Central bank digital currency: 
the future of money and banking?

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Message

- **Central bank digital currency (CBDC)**
  - rapidly growing literature with many proposals
  - this talk: interest-bearing reserve accounts for everyone

- **Market for liquidity**
  - bank deposits: bond with option to sell on demand
  - credit lines: option to get loan on demand

- **Commercial banks**
Deposits and credit card limits at US commercial banks
Message

- Central bank digital currency (CBDC)
  - rapidly growing literature with many proposals
  - this talk: interest-bearing reserve accounts for everyone

- Market for liquidity
  - bank deposits: bond with option to sell on demand
  - credit lines: option to get loan on demand

- Commercial banks
  - add value by providing liquidity
  - complementarity between bank deposits & credit lines

⇒ CBDC not complementary to credit lines, beneficial only if much cheaper to produce than deposits
Framework

- Preferences & technology as in neoclassical growth model
  - households work & consume goods
    - complete financial markets → representative household
  - competitive firms
    - make goods from capital & labor, capital from goods

- Liquidity constraints
  - buyers of goods = households & capital producers
    - need payment instruments before buying
    - unpredictable liquidity needs: only share v gets chance to buy
  - sellers = producers of goods
    - need payment instruments after selling
    - predictable liquidity needs: store funds, pay wages & rents later
  - banks = providers of payment instruments
    - need payment instruments to meet customer outflows
Payment instruments & financial frictions

- Competitive banks offer 2 payment instruments
  - deposits: hold before trade, spend if needed, keep otherwise
  - credit lines: draw down to receive loan if needed, don’t use otherwise
  - prices per unit of liquidity provided

- Financial frictions in banks & firms
  - collateral constraint: debt $\leq \phi$ value of assets
  - asset management services $\kappa$ per unit of assets at price $p$
  - services require capital & labor $\rightarrow$ keep balance sheets short!

- Capital markets
  - costless adjustment of equity in banks, firms
  - equilibrium size of banking "small" relative to capital stock
  - households, banks & central bank can invest directly in capital

  Ricardian equivalence & MM hold except for liquid instruments
Comparing payment systems

- Characterizing equilibrium
  - allocation = solution to planner problem w/ resource constraint
    \[ C_t (1 + \Omega^c_t) + l_t (1 + \Omega^i_t) = Y_t (1 - \Omega^y_t) \]
  - liquidity costs \( \Omega \)s depend on details of payment system

- Real effects of payment system
  - more costly payment system = less efficient production technology
    allocation responds as in neoclassical growth model
  - effects may differ by sector
    for example, \( \Omega^i > \Omega^c \rightarrow \) payment system discourages investment
  - "banking crisis" = shift in \( \Omega \)s = technology shock

- Now derive \( \Omega \)s & steady-state welfare for different payment systems
Banks offer only deposits

- How many deposits are needed to support trade?
- buyers of goods = households & capital producers
  - only share $v$ actually spends deposits to buy
  - buying $C_t + I_t$ requires deposits $D_t = \frac{(C_t + I_t)}{v}$ before trade
  - liquidity needs are unpredictable: precautionary deposit holdings
- sellers = producers of goods
  - selling $C_t + I_t$ requires deposits $vD_t = C_t + I_t$ after trade
- Who trades with whom & bank liquidity management
  - many identical banks, households & firms
  - all interbank flows wash out; bank liquidity constraints do not bind
  - liquidity shocks, reserves & funds market: Piazzesi & Schneider 2018
Banks offer only deposits

Before trade

Buyer
A | L
---|---
D

Seller
A | L
---|---

Bank
A | L
---|---
K | D | E

Central Bank
A | L
---|---

After trade

Buyer
A | L
---|---

Seller
A | L
---|---

Bank
A | L
---|---
K | D | E

Central Bank
A | L
---|---

\[(1 - \nu)D \rightarrow vD\]
Banks offer only deposits

**Before trade**

<table>
<thead>
<tr>
<th>Buyer</th>
<th>Seller</th>
<th>Bank</th>
<th>Central Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>((C + I)/v)</td>
<td>(1 + (\Omega^c_t))</td>
<td>D/(\phi)</td>
<td>D/(\phi)</td>
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</table>

**After trade**

<table>
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<tr>
<td>A</td>
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</tr>
<tr>
<td>(((C + I)^{\frac{1-v}{v}}))</td>
<td>Y</td>
<td>D/(\phi)</td>
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**Liquidity costs**

\[
C_t (1 + \Omega^c_t) + I_t (1 + \Omega^i_t) = Y_t (1 - \Omega^y_t)
\]

\[
\Omega^c = p \frac{\kappa}{\phi} \frac{2 - v}{v}
\]

\[
\Omega^i = p \left( \frac{\kappa}{\phi} + \kappa^i \right) \frac{2 - v}{v}
\]

\[
\Omega^y = p \frac{\kappa}{\phi}
\]
Banks offer only deposits

- Resource constraint for equivalent planner problem

\[
C_t \left(1 + p \frac{\kappa \cdot 2 - v}{\phi} \right) + I_t \left(1 + p \frac{2 - v}{v} \left(\frac{\kappa}{\phi} + \kappa^i\right)\right) = Y_t \left(1 - p \frac{\kappa}{\phi}\right)
\]

