

Central Bank Digital Currency and banks' disintermediation in a portfolio choice model

Huifeng Chang
UCLA

Federico Grinberg
IMF

Lucyna Gornicka
IMF

Marcello Miccoli
IMF

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Motivation: CBDC impact on banks?

CBDC may accomplish different policy objectives

- ▶ more efficient, secure, and modern central bank money available to everyone
- ▶ strengthen resilience, availability, and contestability of retail payments

Key concern:

will CBDC (structurally) disintermediate deposit collecting institutions?

Today:

use a (fairly) standard **portfolio choice model with banks** as a **laboratory to analyse disintermediation** when CBDC is introduced

Findings overview (1/2): Basic model

Portfolio model with banks

- ▶ Households hold illiquid and (imperfectly substitutable) liquid assets
- ▶ Banks have market power in deposits and exogenous investment opportunities

Finding # 1: No disintermediation when CBDC is introduced

Banks compete with CBDC by **increasing deposits' remuneration** → deposits **increase** (even though profits decrease)

Findings overview (2/2): Enriched model

Portfolio model with banks

- ▶ Households hold illiquid and (imperfectly substitutable) liquid assets
- ▶ Banks have market power in deposits and exogenous investment opportunities
- ▶ (Different) Fixed costs of holding CBDC and deposits
- ▶ Heterogeneous and skewed households' wealth distribution
 - ▶ Generates extensive margin: HHs choose which liquid asset to hold

Finding # 2: Total deposits **may fall** in enriched model when CBDC is introduced, **but:**

1. only under special conditions
2. the effect on **lending** is quantitatively **small**

Intuition: Banks do not aggressively fight to prevent the outflow of poorer customers

Open questions

Simple model yields analytical results, while enriched model requires numerical simulations

- ▶ Generality of enriched model results?

Rich parametrization, still many questions to be answered with it:

- ▶ quantitative effect of remunerated CBDC? What if CBDC is a 'supercharged' payment tool with respect to bank deposits? (will not change simple setup result)
- ▶ How important is banking sector structure?

Increasing complexity towards a general equilibrium model

- ▶ Welfare analysis?
- ▶ Role of central bank balance sheet / monetary policy stance?

How does our paper relate to the literature

Macro implications of CBDC Barrdear and Kumhof (2016), Keister and Sanches (2018), Brunnermeier and Niepelt (2019), Williamson (2019), Piazzesi and Schneider (2020)

CBDC and banks Andolfatto (2020), Agur et al. (2019), Keister and Sanches (2019), Chiu et al. (2019)

Imperfect competition in banking system Dreschler et al (2017), Repullo (2020)

Extensive and intensive margins of adjustment
Hopenhayn (1992), Melitz (2003)

Introduction

Model

Basic: analytical results with homogeneous HHs

Enriched: quant. results with heterog. HHs and extensive margin of deposits

Extension: lending and wholesale funding for banks

Next steps and conclusions

Model setup: overview

Portfolio choice model with a monopolistically competitive banking sector:

- ▶ Households invest and manage liquidity needs
 - Notes (cash) (N), earns no return
 - CBDC (C), earns $r_C \geq 0$
 - Deposits (D), earn r_D
 - Bonds (B) do not provide liquidity services, earn f
- ▶ N , C , and B have fully elastic supply
- ▶ Banks provide D (set r^D) and invest in B (extension: lending activities and wholesale funding)
- ▶ Central bank sets the rates on B (f) and C (r^C)

Households' portfolio choice model

- ▶ Homogenous households

$$u(W_0) = \max \left[\left(W^{\frac{\rho-1}{\rho}} + \lambda L^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \right]$$

- ▶ Liquidity services L : $L(N, C, D) = \left(N^{\frac{\epsilon-1}{\epsilon}} + \delta_D D^{\frac{\epsilon-1}{\epsilon}} + \delta_C C^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$
 - ▶ $\rho < 1$: W (wealth) and L (liquidity) are complements
 - ▶ $\epsilon > 1$: N (notes), D (deposits), and C (CBDC) are substitutes

