Systemic Risk in European Banking - Evidence from Bivariate GARCH Models

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Motivation

- Systemic risk as one of the main reasons for regulation and supervision of the banking market.
- In Europe: still supervision at the national level.
- EU-wide systemic risk would call for a reform of the European supervisory system.
- Many theoretical studies on systemic risk.
- However, hardly any empirical work - at least not for Europe.

Systemic risk in the banking market

- In general, the banking sector is viewed more vulnerable to contagion than other industries.
- No uniform definition of systemic risk in the literature.
- Different channels through which systemic risk can occur in banking (concept of systemic risk):
  - Macro shock can simultaneously have adverse effects on several banks.
  - Contagion in the banking market (micro channel)
    - ⇒exposure channel
    - ⇒information channel
- In this paper, focus on the micro channel.

Correlations of bank stock returns as a measure of systemic risk

- De Nicolo and Kwast (2002): estimation of the systemic risk potential using a measure of the interdependencies of financial institutions.
- For an economic shock to become systemic a negative externality must exist.
- Only if banks are interdependent such an externality exists, i.e. there is the threat of systemic risk.
- Correlations of bank stock returns as a measure for interdependencies.
- International context => controlling for common factors

The bivariate GARCH model (1)

Excess returns of the bank stock indices (r_{B1} and r_{B1}):

$$r_{B1}(t) = a_1 + b_1 \cdot r_{M1}(t) + c_1 \cdot is_1(t) + \delta_1 \cdot r_{B1}(t-1) + \varepsilon_1(t)$$

$$r_{B2}(t) = a_2 + b_2 \cdot r_{M2}(t) + c_2 \cdot is_2(t) + \delta_2 \cdot r_{B2}(t-1) + \varepsilon_2(t)$$

The residuals are assumed to follow a bivariate distribution with variance covariance matrix:

$$\Phi(t) = \begin{pmatrix} \sigma^2_{B1}(t) & \sigma_{B1,B2}(t) \\ \sigma_{B1,B2}(t) & \sigma^2_{B2}(t) \end{pmatrix}$$

The bivariate GARCH model (2)

Time varying variances: GARCH(1,1)-process

$$\sigma_{B1}^2(t) = \alpha_1 + \beta_1 \cdot \sigma_{B1}^2(t-1) + \gamma_1 \cdot \varepsilon_1^2(t-1)$$

$$\sigma_{B2}^2(t) = \alpha_2 + \beta_2 \cdot \sigma_{B2}^2(t-1) + \gamma_2 \cdot \varepsilon_2^2(t-1)$$

Covariances:

$$\sigma_{B1,B2}(t) = corr \cdot \sigma_{B1}(t) \cdot \sigma_{B2}(t)$$

Testing for changes in correlations (1)

- Non-parametric test: Bera/Kim (2002)
  - Test the assumption of the constancy of correlation
  - First insights into the stability of the correlations
  - Test based on the standardised residuals

- Parametric tests: ...

Testing for changes in correlations (2)

- Parametric tests:
  - Structural break test:

    Include two dummy variables in the covariance equation (2nd banking directive 1993; start EMU 1999)

$$\sigma_{B1,B2}(t) = [corr1 + corr2 \cdot du1(t) + corr3 \cdot du2(t)] \cdot \sigma_{B1}(t) \cdot \sigma_{B2}(t)$$

  - Test the hypothesis of a gradual increase of the correlations:

    Include a linear time trend in the covariance equation

$$\sigma_{B1,B2}(t) = [corr4 + corr5 \cdot t] \cdot \sigma_{B1}(t) \cdot \sigma_{B2}(t)$$

Estimation method and data

- Quasi- or Pseudo Maximum Likelihood estimation
- 13 European countries (Greece and Luxembourg dropped)

=> 78 bivariate GARCH estimations

- Weekly (since 1990) and monthly (since 1980) estimations

Empirical results:
Testing conditional correlation constancy (1)

