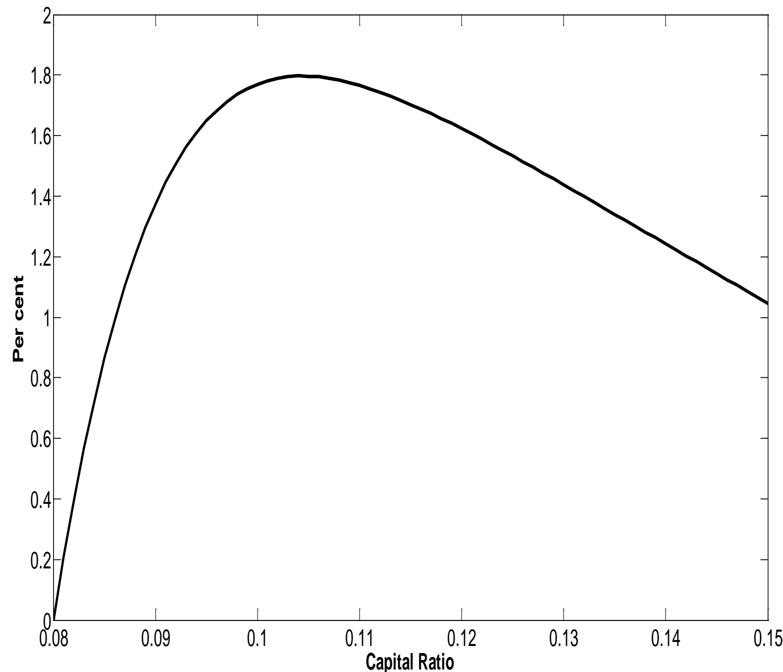
Source: Miles et al. (2012).

WS1: Comparison of "welfare" measure by Miles et al. with 3D

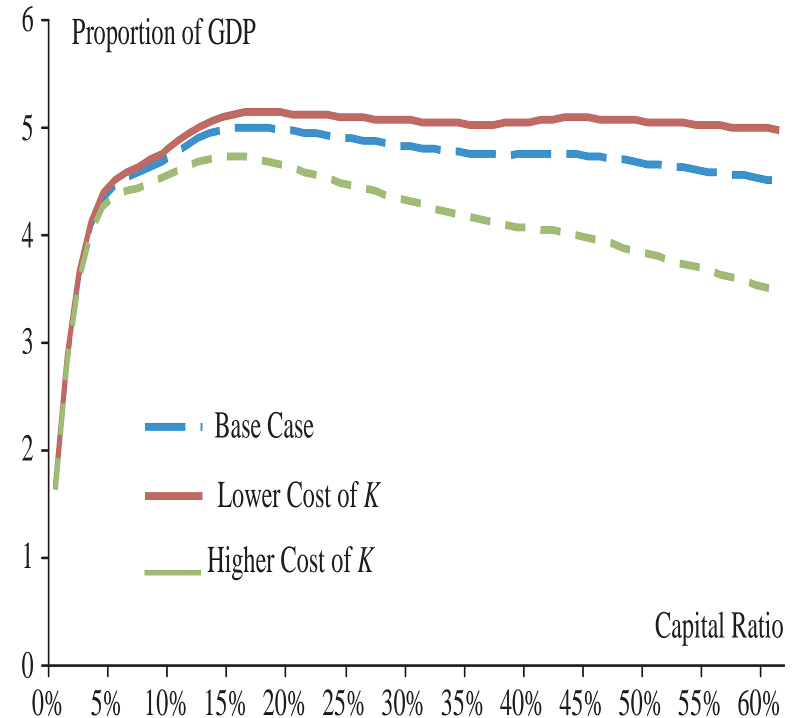
➢ Qualitatively similar conclusions for steady state/medium to long term

- Sizable social benefits of increasing bank capital from low levels
- Limited social costs of relatively high bank capital levels
- Caveat: Transitional costs of increasing capital not captured

Theoretical measure from 3D



Empirical measure from Miles et al.



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WS1: Comparison of "optimal" capital levels in the literature

PAPER	OPTIMAL CAPITAL RATIO	GENERAL FRAMEWORK	BENEFITS OF CAPITAL	COSTS OF CAPITAL
Admati and Hellwig (2013)	20+%	Qualitative reasoning based on Modigliani-Miller type partial equilibrium models and corporate finance literature	General discussion of banks' ability to absorb losses, limiting their risk taking, preventing debt overhangs and the associated social benefits	General discussion rejecting reasons why bank capital is costly (banks can raise equity relatively freely)
Miles, Yang and Marcheggiano (2012)	16-20%	Range of partial equilibrium and ad hoc empirical estimates or models of social benefits and costs of bank equity	Reduced probability of banking crises and therefore their expected output costs	Increased average cost of bank funding and hence borrowing costs for firms and households
Martinez-Miera and Suarez (2012)	14%	Macroeconomic general equilibrium model with moral hazard for banks, for low capital ratios they invest in "correlated/bad" projects	Reduced implicit subsidies associated with deposit insurance, systemic risk taking and bank failures, leading to higher consumption	Reduced credit supply and output (banks cannot raise outside equity)
MaRs 3D	11%	Macroeconomic general equilibrium model with moral hazard for banks, for low capital ratios they generally lend at too low interest rates and therefore too much to firms and households	Reduced implicit subsidies associated with deposit insurance, over-lending and bank failures, leading to higher consumption	Reduced credit supply and output (banks cannot raise outside equity yet – extension of the model ongoing)

