EUROPEAN CENTRAL BANK

Banking System Stability: A Cross-Atlantic Perspective

Philipp Hartmann, European Central Bank

Stefan Straetmans, Maastricht University

Casper de Vries, University of Rotterdam

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The importance of tail risk

- Alan Greenspan at the first "Risk Measurement and Systemic Risk" conference in Washington (DC), 1995:
  - *From the point of view of the risk manager, inappropriate use of the normal distribution can lead to an understatement of risk…From the central bank's corner, the consequences are even more serious because we often need to concentrate on the left tail of the distribution in formulating lender-of-last-resort policies. Improving the characterization of extreme values is of paramount concern.*
- Raghuram Rajan at the 2005 Jackson Hole Symposium (referring to recent changes in financial systems):
  - *…While I think it would be a fair generalization to say that the financial system is more stable most of the time, we may also have the possibility of excessive instability in really bad times (as well as a higher probability of such tail events).*

Contributions of the paper

- Apply new multivariate extreme-value theory (EVT) techniques to banking (bank stock returns)
  - Indicators of contagion and extreme systematic risk
  - Hartmann, Straetmans and de Vries (*RESTAT*, 2004, and, mimeo. 2003), see also Poon, Rockinger and Tawn (*RFS*, 2004)
- Estimate and test changes in banking system risk over time
  - Application of Quintos, Fan and Phillips (*RES*, 2001) to extreme dependence
- Provide cross-country comparisons of banking system risk
  - United States versus euro area
  - Europe: domestic versus cross-border contagion risk
- Literature: See survey by De Bandt and Hartmann (2000) and the version of the paper in the conference folder

Banking system risk - Theory

- Bank contagion (Chen, *JPE*, 1999; Allen and Gale, *JPE*, 2000; Freixas et al., *JMCB*, 2002)
  - Failure of a bank causes failures of other banks
  - Through physical exposures (payment system, money and derivatives markets)
  - Through signal extraction problems of creditors
  - Maybe even through self-fulfilling prophecies
- Shocks affecting banks simultaneously
  - Many banking crises associated with cyclical downturns and/or popping asset price bubbles (Gorton, *OxEcPap*, 1988)
  - Aggregate or systematic shocks reducing asset values while deposit contract is not contingent (Hellwig, *EER*, 1994)
- Equity returns, as many factors not observable

Indicators of banking system risk

- <u>"Contagion risk" or extreme spillover risk measure</u>

$$P_{N|L} = P\left\{\bigcap_{i=1}^{N} X_i > Q_i(p) \,\middle|\, \bigcap_{j=1}^{L} X_j > Q_j(p)\right\} = \frac{P\left\{\bigcap_{i=1}^{N} X_i > Q_i(p)\right\}}{P\left\{\bigcap_{j=1}^{L} X_j > Q_j(p)\right\}}$$

- <u>"Extreme systematic risk" measure ("tail-β")</u>

$$P_{k|M} = P\left\{X_k > Q_k(p) \,\middle|\, X_M > Q_M(p)\right\} = \frac{P\left\{X_k > Q_k(p), X_M > Q_M(p)\right\}}{P\left\{X_M > Q_M(p)\right\}}$$

(See Straetmans, Verschoor and Wolff, 2003)

Estimations

- Estimation of both measures with a generalization of Ledford and Tawn (*Biometrika*, 1996)
- Bivariate semi-parametric EVT approach
- We extend to multivariate dependence

$$P\left\{\bigcap_{i=1}^{N} X_i > Q_i(p)\right\} = P\left\{\bigcap_{i=1}^{N} \tilde{X}_i > q\right\} = P\left\{\min_{i=1}^{N}\left(\tilde{X}_i\right) > q\right\} \approx q^{-\frac{1}{\eta}}$$

- Using Fundamental Theorem of EVT and regular variation
- Tail dependence parameter η can be estimated according to the Hill (1975) approach
- $\eta \xrightarrow{d} N(0,1)$

