The Market for OTC Derivatives

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over-the-counter (OTC) credit derivatives

- Large volume of bilateral trades between lots of banks
  creating an intricate liabilities linking all banks

- Gross notionals are highly concentrated in large banks
  worldwide, about 80% of gross notional held by 14 large banks

- Concentration arises from specific patterns of entry and participation
  large banks participate a lot, intermediating lots of trades
  middle-sized banks participate less, mostly as customer
  small-sized banks do not participate
what we do

A parsimonious equilibrium model of entry and trade in an OTC market

• Positive question: friction(s) \(\Rightarrow\) observed market structure?
  
  bilateral trade patterns: linkages btw institutions and prices
  
  entry patterns:
    why do large banks become intermediaries?
    why do middle-sized banks become customers?

• Normative question: can planner or policy maker do better?
  
  inefficiencies arise at the entry stage
  
  the market is too concentrated in large banks
some related literature

• Search-and-matching models of OTC markets
  Duffie Gârleanu Pedersen (05), Afonso Lagos (12)

• Formation and stability of financial networks
  Rochet Tirole (96), Allen and Gale (00), Babus (09)

• CDS markets
  Bolton and Oehmke (12,13), Biais, Heider, and Hoerova (12)
the economic environment
preference and endowment

• Unit continuum of identical CARA agents called “traders”

• Traders are organized in large coalitions called “banks”

• Banks differ in size
  size: measure of traders in the coalition
  the distribution of bank sizes: $S \sim f(S), \int_0^\infty Sf(S)\,dS = 1$

• Banks differ in endowment of non-tradeable risky tree
  $\omega \in [0, 1]$ trees per trader, $\omega \times S$ for the bank
  $\omega \sim U_{[0,1]}$ in banks’ cross-section, independent from $S$
  each share of the tree has random payoff $1 - D$
  $D$ is the same same for all banks $= \text{aggregate default risk}$
Timing

- **Entry**
  
  Each bank receives its endowment \( \omega \in [0, 1] \) per trader.
  
  Chooses whether to pay a fixed cost to enter the OTC market.

- **OTC market trading**
  
  Traders from all participating banks are matched.
  
  Sign derivative contracts (CDS) subject to trade size limit.

- **Consolidation and payoff**
  
  Each bank consolidates the contracts signed by all its traders.
  
  Loan portfolios and contracts payoff.
• **Entry**

  each bank receives its endowment $\omega \in [0, 1]$ per trader
  chooses whether to pay a **fixed cost** to enter the OTC market

• **OTC market trading**

  traders from all participating banks are matched
  sign derivative contracts (CDS) subject to **trade size limit**

• **Consolidation and payoff**

  each bank consolidates the contracts signed by all its traders
  loan portfolios and contracts payoff
“Traders are specifically hired to take financial risk for the firms gain. Assigning risk limits for each trader is the key control that, when aggregated with all trader limits, ensures that the firms overall market risk remains tolerable. When traders exceed their limits, they are going rogue and exposing the firm to higher market risks than management intended.”

09/18/13, WSJ, Stephen R. Etherington
OTC market trading, after entry
period one: OTC market opens

- Each trader matches with a trader from some other bank
- When a bank-$\omega$ trader matches with a bank-$\tilde{\omega}$ trader, they bargain
- Trader $\omega$ sells $\gamma(\omega, \tilde{\omega})$ CDS contracts to trader $\tilde{\omega}$
  - each CDS contract promises the state-contingent payment $D$
  - in exchange for fixed payment $R(\omega, \tilde{\omega}) = \text{the price}$
- Trade size limit: $\gamma(\omega, \tilde{\omega}) \in [-k, k]$  
  - common risk management practices
period one: OTC market opens

- Each trader matches with a trader from some other bank

- When a bank-ω trader matches with a bank-ω̃ trader, they bargain

- Trader ω sells γ(ω, ω̃) CDS contracts to trader ω̃
  
  each CDS contract promises the state-contingent payment \( D \)
  
  in exchange for fixed payment \( R(ω, ω̃) = \) the price

- Trade size limit: \( γ(ω, ω̃) \in [−k, k] \)
  
  common risk management practices

  this is the main trading friction (≠ search) of the model
period two: consolidation and payoff

