# Cross-Border CBDC, Bank Runs and Capital Flows Volatility

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# Introduction

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Many have discussed about the possibility of run if CBDC is issues in a closed economy.

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The impact could be mitigated by proper regulations and limits on the design of CBDC.

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2. CBDC is digital, easy to access using mobile devices, causing faster substitution rate
3. Commercial banks and domestic central bank both losses deposits, causing even more severe run and financial instability.
4. Currency substitution could ultimately impair monetary policy (Ferrari et al. 2022)

# This Paper

Extends DD to cross-border CBDC.
Chooses the following foreign CBDC design

- Account-base *v.s. token*
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The domestic country has no CBDC technology, while foreign country issues cross-border CBDC that could cause capital outflows.

# Model

# Consumers

Period 0 :
Endowed with 1 unit of goods. Can decide to save domestically or abroad.

Period 1 :
Consumers find out whether they are patient or not.

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

If impatient, consume $c_1$ at t=1

Period 2 :
Patient consumers consumer $c_2$

# Techonology

| Type | Period 0 | Period 1 | Period 2 |
|---|---|---|---|
| Short-term | 1 | 1 | |
| Long-term | 1 | $l < 1$ | $R > 1$ |

Directly take the result that consumers will want to save in bank(foreign or domestic) to pool the risk.

# Domestic Commercial Banks

- Domestic Commercial Banks (DB) offers a demand deposit contract $(c_1, c_2)$.
- DB decide to invest $y \in (0, 1)$ in the short-term technology.

## Sequential Service Constraint

DB pays $c_1$ to depositors until all resources are exhausted.

# DB's problem I

$$\max_{c_1,c_2,y,l\in\mathbb{R}^3_+} \lambda u(c_1) + (1-\lambda)u(c_2) \tag{2}$$

s.t.

$$0 \le y \le 1 \tag{3a}$$
$$\lambda c_1 \le ry + (1-y)l \tag{3b}$$
$$(1-\lambda)c_2 \le R(1-l)(1-y) + ry + (1-y)l - \lambda c_1 \tag{3c}$$
$$c_1 \le c_2 \tag{3d}$$

## Abuse of notation

Previously denote $l$ as liquidation price, but now denote $l$ as the proportion of long-term used for early liquidation.

# DB's problem II

Key intuitions

- Assume bankers are Bertrand competition $\Longrightarrow$ forced to maximize E.U of consumers
- 3b — might use liquidated long-term to pay $c_1$
- 3c — Non-liquidated long-term plus after return is yield plus the leftover from period 1
- 3d — Incentive compatibility constraint, patient consumers don't pretend to be impatient

# Foreign CBDC-issuing Central Bank

- Assume perfect credible, i.e. no runs
- Justification: Fernandez-Villaverden et al. (2021) point out, certain punishment (for early withdrawal) and treatment (with patient depositors) ensures no run on CB is a DSE
- Foreign CBDCs are open to foreigners
- Constract — $(c_1^*, c_2^*) \in \mathbb{R}_+^2$

# Consumers' Problem

Consumer invest in the highest ex-ante utility

1. Pick the contract, denote $d_i \in \{0, 1\}$. $d_1 = 0$ means save in domestic.
2. If utility ties, fraction $f \in [0, 1]$ of consumers pick the foreign contract

Consumers also decide when to withdraw their funds, denote $w_i \in \{1, 2\}$. Note that $w_i = w_i(w_{-i})$

Capital account constraint — Total investment in foreign asset must not exceed $k$

- Exogenous ceiling
- Regulation restriction

# Equilibrium

# Equilibrium with no Runs

## Lemma 2

*In equilibrium, all commercial banks that have depositors make zero-profis and offer socially optimal contract.*

## Lemma 3

*The foreign CB can replicate the socially optimal bank deposit contract, if* $c_1^* = \bar{c}_1$ *and* $c_2^* = \bar{c}_2$

## Proposition 4

*In an equilibrium,*

1. *DB offers better contract :* $f = 0$
2. *FCB offers better contract :* $f = k$
3. *Both offer best :* $f \in (0, k)$