Budget constraint:

$$\begin{aligned} W &= W_0(1+f) - Nf - D(f - r_D) - C(f - r_C) \\ &= W_0(1+f) - s_L L \end{aligned}$$

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Where s_L : opportunity cost of holding liquid assets

Banking sector

- ▶ There are J identical banks, indexed by j
- ▶ Banks provide D_j and invest in B with return f
- ▶ Banks act as competitive monopolists in deposits
 - ▶ set r_j^D in order to maximize profitability, $D_j(f - r_j^D)$
 - ▶ Deposits are aggregated with

$$D = \left(\frac{1}{J} \sum_{j=1}^J D_j^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}},$$

where $\eta > 1$: D_j from each bank are substitutes

CBDC characteristics

- ▶ It is an imperfect substitute to both cash and deposits, but under $\delta_C > \delta_D > 1$, it provides more liquidity services than deposits and cash.
- ▶ It can pay a positive rate r_C

The exercise is to **compare the equilibrium without CBDC ($\delta_C = 0$) with one in which CBDC is present ($\delta_C > 0$)** :

Equilibrium without CBDC

Assume there is no CBDC ($\delta_C = 0$). Then (as $\lambda \rightarrow 0$):

$$r^{D*} = \omega(\cdot)f, \quad \text{where } 0 < \omega < 1$$

$$D^* = \kappa(\cdot) \left(f - r^{D*} \right)^{-\rho}$$

- ▶ r^{D*} increases in the policy rate, but less than proportionally (banks' market power)
- ▶ Deposits increase in the rate on deposits, and decrease with the policy rate

Equilibrium with CBDC

Assume now the CBDC is introduced ($\delta_C > 0$). Then (as $\lambda \rightarrow 0$):

$$r_{CBDC}^D = \omega_{CBDC} f, \quad \text{where } 0 < \omega_{CBDC} < 1$$
$$D_{CBDC}^* = \kappa_{CBDC} \left(f - r_{CBDC}^D \right)^{-\rho}$$

Prop. 1: When CBDC is introduced, r^{D*} and D^* increase

▶ Competition from C forces banks to increase r^D
⇒ banks prevent HHs substituting away from D

▶ Overall cost of holding liquid assets decline

$$s_l = \left(f^{1-\epsilon} + \delta_D^\epsilon (f - r^{D*})^{1-\epsilon} + \delta_C^\epsilon (f - r_C)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} \downarrow$$

⇒ demand for liquidity increases, which also increase D holdings

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Equilibrium with CBDC: comparative statics (1/2)

When the CBDC is introduced:

Prop. 2: the increase in r^{D^*} and D^* is higher if C is remunerated

- ▶ Increased competition to deposits from interest bearing C ($r^C > 0$)

Prop. 3: the increase in r^{D^*} is higher, while the increase in D^* holdings is lower when the f is high

- ▶ Higher f allow banks more space to increase r^{D^*}
- ▶ When f high, costs of holding liquid assets decrease relatively less

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Equilibrium with CBDC: comparative statics (2/2)

When CBDC is introduced:

Prop. 4: r^{D^*} increase by less, and D^* grow by more, if there is more competition among banks (higher J or higher D_j substitutability η)

More competition implies:

- ▶ banks do not have much space to change remuneration on deposits \rightarrow smaller increase in r^{D^*}
- ▶ higher elasticity of aggregate deposits with respect to changes in rates \rightarrow larger increase in D^*

