# Financial Linkages, Transparency, and Systemic Risk[1]

Co-Pierre Georg

Deutsche Bundesbank

and

University of Cape Town
Graduate School of Business

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[1] Joint work with Toni Ahnert, Financial Markets Group, London School of Economics and Political Science. The views in this presentation are not necessarily the views of Deutsche Bundesbank or the ESCB.

# The financial system changed over the last few years

Three key developments:

1. More direct linkages (interbank loans, repos, CDS, etc.) amongst financial intermediaries lead to higher **counterparty risk**

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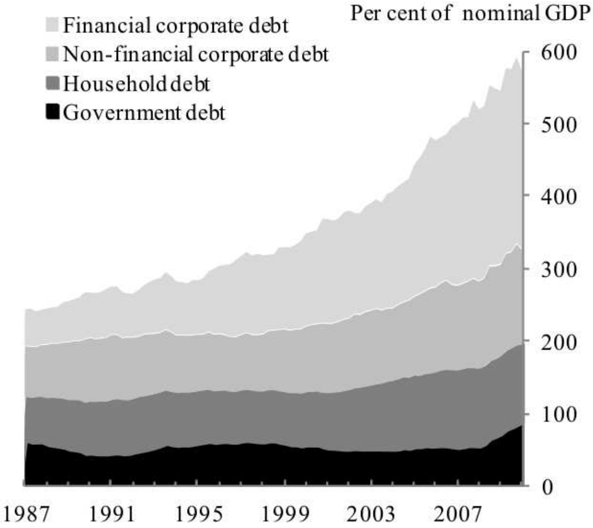


Figure: Decomposition of UK debt. Source: Gai, Haldane and Kapadia (2011).

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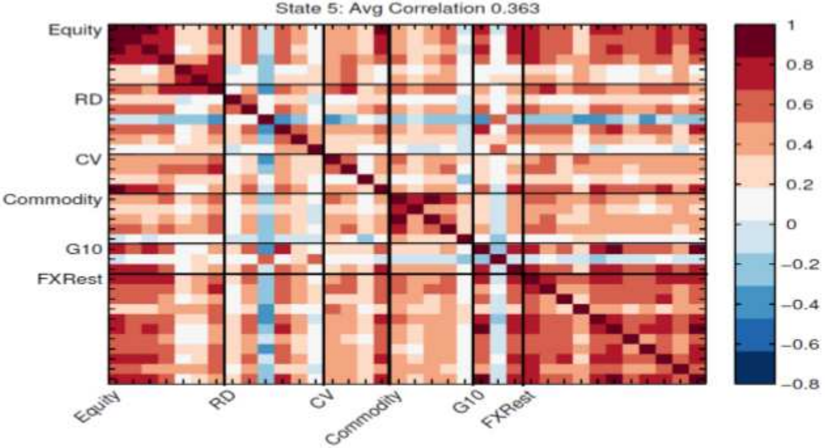


Figure: Correlation of World Assets. Source: Keynote by Ricardo Caballero, FMS 2012

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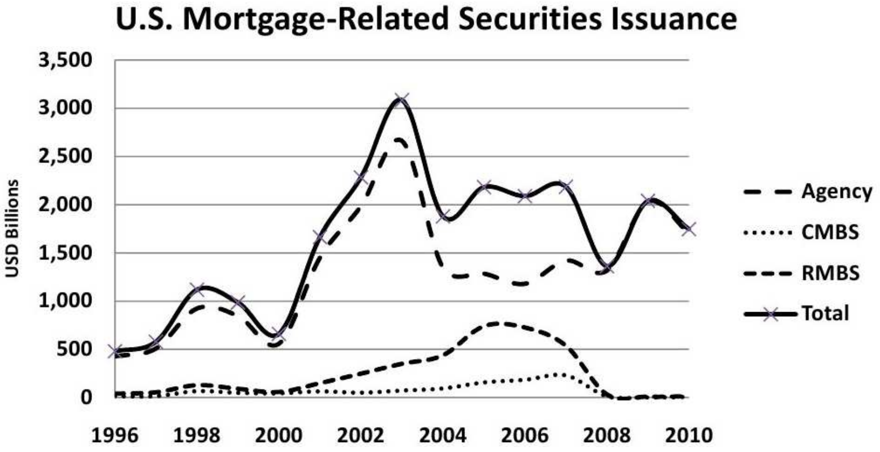


Figure: U.S. Mortgage-Related Securities Issuance. Source: Gorton and Metrick (2010).

