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

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

Functions it performs:

- novation: transfers counterparty risk (from bilateral counterparty to CCP)
- counterparty risk management through:
  - margin requirements
  - loss mutualization
- multilateral netting

Motivation: How CCPs affect trading in securities they clear

- Policy makers have recently pushed for central clearing of financial transactions
- Some recent research focused on CCPs as mechanism that provides insurance, transparency, efficient clearing services to counterparties in financial transactions
- This project: CCPs' impact terms of trade of contracts they clear and resulting allocation
- In economies where trading securities improves on allocations, a desirable feature of a security is its liquidity

Idea and Results

- **Idea:**
  - Liquidity of a security is linked to its information insensitivity (i.e. incentive to acquire information about its payoff)
  - Some functions of a CCP can affect information sensitivity
    - insurance through margin requirements and default fund
    - multilateral netting in clearing
- **Results:**
  - CCPs can make the security more information insensitive (reduce the incentive to acquire information)

Outline

- Understand information insensitivity in a simple example
  - environment and PO allocation
  - full information equilibrium
  - costly information equilibrium
- what is a CCP and how we define it in this environment
  - a counterparty risk management through
    - a.1 margin requirements
    - a.2 default fund constributions
  - b multilateral netting
- effect of CCPs on information sensitivity: CCPs may be welfare enhancing

Information sensitivity in a simple example (Dang, Gorton, Holmstrom)

- 1 period
- 2 agents: A, B (for buyer of a security)
- endowments:
  - A has a good $\tilde{x} = \begin{cases} x_L & \text{w.p.} \quad p_L \\ x_H & \text{w.p.} \quad p_H = (1 - p_L) \end{cases}$
  - B has a good ω_B
- preferences
  - $U^A = c_\omega^A + E_x(c_x^A)$
  - $U^B = c_\omega^B + \alpha E_x(c_x^B)$, with $\alpha > 1$
- PO allocation
  - $c_x^B = x$
  - other consumption allocation indeterminate

Timing

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- agents A and B meet; B makes a TIOLI offer to A
    - a transfer from B to A: $T_B^A \leq \omega_B$
    - a transfer from A to B: function (or security) $s_A(x) \in [0, x]$

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  - pay γ, accept or reject TIOLI based on x
  - accept or reject TIOLI without information about x

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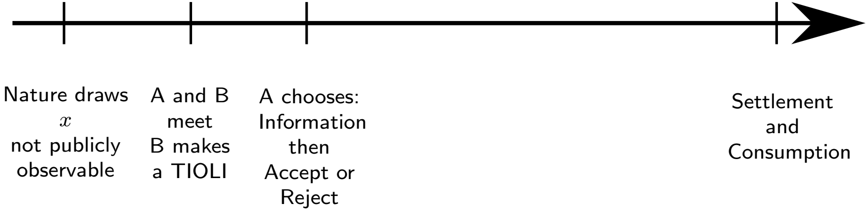
- settlement and consumption take place: full commitment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Consumption

Full information ($\gamma = 0$)

- agent A is informed: he trades if and only if for a given x:

$$T_B^A \geq s_A(x)$$

- under full information a PO allocation is implemented if and only if:

$$\omega_B \geq x_H$$

and B's participation constraint satisfied:

$$\alpha x_L \geq \omega_B$$

Costly information acquisition ($\gamma > 0$)

- suppose $s_A(x) = x$
  - B's objective function:

$$\omega_B - T_B^A + \alpha(p_H x_H + p_L x_L)$$

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

$$T_B^A \geq (p_H x_H + p_L x_L)$$

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

$$\begin{aligned} T_B^A - (p_H x_H + p_L x_L) &\geq \Pr\left(T_B^A \geq x\right)[T_B^A - x] - \gamma \\ T_B^A &\geq x_H - \frac{\gamma}{p_H} \end{aligned}$$

- Therefore a PO allocation is implemented if and only if:

$$\omega_B \geq \max(x_H - \frac{\gamma}{p_H}, E(x))$$

and B's participation constraint satisfied:

$$\alpha x_L \geq \omega_B$$

- Information insensitivity is good: a PO allocation feasible in a larger set of economies
- CCP can enhance this result for a variety of contracts

CCP and information insensitivity

- features of a CCP that affect information insensitivity involve collateral
  - change the basic framework to introduce collateral as counterparty risk insurance, costly to post
- Economy with collateral (margin requirements in a CCP)
- Introduce a continuum $[0, 1]$ of A and B: compare default fund and margin
- Introduce a 3^{rd} agent type S: multilateral netting