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WS2: Selected highlights

Research progress Early Warning Models (EWMs)

- Evaluation methodologies: taking into account policymaker's relative aversion against missing crises and false alarms and checking robustness across range of thresholds (AUROC=Area under the receiver operating characteristic)
- Variable selection methodologies: Bayesian model averaging; bootstrapping (random forests, see slide 15); principal components; should all improve out-of-sample performance of models
- Visualisation of EWM results for policy purposes: Decision trees; self-organising maps

Analytical tools

Early warning models:

- Univariate signalling approach
- Multivariate logit/probit (also including random coefficient models)
- Decision trees (binary classification trees, see slide 15)
- Bayesian model averaging

Systemic instability indicator:

- CISS: aggregates stress indicators for the main financial markets and institutions (broad coverage of financial system) taking into account their dependence and relation to real economy (next slide); useful e.g. in guiding the release phase of the countercyclical capital buffer

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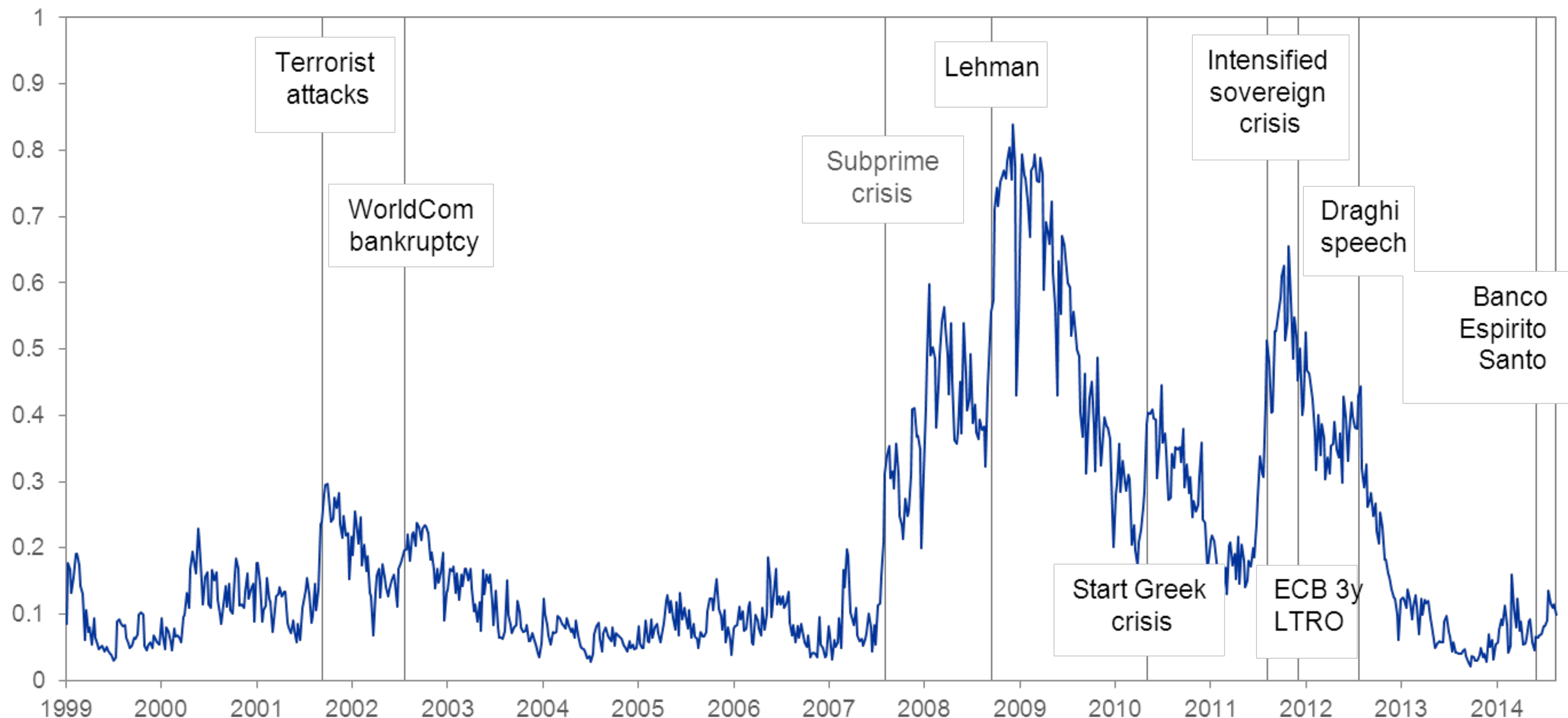
WS2: Measuring systemic financial instability

➢ Composite Indicator of Systemic Stress ("CISS")



- Scope: Equity, bond, money and FX markets plus banks/financial institutions - real time
- Basic sub-measures include volatilities, trends, spreads, recourse to marginal lending (weekly data)
- Normalisation between 0 and 1 and aggregation weighted with correlations ("systemic")

Source: Holló, Kremer and Lo Duca (2012).