Tests

- Time variation of indicators/asymptotic dependence
  - Quintos, Fan and Phillips (*RES*, 2001) structural stability test
  - GARCH-robust recursive test detecting the most significant break point for η across the sample (block bootstrapped)
  - Compares estimates of η for sub-samples to the estimate for the whole sample, finding the supremum (most likely break point)
  - Quintos et al. provide critical values
- Cross-sectional variation of indicators/asymptotic dependence
  - Asymptotic normality of the Hill estimator allows us to apply standard T-tests of the differences between dependence parameters η for different cross-sections of banks (say US versus euro area)
  - Block bootstrapped standard errors to account for volatility clustering (GARCH robust)

Data

- 25 banks for the euro area and United States, respectively
- Stock prices, indices and yield spreads taken from Datastream
- Daily excess returns, using 3-month LIBOR
- Sample: April 1992 to February 2004 (EA spreads 98-04)
- ca. 3,100 daily return observations per bank (Appendix D)
- Banks chosen according to 1) size and 2) interbank activity
- Balance sheet data from Bankscope and Fed Chicago 1992 to 2003 (Appendices B and C)
- Short time span explained by data availability for European banks (public ownership, bank mergers etc.)
- Bank stock crashes considered: Historically large, at sample boundary and beyond (Tables 1 and 2)

Contagion risk estimates and tests

- Euro area: Domestic versus cross-border contagion risk
  - Table 3: *Estimation* (only sub-set of many possibilities)
  - Domestic spillover probabilities in most cases larger
  - Some small countries unlikely to be affected
  - Table 4: *Tests*
  - Among Dutch, French, German and Spanish banks no significant difference between domestic and cross-border contagion risk
  - For smaller countries (Finland, Greece, sometimes also Ireland and Portugal), cross-border spillovers are statistically weaker
- Cross-Atlantic comparison
  - Use tail dependence parameter (table 5): η_{EU}=0.17 and η_{US}=0.39
  - Test: Difference highly significant, T=7.25
  - But US similar to η_{FR}=0.42, η_{GE}=0.48, η_{IT}=0.62
  - Integration story