- All traders from bank $\omega$ consolidate their CDS positions

- After consolidation, the “post-trade exposure” to default risk, $D$:

$$g(\omega) = \omega + \int_0^1 \gamma(\omega, \tilde{\omega}) n(\tilde{\omega}) \, d\tilde{\omega} \quad \text{per capita}$$

- CARA certainty equivalent cost of bearing $g(\omega)$ units of $D$,

$$\Gamma [g(\omega)] : \text{increasing and convex}$$
Nash Bargaining

- A $\omega$-trader is small relative her bank

\[
\text{sell } \gamma \text{ CDS } \implies \text{cost of risk bearing increases by } \gamma \times \Gamma'[g(\omega)]
\]
Nash Bargaining

- A \( \omega \)-trader is small relative her bank

\[
sell \gamma \text{ CDS} \implies \text{cost of risk bearing increases by } \gamma \times \Gamma' [g(\omega)]
\]

\( \implies \) Low post-trade exposure sells CDS to high post-trade exposure

\[
\gamma(\omega, \tilde{\omega}) = \begin{cases} 
  k & \text{if } g(\omega) < g(\tilde{\omega}) \\
  [-k, k] & \text{if } g(\omega) = g(\tilde{\omega}) \\
  -k & \text{if } g(\omega) > g(\tilde{\omega})
\end{cases}
\]

\( \implies \) CDS prices split the gains from trade in half

\[
R(\omega, \tilde{\omega}) = \frac{1}{2} \left( \Gamma' [g(\omega)] + \Gamma' [g(\tilde{\omega})] \right)
\]
the equilibrium fixed point problem

- Contracts $\gamma(\omega, \tilde{\omega})$ are optimal given post-trade exposures

$$\gamma(\omega, \tilde{\omega}) = \begin{cases} 
  k & \text{if } g(\tilde{\omega}) > g(\omega) \\
  [-k, k] & \text{if } g(\tilde{\omega}) = g(\omega) \\
  -k & \text{if } g(\tilde{\omega}) < g(\omega) 
\end{cases}$$

- Post-trade exposures are consistent with the signed contracts

$$g(\omega) = \omega + \int_{0}^{1} \gamma(\omega, \tilde{\omega}) n(\tilde{\omega}) d\tilde{\omega}$$
basic properties

- Unique $g(\omega)$ and $R(\omega, \tilde{\omega})$

- Post-trade exposures, $g(\omega)$, are non-decreasing

- Post-trade exposures are closer together than pre-trade exposures

$$|g(\tilde{\omega}) - g(\omega)| \leq |\tilde{\omega} - \omega|$$

a manifestation of risk sharing!
a special case of interest

result of entry decisions to be determined later in equilibrium
post-trade exposure, $g(\omega)$

- $g(\omega)$ is flat in regions where the density of traders, $n(\omega)$, is large

b/c in these region traders find each other easily to pool their risks
contracts signed per capita
gross notional per capita

- Middle-$\omega$ banks trade more than extreme-$\omega$ banks
contracts signed per capita

- Middle-ω banks trade more than extreme-ω banks
- Low-ω banks sell much more than they buy
- High-ω banks buy much more than they sell

CDS sold per capita

CDS bought per capita
contracts signed per capita

- Middle-$\omega$ banks trade more than extreme-$\omega$ banks
- Low-$\omega$ banks sell much more than they buy
- High-$\omega$ banks buy much more than they sell
- All banks provide some intermediation: they buy andsell CDS
intermediation per capita

- Volume of fully offsetting CDS contracts
  \[ \min\{\text{CDS sold, CDS purchased}\} \]

- Middle-\(\omega\) banks are the biggest intermediaries
  net exposures \(\approx 0\)
  use all their trading capacity
entry in the OTC market
Utility of entering per capita, before cost:

\[ \Delta(\omega) = \Gamma[\omega] - \Gamma[g(\omega)] + \int_0^1 \gamma(\omega, \tilde{\omega})R(\omega, \tilde{\omega})n(\tilde{\omega}) d\tilde{\omega} \]
the entry decision