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WS2: Joint cross-country project comparing early warning models

➢ **"Horse race": Exercise set up to compare in a systematic way alternative EWMs for systemic banking crises in the EU**

- Common dataset of systemic banking crises in EU countries collected by MaRs researchers and other ESCB staff with the help of Heads of Research (Babecký et al. 2012)
- Harmonised explanatory data (as much as possible)
- Common rules of the game (e.g. prediction horizon 1-5 years ahead, recursive de-trending, pseudo-real time data)
- Common evaluation method
- Nine teams from seven NCBs and the ECB participated (next slide one example: decision tree based on random forest)

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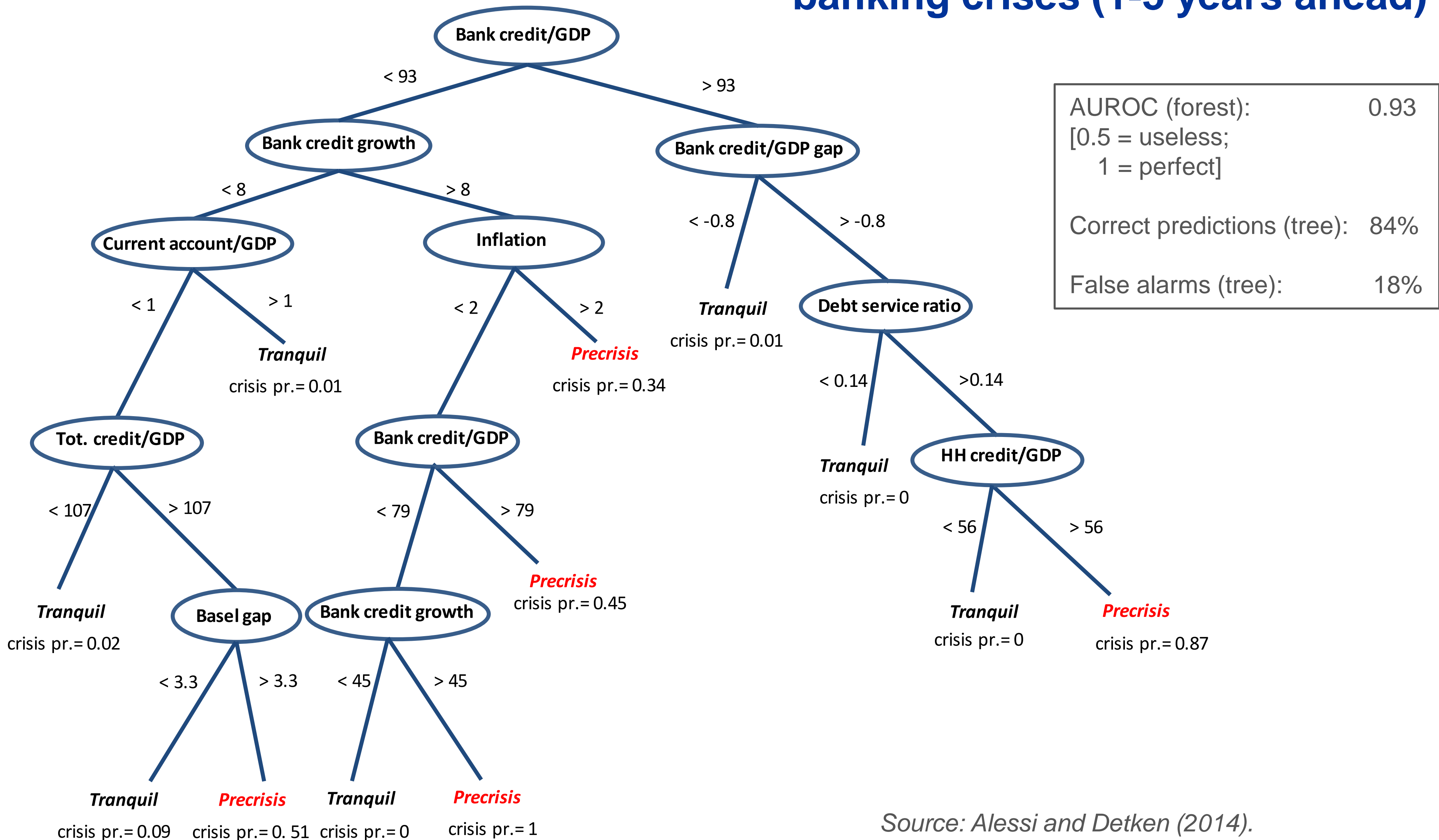
➤ A decision tree (as part of a random forest) for signalling systemic banking crises (1-5 years ahead)



AUROC (forest): [0.5 = useless; 1 = perfect]	0.93
Correct predictions (tree):	84%
False alarms (tree):	18%

Source: Alessi and Detken (2014).