Evolution of contagion risk

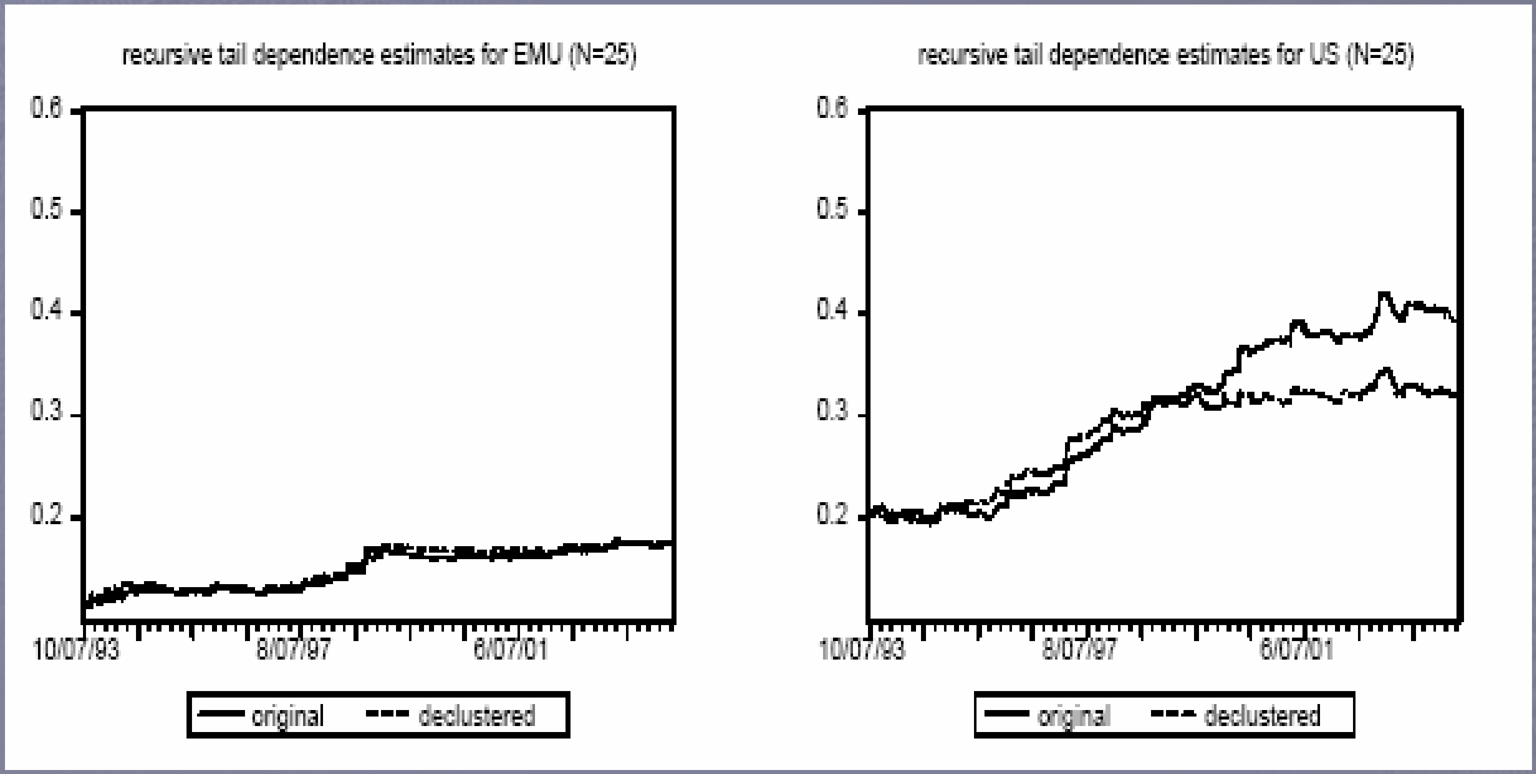
