Bank Distress During the Credit Crisis: Contagion, or Common Shocks?

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— work in progress, comments welcome! —

Motivation (1)

"The provision of [...] liquidity support undermines the efficient pricing of risk by providing *ex post* insurance for risky behaviour. That encourages excessive risk-taking, and sows the seeds of a future financial crisis."

Mervyn King, Governor of the Bank of England
12 September 2007

Motivation (2)

- Despite this insight, fiscal and monetary authorities engaged in large scale rescue operations of financial intermediaries:
  - provision of emergency liquidity assistance
  - extension of deposit insurance
  - quantitative and qualitative monetary easing
  - purchase of 'troubled' assets
  - capital injections
  - nationalisations
  - ...
- Authorities this way aimed to protect depositors and avoid *contagion* (BIS 2009, p.24)

Motivation (3)

- Empirical research shows that banks indeed become unstable simultaneously:
  - autocorrelation in bank failures after controlling for macro-economic factors
  - reaction of banks' stock prices to adverse events
  - correlation between banks' stock returns
  - tail-correlation between banks' stock returns
  - decomposition of system-wide Value at Risk measures
  - ...
- But this correlation does not imply contagion, with instability of one bank *causing* the instability of another

Motivation (4)

- A smaller literature finds limited evidence for such contagion:
  - Calomiris & Mason (1997): banks fail primarily due to common asset value shocks
  - Aharony & Swary (1983): bank failures do not affect other banks' stock prices when they are due to bank-specific factors
  - Kho, Lee & Stulz (2002): stock markets distinguish between exposed and non-exposed banks when a crisis event occurs
  - Van Lelyveld & Liedorp (2006): limited potential for contagion through bilateral exposures on the interbank market
  - Taylor (2009): turmoil after the Lehman failure merely reflected uncertainty about government safety nets
- We aim to disentangle the impact of common shocks and contagion on banks' asset values during the crisis

Method (1)

- We define interbank contagion as the default of bank k causing bank i to suffer a loss:
  - from bilateral exposures on k (Allen and Gale 2000; Freixas, Parigi and Rochet 2000)
  - from write-downs induced by bank k's fire-sales (Brunnermeier *et al.* 2009, Wagner 2010)
  - from premature asset liquidation due to bank runs triggered by confidence effects from k's failure(Chen 1999)
  - from feedback effects due to a credit crunch in the real economy (Ashcraft 2005)
  - ...
- These actual losses are hard to observe, but bank i's observed market value reflects the *expected* losses from a default of k

Method (2)

- The expected losses from bank k's default are equal to the actual losses if k defaults, multiplied by the probability PD_k that this default occurs

- We thus model changes in bank i's market value as

$$\Delta V_{it} = \alpha_i + \beta_i M_t + \sum_{k \neq i}^{N} \gamma_{ik} \Delta PD_{kt} + \epsilon_{it},$$

  - market factor M_t reflects common asset value shocks
  - default probability PD_{kt} reflects contagion from k to i
  - idiosyncratic factor ϵ_{it} reflects bank-specific shocks

- $\gamma_{ik} \Delta PD_{kt}$ indicates the change in the expected loss for bank i associated with contagion from k's potential future default

Method (3)

- We use the expression for ΔV_{jt} to substitute M_t out of the expression for ΔV_{jt}, which yields:

$$\begin{aligned} \Delta V_{i,t} &= \alpha_{ij} + \beta_{ij}\Delta V_{j,t} + \gamma_{ij}\Delta PD_{j,t} + \epsilon_{ij,t} \\ &\quad + \sum_{k \neq j}^{N} \delta_{ik}\Delta PD_{k,t}, \end{aligned}$$

  - β_{ij} indicates *correlation* between i and j's asset values
  - γ_{ij} indicates *contagion* from j to i
  - δ_{ik} for control variables is a function of β_{ij} and γ_{jk}

- We estimate separate regressions for all i, j bank pairs
- Rescue operations do not lead to underestimation of γ_{ij}

