Can cross-border financial markets create good collateral in a crisis?

Makoto Saito, Shiba Suzuki, and Tomoaki Yamada

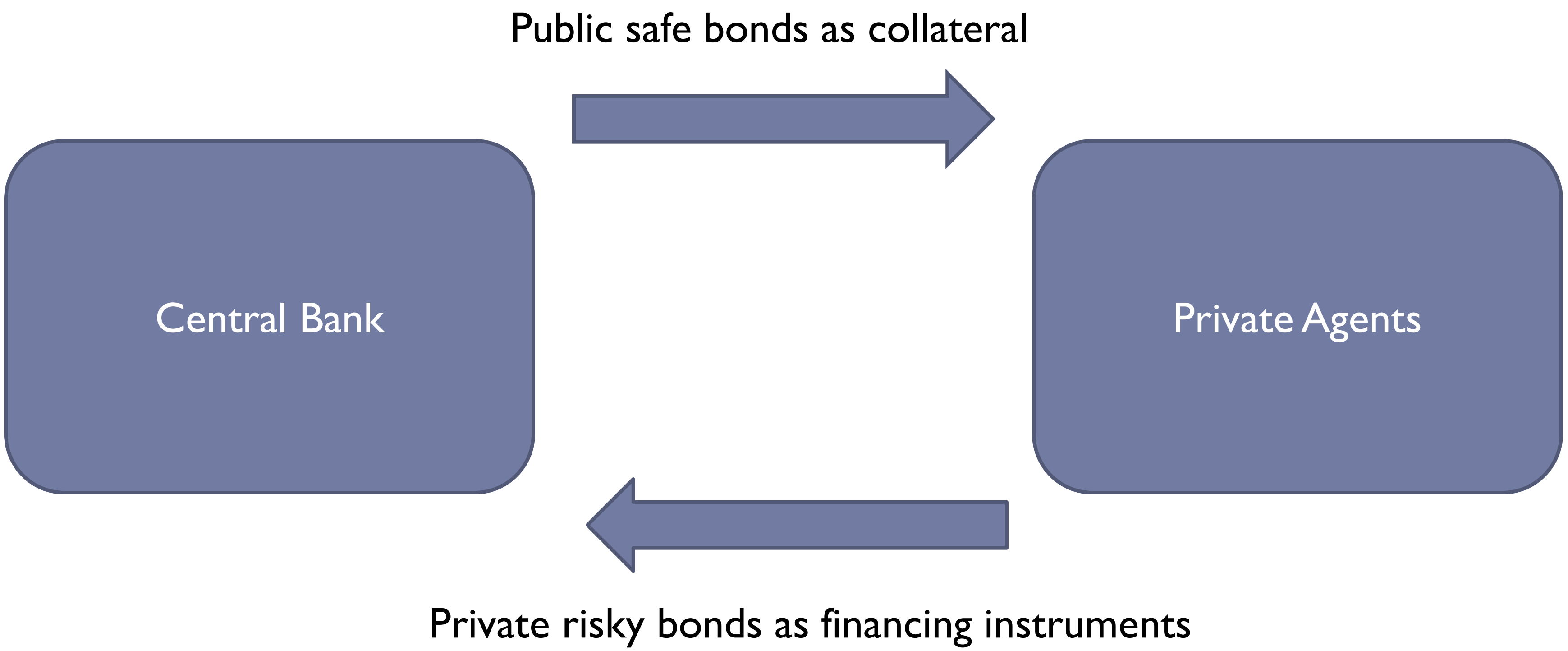
Questions raised here

- Theoretical question
  - Can cross-border markets create high-quality collateral when collateral is urgently needed?
  - Does collateral creation emerge endogenously in equilibrium?

- Toward policy implications
  - Is public collateral provision during financial crises justifiable, given a theoretical case of collateral creation as an equilibrium phenomenon?
  - Which kinds of economic functions are carried out by public collateral provision?

Public collateral provision during a financial crisis

- Public collateral provision during a financial crisis often consists of:
  1. Public institutions (including central banks) provide private agents with high-quality collateral (safe bonds).
  2. Private agents utilize safe bonds as collateral to issue risky bonds.
  3. Public institutions quite positively evaluate private risky bonds (‘Reasonable’ prices may be even above fundamental prices).
  4. Both public institutions and private agents expand financial balance sheets to maintain such financial operations.