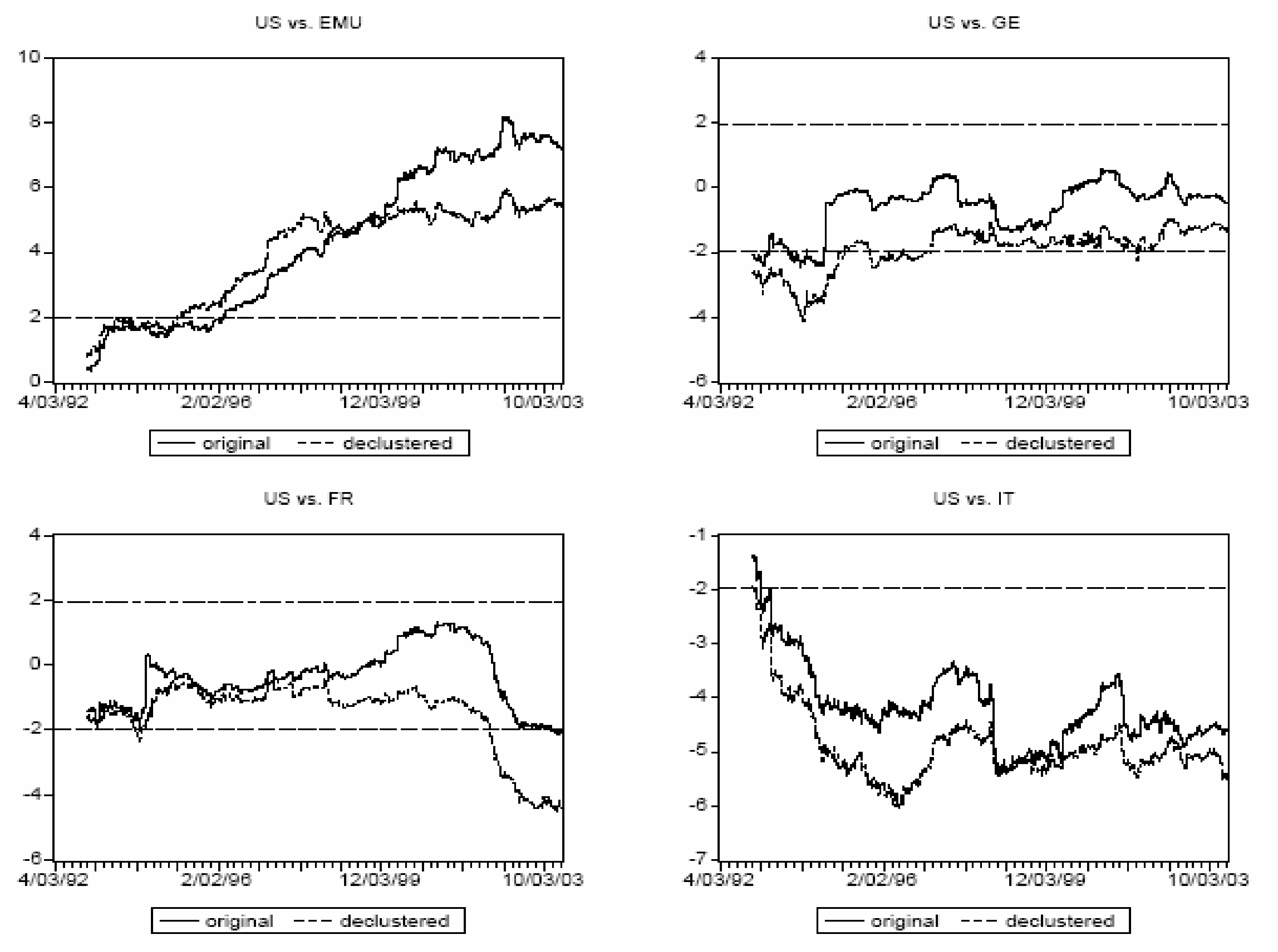


