What Does Not Kill You Makes You Riskier: The Impacts of CBDC on Banking Stability

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Motivation

- CBDC recently drew attention of policy makers and economists.
  - An optimal design of CBDC-based payments and settlement mechanisms;
  - A shift in monetary policy targets;
  - Financial consumer protection for privacy and financial inclusion.
  - Agur et al. (2022)
- An important policy-related issue is impacts on banking:
  - CBDC is deemed as a substitute of bank deposits as a means of payments;
    - Guaranteed by central banks, exposing a smaller risk of bank panic.
    - Fernández-Villaverde et al. (2021)
  - An increase in CBDC users means banks lose depositors;
  - Resulting in a reduction in loan supply (*disintermediation*);
    - Central banks do not have an expertise in lending as private banks.

Motivation

- We further focus on banks' *risk-taking* associated with CBDC.
  - Competition with CBDC raises the cost of deposit raising (Kim and Kwon, 2022).
  - An increased borrowing cost adversely incentivizes banks for excessive risk-taking.
  - Highly financially intelligent consumers will prefer CBDC to bank money.
    - The remaining depositors cannot effectively monitor bank risk any longer.

Q. Under which conditions does CBDC induce traditional banks to take on excessive risks?

- To answer this, we study a tradeoff of CBDC as follows:
  - Technological and regulatory supports of CBDC increases its consumer surplus;
  - But, strong CBDC promotions may encourage banks to take excessive risks.

What We Do & Find

- We provide normative analysis of the impacts of CBDC on banking stability.
  - Consumer surplus from CBDC varies with each user's financial intelligence.
  - A bank competes with CBDC by raising a deposit rate.
  - The bank's risk-taking depends on
    - its capital structure;
    - depositors' financial intelligence for market discipline.
- We found that the bank's risk-taking behavior depends on R (baseline CBDC surplus).
  - The bank takes on excessive risk *iff* R is neither too high nor too low.
- We next discuss how CBDC promotion policies influence banking stability, such as
  - ICT infrastructure, regulations on DeFi, and interests on CBDC.

Model

- An economy consisting of a bank and consumers with measure 1.
- Timeline of actions:
  1. A bank offers a single deposit rate to the consumers;
  2. Each consumer decides whether to deposit to the bank or transfer to CBDC;
  3. The bank decides which type of the asset to invest in;
  4. The return of the bank investment is realized and accrued to each player.

- Each consumer is indexed by $\theta \in [0,1]$ and uniformly distributed over $[0,1]$.
  - We throughout call θ as each consumer's "type."
- Each consumer is endowed with one unit of capital.
  - She can buy CBDC to get θR;
  - or she can deposit to a bank for repayment.

- The bank raises deposits to invest in CRS financial project.
  - The bank offers a repayment term D to every consumer;
  - After raising the capital, the bank can invest in
    - Project G that gives S with probability 1;
    - Project B that gives H with probability $p \in (0,1)$;
    - Assumption: $pH < 1 < S < H$, i.e., B is "riskier" than G.
- Depositors can (imperfectly) monitor the bank's risk-taking.
  - μ_D: the average value of consumers' types who become depositors.
  - The bank's risk-taking is detected and forced to adjust its investment with prob. μ_D.
    - Assume zero cost of monitoring and zero cost of corrective action.

- First, consider an equilibrium where the bank chooses B.
  - By depositing to the bank, type θ consumer gets $((1-\mu_D)p+\mu_D)D$.
  - If type θ consumer buys CBDC, it gets θR.
  - Due to the monotonicity, there exists a $\hat{\theta}$ *s.t.* type θ deposits *iff* $\theta \leq \hat{\theta}$.
    - $\mu_D = \mathbb{E}[\theta|\theta \leq \hat{\theta}] = \frac{1}{2}\hat{\theta}$.
    - Thus, given $\hat{\theta}$, the equilibrium repayment D_B must be determined by

$$\left[\left(1-\frac{1}{2}\hat{\theta}\right)p+\frac{1}{2}\hat{\theta}\right]D_B = \hat{\theta}R,$$

which yields

$$D_B(\hat{\theta}) = \frac{\hat{\theta}R}{p+(1-p)\frac{1}{2}\hat{\theta}}.$$

- For $D_B(\hat{\theta})$, the bank must prefer B to G, i.e., $p(H - D_B(\hat{\theta})) \geq S - D_B(\hat{\theta})$, or equivalently,

$$D_B(\hat{\theta}) \geq \frac{1}{1-p}(S - pH).$$

Lemma

Define $\underline{\theta}_B$ *as*

$$\underline{\theta}_B := \min\left\{ \frac{p(S-pH)}{(1-p)\left[R - \frac{1}{2}(S-pH)\right]}, 1 \right\}.$$

Then, the equilibrium where the bank chooses B exists only if $\hat{\theta} \geq \underline{\theta}_B$.