- Utility of entering per capita, before cost:

\[
\Delta(\omega) = \Gamma[\omega] - \Gamma[g(\omega)] + \int_0^1 \gamma(\omega, \tilde{\omega}) R(\omega, \tilde{\omega}) n(\tilde{\omega}) \, d\tilde{\omega}
\]

- Enter if and only if:

\[
\Delta(\omega) \geq \frac{c}{S} \iff S \geq \Sigma(\omega) \equiv \frac{c}{\Delta(\omega)}
\]
the entry decision

- Utility of entering per capita, before cost:

\[ \Delta(\omega) = \Gamma[\omega] - \Gamma[g(\omega)] + \int_0^1 \gamma(\omega, \tilde{\omega}) R(\omega, \tilde{\omega}) n(\tilde{\omega}) \, d\tilde{\omega} \]

- Enter if and only if:

\[ \Delta(\omega) \geq \frac{c}{S} \iff S > \Sigma(\omega) \equiv \frac{c}{\Delta(\omega)} \]

- Implies a fixed point equation for \( n(\omega) \)

\[ n(\omega) = \frac{\Phi[\Sigma(\omega)]}{\int_0^1 \Phi[\Sigma(\tilde{\omega})] \, d\tilde{\omega}}, \text{ where } \Phi(S) \equiv \# \text{ traders in banks} \geq S \]

Schauder \( \Rightarrow \) an equilibrium with positive entry exists
equilibrium entry incentives

- Per capita, assuming quadratic cost of risk bearing

utility of entering: $\Delta(\omega)$
equilibrium entry incentives

- Per capita, assuming quadratic cost of risk bearing

utility of entering: $\Delta(\omega)$

Now recall that banks have to pay a fixed cost to enter. Therefore:
- small-sized banks do not enter
- middle-sized banks only enter at the extremes, as customers
- large-sized banks enter in the middle, as intermediaries
positive results
positive results

- Gross Notional per Capita
  - Graph shows a positive trend.
- Absolute Net Notional per Capita
  - Graph shows a decreasing trend.
- Intermediation Volume per Capita
  - Graph shows an increasing trend.
- Price Dispersion
  - Graph remains relatively constant.

Size Percentile
linkages
per capita

- everyone trades more with largest banks
- large banks endogenously emerge as central counterparties

Even though all matching is random!
welfare
is equilibrium entry socially optimal?

- Perturb the equilibrium
  
  at each $\omega$, add a small measure $\delta(\omega)$ of $\omega$-traders
is equilibrium entry socially optimal?

• Perturb the equilibrium
  
at each \( \omega \), add a small measure \( \delta(\omega) \) of \( \omega \)-traders

• Result 1: given composition, \( n(\omega) \), market size is socially optimal
is equilibrium entry socially optimal?

- Perturb the equilibrium
  
  at each $\omega$, add a small measure $\delta(\omega)$ of $\omega$-traders

- Result 1: given composition, $n(\omega)$, market size is socially optimal

- Result 2: however, composition, $n(\omega)$, is not socially optimal.
is equilibrium entry socially optimal?

• Perturb the equilibrium
  at each \( \omega \), add a small measure \( \delta(\omega) \) of \( \omega \)-traders

• Result 1: given composition, \( n(\omega) \), market size is socially optimal

• Result 2: however, composition, \( n(\omega) \), is not socially optimal.
  extreme-\( \omega \) banks should enter
  small banks at the margin
  middle-\( \omega \) banks should exit
  large banks at the margin
• A new framework for OTC credit derivatives

• Networks of cross-exposures arises endogenously
  incentives to hedge and intermediate economies of scale when entering in OTC markets

• Rationalizes observed patterns of participation

• Identifies an inefficiency
  large banks enter too much
  middle sized banks enter too little
large banks trade disproportionately more
for large banks, net positions are much smaller than gross positions
middle-sized banks hedge

Q2 2009 to Q4 2011, % notional that count as hedge ("guarantee")
i.e., that the bank can use to reduce regulatory capital requirement

back to introduction