

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

Monika Piazzesi
Stanford & NBER

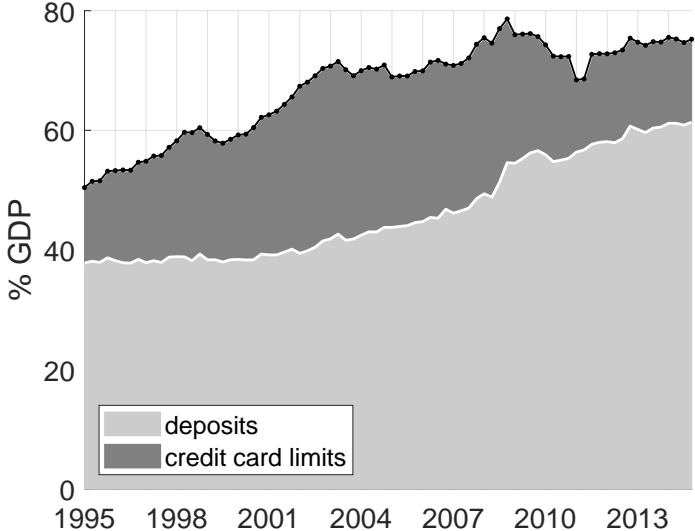
Martin Schneider
Stanford & NBER

Eltville, June 21 & 22, 2019

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: $\text{debt} \leq \phi$ value of assets
 - ▶ asset management services κ 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

$$C_t(1 + \Omega_t^c) + I_t(1 + \Omega_t^i) = Y_t(1 - \Omega_t^y)$$

- ▶ liquidity costs Ω 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 Ω s = technology shock

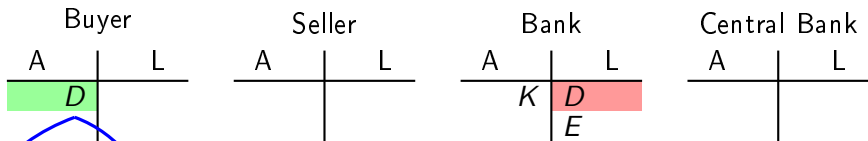
- Now derive Ω s & steady-state welfare for different payment systems

Banks offer only deposits

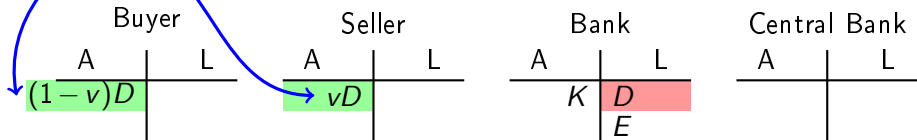
- How many deposits are needed to support trade?
- buyers of goods = households & capital producers
 - ▶ only share v actually spends deposits to buy
 - ▶ buying $C_t + I_t$ requires deposits $D_t = (C_t + I_t)/v$ *before* trade
 - ▶ liquidity needs are unpredictable: precautionary deposit holdings
- 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



After trade



Banks offer only deposits

Before trade

Buyer	Seller	Bank	Central Bank																		
<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td>$(C+I)/v$</td><td></td></tr> </table>	A	L	$(C+I)/v$		<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td></td><td></td></tr> </table>	A	L			<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td>D/ϕ</td><td>D</td></tr> <tr><td></td><td>E</td></tr> </table>	A	L	D/ϕ	D		E	<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td></td><td></td></tr> </table>	A	L		
A	L																				
$(C+I)/v$																					
A	L																				
A	L																				
D/ϕ	D																				
	E																				
A	L																				

After trade

Buyer	Seller	Bank	Central Bank																		
<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td>$(C+I)\frac{1-v}{v}$</td><td></td></tr> </table>	A	L	$(C+I)\frac{1-v}{v}$		<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td>Y</td><td></td></tr> </table>	A	L	Y		<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td>D/ϕ</td><td>D</td></tr> <tr><td></td><td>E</td></tr> </table>	A	L	D/ϕ	D		E	<table border="1"> <tr><td>A</td><td>L</td></tr> <tr><td></td><td></td></tr> </table>	A	L		
A	L																				
$(C+I)\frac{1-v}{v}$																					
A	L																				
Y																					
A	L																				
D/ϕ	D																				
	E																				
A	L																				

Liquidity costs

$$C_t(1 + \Omega_t^c) + I_t(1 + \Omega_t^i) = Y_t(1 - \Omega_t^y)$$

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

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

$$\Omega^y = p \frac{\kappa}{\phi}$$

Banks offer only deposits

- Resource constraint for equivalent planner problem

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

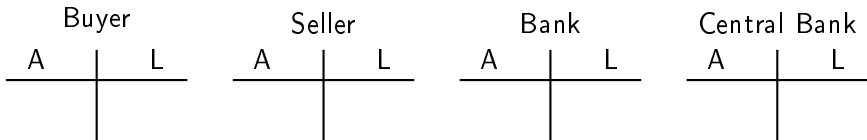
- Properties of banking with deposits
 - ▶ liquidity costs are high if liquidity needs are unpredictable
(v small, large precautionary deposit holdings)
 - ▶ investment extra costly because firms are not natural savers
(balance sheet costs κ^i)