- Implications:
  - *(i)* The bank takes on excessive risk only if it retains a large deposit pool.
    - The bank must offer high repayment terms, worsening its capital structure.
  - *(ii)* Excessive risk-taking takes place only if $R > \frac{1}{2}(S - pH)$.
    - The bank has to offer a hefty deposit rate to maintain large-sized deposit pool.

- Next, consider an equilibrium where the bank chooses G.
  - Depositors do not need to monitor the bank's risk-taking.
  - By depositing to the bank. type θ consumer surely gets D.
  - By buying CBDC, type θ consumer gets θR.
- There exists a $\hat{\theta}$ *s.t.* type θ consumer deposits *iff* $\theta \leq \hat{\theta}$.
  - I.e., $\hat{\theta}$ is determined by $D = \hat{\theta} R$.
  - The repayment term D_G must be also determined by $D_G(\hat{\theta}) = \hat{\theta} R$.

- For $D_G(\hat{\theta})$, the bank must prefer G to B, i.e., $S - D_G(\hat{\theta}) \geq p(H - D_G(\hat{\theta}))$.

Lemma

Define $\overline{\theta}_G$ *as*

$$\overline{\theta}_G := \min\left\{\frac{S - pH}{(1-p)R}, 1\right\}.$$

Then, the equilibrium where the bank chooses G exists only if $\hat{\theta} \leq \overline{\theta}_G$.

- Implications:
  - The bank needs not to take excessive risk when it loses many depositors to CBDC.
  - The bank rather cheaply borrows from low-θ consumers.
    - Such a strategy shrinks the investment size but raises net return per unit capital.

- If the bank chooses B, the payoff is

$$\pi_B(\hat{\theta}) := \hat{\theta}\left[\left(1-\frac{1}{2}\hat{\theta}\right)(pH - D_B(\hat{\theta})) + \frac{1}{2}\hat{\theta}(S - D_B(\hat{\theta}))\right].$$

  Then, the maximum payoff for given R is

$$\bar{\pi}_B(R) := \max_{\hat{\theta}\geq\underline{\theta}_B} \pi_B(\hat{\theta}).$$

- Similarly, if the bank chooses G, the payoff is

$$\pi_G(\hat{\theta}) := \hat{\theta}(S - D_G(\hat{\theta})).$$

  Then, the maximum payoff for given R is

$$\bar{\pi}_G(R) := \max_{\hat{\theta}\leq\bar{\theta}_G} \pi_G(\hat{\theta}).$$

- Hence, for given R, the bank's optimal project is B *iff*

$$\bar{\pi}_B(R) \geq \bar{\pi}_G(R).$$

Theorem

There exist $\underline{R}^* \leq \overline{R}^*$ *such that the bank's optimal project selection is B if and only if* $R \in [\underline{R}^*, \overline{R}^*]$.

- The bank does not take on excessive risk if R is very high or very low.
  - If R is low ($R < \underline{R}^*$),
    - The bank needs not to offer a high deposit rate to keep many depositors.
    - At a relatively low borrowing cost, the bank has no incentive to risk-shift.
  - If R is high ($R > \overline{R}^*$),
    - The bank must offer a hefty rate if it decides to keep a large deposit pool.
    - But, such a strategy is loss-making, although the bank takes on high risk.
    - Instead, the bank lowers the borrowing cost by holding low-θ depositors only.