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WS2: “Horse race” cross-country project results

➢ Policy advice (for building a robust early warning system)

- No single model dominating across all evaluation criteria and policy makers’ preferences. A suite of models recommended; best models, indicators and especially (optimal) triggers strongly dependent on policy makers’ preferences
- Credit is key indicator (credit/GDP gaps, credit growth) but other indicators also useful: proxies for asset (housing) price misalignments, CA/GDP, debt-service-to-income ratios; global indicators and interaction terms, bank leverage (see also Detken et al. 2014)
- Multivariate models outperform single credit and housing indicators by conditioning credit developments and adding time dependency and contagion/herding information [best AUROCs 0.9 (univariate 0.8), false alarms 10-30% (univariate 35%); correct predictions for univariate and multivariate 80-86%]

→ Support for overcoming “this-time-is-different syndrome”

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WS2: Research questions and main findings

1. What are the key macro-prudential early warning indicators for groups of countries (with relatively similar financial structures in the European Union)?
   - Important to make a distinction between indicators of the **potential sources and transmission of vulnerabilities.**
   - Key **domestic variables**: credit-to-GDP gaps are the best single leading indicators for systemic banking crises associated with excessive credit growth and leverage. Other important indicators measuring asset price misalignments are e.g. house price to income ratio, the growth rate of commercial real estate prices, and the debt service ratio.
   - In addition, WS 2 research also emphasises the importance of **global variables** in early warning models, in particular those related to global credit growth, leverage and asset price misalignments.
2. How can the different indicators be aggregated at the EU level?
   - The WS 2 analysis shows that it is desirable to apply **a suite of early warning models** rather than to try identifying the single best performing model and use it alone. This applies in particular in situations where policy makers' preferences towards type I and II errors are not the same across jurisdictions, stable over time or entirely clear.
3. What are the best early indicators of widespread imbalances, asset price bubbles, credit booms and over-indebtedness?
   - The empirical evidence of WS 2 warns **against relying too much on simple statistical de-trending or filtering methods** to detect imbalances.
   - New developments to detect excessive credit and leverage include e.g. construction of structural or regime switching models. In the area of equity bubbles, factors contributing to mispricing, highlighted by WS2 researchers, include market sentiment and the intensity of herding behaviour.
4. What are the best indicators of current systemic stress or instability?
   - A **composite indicator (CISS)** captures the systemic dimension by being broad in covering stress in the main financial markets and intermediaries and by aggregating these components taking their dependence into account, with their weights linked to their relation to the real economy.
   - This indicator proves to be useful e.g. in guiding the release phase of the countercyclical capital buffer.

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WS3: Selected research highlights and support for policy

➢ Research progress

- Several contagion mechanisms analysed: default cascades, marginal contagion (see slide 18), payment delays, contagion versus integration
- Sources of amplification and non-linearities identified
- Two-sided nature of interbank relationships: can ensure funding sources during crisis times or act as a conduit for contagion
- Analysis of time-varying spillovers in interbank rates (fragmented versus integrated times, stressed versus non-stressed countries)
- Substantial further evidence of sovereign contagion (e.g. through statements questioning commitment to support weak sovereigns), although debate on alternative explanations continues (fundamentals and risk aversion)

➢ Analytical tools

- Construction of data base of interbank loans/exposures from TARGET2 transaction-level data using Furfine (1999) algorithm (effort 15 researchers from 11 NCBs with payment experts in a large joint cross-country project; Arciero et al. 2013, de Frutos et al. 2013 – ESRB efforts with different data)
- Default simulation model with amplification through asset fire sales
- Indicators of money market stress/fragmentation (see slide 19 and background slides)
- New TARGET2 data base and infrastructure opens up an enormous range of opportunities for macro-prudential surveillance and assessment tools (but also other areas)

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WS3: Construction of the TARGET2 data base

- Most of WS3 TARGET2 related studies focus on interbank loans
- Identification of interbank loans based on Furfine (1999) algorithm (see next slide)
- Two studies have created two alternative data sets:
  - De Frutos, Garcia, Heider and Papsdorf (2013)
    - Focus on overnight transactions, robust to periods of high stress
  - Arciero, Heijmans, Heuver, Massarenti, Picillo and Vacirca (2013)
    - Extract term loans up to 12-month maturity (reliable identification only up to 3m)
- Both studies go at great length to validate the algorithm (using Spanish and Italian trading platforms where interbank loans are observed)
- They find remarkable degree of accuracy (in contrast to a few previous studies on US Fedwire), e.g. comparison with (Spanish) MID trading platform
  - Type I error (false identification of interbank loans): 0.7%
  - Type II error (MID loans not detected): 11.7%

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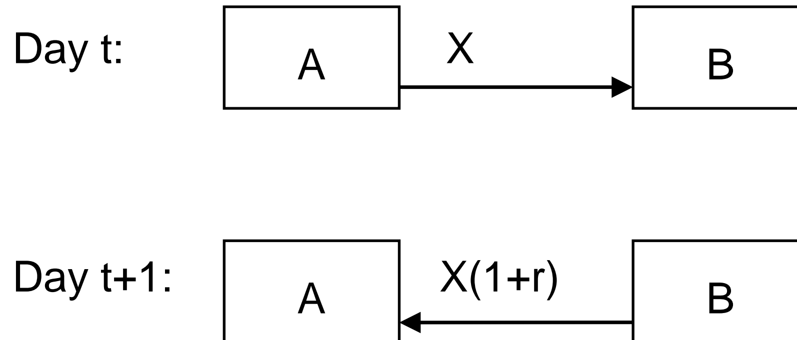
WS3: Furfine algorithm to identify interbank loans



- Payment X at time t matched with re-payment at t+1
  - Interest rate r is within certain bounds (0, MLF + 100 bp)
  - TARGET2 sender-accounts are identical
  - Remove payments within consolidated groups

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WS3: Statistics of TARGET2 data and derived interbank loans

	TARGET2 dataset of unsecured loans	EONIA
Number of loans	Ca. 1 million since June 2008 (ca. 700 loans per day)	Not reported (only aggregate lending rates and volume)
Average daily value	61 billion	32 billion
Banks	392	35 (high activity of Landesbanken)
Coverage	Banks in all TARGET2 countries, allowing analysis at country level	Countries represented only by panel banks

Source: ECB.