Counterparty risk management: collateral/margin requirements

- Preferences:

agent A $U^A(c^A_\omega) + E_x c^A_x$

agent B $E_x U^B(c^B_c) + c^B_\omega$

- Assume

$$\begin{aligned} U^i(0) &= 0 \quad U'^i > 0, U''^i < 0, i = A, B \\ U'^A(c_\omega) &> 1, \quad \forall c_\omega \in [0, \omega_B] \\ U'^B(c_x) &> 1, \quad \forall c_x \in C = \{\text{feasible } c_x \text{ given } x \sim F(x) \text{ on } [\underline{x}, \overline{x}]\} \end{aligned}$$

- Technologies:
  - A (B) has a technology for $x(\omega)$ that produces output right before settlement

$$
\begin{aligned}
x &\rightarrow \rho^A x, \rho^A > 1 \\
\omega &\rightarrow \rho^B \omega, \rho^B > 1
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  - A (B) has access to storage after contract accepted/rejected

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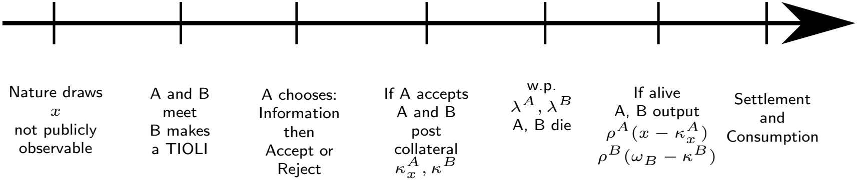
- before settlement A (B) dies w.p. $\lambda^A(\lambda^B)$.

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 and B post collateral κ_x^A, κ^B
w.p. λ^A, λ^B A, B die
If alive A, B output $\rho^A(x - \kappa_x^A)$ $\rho^B(\omega_B - \kappa^B)$
Settlement and Consumption

B's TIOLI offer

B's objective function:

$$(1-\lambda^B)\{(1-\lambda^A)[E_x U^B(s_A(x)) + c_\omega^B] + \lambda^A[E_x U^B(\kappa_x^A) + \bar{c}_\omega^B]\}$$

A's Participation constraint

$$\begin{aligned} &(1-\lambda^A)(1-\lambda^B)\left[U^A(T_B^A) + E_x(\rho^A(x-\kappa_x^A) - s_A(x))\right] + \\ &(1-\lambda^A)\lambda^B\left[U^A(\kappa^B) + E_x(\rho^A(x-\kappa_x^A) + \kappa_x^A)\right] - (1-\lambda^A)E_x(\rho^A x) \quad \geq \quad 0 \end{aligned}$$

A's Incentive constraint

$$\begin{aligned} \gamma \geq \quad & \Pr\left((1-\lambda^B)[U^A(T_B^A) - s_A(x)] + \lambda^B[U^A(\kappa^B) + \kappa_x^A] - \rho^A\kappa_x^A < 0\right) \\ & (1-\lambda^A)\left[\rho^A\kappa_x^A - (1-\lambda^B)(U^A(T_B^A) - s_A(x)) - \lambda^B(U^A(\kappa^B) + \kappa_x^A)\right] \end{aligned}$$

where

$$\begin{aligned} c_\omega^B + T_B^A &\leq \rho^B(\omega_B - \kappa^B) + \kappa^B \\ \bar{c}_\omega^B &\leq \rho^B(\omega_B - \kappa^B) + \kappa^B \end{aligned}$$

Restrict contract to $s_A(x) = \rho^A(x - \kappa_x^A) + \kappa_x^A$

Notice:

- the PO allocation within the match involves some storage (unless $U^{i'}(0) < \infty$ and small enough)
- The only way to insure completely against default risk (λ^i) is

$$
\begin{aligned}
\kappa_x^A &= x \\
\kappa^B &= \omega_B
\end{aligned}
$$

- κ_x^A increasing in x

Relative to an economy without collateral (storage):

trade off B faces: insurance provided by collateral κ^B and opportunity cost of having to post collateral κ_x^A

- A's Participation constraint: key term

$$(1-\lambda^B)\Big(U^A(\rho^B\omega_B-\kappa^B(\rho^B-1))-\rho^A E_x\Big)+\lambda^B U^A(\kappa^B)-E_x\kappa_x^A(1+\lambda^B(\rho^A-2))$$

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- A's Incentive constraint: key term $\forall x \in [\underline{x}, \overline{x}]$

$$(1-\lambda^B)\left(U^A(\rho^B\omega_B-\kappa^B(\rho^B-1))-\rho^A x\right)+\lambda^B U^A(\kappa^B)-\kappa_x^A(1+\lambda^B(\rho^A-2))$$

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- $(\kappa^B, \kappa_x^A) = (0,0)$ still feasible but not chosen $\Rightarrow$ PO allocation feasible for larger set of economies

