Will Central Bank Digital Currency Disintermediate Banks?

NBER Summer Institute: Risks of Financial Institutions

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What is a CBDC?

A central bank digital currency (CBDC) is a country’s official currency in digital form.
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- Different from **existing digital money**: CBDC is a direct liability of the central bank rather than that of a commercial bank
- Different from **existing central bank accounts**: CBDC can be held by the public, not just banks
The increasing popularity of CBDC

data source: https://www.atlanticcouncil.org/cbdctracker/
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- CBDC countries account for over 95% of global GDP
Concerns about CBDC

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“Given that the average loan-to-deposit ratio for banks is generally around 1:1, every dollar that migrates from commercial bank deposits to CBDC is one less dollar of lending.”

—“Confronting the hard truths and easy fictions of a CBDC”, President of Bank Policy Institute, 2021
To what extent would CBDC disintermediate banks?
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- We estimate a dynamic banking model:
  - households: demand assets, based on interest rate & non-rate factors (estimated via BLP)
  - banks: take deposits/supply loans, in the presence of frictions (estimated via SMD)
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Quantify: the elasticity of substitution between CBDC and bank deposits
the pass-through from deposits to loans
Model overview

Time: 1, 2, 3 ...

Three players:

1. Depositors: simple, choose where to invest wealth
2. Borrowers: simple, choose (whether or not) how much to borrow
3. Banks: make dynamic optimization decisions ...
Imperfect competition in the deposit market

- Households choose from: savings/transaction deposits from $J$ oligopolistic banks, cash (and CBDC, in the counterfactual exercise), outside option (short-term bonds) to:

$$\max_{j \in A_d} \pi_{i,j}^d = \alpha_{i,j}^d r_{i,j}^d + q_{i,j}^d + \epsilon_{i,j}^d$$

- $r_{i,j}^d$ is the rate
- $q_{i,j}^d \equiv \beta_{i,j}^d \times x_{i,j}$ is the "quality" non-rate characteristics: #branch network, transaction convenience, ...
- $\epsilon_{i,j}^d$ is a preference shock (imperfect substitution)

Households differ in sensitivities to rate/non-rate characteristics ($\{\alpha, \beta\}$ are heterogeneous)
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Imperfect competition in the loan market

Same set of $J$ oligopolistic banks & mass 1 of borrowers (firms) who can borrow from a bank, issue a bond, or not borrow, to

$$\max_{j \in A^d} \pi^l_{i,j} = q^l_{i,j} - \alpha^l_i r^l_j + \epsilon^l_{i,j}$$

- $q^l_{i,j}$ is benefit from borrowing (and thus being able to invest), minus the issuance costs
- $r^l_{i,j}$ is the interest rate charged
- $\epsilon^l_{i,j}$ captures any firm-bank relationship
Banks’ problem

- Impose the standard assumption that $\epsilon$ follows a type I extreme value distribution
- We can calculate the total deposit and loan demanded for bank $j$:

\[
D_j^S(r^d, S) = \int \frac{\exp \left( \alpha_i^d r_j^d, S + q_{i,j}^d, S \right)}{\sum_{k \in A^d} \exp \left( \alpha_i^d r_k^d + q_{i,k}^d \right)},
\]

\[
D_j^T(r^d, T) = \int \frac{\exp \left( \alpha_i^d r_j^d, T + q_{i,j}^d, T \right)}{\sum_{k \in A^d} \exp \left( \alpha_i^d r_k^d + q_{i,k}^d \right)},
\]

\[
B_j(r^l) = \int \frac{\exp \left( q_{i,j}^l - \alpha_i^l r_j^l \right)}{\sum_{k \in A^l} \exp \left( q_{i,k}^l - \alpha_i^l r_k^l \right)}.
\]
The remaining bank balance sheet