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WS3: di Iasio et al. (2013) marginal contagion approach

- Use bilateral interbank exposures derived from TARGET2 data and match them with balance sheet data from Bankscope to simulate contagion
- One bank is assumed to fail at a time
- Its contagion effect on other banks is assumed to be
  - the respective bilateral exposure
  - times its loss relative to its equity
  - divided by its tier 1 ratio relative to the average tier 1 ratio among all banks
- Full chain of transmission is calculated for subsequently defaulting and not defaulting banks
- Approach is meant to proxy the idea that other banks may also be affected when no further banks default ("marginal" contagion, e.g. also Ota 2013): Effects through market valuations of assets and liabilities
- At each point in time each bank has a "debt rank": Sum of the total losses its failure would ultimately cause among all banks in the system as share of total equity in the system

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WS3: Summary of results by di Iasio et al. (2013)

- The banks identified as systemic by the “debt rank” methodology tend to be the largest ones in terms of total assets
- The relationship between size and systemic impact is highly non-linear
- There is significant dispersion in the systemic impact of the largest banks

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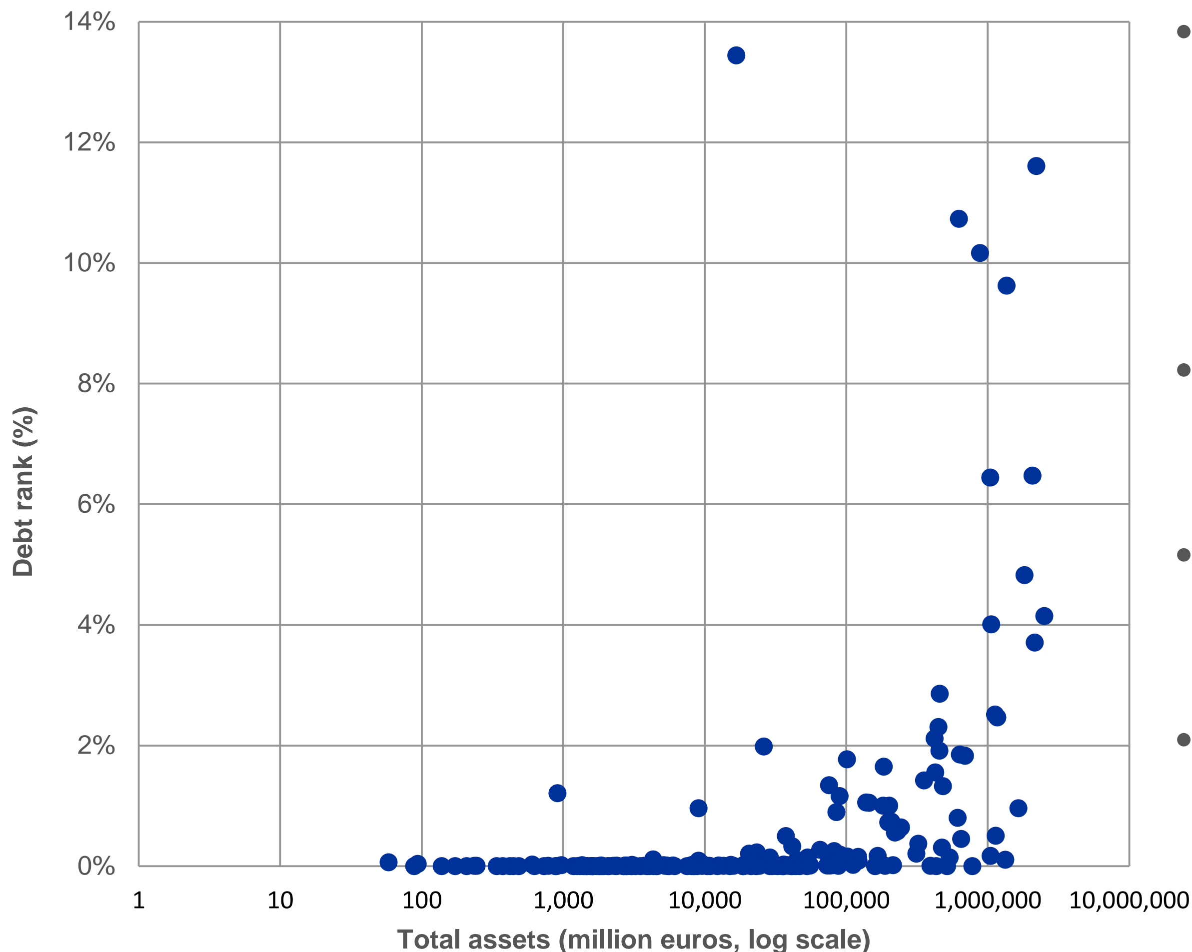
WS3: Indicator of marginal bank contagion risk

➢ Effect of bank failure on euro interbank network (example Dec. 08)



- Transmission not only through defaults but also proportional to Furfine interbank exposures, relative losses and relative capitalisation of banks
- Contagion risk larger than found in traditional default simulations
- Largest banks have systemic effect (non-linear) but wide dispersion
- Helps, inter alia, to under-stand the systemic impor-tance of individual banks and how it evolves over time

Simulation of the overall loss of equity (in % of total) among all banks active in TARGET2 caused by individual bank failures ("debt rank" methodology based on a further development of Battiston et al. (2012)) and bank size.
Source: di Iasio, Rainone, Rocco and Vacirca (2013).