Table 10

Break euro area May 1996:
$\eta^{EA}{}_{T1}$=0.13, $\eta^{EA}{}_{T2}$=0.20;
No further increase with euro, decline if anything

Break US November 1995:
$\eta^{US}{}_{T1}$=0.20, $\eta^{US}{}_{T2}$=0.41
(De Nicolo and Kwast, 2002: Break US 1996f.)

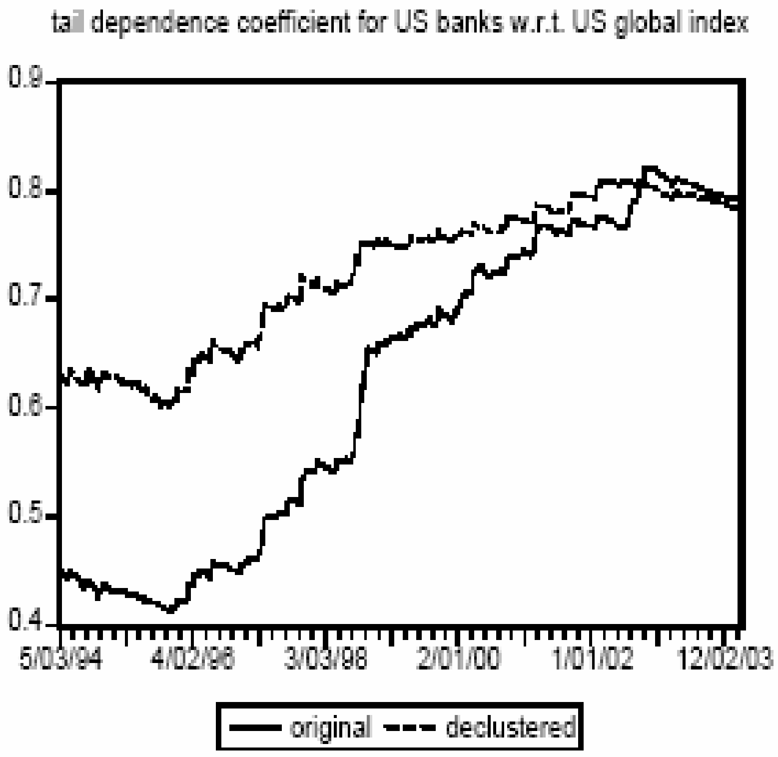
Differences of contagion risk over time

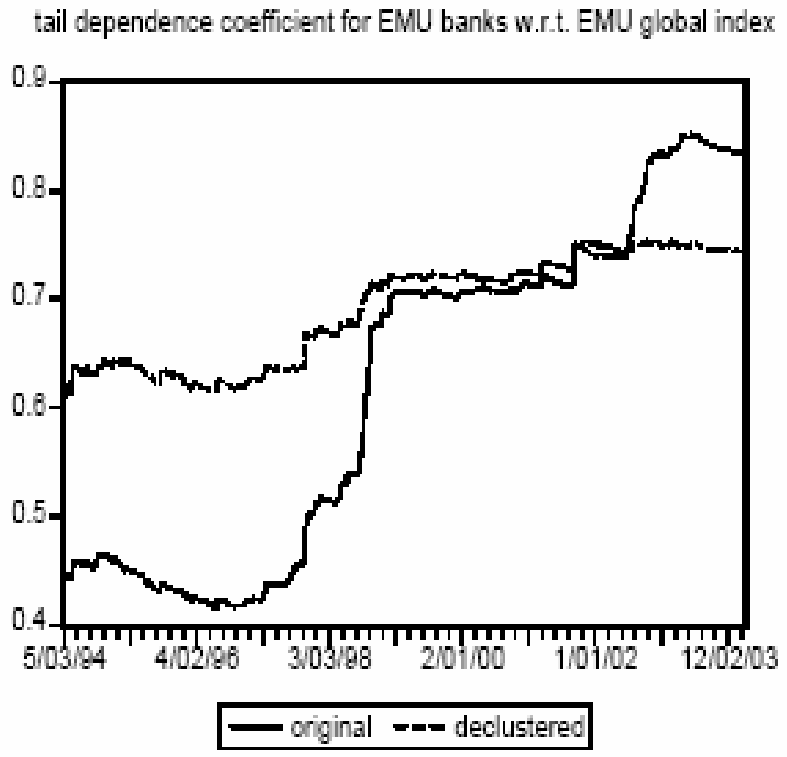


Extreme systematic risk estimates and tests

- Tail-βs for stock indices, bank indices and yield spreads
- Yield spreads don't work: No good measure of extreme systematic risk in the banking system
- Tables 6 and 7: *Estimates* for stock indices
  - Europe: Berliner Bankgesellschaft 2%, ING 46%
  - US: Unionbancal 4%, Citigroup 27%
  - On average, similar tail-βs (table 8); Europe more diverse
  - Larger, more diversified banks have higher tail-βs
  - Smaller, more regional banks are less exposed to area-wide shocks
- Tables 11 and 12: *Tests*
  - Basically, all βs increase
  - Euro area: Breaks around (1996-) 1997
  - US: Breaks around 1995-1997 (de Nicolo and Kwast, 2002, no break)

Evolution of extreme systematic risk





Conclusions 1

- Overall multivariate extreme spillover risk among US banks higher than between euro area banks
- Within euro area countries comparable to the US
- But cross-border extreme spillover risk estimated to be lower than domestic risk
- But for large banks in “center” countries the difference between domestic and cross-border is not significant
- For some “periphery” country banks the difference is significant (similarly Italian banks)
- Extreme systematic risk between US and euro area banks is similar
- High-yield bond spreads do not perform well as an indicator of extreme systematic risk

