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Information Insensitive Securities: The Benefits of Central Counterparties

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Information insensitive securities: the benefits of Central Counterparties

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1 The opinions are the authors’ and do not necessarily reflect those of the Federal Reserve Board or its staff
Central Counterparties (CCP)

**Definition 1**
Entity that is the buyer to every seller and seller to every buyer of a specified set of contracts.

Functions it performs:

- multilateral netting
- counterparty risk management through:
  - margin requirements
  - loss mutualization
Motivation: How CCPs affect trading in securities they clear

- In late 19th century first in Europe, then in the US, CCPs emerged gradually and endogenously.
- Some recent research focused on CCPs as mechanism that provides insurance, transparency, efficient clearing services to counterparties in financial transactions.
- This project: CCPs’ impact on terms of trade of contracts they clear and on their liquidity.
- In economies where trading securities improves on allocations, a desirable feature of a security is its liquidity.
Idea

- Liquidity of a security is linked to its information insensitivity (i.e. incentive to acquire private information about its payoff)

- Some functions of a CCP can affect information sensitivity
  - CCP provides services valuable to agents when they trade,  
    \[ \Rightarrow \text{can raise the payoff from trading without acquiring private information} \]
Basic model

▶ 1 period
▶ 2 agents: A, B (for buyer of a security)
▶ endowments:
  ▶ A has a good \( \tilde{x} = \begin{cases} x_L & \text{w.p. } p_L \\ x_H & \text{w.p. } p_H = (1 - p_L) \end{cases} \)
  ▶ B has a good \( \omega \)
▶ preferences (over \( c_{ij}^i \geq 0 \))
  ▶ agent A: \( c_\omega^A + E_x c_x^A \)
  ▶ agent B: \( E_x U^B(c_x^B) + c_\omega^B \)
before consumption occurs A dies w.p. $\lambda$ (counterparty risk)

Technologies:

- A productive technology for $x$ that produces output if A is alive
  
  $$x \mapsto \rho x$$
  
  $$\rho > 1$$

- A has access to storage
  
  $$x \mapsto x$$
Timing

Endowments \( \tilde{x}, \omega \)

Technologies
- Storage: \( x \mapsto x \)
- Production: \( x \mapsto \rho x \)

A dies w.p. \( \lambda \)

Output:
- Storage: \( \kappa \)
- Production: if A alive \( \rho(x - \kappa) \)
PO allocation

Assumption 1

\[\begin{align*}
U^B(0) &= 0, \quad U'^B > 0, \quad U''^B < 0 \\
U'^B(0) &= +\infty, \quad U'^B(c^B_x) > 1, \forall c^B_x \in C = \{\text{feasible } c^B_x \text{ given } x \sim F(x)\}
\end{align*}\]

Then:

\[\begin{align*}
\text{\(\triangleright\)} \quad & c^B_x = x \\
\text{\(\triangleright\)} \quad & \text{other consumption allocation indeterminate}
\end{align*}\]
Timing

1. Nature draws a realization $x$ of $\tilde{x}$ which is NOT publicly observable

2. agents A and B meet; B makes a TIOLI offer to A
   ▶ a transfer of good $\omega$ from B to A: $T_x$
   ▶ a transfer of good $x$ from A to B: function (or security) $s(x)$

3. A can pay a cost $\gamma$ to privately learn $x$:
   ▶ pay $\gamma$, accept or reject TIOLI based on $x$
   ▶ accept or reject TIOLI without information about $x$

4. Investment into production and storage

5. A dies w.p. $\lambda$

6. settlement and consumption take place: full commitment
Timing

Nature draws $x$ not publicly observable

A and B meet B makes a TIOLI

A chooses: Information then Accept or Reject

If A accepts A posts collateral $\kappa_A x$

w.p. $\lambda$ A dies

If alive A output $\rho(x - \kappa_A x)$

Settlement and Consumption
Definition 2
A feasible contract is \((T_x, s(x), \kappa^A_x)\) such that:

\[
T_x \leq \omega
\]

\[
s(x) \leq \rho(x - \kappa^A_x) + k^A_x
\]

\[
\kappa^A_x \leq x
\]
B’s TIOLI offer: contract \((T_x, s(x), \kappa_x^A)\)