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WS3: Indicators of contagion risk using TARGET2 data

➢ Effect of bank failure on euro interbank network (example Dec. 08)

- Contagion risk larger than found in traditional default simulations
- Largest banks have systemic effect (non-linear) but wide dispersion

Debt Rank

14%
12%
10%
8%
6%
4%
2%
0%

0.0% 0.5% 1.0% 1.5% 2.0% 2.5% 3.0% 3.5% 4.0%

Default cascade

Simulation of the overall loss of equity among all banks active in TARGET2 caused by individual bank failures ("debt rank" methodology based on a further development of Battiston et al. (2012) compared to "default cascades" based on Furfine (1999)).
Source: di Iasio, Rainone, Rocco and Vacirca (2013).

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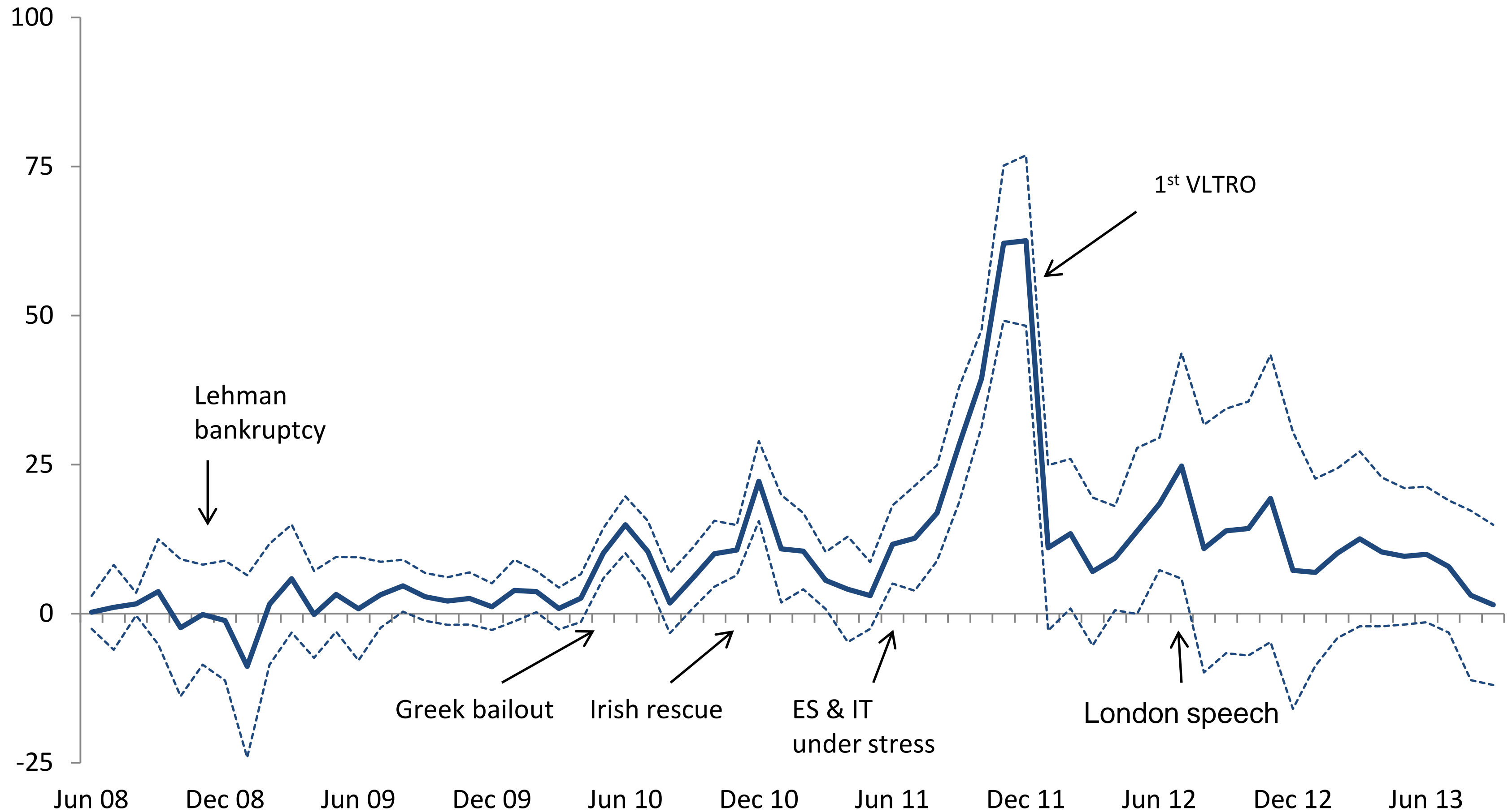
WS3: Indicator of fragmentation/stress in the interbank market

➢ Impact of bank geographical location on the price of euro liquidity



Estimated average country risk premium that banks from five stressed euro area countries pay on euro overnight loans after controlling for their own risk in a panel regression with monthly data.
Source: Garcia, Hoffmann and Manganelli (2013).