Denote the social optimal contract and short-term investment as a tuple $(\bar{c}_1, \bar{c}_2, \bar{y})$.
The payoff matrix for an early withdraw episode:

| Event | Withdraw | Roll-over |
|---|---|---|
| No run | $u(\bar{c}_1)$ | $u\left(\frac{R[(1-\bar{y})-(\alpha-\lambda)\bar{c}_1/l]}{1-\alpha}\right)$ |
| Run | $\frac{r\bar{y}+(1-y)l}{\alpha\bar{c}_1}u(\bar{c}_1)$ | 0 |

Strategic complementarity.

# Equilibrium with Runs in the Foreign CBDC

## Lemma 6

*If the foreign central bank offers a riskless deposit contract which mimics the payoff of the social-optimal contract, then it will attract all deposits up to the capital account constraint.*

## Point of view

1. Lack of proper proof. At least model an exogenous probability of run to justify the lemma.
2. Too strong an assumption; deposits are also used as digital payment assets, it is too naive to discard the fact that an asset can be MoP.

# Non-social optimal contract for F-CBDC

## Proposition 7

*As consumers internalize that the foreign central bank deposit contract is perfectly safe, the foreign central bank can offer a deposit contract with lower payoffs than the social optimal one, and still attract the highest possible amount of deposits (up to the capital account constraint).*

The author's "proof" :
As run can occur with commercial banks, but not with central bank, it has to be that $U_1 < U_2$

**Proposition 7** *As consumers internalize that the central foreign bank deposit contract is perfectly safe, the foreign central bank can offer a deposit contract with lower payoffs than the socially optimal one, and still attract the highest possible amount of deposits (up to the capital account constraint).*

**Proof.** Let's denote by $U_1$ the utility the agent derives from the socially-optimal commercial bank deposit contract, which can be subject to runs, and by $U_2$ the utility derived from a 'safe' CBDC deposit contract with the same payouts. As runs can occur with commercial banks, but not with the central bank, it has to be that $U_1 < U_2$. In this case, the central bank can offer lower payoffs $c_1^* < c_1$ and $c_2^* < c_2$ such that $U_1 < U(c_1^*, c_2^*) < U_2$ and still attract all deposits up to the capital account constraint. ■

proof ?

# Discussion

# Comments I

1. Lack of rigorous mathematical proof

   Some propositions and lemmas are concluded without a proper proof, and some are even contradicting one another. For example, in proposition 4, both offering best contract yields equilibria for all $f \in (0, k)$, but in the elaborative proof of proposition 7, he concludes that even both in the optimal contract level, the foreign central bank extracts all deposit, identical to justifying that $f = k$, which contradicts to his previous claim of multiple equilibria.

# Comments II

2. The roll of CBDC in this paper

   It is unclear how CBDC deposit differs from other risk-free assets such as US treasury bond.
   Accessibility might be something the author used to justify this possibility, but as agents don't see benefits from substituting a potential means of payment for another, this explanation is not convincing.

# Comments III

3. Connection with fundamentals

   As with typical Diamond and Dybvig structure, the run happens purely from a sunspot shock. If fundamentals are not considers, any country turns out to be vulnerable after dollar is digitalized.
   Conditions such as high inflation rate, described in Calvo (1922), exacerbated currency substitution, which are more likely to set the domestic financial system on crisis.

# Extensions / Motivations for ABM

1. Consider the roll of CBDC as a mean of payment
   - Endogenously emerge as a MoP
   - Becoming MoP, then causes run?
   - Or first run, then ended up as a MoP?

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2. Understand how such disintermediation damages the economy, and the best measure government could conduct to cease the crisis.
3. The role of exchange rate
   - Will purchasing power imparity emerge endogenously? (No story yet)
   - Purchasing power imparity cause direct demand on foreign currency ($\because$ easy access)
   - Holding F-CBDC is optimal
   - Further cause devaluation on domestic currency, PP drop further