<table>
<thead>
<tr>
<th>Assets</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Existing loans</td>
<td>Deposits</td>
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<td>New loans</td>
<td>$D^{S}(r^{d,S})+D^{T}(r^{d,T})$</td>
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<td>$L$</td>
<td>$D + N + E$</td>
</tr>
<tr>
<td>$B_{(r'_1)}$</td>
<td></td>
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<tr>
<td>$R$</td>
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This table illustrates the balance sheet of a typical bank at the beginning of the period. The bank's assets consist of existing plus new loans, reserves, and holdings of government securities; its liabilities consist of deposits and non-reservable borrowings.
Bank’s choice in a static, frictionless world

1. No financial frictions
2. No regulatory constraints
3. No maturity mismatch

\[ \Pi = \max_{\{r^l, r^d\}} \left( r^l L_j - r^d, S D_j^S - r^d, T D_j^T - f \left( L_j - D_j^S - D_j^T \right) \right) \]

* \( \left( L_j - D_j^S - D_j^T \right) \) is the bank’s funding surplus/gap
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* the optimal lending and deposit rates:

\[ r^{d,T/S}_j = f - \left( \frac{D_j^{T/S}'}{D_j^{T/S}} \right)^{-1}; \quad r^l_j = f + \left( -\frac{L_j'}{L_j} \right)^{-1} \]
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Irrelevance result: deposit-taking and loan-origination are **separable** in the frictionless benchmark
Intuition behind the irrelevance result

- If banks can frictionlessly access wholesale funding, then loans should be priced w.r.t. the market interest rate rather than deposit rates.
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- Accessing cheap deposits makes banks overall more profitable but does not make lending more profitable at the margin.
Intuition behind the irrelevance result

- If banks can frictionlessly access wholesale funding, then loans should be priced w.r.t. the market interest rate rather than deposit rates.

- Accessing cheap deposits makes banks **overall more profitable** but does not make lending more profitable **at the margin**.

- Clarify some confusions in the current discussion of CBDC:
  - e.g., “given that loan-to-deposit ratio is 1:1, every dollar that migrates from deposits to CBDC is one less dollar of lending.”
Potential disintermediation channels

- The irrelevance result also guides us to isolate channels that do allow CBDC to impact lending:
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1. External financing frictions:
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   — CBDC reduces bank capital, constraining lending capacity
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3. Maturity transformation:
   — Banks’ market power makes deposits effectively long duration; CBDC changes banks’ asset composition and their interest risk exposure
Banks’ choice in a dynamic model with frictions

\[ V = \max_{\{\text{prices, BS var}\}} \beta \{\text{Dividend} = \text{frictionless } \Pi - \text{financing costs} - \Delta \text{ Equity}\} + \beta \mathbb{E} V' \]

*Bank defaults and is auctioned off when \( V < 0 \)
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1. **Regulatory constraints:**
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2. **Financial frictions** for wholesale borrowing = \( \phi(N) + r^N \)
   - \( \phi(N) \) is the exogenous cost to search/maintain relationships
   - \( r^N \) is endogenous credit spread so that lenders break even
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\( 1 + 2 + 3 \) connects banks’ optimal deposit and lending decisions
Characterize our solution

- We solve the model by value function iteration:

- A Perfect Bayesian Equilibrium occurs when:
We solve the model by value function iteration:

A Perfect Bayesian Equilibrium occurs when:

1. All agents optimize
2. All markets clear
3. Everyone has rational expectation
IO estimation in a dynamic banking model

We divide our estimation into two stages:

1. **First stage:** estimate deposit/loan demand via BLP
   - how consumers’ utilities (portfolio share) vary with rates
   - value attached to non-rate characteristics
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▶ Untargeted moments:
   - bank credit spread
   - time series variations of deposit and loan rates
We introduce CBDC