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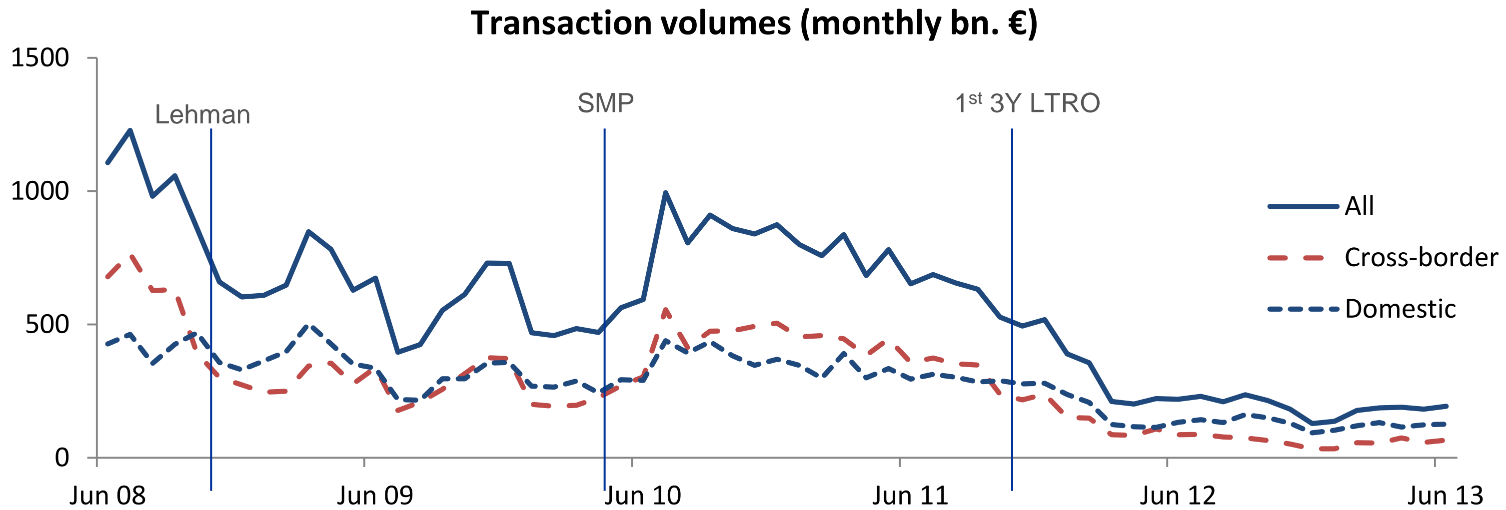
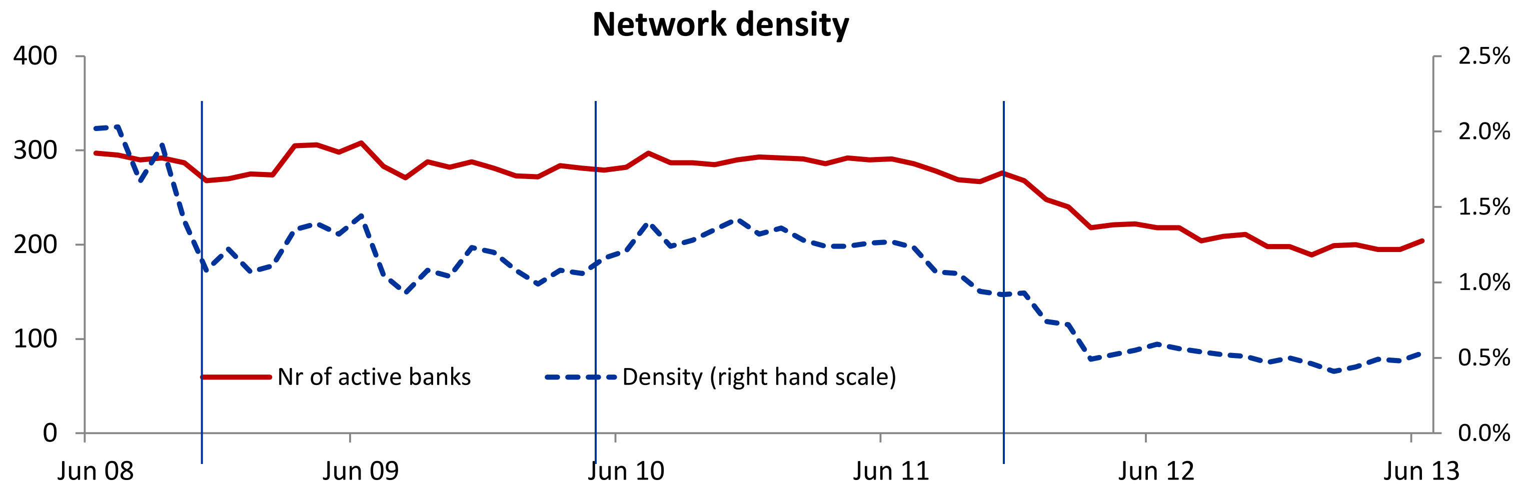
WS3: Tracking the interbank market with TARGET2 data





Source: Garcia, Heider and Rünstler (2013).