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) set up by a central agent (CCP, could be owned by participants)
- DF pays every time the counterparty has 0 goods to pay for his obligations
- Contribution to a DF τ^A, τ^B made regardless of accepting/rejection TIOLI offer (no commitment issues)
- Social Planner would insure both against variance of $\tilde{x}$ and default risk λ^i
- Here: example of DF that insures only against default risk λ^i, compare with economy with margin

Example of DF

Design the DF:

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

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

- Let $\tilde{T}_B^A$ denote consumption of good ω for A agents whose B defaulted

$$T_B^A = \tilde{T}_B^A$$

- Design τ^A, τ^B so that:

$$\begin{aligned} \tau^A &= (1-\lambda^B)\lambda^A \tilde{s}_A(x) \\ \tau^B &= (1-\lambda^A)\lambda^B \tilde{T}_B^A \end{aligned}$$

- Restrict attention to contract

$$\begin{aligned} s_A(x) &= \rho^A(x-\tau^A) \\ T_B^A &= \rho^B(\omega_B-\tau^B) \end{aligned}$$

- Assume $\underline{x} > \frac{(1-\lambda^B)\lambda^A\rho^A}{(1-\lambda^B)\lambda^A\rho^A+1}E_x(x)$. Then a feasible DF contribution scheme is:

$$\begin{aligned} \tau^A &= \frac{(1-\lambda^B)\lambda^A\rho^A}{(1-\lambda^B)\lambda^A\rho^A+1}E_x(x) \\ \tau^B &= \frac{(1-\lambda^A)\lambda^B\rho^B}{(1-\lambda^A)\lambda^B\rho^B+1}\omega_B \end{aligned}$$

B's TIOLI offer

B's objective function:

$$(1-\lambda^B) \quad \{(1-\lambda^A)[E(U^B(s_A(x))) + \rho^B(\omega_B - \tau^B) - T_B^A] + \lambda^A[E(U^B(\tilde{s}_A(x))) + \rho^B(\omega_B - \tau^B)]\}$$

A's Participation constraint:

$$(1-\lambda^A)\{(1-\lambda^B)[U^A(T_B^A) - s_A(x)] + \lambda^B U^A(\tilde{T}_B^A)\} \quad \geq \quad 0$$

A's Incentive constraint

$$(1-\lambda^A)\{(1-\lambda^B)[U^A(T_B^A) - s_A(x)] + \lambda^B U^A(\tilde{T}_B^A)\} \quad \geq$$
$$(1-\lambda^A)\Pr\Big((1-\lambda^B)[U^A(T_B^A) - s_A(x)] + \lambda^B U^A(\tilde{T}_B^A) \geq 0\Big)$$
$$(1-\lambda^B)[U^A(T_B^A) - s_A(x)] + \lambda^B U^A(\tilde{T}_B^A) - \gamma$$

Compare DF with margins

- A's participation constraint:

$$U^A(T_B^A) - (1-\lambda^B)E(s_A(x)) \geq 0$$

$$\begin{aligned}(1-\lambda^B)[U^A(T_B^A) + E_x(\rho^A(x - \kappa_x^A) - s_A(x))] + \\ \lambda^B[U^A(\kappa^B) + E_x(\rho^A(x - \kappa_x^A) + \kappa_x^A)] &\geq E_x(\rho^A x)\end{aligned}$$

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- A's incentive constraint:

$$\begin{aligned}\frac{\gamma}{(1-\lambda^A)} &\geq \Pr\left(U^A(T_B^A) < (1-\lambda^B)s_A(x)\right)[(1-\lambda^B)s_A(x) - U^A(T_B^A)] \\ \frac{\gamma}{(1-\lambda^A)} &\geq \Pr\left((1-\lambda^B)[U^A(T_B^A) - s_A(x)] + \lambda^B[U^A(\kappa^B) + \kappa_x^A] - \rho^A\kappa_x^A < 0\right) \\ &\quad \{\rho^A\kappa_x^A - (1-\lambda^B)[U^A(T_B^A) - s_A(x)] - \lambda^B[U^A(\kappa^B) + \kappa_x^A]\}\end{aligned}$$

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- DF contribution independent of A's strategy $\Rightarrow$ constraints relaxed

If additionally DF provides further 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

$$
\begin{aligned}
\kappa_x^A &= x \\
\kappa^B &= \omega_B
\end{aligned}
$$

- Suppose

$$\begin{aligned} \tau_x^A &= x \\ \tau^B &= \omega_B \end{aligned}$$

- Then the DF at settlement
  - has to pay
  $$(1-\lambda^B)E_x(x)$$
  - has resources
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  - similarly for good ω

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- So DF has extra resources $\lambda^B E_x(x)$ that could be rebated to B agents $\Rightarrow$ DF relaxes constraints further

Conclusion

- CCPs can enhance the liquidity of the securities they clear by relaxing incentive constraints through:
  - insurance provision
  - saving on collateral
- 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.

back