Conclusions 2

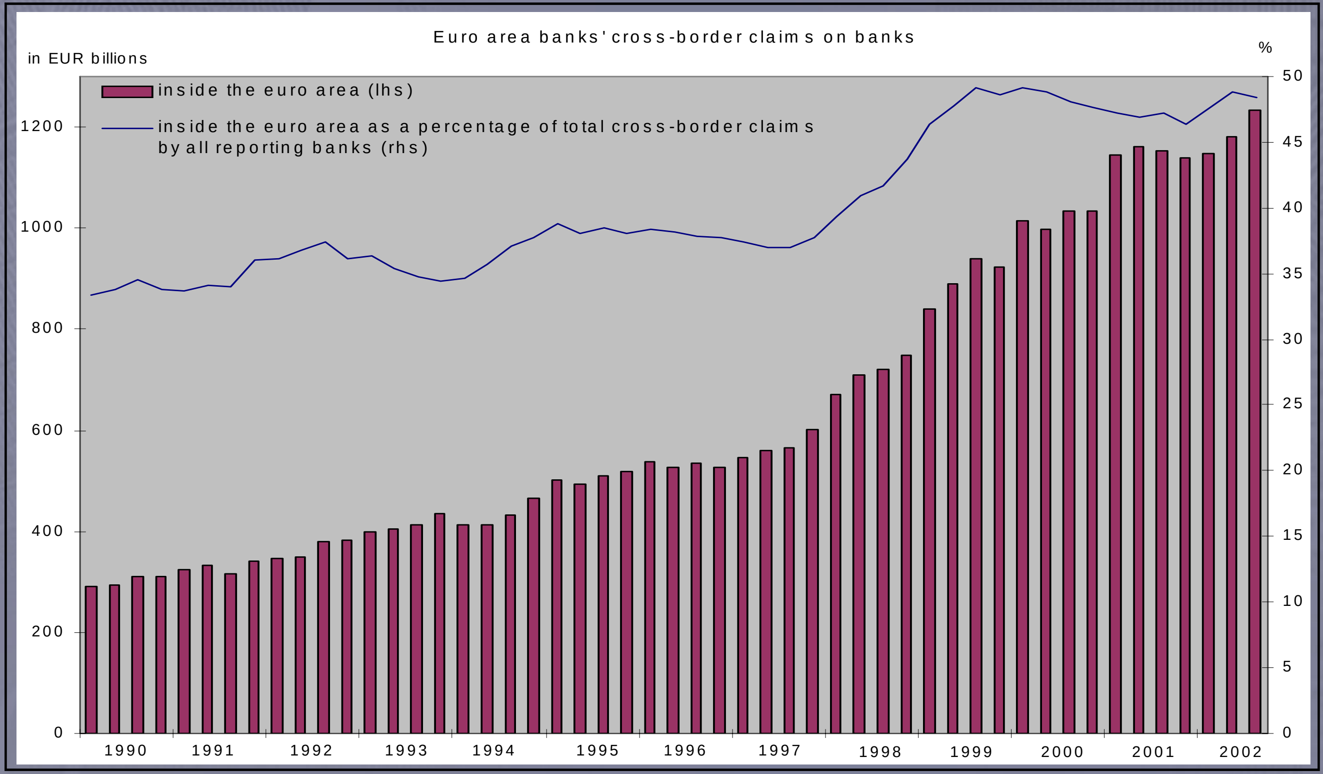
- Systemic risk, both extreme systematic and spillover risk, seems to be increasing in the euro area and the United States (but in the literal sense very low probability still)
- Changes are gradual but somewhat stronger in the US (statistical breaks during the second half of the 1990s)
- But we don't find an additional EMU upward break
- Effects of financial integration ambiguous in theory
- Need to be monitored, e.g. as the integration of banking markets may make Europe more similar to the US
- Importance for cross-border macro-prudential surveillance
- Results also some input in the ongoing debate about future supervisory structures in Europe (beyond Lamfalussy Committees)

Your safe place to be ...