B’s objective function:

\[
(1 - \lambda)[E_x U^B(s(x)) + \omega - E_x T_x] + \lambda[E_x U^B(\kappa_x^A) + \omega]
\]

A’s Participation constraint

\[
E_x[T_x + \rho(x - \kappa_x^A) + \kappa_x^A - s(x)] \geq E_x \rho x
\]

A’s Incentive constraint

\[
\gamma \geq \Pr \left( T_x - \kappa_x^A(\rho - 1) - s(x) < 0 \right)
\]

\[
(1 - \lambda) \left[ \kappa_x^A(\rho - 1) + s(x) - T_x \right]
\]
Free information ($\gamma = 0$)

- Agent A is informed:
  - Incentive constraint irrelevant
  - Participation constraint for a given $x$:
    \[ T_x \geq \kappa_x^A (\rho - 1) + s(x), \quad \forall x \]

- Under free information a PO allocation is implemented if and only if:
  \[ \omega \geq T_x \geq \kappa_{x_H}^A (\rho - 1) + s(x_H) \]
  and B's PC satisfied
Costly information acquisition ($\gamma > 0$)

- A’s participation constraint: accept not worse than reject

$$E_x[T_x - \kappa^A_x(\rho - 1) - s(x)] \geq 0$$

- A’s incentive constraint: accept not worse than info acquisition

$$\gamma \geq p_H(1 - \lambda)[s(x_H) + \kappa^A_H(\rho - 1) - T_H]$$
Both constraints can be rewritten as:

\[ T_H \geq s(x_H) + \kappa_H^A (\rho - 1) - \frac{p_L}{p_H} [T_L - \kappa_L^A (\rho - 1) - s(x_L)] \]

\[ T_H \geq s(x_H) + \kappa_H^A (\rho - 1) - \frac{\gamma}{p_H} \]

A Pareto efficient allocation can be implemented if and only if

\[ \omega \geq T_H \geq \overline{T} \]

with

\[ \overline{T} = s(x_H) + \kappa_H^A (\rho - 1) - \min \left( \frac{p_L}{p_H} [T_L - \kappa_L^A (\rho - 1) - s(x_L)], \frac{\gamma}{p_H} \right) \]

and B's PC satisfied
Information insensitivity is good: a PO allocation can be implemented in a larger set of economies, where

\[ \kappa^A_{xH} (\rho - 1) + s(x_H) > \omega \geq \bar{T} \]

CCP can enhance this result for a variety of contracts by relaxing incentive and participation constraints.
Notice:

- the PO allocation involves some storage (if $\lambda > 0$)
  - $\Rightarrow$ Multilateral netting
  - The only way to insure completely against default risk ($\lambda$) is
    \[ \kappa^A_x = x \]
  - $\Rightarrow$ Margins versus Default Fund
Equilibrium characterization

**Proposition 1**

A solution to B’s TIOLI offer problem is such that:

- \( \kappa_A^x > 0 \)

- \( \kappa_A^x \) increasing in \( s(x) \)
Effect of collateral (storage) on incentives:

- **A’s Participation constraint:**
  \[ E_x[T_x - \kappa_x^A(\rho - 1) - s(x)] \geq 0 \]

- **A’s Incentive constraint:** \( \forall x \in [\underline{x}, \bar{x}] \)
  \[ \gamma \geq \Pr \left(T - \kappa_x^A(\rho - 1) - s(x) < 0\right)(1 - \lambda) \left[\kappa_x^A(\rho - 1) + s(x) - T\right] \]

- **PO allocation implementable depending on \( \omega \)**
Multilateral Netting

Definition 3
Agreed offsetting of positions or obligations among 3 or more trading partners.