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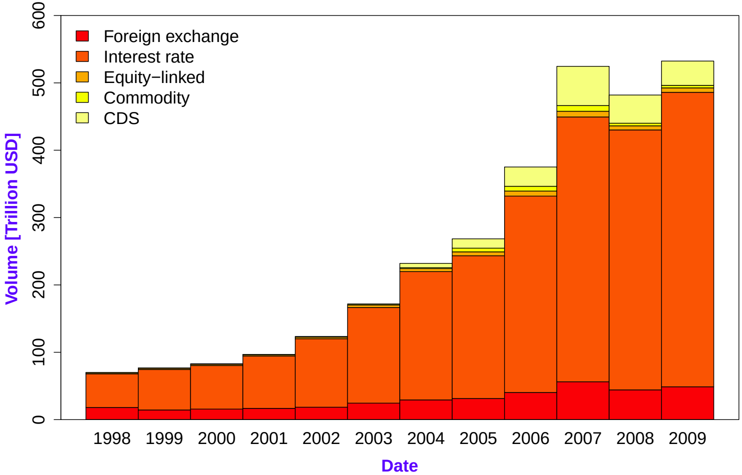


Figure: Global over-the-counter derivatives markets, notional amounts of contracts outstanding. Source: IMF

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**In this paper:**

- existence of a stabilising effect from banks' strategic liquidation decisions on a joint market for liquidity
- analyse the robustness of this effect (counterparty risk, opacity)

# Main results and intuition

- Similar assets are liquidated on a joint market
- Large liquidation volumes lead to depressed prices and assets become illiquid
- Banks facing a joint liquidation market have to take the liquidation decision of other banks into account
- Joint liquidation leads to strategic substitutability in the liquidation decision

Strategic Liquidation $\Rightarrow$ **Stabilising Effect**

- Transparency supports this effect
- Counterparty risk creates strategic complementarity $\Rightarrow$ sufficiency condition for the existence of our effect

# Model: Timing and agents

- Three dates $t = 0, 1, 2$
- Two regions $k = A, B$
- Agents (in each region):
  - Continuum of depositors (e.g. money market fund)
  - A representative bank (e.g. an investment bank)
- **Systemic risk** $\equiv$ joint failure of banks at the interim date
  - Consequences for real economy (e.g. credit crunch, bail-out costs)

# Model: Depositors

- Liquidity preferences
  - uncertainty about liquidity preference at date $t = 0$
  - uncertainty resolved at the beginning of $t = 1$
  - early despositors of mass $\lambda$, late depositors of mass $1 - \lambda$
- Risk averse depositors:

$$U(c_1, c_2) = \begin{cases} u(c_1) & \text{w.p.} \quad \lambda \\ u(c_2) & \text{w.p.} \quad 1-\lambda \end{cases} \tag{1}$$

- Unit endowment
- Store or deposit at bank

# Model: Investment opportunities

1. Storage:
   - risk-free, zero net return
   - one period to maturity
2. Investment project:
   - two periods to maturity
   - bivariate investment return at $t = 2$ (Goldstein and Pauzner (2005))

$$\widetilde{R}_k = \begin{cases} R & \text{w.p. } p(\theta_k) \\ 0 & \text{w.p. } 1 - p(\theta_k) \end{cases}$$

   - success probability p depends on independent regional fundamental $\theta_k$ $(p'(\cdot) > 0)$

# Model: Liquidation costs and fire sales

- Liquidation costs $\widetilde{\beta} \in [0, 1)$ at $t = 1$ (alternative use of resources)
- Liquidation value depends on the liquidation decision in the other region
- Fire sales: $\beta \in \{\underline{\beta}, \overline{\beta}\}$ with $0 \leq \underline{\beta} < \overline{\beta} \leq 1$
  - cash-in-the market pricing, alternative asset use (Shleifer and Vishny (1992))
  - limited market participation (Allen and Gale (1994)))
  - potential buyers not to buy as they expect lower future prices → precautionary and strategic liquidity holding motive (Gale and Yorulmazer (2011))
- Underlying assumption: banks are large
- Joint market for liquidation generates **strategic interaction** between banks

# Model: The bank

- Collects deposits by offering a demand deposit contract ($d_1$) at $t = 0$
  - insurance against idiosyncratic liquidity risk for risk-averse depositors
- Choice of interbank insurance $b \geq 0$ and liquidity $y$ at $t = 0$
- Free entry $\Rightarrow$ maximize depositors expected utility
  - deposit in full at bank
- Bank distribute proceeds equally at $t = 2$ (mutual bank)