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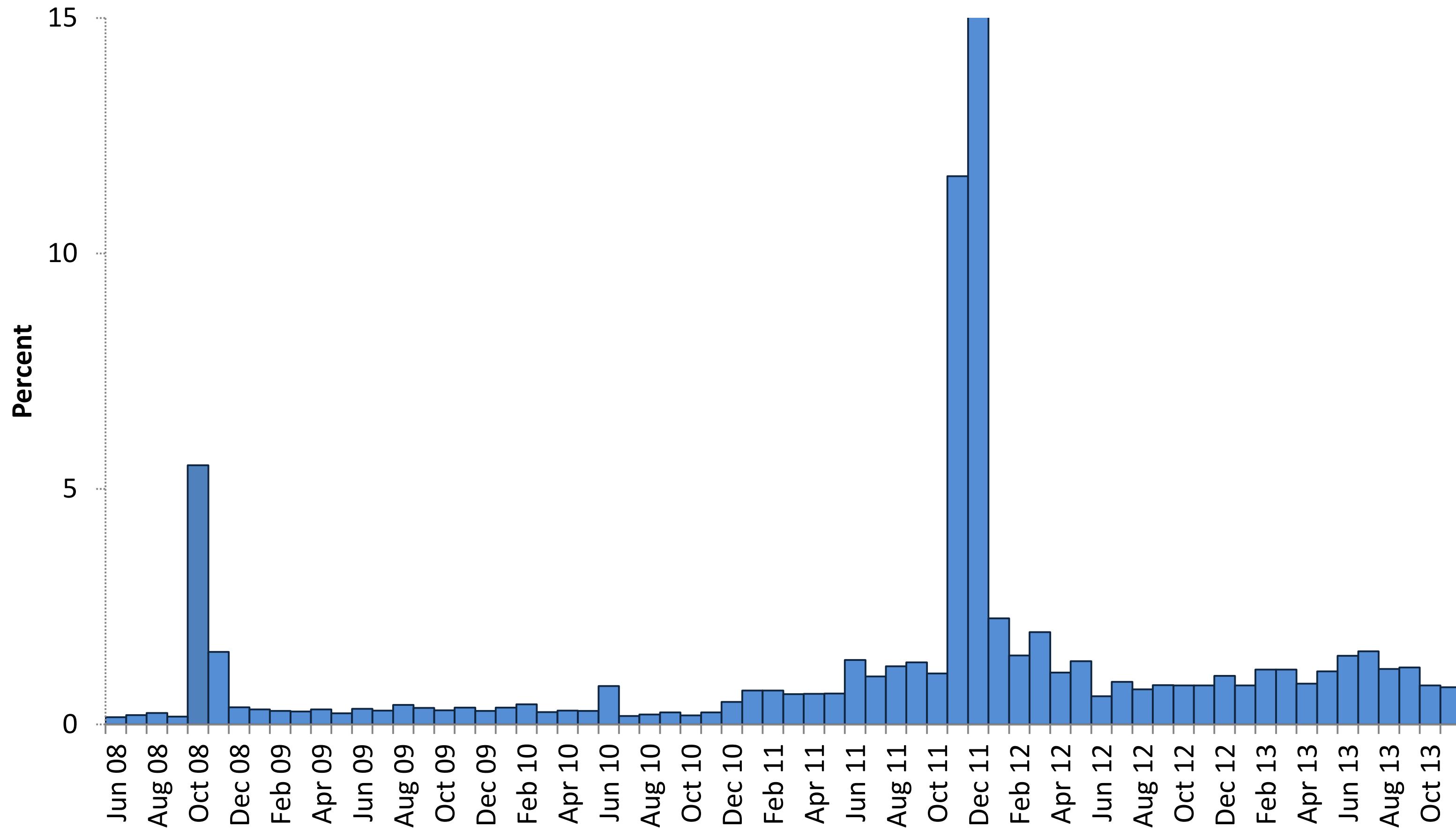
WS3: Indicator of stress in the interbank market



Monthly percentages of overnight loans identified with TARGET2 data with an interest rate above the ECB marginal lending facility rate. Source: de Frutos, Garcia, Heider and Papsdorf (2013).

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WS3: Studies on bank spillovers and contagion

- Global empirical study of regional bank fragility and spillovers using market data
- New methodology to disentangle short-term contagion from long-term market integration
- Further progress on applying the network approach at the macro level, using financial accounts
- Network approach to counterfactual simulation of interbank contagion introduces fire sales and shows how they amplify contagion effects in a non-linear fashion

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WS3: Special initiative on sovereign contagion

- Range of methodologies: Dynamic factor models, multivariate frequency decomposition, cointegration analysis, forecasting error variance decompositions, dynamic copulas and event studies
- Different data: Sovereign bond yield spreads, sovereign CDS, bank equity returns
- Most papers (but not all) find evidence of sovereign contagion in the euro area since the onset of the debt crisis
- One paper argues that bad news about a country's economy may be confounded with news about a lack of commitment to support it by other countries
- Two papers argue that fundamentals and risk aversion may explain sovereign yield increases

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