- 3 agents: A, B (buyer of a security), S (seller of a security)
- Endowments and preferences:
  A goods $\tilde{x}, \nu$; $U^A = c^A_\omega + E_x c^A_x + E_y c^A_y + c^A_\nu$
  B good $\omega$; $U^B = E_{x,y} U^B (c^B_x + c^B_y) + c^B_\omega$
  S good $\tilde{y}(\perp \tilde{x})$; $U^C = \alpha c^S_\nu + E_y c^S_y$ with $\alpha > 1$
Timing

- B and S do not meet
- before settlement A dies w.p. $\lambda$

Nature draws $x, y$
not publicly observable

A and B meet
B makes a TIOLI

A and S meet
S makes a TIOLI

A chooses:
Information then
Accept or Reject

If A accepts
A posts collateral
$\kappa^A_x, \kappa^A_\nu$

If alive
A’s output
$\rho(x - \kappa^A_x)$
$\rho(\nu - \kappa^A_\nu)$

w.p. $\lambda$
A dies

Settlement and Consumption
Motivation

Basic Model

Information and efficiency

Central clearing

A pays $s(x) - s_s(y)$ to CCP (who pays B)
  - B indifferent between good $x$ and good $y$

S pays $s_s(y)$ to CCP (who pays B)

A TIOLI offer by B is

$$(T_x, s(x), \kappa_A^{xy})$$

where $\kappa_A^{xy}$ denotes the stored amount of good $x$
Compare central with bilateral clearing

- A’s Participation constraint

\[
\begin{align*}
\text{Central clearing:} & \quad Tx + E_{x,y}[\rho(x - \kappa_{x,y}^A) - s(x)] \geq E_x(\rho x) \\
\text{Bilateral clearing:} & \quad Tx + E_x[\rho(x - \kappa_x^A) - s(x)] \geq E_x(\rho x)
\end{align*}
\]
Compare central with bilateral clearing

- A’s Incentive constraint

\[ Central \ clearing \quad \gamma \geq \Pr \left( (1 - \lambda) [T_x - s(x) - \rho E_{y|x}k_{x,y}^A] < 0 \right) \]
\[ (1 - \lambda) \left[ s(x) + \rho E_{y|x}k_{x,y}^A - T_x \right] \]

\[ Bilateral \ clearing \quad \gamma \geq \Pr \left( (1 - \lambda) [T_x - s(x) - \rho E_{y|x}k_{x}^A] < 0 \right) \]
\[ (1 - \lambda) \left[ s(x) + \rho k_{x}^A - T_x \right] \]

Proposition 2
If \( s_s(y) > 0, \forall y \in Y \) then \( E_{y|x}k_{x,y}^A < k_{x}^A \Rightarrow \) constraints relaxed
CCP counterparty risk management: default fund

Same environment as above, further assume:

- continuum $[0, 1]$ of types A and B
- $\tilde{x}$ are iid across type A agents
- each type A meet a type B and always trades bilaterally
Default Fund scheme

- Storage through a Default Fund (DF)
- DF pays every time the counterparty has 0 goods to pay for his obligations
- Contribution to a DF, $\tau^A$, made regardless of accepting/rejection TIOLI offer (no commitment issues)
- Social Planner would insure both against variance of $\tilde{x}$ and default risk $\lambda$
- Here: example of DF that insures only against default risk $\lambda$, compare with economy with margin
Example of DF

Design the DF:

- Let $\tilde{s}(x)$ denote consumption of good $x$ for B agents whose A defaulted

$$s(x) = \tilde{s}(x)$$

- Design $\tau^A$ so that:

$$\tau^A = \lambda E_x \tilde{s}(x)$$
Restrict attention to contract

\[ s(x) = \rho(x - \tau^A) \]