# Model: Information structure

- Distribution of independent fundamentals: common knowledge

$$\theta_k \sim U[0,1]$$

- A signal about each region
  - Own region: always fully revealing (learn $\theta_k$)
  - Other region
    - fully revealing (w.p. $q \in [0,1]$), symmetry
    - pure noise (w.p. $1-q$)
- Transparency is any information about the other region's profitability and measured by $q$. Other notions of transparency and opacity:
  - completeness of payment history of other banks in network (Babus (2011))
  - information about own fundamentals (Parlatore Siritto (2011))
  - complexity of the Finanical System (Caballero and Simsek (2011))

# Baseline case

- No interregional liquidity shocks ($\eta = 0$), regional liquidation markets ($\widetilde{\beta} = \beta$)
- Liquidation yields $d_\beta = y + (1-y)\beta$
- Wait

$$\begin{cases} c_2^G \equiv \frac{(1-y)R+(y-\lambda d_1)}{1-\lambda} & \\ & \text{w.p.} \\ c_2^B \equiv \frac{(y-\lambda d_1)}{1-\lambda} & \end{cases} \quad \begin{matrix} p(\theta_k) \\ \\ 1-p(\theta_k) \end{matrix}$$

- Indifference leads to unique signal threshold:

$$\overline{\theta_1} = p^{-1}\left(\frac{u(d_\beta) - u(c_2^B)}{u(c_2^G) - u(c_2^B)}\right)$$

- Focus on essential bank-runs
- Households withdraw if signal is smaller than threshold, hence systemic risk is:

$$SR_1 = (\overline{\theta_1})^2$$

# Joint liquidation - informed case

- Complete information - Nash
- Exogenous uncertainty about bivariate investment return only
- Withdraw

$$d_\beta = \begin{cases} \overline{d}_\beta \equiv y + \overline{\beta}(1-y) & \text{if} \quad \text{other bank survives} \\ \underline{d}_\beta \equiv y + \underline{\beta}(1-y) & \quad\quad \text{other bank fails} \end{cases}$$

$\Rightarrow$ strategic substitutability

- Optimal behaviour characterised by two thresholds $\overline{\theta}_2^{\mathrm{i,D}} < \overline{\theta}_2^{\mathrm{i,N}}$
  - Always wait for good fundamentals ($\theta \geq \overline{\theta}_2^{\mathrm{i,N}}$)
  - Always withdraw for bad fundamentals ($\theta \leq \overline{\theta}_2^{\mathrm{i,D}}$) $\Rightarrow$ If it rains, it pours
  - For interim fundamentals ($\overline{\theta}_2^{\mathrm{i,D}} \leq \theta \leq \overline{\theta}_2^{\mathrm{i,N}}$): **stabilising effect**

# Robustness check 1: interbank contagion

- Regional liquidity shocks...
  - Allen and Gale (2000)
  - negatively correlated across regions
  - constant aggregate liquidity

| probability | region A | region B |
|---|---|---|
| 1/2 | $\lambda_A = \lambda_H \equiv \bar{\lambda} + \eta$ | $\lambda_B = \lambda_L$ |
| 1/2 | $\lambda_A = \lambda_L \equiv \bar{\lambda} - \eta$ | $\lambda_B = \lambda_H$ |

- ...motivate interbank lending $b \geq 0$
  - $t = 0$: agree on an amount of interbank lending
  - $t = 1$: observe the regional liquidity shock and transfer funds
  - $t = 2$: repay funds at rate $\phi > 1$ if solvent
- Direct linkages
  - interbank linkages generate counterparty risk from region $H$ to $L$

# Strategic liquidation and interbank contagion

- In a joint model where both forms of linkages are present, which effect dominates?
- Threshold in $H$ depends on threshold in $L$ (strategic liquidation) and vice versa (strategic liquidation + interbank contagion)
- Strategic liquidation is dominated by interbank contagion, if:

$$\underbrace{\frac{u(c_{2L}^{BN}) - u(c_{2L}^{BD})}{u(\underline{d}_\beta - b) - u(c_{2L}^{BD})}}_{\text{contagion effect in region L}} > \underbrace{\frac{u(\overline{d}_\beta + b) - u(\underline{d}_\beta + b)}{u(\underline{d}_\beta + b) - u(c_{2H}^{B})}}_{\text{fire sale effect in region H}} + \underbrace{\frac{u(\overline{d}_\beta - b(1-\beta\phi)) - u(\underline{d}_\beta - b)}{u(\underline{d}_\beta - b) - u(c_{2L}^{BD})}}_{\text{fire sale effect in region L}}$$