- We model a new product (CBDC) as a "bundle" of characteristics
  1. may bear some interest rate (baseline: 0%)
  2. offers transaction convenience like transaction deposits
  3. has the same issuer FE as cash
  4. carries a "digital premium"
     * Koont (2022): deposit demand 20% after commercial banks go "digital"
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- Large *uncertainty in the “quality" perception of CBDC
  — we vary the CBDC “quality” parameter and calculate the elasticity of bank behaviors ...
### Counterfactuals: varying CBDC quality

<table>
<thead>
<tr>
<th>(1) CBDC Share</th>
<th>(2) 25%</th>
<th>(3) 50%</th>
<th>(4) 75%</th>
<th>(5) 100%</th>
<th>(6) Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) No CBDC</td>
<td>0.000</td>
<td>0.005</td>
<td>0.012</td>
<td>0.030</td>
<td>0.076</td>
</tr>
<tr>
<td>(2) Deposits</td>
<td>0.876</td>
<td>0.872</td>
<td>0.868</td>
<td>0.851</td>
<td>0.814</td>
</tr>
<tr>
<td>(3) Cash</td>
<td>0.070</td>
<td>0.069</td>
<td>0.068</td>
<td>0.066</td>
<td>0.062</td>
</tr>
<tr>
<td>(4) Loan</td>
<td>1.021</td>
<td>1.016</td>
<td>1.015</td>
<td>1.016</td>
<td>1.007</td>
</tr>
<tr>
<td>(5) Deposit spread (%)</td>
<td>1.125</td>
<td>1.117</td>
<td>1.117</td>
<td>1.113</td>
<td>1.092</td>
</tr>
<tr>
<td>(6) Loan spread (%)</td>
<td>2.177</td>
<td>2.182</td>
<td>2.183</td>
<td>2.182</td>
<td>2.189</td>
</tr>
<tr>
<td>(7) Bank credit spread (%)</td>
<td>0.100</td>
<td>0.112</td>
<td>0.112</td>
<td>0.112</td>
<td>0.132</td>
</tr>
<tr>
<td>(8) Funding cost (%)</td>
<td>1.291</td>
<td>1.305</td>
<td>1.321</td>
<td>1.335</td>
<td>1.357</td>
</tr>
<tr>
<td>(9) Bank value</td>
<td>1.846</td>
<td>1.843</td>
<td>1.835</td>
<td>1.833</td>
<td>1.821</td>
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— One dollar increase in CBDC decreases deposits by 82 cents,

...the effect on loans is much smaller (19 cents)
Alternative implementation

**Interest-bearing CBDC**: pays an interest ranging from 0% to 100% of FFR

- crowds out bank deposits more strongly
- stronger substitution with high-rate products
- $1 of CBDC crowds out lending by 27 cents
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(2) central bank will reimburse private banks for their service

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Across all cases: a small fraction of deposit market effect ($< \frac{1}{3}$) is passed through to loan provision
The heterogeneous Impact of CBDC

1. Among smaller banks:
   — $1 CBDC decreases lending of big (small) banks by 14.6 (40.7) cents
   — $1 CBDC decreases deposits by similar magnitudes
   — smaller banks face much higher costs of accessing wholesale funding
The heterogeneous Impact of CBDC

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2. In more competitive markets:
   — $1 CBDC decreases lending by 5 cents (42 cents) when the county-level market concentration is at the 50th (90th) percentile
   — less well capitalized banks find it harder to adapt to competition shocks
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▶ CBDC is likely to have important redistributional effects
Robustness

- Treasuries have a liquidity premium
  - can increase if the central bank invests funds raised from CBDC into treasuries
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- Alternative forms of wholesale borrowing cost
  - pin the curvature of banks’ wholesale borrowing cost
  - let the cost depend on aggregate deposit/loan market variables
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- Consider banks’ costly equity issuance
Conclusion: we provide a framework to quantify the impact of CBDC on bank behavior

CBDC can replace a significant fraction of bank deposits

...but unlikely to disintermediate banks too much on average
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Subsample analysis implies that the effect can be more significant for smaller & more competitive banks