Public safe bonds as collateral
Central Bank
Private Agents
Private risky bonds as financing instruments

Two-country setup with country-specific catastrophic shocks and solvency constraints

- Country-specific catastrophic shocks:
  - Level shocks (not growth shocks)
  - Maybe persistent

- Cross-border financial markets:
  - Complete markets
  - To trade Lucas trees and contingent bonds between two countries

- Solvency (collateral) constraints:
  - In any *financial* portfolio, gross repayments on debts need to be up to gross receipts from investments for every possible future state.

How to compute the constrained competitive equilibrium

- We first compute the constrained social optimal by solving a **social planner's problem**.
  - We do <u>not</u> solve directly market problems.
- Then, we translate the constrained social optimal to the constrained competitive equilibrium.
  - The corresponding market problem is <u>not</u> dynamically complete markets, but **time-0 complete markets**.
  - A difference between the two versions of complete markets is no longer trivial in the presence of solvency constraints.

Market problem

1. **Each country's optimization problem:**

$$\max_{\{c^i\},\{\theta^i\},\{a^i\}} \sum_{t=0}^{\infty} \sum_{s^t \in S^t} \beta^t \pi(s^t|s_0) u\left[c^i(s^t)\right],$$

$$\text{s.t. } c^i(s^t) + p(z^t)\theta^i(s^t) + \sum_{s' \in S} q(s^t, s')a^i(s^t, s') \le w^i(s^t),$$

$$\left[p(z^{t+1}) + d(z_{t+1})\right] \theta^i(s^t) \ge -a^i(s^t, s'),\ \forall s' \in S.$$

2. **Market clearings:**

$$\begin{aligned} \theta^1(s^t) + \theta^2(s^t) &= 1, \\ a^1(s^t, s') + a^2(s^t, s') &= 0, \text{ for all } s' \in S. \end{aligned}$$

3. **Resource constraints:**

$$e(z_t) = e^1(y_t) + e^2(y_t) + d(z_t).$$

4. **Availability of Lucas trees:**

$$\alpha = \frac{d(z_t)}{e(z_t)}.$$

Collateral (solvency) constraints

$$\left[p(z^{t+1}) + d(z_{t+1})\right] \theta^i(s^t) \geq -a^i(s^t, s'), \ \forall s' \in S.$$

1. **Contingent claims as insurance:** For state s', $a^i(s^t, s') > 0$ (insuree), and $a^{i'}(s^t, s') < 0$ (insurer).

2. **Contingent claims as bonds:** For all states s' ($\forall$ s'), $a^i(s^t, s') > 0$ (creditor), and $a^{i'}(s^t, s') < 0$ (debtor).

3. **Without any physical delivery**, it is possible to have $\theta(s^t) < 0$. A short position in Lucas trees without delivery can be regarded as **risky bonds**.

Computing social optimal by a representative agent

$$\max_{\{c^1,c^2\}} \sum_{t=0}^{\infty} \sum_{s^t \in S^t} \beta^t \pi(s^t|s_0) \left[\zeta^1(s^t) u\left[c^1(s^t)\right] + \zeta^2(s^t) u\left[c^2(s^t)\right]\right].$$

1. Negishi weights $(\zeta^i(s^t))$ are time-varying!
2. A constrained state implies that a state where resources cannot be transferred from a constrained state to another state (or today).
3. Thus, in a constrained state, consumption becomes too much.
4. Consequently, Negishi weight is **revised upward** at a state where a solvency constraint is binding.

5. It is possible to compute **stochastic discount factors** from a representative agent framework.
6. With a solvency constraint binding,

$$\sum_{j \geq t} \sum_{s^j \succeq s^t} Q(s^t, s^j) c^i \left(s^j\right) = \sum_{j \geq t} \sum_{s^j \succeq s^t} Q(s^t, s^j) e^i \left(y_j\right)$$

still holds from a constrained state onward.

7. That is, it is assumed that a consumer can finance current consumption against far future endowment in **time-0 complete markets**, much more flexible than **dynamically complete markets**.