… this is the end.

Interbank market

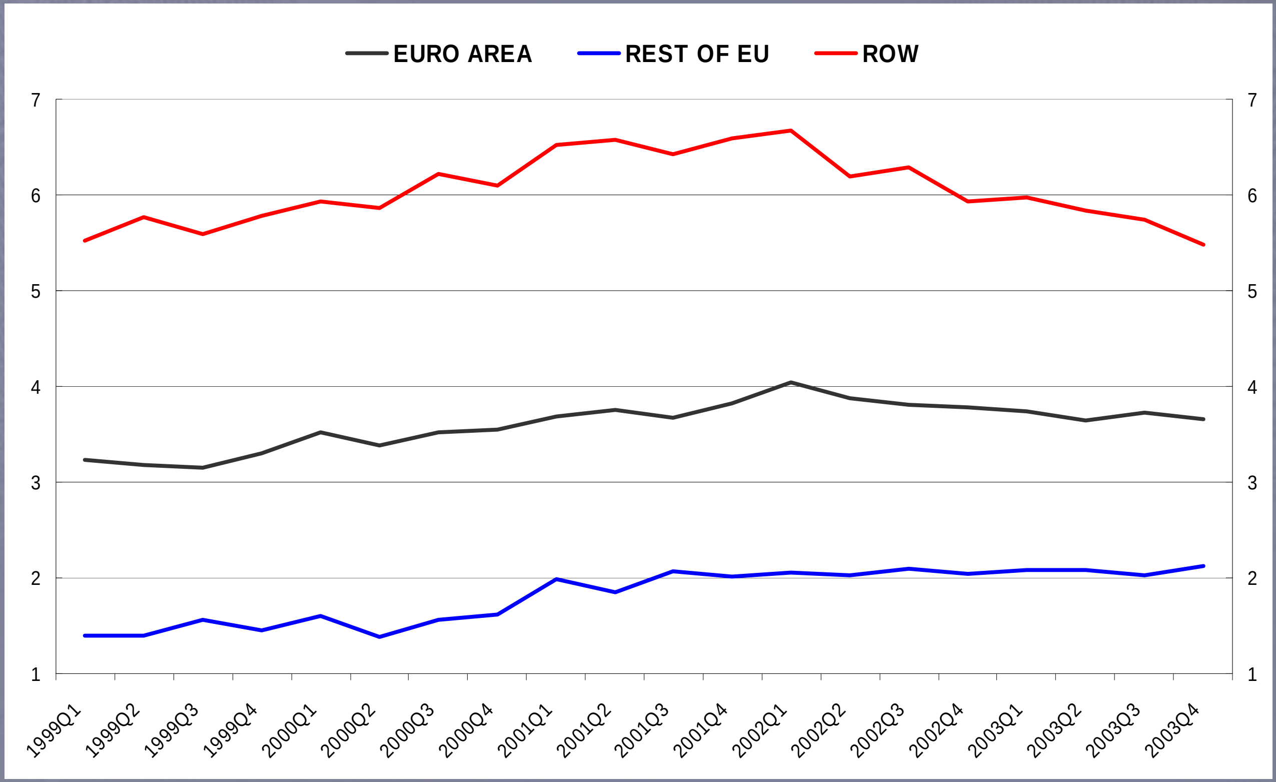
Euro-area cross-border interbank lending



Source: Gaspar, Hartmann and Sleijpen (2003), building on Galati and Tsatsaronis (2001) and BIS data

Corporate loan market

Cross-border loans to non-banks (in % of domestic loans)



Source: Update from Hartmann, Maddaloni and Manganelli (Oxford Review of Economic Policy, 2003), using ECB data