Data description (1)

- We calculate changes in asset values as

$$\Delta V_{it} = \Delta V_{it}^{E} + \Delta V_{it}^{D} \approx \Delta V_{it}^{E},$$

where V_{it}^{E} and V_{it}^{D} are market values of equity and debt

- We calculate changes in default probabilities as

$$\Delta PD_{it} = \Delta \mathcal{N}\left(-DD_{it}\right) \approx 0.5\Delta e^{-1/\sigma_{i,t+1}^{E}},$$

where $\sigma_{i,t+1}^{E}$ is the expected standard deviation of future equity returns, estimated using GARCH (see Byström, 2006)

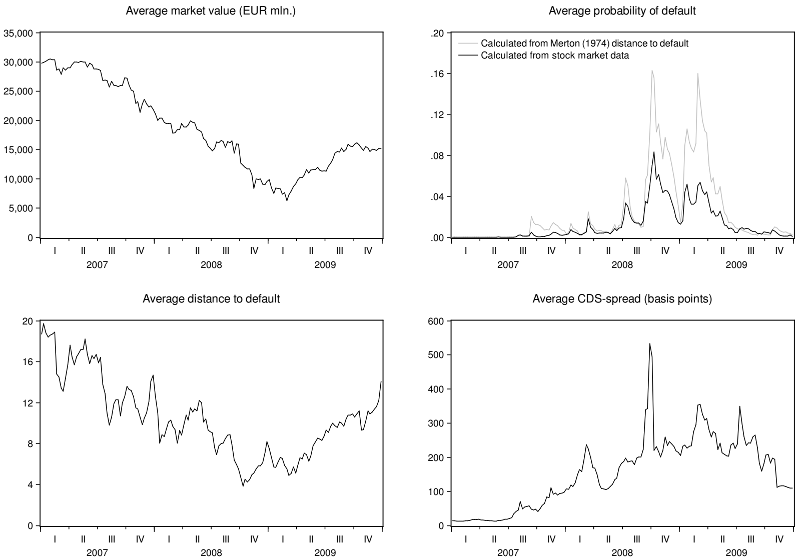
- We also calculate the change in default risk as the change in CDS-spreads, i.e. ΔCDS_{it}

Data description (2)

- Sample period from January 2007 to January 2010
- Weekly data to reduce sensitivity to noise and time-lags
- 96 largest banks in US (25%), EU15, Iceland, Norway, and Switzerland (in terms of market capitalisation at 2007M01)
- Largest bank: Citigroup (US) V^E = EUR 205 bln.
- Smallest bank: UCBH Holdings (US) V^E = EUR 1.25 bln

- ΔV and ΔPD are calculated from stock market data
- ΔCDS is the 5-year CDS-spread on senior debt (55 banks)

Data description (3)



Empirical analysis (1)

Table: Results from ordinary least squares regressions

$$\frac{\Delta V_{i,t}}{V_i^{max}} = \alpha_{ij} + \beta_{ij}\frac{\Delta V_{j,t}}{V_j^{max}} + \gamma_{ij}\frac{\Delta PD_{j,t}}{PD_j^{max}} + \epsilon_{ij,t} + controls$$

	Model with ΔPD	Model with ΔCDS
Correlation between i and j		
Average of all estimates	0.34	0.29
Frequency of t-stat(β_{ij}) > 1.645	0.84	0.76
Average estimate when t-stat(β_{ij}) > 1.645	0.38	0.35
Contagion from j to i		
Average of all estimates	0.00	-0.01
Frequency of t-stat(γ_{ij}) < -1.645	0.12	0.08
Average estimate when t-stat(γ_{ij}) < -1.645	-0.10	-0.25
Frequency that no-contagion model cannot be rejected	0.43	0.35

Empirical analysis (2)