- Rejection of the null of constancy of the conditional correlations in only
  - 7 of the 78 cases (= ca. 9%) for the weekly sample
  - 24 of the 78 cases (= ca. 31%) for the monthly sample

- Bera/Kim of minor importance for our analysis:
  - A rejection of the null does not tell us in which direction the correlations changed.
  - Non-parametric test against an unspecified alternative

Empirical results:
Testing conditional correlation constancy (2)

=> power against specified alternatives (parallel shift, time trend) might be relatively low

=> Parametric tests (structural break test; estimation of a time trend in the correlations) can give more information about the changes in the systemic risk potential

Empirical results:
Testing for structural breaks (1)

	significant positive	*positive, but insignificant*	*significant negative*	*negative, but insignificant*
			weekly	
corr1	8	29	2	16
corr2 (structural break in 1994)	15	29	1	10
corr3 (structural break in 1999)	11	25	3	16
Wald test[3]	20	35		
			monthly	
corr1	17	37	3	21
corr2 (structural break in 1994)	23	44	0	11
corr3 (structural break in 1999)	10	37	2	29
Wald test[2]	33	45		

Empirical results:
Testing for structural breaks (2)

- Weekly regressions:
  - corr2 (2nd banking directive):
    - ⇒significantly positive in 15 out of 55 (= 27.3%)
    - ⇒only in one case significantly negative
  - corr3 (start EMU)
    - ⇒significantly positive in 11 out of 55 (= 20%)
    - ⇒significantly negative in 3 cases
  - jointly significant different from zero in 20 regressions (= 36.4%)

Empirical results:
Testing for structural breaks (3)

- Monthly regressions:
  - corr2 (2nd banking directive):
    - ⇒significantly positive in 23 out of 78 (= 29.5%)
    - ⇒in no single case significantly negative
  - corr3 (start EMU)
    - ⇒significantly positive in 10 out of 78 (= 12.8%)
    - ⇒significantly negative in 2 cases
  - jointly significant different from zero in 33 regressions (= 42.3%)

Empirical results:
Testing for a trend in correlations (1)

	significant positive	*positive, but insignificant*	*significant negative*	*negative, but insignificant*
			weekly	
corr4	63	11	0	4
corr5 (linear trend)	30	32	0	16
			monthly	
corr4	54	22	0	2
corr5 (linear trend)	29	40	0	9

Empirical results:
Testing for a trend in correlations (2)

- Weekly regressions:
  - linear time trend:
    - ⇒significantly positive in 30 out of 78 (= 38.5%)
    - ⇒insignificantly positive in 32 cases
    - ⇒in no single case significantly negative
- Monthly regressions:
  - linear time trend:
    - ⇒significantly positive in 29 out of 78 (= 37.2%)
    - ⇒insignificantly positive in 40 cases
    - ⇒in no single case significantly negative

Empirical results:
Testing for a trend in correlations (3)

=> Correlations between bank stock index returns of European countries have increased significantly over the last 10 and 20 years.

=> Further evidence that the systemic risk potential in the EU banking market has increased over time.

Empirical results:
Comparison non-parametric and parametric test

Cases	*Weekly regressions*	*Monthly regressions*
1a: Bera and Kim significant, shifts and/or trend significant	5	16
1b: Bera and Kim not significant, shifts and trend not significant	33	26
2: Bera and Kim significant, shifts and trend not significant	2	8
3: Bera and Kim not significant, shifts and/or trend significant	38	28
Sum	78	78

Conclusions (1)

- Has the systemic risk potential increased over time?
- Conditional correlations between pairs of national bank stock indices (estimated using a bivariate GARCH-model) as a measure for systemic risk. Non-parametric and parametric tests to asses the changes in correlelations.
- Many correlations exhibit significant upward changes over time either as parallel shifts at the two specified dates (completion of the single banking market; introduction of the Euro) or as linear time trends.

Conclusions (2)

- Evidence of an ongoing integration process in the EU banking business which leads to growing similarities in the international economic factors that drive the profits of the banks.
- Evidence for an increase in the systemic risk potential in the EU banking market.