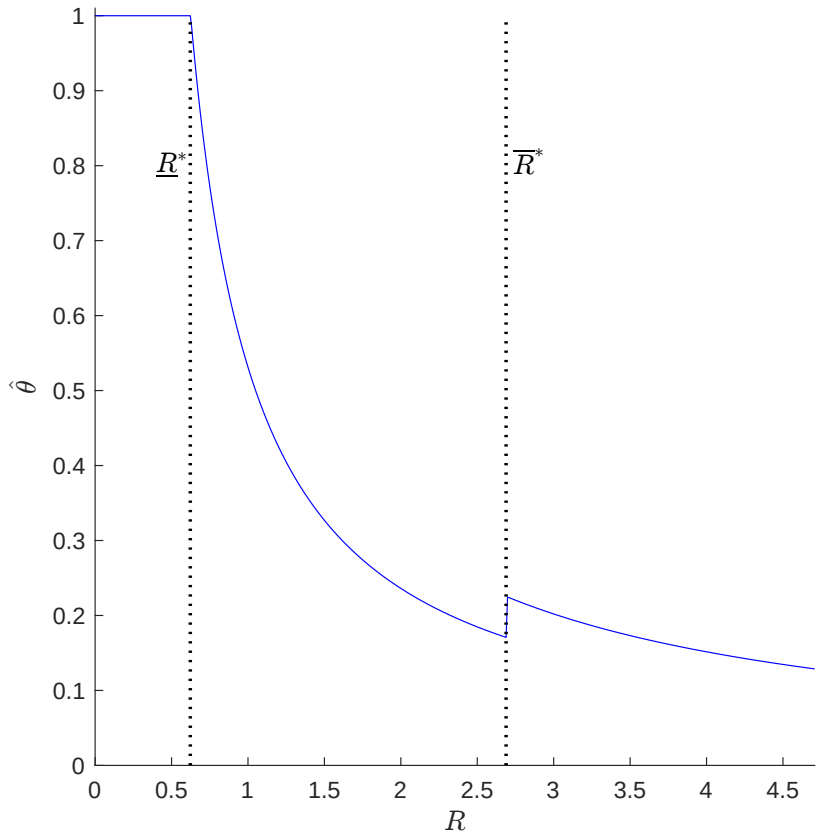
Theorem

There exist $\underline{R}^* \leq \overline{R}^*$ *such that the bank's optimal project selection is B if and only if* $R \in [\underline{R}^*, \overline{R}^*]$.

- However, the bank takes on excessive risk if R has intermediate value.
  - CBDC does not highly benefit users on average.
  - The bank can keep a relatively large deposit pool in competition with CBDC.
  - But, keeping the deposit pool in large size yields a high repayment cost.
  - The bank reacts to the high borrowing cost by taking on excessive risk.
  - Such excessive risk taking is less likely to be detected by depositors ($\hat{\theta} < 1$).
    - The depositors' average ability of bank monitoring is not very high.

Impacts of CBDC on Aggregate Banking Surplus

- Net surplus from banking per unit capital: $(S-1) \Rightarrow \left(1-\frac{1}{2}\hat{\theta}\right)(pH-1)+\frac{1}{2}\hat{\theta}(S-1)$.
- The impact on (dis-)intermediation by banking ($S=1.25, H=2.5$, and $p=0.34$):



Impacts of CBDC on Aggregate Banking Surplus

Theorem

There exists a $\hat{R}^* \in (\underline{R}^*, \overline{R}^*]$ *such that the aggregate banking surplus is decreasing (increasing) in* R *if* $R \in (\underline{R}^*, \hat{R}^*]$ *(*$R \in (\hat{R}^*, \overline{R}^*]$*).*

- Two opposing effects of increasing R:
  - (-) Weakened monitoring by the remaining depositors;
  - (+) Less consumers deposit into the bank investing in risky project.
- For relatively low (high) R, the negative (positive) effect outweighs.

(Normative) Implications

- In our model, R represents baseline consumer benefits from using CBDC.
  - Technological support of CBDC-based digital financial services.
  - Regulatory restrictions on DeFi service industry.
  - Network effects thanks to wide acceptance of CBDC as a major means of payment.

Normative Implications

#1: ICT Infrastructure for Digital Finance

- IT infrastructure provision may influence risk-taking behavior of traditional banks.
  - $R \uparrow$ as CBDC interoperability with blockchain and fintech industries increases.

    e.g. smart contracts in property trading via seamless linkage with CBDC ledger
- Fledgling or full-fledged IT infrastructure does not harm banking stability.
- In other states, CBDC distribution may result in excessive risk-taking by banks.

Normative Implications

#2: Regulations on CBDC

- R increases as financial regulations on CBDC in use for financial contracts are lifted.
- If banking stability is important, either light or heavy regulation on CBDC should be adopted.
  - In early CBDC stage, heavy regulations on the use of CBDC are natural.
  - But, a gradual de-regulation on CBDC may adversely worsen bank risk.
  - Rather, a jump to light-regulation regime may preserve banking stability.

Normative Implications

#3: Deposit Insurance

- Raising the limit of deposit insurance (DI) may help preservation of banking stability.
  - Bank “money” will become safer, and thus more attractive.
  - In our model, R becomes small relative to deposit repayments.
- To achieve banking stability, the DI limit should be substantially raised.
  - A high but mediocre increase in the DI limit adversely worsen banking stability.
- Furthermore, depositors’ incentive for bank discipline must be taken into account, too.
  - An increased deposit guarantee makes depositors less concerned about banks’ risk.
  - Demirgüç-Kunt and Detragiache (2002).

Conclusion

- We provide normative analysis of impacts of CBDC on banking stability.
  - Banks must offer generous deposit rates to keep depositors from adopting CBDC.
  - A change in capital structure may incentivize banks to take excessive risks.
  - Excessive risk taking occurs when the baseline CBDC surplus has intermediate value.
  - We then discuss the impacts of major policy changes with CBDC on banking stability.
- Future works:
  - Lobbying for regulations on DeFi.
    - between traditional banks and fintech service providers;
    - between central banks and private digital currency issuers.