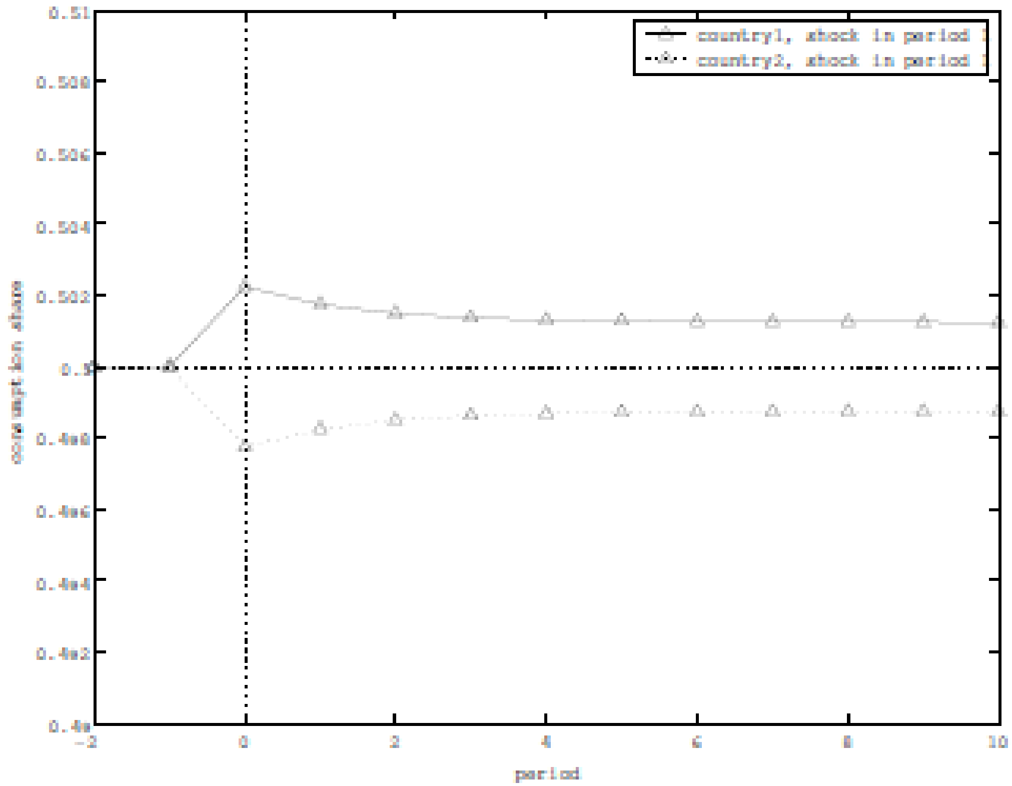
Calibration setup: A **purely transitory** case

- A country-specific catastrophic shock reduces labor endowment by 20% with probability 1.8% per year.
  - The labor endowment share of the damaged country declines from 50% to 44.4% (by 5.6%)

- The availability of Lucas trees is extremely limited
  - $\alpha = 0.1\%$
  - The solvency of an insurer country, which is backed by investments in Lucas trees, is lowered substantially.

- A calibrated case:
  - Country 1 faces a catastrophic event in time 0. But, there is not any more catastrophic event in either country.

Figure 1: Consumption shares with one-time shock (shock size: 20%, persistence: i.i.d., α=0.1%)



Almost perfect insurance as the social optimal: Country 2 (damaged country)

- The loss borne by Country 2 reduces from 5.6% to 0.2% in time 0.

  - Direct loss -5.6%
  - Insurance benefit from Country 1 +0.7%
  - Gross return from Lucas trees +0.7%
  - *Ex-post* borrowing must be **4.0%**

- Country 2 bears 0.1% long-run losses (from time 2 onward).

Almost perfect insurance as the social optimal: Country 1 (nondamaged country)

- The gain obtained by Country 1 reduces from 5.6% to 0.2% in time 0.

  - Direct gain +5.6%
  - Insurance payment to Country 2 -0.7%
  - Gross return from Lucas trees +0.7%
  - *Ex post* lending must be **5.4%**

- Country 1 receives 0.1% long-run benefits (from time 2 onward).

How is the almost perfect insurance outcome (social optimal) achieved by market transactions?

- It is impossible to support the social optimal by financial transactions <u>even when markets are dynamically complete.</u>
  - A big difference emerges between economies with and without solvency constraints!

- It requires <u>time-0 complete markets</u>.
  - To achieve the social optimal, not only one-period contingent bonds, but also multi-period contingent bonds are necessary.
    - Given severe solvency constraints, one-period installment is too short for the damaged country to cover catastrophic losses.
  - However, time-0 complete markets may not be realistic.
    - They require a fairly wide variety of financial instruments, and involve **extremely complicated financial transactions**.