Table: Results from nonlinear least squares regressions

$$\frac{\Delta V_{i,t}}{V_i^{max}} = \alpha_{ij} + \beta_{ij}\frac{\Delta V_{j,t}}{V_j^{max}} + \gamma_{ij}\frac{\Delta PD_{j,t}}{PD_j^{max}} + \epsilon_{ij,t} + controls, \text{ with } \gamma_{ij} < 0$$

	Model with ΔPD	Model with ΔCDS
Correlation between i and j		
Average of all estimates	0.32	0.28
Frequency of t-stat$(\beta_{ij}) > 1.645$	0.83	0.73
Average estimate when t-stat$(\beta_{ij}) > 1.645$	0.37	0.34
Contagion from j to i		
Average of all estimates	0.00	-0.06
Frequency of t-stat$(\gamma_{ij}) < -1.645$	0.12	0.09
Average estimate when t-stat$(\gamma_{ij}) < -1.645$	-0.10	-0.25
Frequency that no-contagion model cannot be rejected	0.55	0.45

Empirical analysis (3)

Table: Results from nonlinear least squares regressions for ΔPD

$$\frac{\Delta V_{i,t}}{V_i^{max}} = \alpha_{ij} + \beta_{ij}\frac{\Delta V_{j,t}}{V_j^{max}} + \gamma_{ij}\frac{\Delta PD_{j,t}}{PD_j^{max}} + \epsilon_{ij,t} + controls, \text{ with } \gamma_{ij} < 0$$

	Average of correlation estimates	Frequency of t-stat(γ_{ij}) < -1.645	Rejection freq. no-contagion model
Full sample	0.32	0.12	0.55
Sub-samples based on geography			
j from US, i from US	0.45	0.10	0.58
j from US, i from EU	0.27	0.17	0.59
j from EU, i from EU	0.35	0.11	0.57
j from EU, i from US	0.25	0.09	0.47
Sub-samples based on size			
j is large, i is large	0.45	0.14	0.46
j is large, i is small	0.31	0.10	0.66
j is small i is small	0.23	0.11	0.64
j is small i is large	0.30	0.12	0.45

Empirical analysis (4)

Table: Results from nonlinear least squares regressions for ΔCDS

$$\frac{\Delta V_{i,t}}{V_i^{max}} = \alpha_{ij} + \beta_{ij}\frac{\Delta V_{j,t}}{V_j^{max}} + \gamma_{ij}\frac{\Delta CDS_{j,t}}{CDS_j^{max}} + \epsilon_{ij,t} + controls, \text{ with } \gamma_{ij} < 0$$

	Average of correlation estimates	Frequency of t-stat(γ_{ij}) < -1.645	Rejection freq. no-contagion model
Full sample	0.28	0.09	0.45
Sub-samples based on geography			
j from US, i from US	0.37	0.07	0.47
j from US, i from EU	0.23	0.07	0.48
j from EU, i from EU	0.32	0.09	0.51
j from EU, i from US	0.19	0.12	0.27
Sub-samples based on size			
j is large, i is large	0.34	0.08	0.33
j is large, i is small	0.26	0.07	0.63
j is small i is small	0.21	0.15	0.54
j is small i is large	0.22	0.12	0.20

Empirical analysis (5)

- Summary of findings on common asset value shocks:
  - Significant in about 80% of the regressions
  - More important for large banks or banks from the same region
- Summary of findings on interbank contagion:
  - Significant in only 10% of the regressions
  - Not more important for large banks or banks from the same region
  - The no-contagion model is not rejected for about 50% of the regressions
- Apparently, contagion explains only a limited part of banks' declining asset values

Discussion and implications

- If interbank contagion indeed was relatively limited:
  - Financial instability might arise primarily because of common shocks due to balance sheet homogeneity
  - Banks' opacity is more likely to be a problem, causing markets to interpret idiosyncratic shocks as common ones
  - Maintaining financial stability by regulating 'systemic institutions' might be a less fruitful exercise
  - Rescue operations might merely stabilise the system by their signalling effect
- These questions are open to further research