# Robustness check 2: opacity

- Incomplete information - Bayesian Nash
- Exogenous and strategic uncertainty
- Expected utility from withdrawing

$$\mathbb{E}[u(\widetilde{d}_\beta)] = \underbrace{\overline{\theta}^{\text{u}}_{-k} u(\underline{d}_\beta)}_{\text{-k withdraws}} + \underbrace{(1 - \overline{\theta}^{\text{u}}_{-k}) u(\overline{d}_\beta)}_{\text{-k waits}}$$

- Expected utility from waiting

$$p(\theta) u(c_2^G) + [1 - p(\theta)] u(c_2^B)$$

- Unique threshold $\overline{\theta}^{\text{u}}$
- Systemic risk (in the uninformed case)

$$SR_2^u = (\overline{\theta}^{\text{u}})^2$$

# Strategic liquidation and opacity

- Ranking of withdrawal thresholds: $\overline{\theta}_2^{\mathrm{i,N}} > \overline{\theta}^{\mathrm{u}} > \overline{\theta}_2^{\mathrm{i,D}}$
- Consequence for systemic risk $SR_2^u > SR_2^i$

- Overall systemic risk falls with transparency:

$$SR \equiv qSR^{\mathrm{i}} + (1-q)SR^{\mathrm{u}}$$

- **Indirect linkages: more transparency - lower systemic risk**

# Pure interbank contagion and opacity

- Opacity: equate expected utility from withdrawing and waiting $\Rightarrow \overline{\theta}^{u}_{3,L}$
- Contagion exists in the opaque case:

$$\partial\overline{\theta}^{u}_{3,L}/\partial\overline{\theta}_{3,H} > 0$$

- Threshold ranking: $\overline{\theta}^{i,N}_{3,L} < \overline{\theta}^{u}_{3,L} < \overline{\theta}^{i,D}_{3,L}$ (contagion)
- Higher systemic risk in the informed case:

$$SR^{i}_{3} = \overline{\theta}_{3,H}\overline{\theta}^{i,D}_{3,L} > \overline{\theta}_{3,H}\overline{\theta}^{u}_{3,L} = SR^{u}_{3}$$

- **Direct linkages: more transparency - higher systemic risk**

# Conclusion

- Simple model of financial intermediation
  - Transparency, systemic risk
  - Direct and indirect linkages ⇒ Transparency and linkages jointly determine systemic risk
  - Implications for policy: transparency regulation

- Stabilising effect from joint acces to liquidation market for interim solvency shocks
- Pure interbank contagion can offset this effect ⇒ condition for the existence of our effect in a joint model
- Transparency amplifies the effect

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**Thank you!**

# Backup (i): Pure interbank contagion - region H

- Regions are asymmetric: contagion from $H$ to $L$
- Region H first
- Withdraw: $y + \beta(1-y) + b$
- Wait:

$$\begin{cases} c_{2H}^{G} \equiv \frac{(1-y)R + y - \lambda_H d_1 - (\phi-1)b}{1-\lambda_H} & \text{w.p.} \quad p(\theta_H) \\ c_{2H}^{B} \equiv \frac{y - \lambda_H d_1 - (\phi-1)b}{1-\lambda_H} & \phantom{\text{w.p.}} \quad 1 - p(\theta_H) \end{cases}$$

- Threshold $\overline{\theta}_{3,\mathrm{H}}$:

$$\overline{\theta}_{3,\mathrm{H}} \equiv p^{-1}\left(\frac{u(d_\beta + b) - u(c_{2H}^{B})}{u(c_{2H}^{G}) - u(c_{2H}^{B})}\right)$$

# Backup (ii): Pure interbank contagion - Region L

- Region $L$
- Withdraw

$$\begin{cases} y + (1-y)\beta - b + b\phi\beta & \text{bank in } H \text{ survives} \\ & \text{if} \\ y + (1-y)\beta - b & \text{bank in } H \text{ fails} \end{cases}$$

- Wait:

$$\widetilde{c}_{2L} \equiv \frac{(1-y)\widetilde{R} + y - \lambda_H d_1 - b + \phi\widetilde{b}}{1-\lambda_H}$$

- Thresholds $\overline{\theta}^{\mathrm{i,N}}_{\mathrm{3,L}} < \overline{\theta}^{\mathrm{i,D}}_{\mathrm{3,L}}$ depend upon survival of bank in $H$ $\Rightarrow$ **Contagion**
- Systemic risk:

$$SR_3 = \overline{\theta}_{\mathrm{3,H}}\overline{\theta}^{\mathrm{i,D}}_{\mathrm{3,L}}$$