Assumption 2

\[ x_L > \tau^A. \]

Then a feasible DF contribution scheme that provides full counterparty risk insurance is:

\[ \tau^{A*} = \frac{\lambda \rho}{1 + \rho} E_x(x) \]
B’s TIOLI offer: contract \((T, s(x))\)

B’s objective function:

\[
E(U^B(s(x))) + \rho \omega - E_x T (1 - \lambda)
\]

A’s Participation constraint:

\[
(1 - \lambda)[E_x(T - s(x)) + \rho(x - \tau^A)] \geq (1 - \lambda)E_x \rho(x - \tau^A)
\]

\[
(1 - \lambda)[E_x(T - s(x))] \geq 0
\]

A’s Incentive constraint

\[
\gamma \geq \Pr(T - s(x) < 0)(1 - \lambda)[s(x) - T]
\]
Compare DF with margins

- A’s participation constraint:

  \[ DF (1 - \lambda)[E_x(T - s(x)))] \geq 0 \]

  \[ Margin \ E_x[T - k^A_x(\rho - 1) - s(x)] \geq 0 \]

- A’s incentive constraint:

  \[ DF \ \gamma \geq \Pr(T - s(x) < 0)(1 - \lambda)[s(x) - T] \]

  \[ Margin \ \gamma \geq \Pr \left(T - k^A_x(\rho - 1) - s(x) < 0\right)(1 - \lambda)\left[k^A_x(\rho - 1) + s(x) - T\right] \]

- DF contribution independent of A’s strategy \(\Rightarrow\) constraints relaxed
If additionally DF provides cheaper insurance than margin, then constraints relaxed even further:

- DF can do at least as well as margins
- Recall: to have full default insurance with margin we needed

\[ \kappa_x^A = x \]
Let \( \tau^A* = \frac{\lambda \rho E_x x}{1 + \rho} \).

Consider the following DF scheme, \( \tau^A \):

\[
\left( x \geq \right) \tau^A_x = \tau^A* + \epsilon
\]

where \( \epsilon > 0 \) chosen so that Assumption 2 is still satisfied

Then

\[
\tau^A_x > \tau^A* \implies B \text{ gets full insurance}
\]

\[
\tau^A_x \leq x \implies \text{the DF scheme is feasible}
\]
Then the DF at settlement
  - has to pay
    \[ \lambda E_x(x) \]
  - has resources
    \[ \lambda E_x(x) + \epsilon \]

So the DF scheme can be designed to rebate extra resources \( \epsilon \) to the A agents who accepted B’s TIOLI offer

\[ \Downarrow \]
DF relaxes constraints further
A’s participation constraint

$$E_x[T + \epsilon - s(x)] \geq 0$$

A’s incentive constraint

$$\gamma \geq \Pr(T + \epsilon - s(x) < 0)(1 - \lambda)(s(x) - T - \epsilon)$$
Conclusion

- CCPs can enhance the liquidity of the securities they clear by relaxing incentive constraints through:

  1. saving on collateral
  2. insurance provision: DF relaxes constraints further than margin
     - idiosyncratic risk pooling
     - prepaid feature is nondistortive

- when securities need to be liquid to decentralize PO allocations then CCPs are welfare enhancing
Multilateral Netting: definition

- It is arithmetically achieved by summing each participant’s bilateral net positions with the other participants to arrive at a multilateral net position.
- Such netting is conducted through a central counterparty that is legally substituted as the buyer to every seller and the seller to every buyer.
- The multilateral net position represents the bilateral net position between each participant and the central counterparty.
Bilateral Clearing

\[ \kappa(5) \]

\[ \kappa(2) \]

\[ \kappa(1) \]
Central Clearing: Netting

A \rightarrow CCP \leftarrow B
A \xrightarrow{\kappa(3)} CCP
B \xrightarrow{\kappa(1)} CCP
C \xrightarrow{\kappa(4)} CCP