Banks offer deposits & credit lines

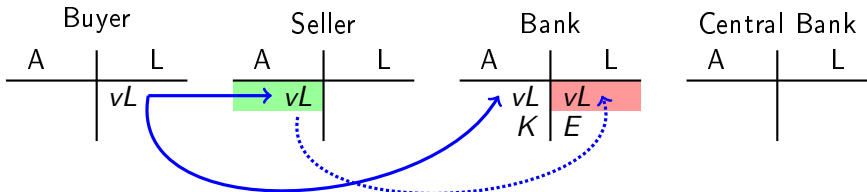
- How many deposits & credit lines are needed to support trade?
- buyers of goods
 - ▶ suppose only use credit lines
 - ▶ buying $C_t + I_t$ requires credit limits $L_t = (C_t + I_t)/v$ *before* trade
 - ▶ actual loans drawn down = $vL_t = C_t + I_t$
- sellers
 - ▶ selling $C_t + I_t$ requires deposits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

Banks offer deposits & credit lines

Before trade



After trade

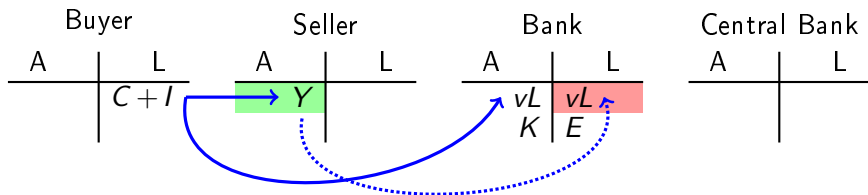


Banks offer deposits & credit lines

Before trade



After trade



Liquidity costs

$$C_t(1 + \Omega_t^c) + I_t(1 + \Omega_t^i) = Y_t(1 - \Omega_t^y)$$

$$\Omega^c = 0$$

$$\Omega^i = 0$$

$$\Omega^y = p \frac{\kappa}{\phi}$$

Banks offer deposits & credit lines

- Resource constraints with & without credit lines

$$C_t + I_t = Y_t \left(1 - p \frac{\kappa}{\phi} \right)$$
$$C_t \left(1 + p \frac{\kappa}{\phi} \frac{2 - \nu}{\nu} \right) + I_t \left(1 + p \frac{2 - \nu}{\nu} \left(\frac{\kappa}{\phi} + \kappa^i \right) \right) = Y_t \left(1 - p \frac{\kappa}{\phi} \right)$$

- Welfare gains from credit lines
 - avoid precautionary holdings of deposits = higher TFP
 - avoid firms' balance sheet costs = investment-specific tech progress
 - complementarity of products at banks = higher TFP
due to collateral savings, not liquidity constraint

Central bank offers CBDC

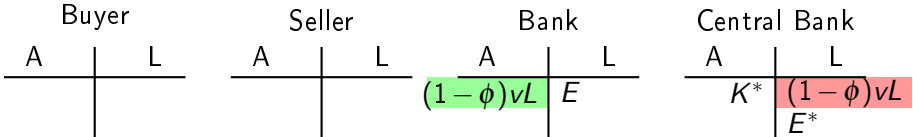
- Central bank
 - ▶ maximal leverage ϕ^* , asset management costs κ^*
 - ▶ CBDC = central bank deposits offered at marginal cost
- CBDC good only if central bank technology better
 - ▶ welfare gains require $\kappa^*/\phi^* < \kappa/\phi$
 - ▶ either cheaper asset management or better ability to commit
- 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

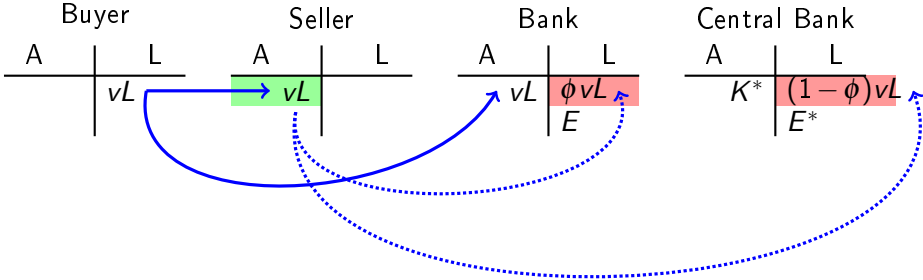
- Buyers' and sellers' choice of payment instruments
 - ▶ deposits and CBDC priced the same \rightarrow bank customers indifferent
 - ▶ here: buyers still use credit lines (v small, κ^*/ϕ^* not too small)
 - ▶ paper: also case when households stop using credit lines
- Response by commercial banks
 - ▶ 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



After trade



Equilibrium with CBDC, bank deposits & credit lines

- Comparing resource constraints

CBDC improves welfare if & only if $\frac{\kappa^*}{\phi^*} < \frac{1-\phi}{2} \frac{\kappa}{\phi}$

- if CBDC sufficiently cheap to offset cost of credit line = higher TFP
- if κ^*/ϕ^* only marginally below κ/ϕ , CBDC reduces welfare

Central bank credit line

- Can CB help keep asset side of banks unchanged?
 - ▶ Yes: offer credit line *to banks*, priced at κ/ϕ
- 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

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