- Properties of banking with deposits
  - liquidity costs are high if liquidity needs are unpredictable
    (\(v\) small, large precautionary deposit holdings)
  - investment extra costly because firms are not natural savers
    (balance sheet costs \(\kappa^i\))
Banks offer deposits & credit lines

- How many deposits & credit lines are needed to support trade?
- buyers of goods
  - suppose only use credit lines
  - buying $C_t + l_t$ requires credit limits $L_t = (C_t + l_t)/v$ before trade
  - actual loans drawn down = $vL_t = C_t + l_t$
- sellers
  - selling $C_t + l_t$ requires deposits $vD_t = C_t + l_t$ after trade
Banks offer deposits & credit lines

Before trade

Buyer
A  L

Seller
A  L

Bank
A  L

Central Bank
A  L

After trade

Buyer
A  L

Seller
A  L

Bank
A  L

Central Bank
A  L

The diagram illustrates the flow of deposits and credit lines before and after a trade. The arrows indicate the movement of funds between the buyer, seller, bank, and central bank.
Banks offer deposits & credit lines

Before trade

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After trade

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<td>L</td>
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<tr>
<td>C + I</td>
<td>Y</td>
<td>vL</td>
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Liquidity costs

\[ C_t (1 + \Omega^c_t) + I_t (1 + \Omega^i_t) = Y_t (1 - \Omega^y_t) \]

\[ \Omega^c = 0 \quad \Omega^i = 0 \quad \Omega^y = p \frac{K}{\phi} \]
Banks offer deposits & credit lines

- Resource constraints with & without credit lines
  \[ C_t + I_t = Y_t \left(1 - p \frac{\kappa}{\phi}\right) \]
  \[ C_t \left(1 + p \frac{\kappa 2 - \nu}{\phi \nu}\right) + I_t \left(1 + p \frac{2 - \nu}{\nu} \left(\frac{\kappa}{\phi} + \kappa^i\right)\right) = Y_t \left(1 - p \frac{\kappa}{\phi}\right) \]

- Welfare gains from credit lines
  1. avoid precautionary holdings of deposits = higher TFP
  2. avoid firms’ balance sheet costs = investment-specific tech progress
  3. complementarity of products at banks = higher TFP
due to collateral savings, not liquidity constraint
Central bank offers CBDC

- Central bank
  - maximal leverage $\phi^*$, asset management costs $\kappa^*$
  - CBDC = central bank deposits offered at marginal cost

- CBDC good only if central bank technology better
  - welfare gains require $\kappa^*/\phi^* < \kappa/\phi$
  - either cheaper asset management or better ability to commit

- CBDC good if technology better & banks offer only deposits
  - all depositors migrate to central bank
  - commercial banks disappear; no value beyond liquidity provision
  - investment *increases* because liquidity is cheaper

- CBDC good if banks also offer credit lines?
Equilibrium with CBDC, bank deposits & credit lines

- Buyers’ and sellers’ choice of payment instruments
  - deposits and CBDC priced the same $\rightarrow$ bank customers indifferent
  - here: buyers still use credit lines ($\nu$ small, $\kappa^*/\phi^*$ not too small)
  - paper: also case when households stop using credit lines

- Response by commercial banks
  - still issue deposits, match higher interest rate earned on CBDC
  - increase price of credit lines to break even
  - high funding costs, no longer profitable to invest in capital
  - bank assets = loans from drawn credit lines
  - deposit outflow to CBDC
  - liquidity constraint: banks hold CBDC before trade
Equilibrium with CBDC, bank deposits & credit lines

Before trade

Buyer

A | L

Seller

A | L

Bank

A | L

\[(1 - \phi)vL \quad EvL\]

Central Bank

A | L

\[K^* \quad (1 - \phi)vL \quad E^*\]

After trade

Buyer

A | L

\[vL \quad vL\]

Seller

A | L

\[vL \quad \phi vL\]

Bank

A | L

\[vL \quad \phi vL \quad E\]

Central Bank

A | L

\[K^* \quad (1 - \phi)vL \quad E^*\]
Equilibrium with CBDC, bank deposits & credit lines

- Comparing resource constraints

CBDC improves welfare if & only if

\[
\frac{\kappa^*}{\phi^*} < \frac{1 - \phi \kappa}{2 \phi}
\]

- if CBDC sufficiently cheap to offset cost of credit line = higher TFP
- if \(\kappa^*/\phi^*\) only marginally below \(\kappa/\phi\), CBDC reduces welfare
Central bank credit line

- Can CB help keep asset side of banks unchanged?
  - Yes: offer credit line to banks, priced at $\kappa/\phi$

- Choice of payment instruments
  - buyers still use credit line
  - all deposits migrate to CB

- Commercial bank response
  - before trade: no need for holding liquid funds
  - after trade: deposits replaced by loan from central bank

- Comparing resource constraints
  - $\Omega^c = \Omega^i = 0$, same as before CBDC
  - but $\Omega^y = p(\kappa/\phi + \kappa^*/\phi^*)$ is larger
  - sum of balance sheets now longer $\rightarrow$ higher cost
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