Can the social optimal be sustained by dynamically complete markets *with minor interventions*? (1/2)

- **Yes**, if asset pricing *slightly* deviates from arbitrage pricing.
  - In particular, the price of Lucas trees is slightly above fundamentals:

$$p(z^0) = \sum_{s^1 \succeq s^0} q(s^0, s^1) \left[p(z^1) + d(z_1) \right] + \epsilon$$

- Deviation from arbitrage pricing may be justifiable in an economy with solvency constraints.

- Richness in Lucas trees would give Country 2 (damaged) an opportunity to finance by making short in Lucas trees.

Can the social optimal be sustained by dynamically complete markets *with minor interventions*? (2/2)

- **Richness in Lucas trees** and **Cheapness in contingent bonds** result in:
  - Country 2 can finance resources by making long in contingent bonds and short in Lucas trees.
  - Country 1 can construct long-run investment opportunities by making long in Lucas trees and short in contingent bonds.

Large-scale bilateral financial transactions in time 0

- Country 2 (damaged):
  - Long positions in contingent bonds: 3.6%
  - Short positions in risky bonds (Lucas trees): -7.5%
  - Ex-post borrowing: **4.0%**

- Country 1 (nondamaged):
  - Long positions in risky bonds (Lucas trees): 8.8%
  - Short positions in contingent bonds: -3.6%
  - Ex-post lending: **5.4%**

Payoff structure of contingent bonds

- Country 2's receipts and repayments in time 1:

Cat. shocks on	Receipts from safe bonds	Repayments on risky bonds (Lucas trees)	Solvency constraints
Neither country	11.8%	11.8%	Binding
Country 2 only	**9.5%**	**8.0%**	Not binding thanks to insurance from Country 1
Country 1 only	8.0%	8.0%	Binding
Both countries	5.1%	5.1%	Binding

- Utilizing safe bonds issued by Country 1 as good collateral, Country 2 can finance effectively uncovered losses.

Large-scale bilateral transactions emerges only in the aftermath.

Table 1: Portfolio transaction behavior with one-time shock (shock size: 20%, persistence: i.i.d., α=0.1%)

	labor endowment share	realized tree value $(p(z)+\alpha)\theta^i(s^{-1})$	insurance receipt $a^i(s^{-1},s)$	consumption share	invested trees $\theta^i(s)$	invested trees value $p(z)\theta^i(s)$	invested contingent claims $\sum q(s,s')a^i(s,s')$
			nondagmaged country				
time -1	0.500	0.011	0.000	0.500	0.500	0.010	0.000
time 0	0.556	0.007	-0.007	0.502	6.540	0.088	**-0.036**
time 1	0.500	0.139	-0.118	0.502	0.920	0.019	0.000
time 2	0.500	0.020	0.002	0.501	0.940	0.019	0.000
time 3	0.500	0.020	0.001	0.501	0.950	0.019	0.000
			damaged country				
time -1	0.500	0.011	0.000	0.500	0.500	0.010	0.000
time 0	0.444	0.007	0.007	0.498	**-5.540**	**-0.075**	0.036
time 1	0.500	-0.118	0.118	0.498	0.080	0.002	0.000
time 2	0.500	0.002	-0.002	0.499	0.060	0.001	0.000
time 3	0.500	0.001	-0.001	0.499	0.050	0.001	0.000

Summary of calibration exercises

- Even when markets are only dynamically complete (a set of contingent claims is fairly limited), slight richness in Lucas trees allows for restoring the social optimal as follows.

    - Country 1 issues **safe bonds** on large scale.
    - Country 2 exploits such safe bonds as **collateral**, and issues **risky bonds** (short positions in Lucas trees without delivery).
    - Both countries close such large-scale bilateral transactions immediately after a catastrophic shock goes away.

- The above implications survive with high degree persistence and consecutive occurrence.

Policy implications from the calibration exercises

- How we should interpret central banks' behavior during a financial crisis, including:
  - aggressively positive evaluation of private risky bonds (even above fundamental prices),
  - large-scale public collateral provision, and
  - expanding hugely financial balance sheets.

- It *is* justifiable.
  - With slight richness in private risky bonds initiated by public interventions, financially-damaged agents can finance effectively uncovered losses in a situation where the availability of financial instruments is rather limited.
  - Large-scale interventions need to be closed immediately after a financial crisis goes away.