Household portfolio choice: enriched model

- ▶ Households differ in initial wealth (W_0 , distributed as Pareto)
- ▶ Households face a utility cost to access D (ϕ^D) or C (ϕ^C):
assume $\phi^C < \phi^D$

$$u(W_0) = \max \left[(W^{\frac{\rho-1}{\rho}} + \lambda L^{\frac{\rho-1}{\rho}})^{\frac{\rho}{\rho-1}} - \mathbb{1}(\phi) \right]$$

$$\text{where } \mathbb{1}(\phi) \equiv \begin{cases} \phi^C & \text{if } C > 0 \\ \phi^D & \text{if } D > 0 \\ \phi^C + \phi^D & \text{if } C > 0 \text{ and } D > 0 \end{cases}$$

Enriched model:

- ▶ Utility costs to access C , HHs can hold C and/or $D \Rightarrow$ financial inclusion (extensive margin)
- ▶ Richer setup, more complex \Rightarrow numerical solutions

HH's heterogeneity and costly access: equilibrium

Equilibrium: Households will sort into users of one more liquidity instruments, depending on their wealth level.

▶ **Before CBDC:**

Poorer households will hold only N

Richer households will also hold D

▶ **After CBDC's introduction:**

▶ Very poor households will hold only N

Middle class households will hold N and C

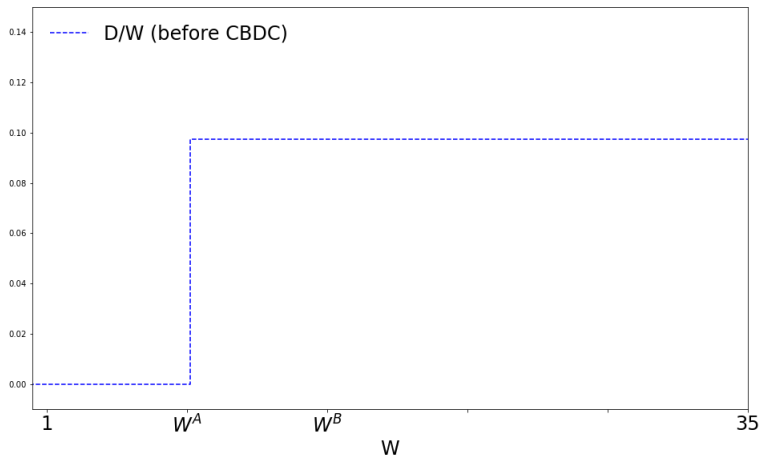
Richer households will hold N , C and D

▶ For high $f \rightarrow$ high opportunity costs of not holding $D \rightarrow$ more households will hold D (incl "middle class")

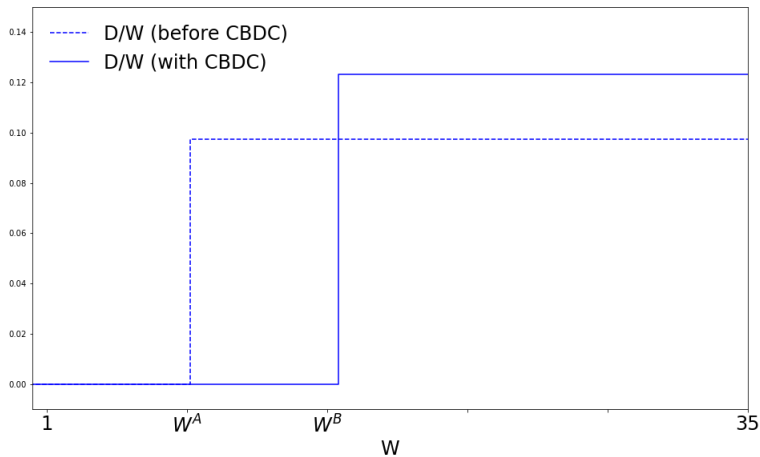
Calibration

Parameter	Value
λ	0.001
ρ	0.2
ϵ	2
η	1.1
J	4
δ_D	1.3
δ_C	1.5
ϕ^D	$0.15 \times \lambda^\rho$
ϕ^C	$0.001 \times \lambda^\rho$
f	0.03
r_C	0

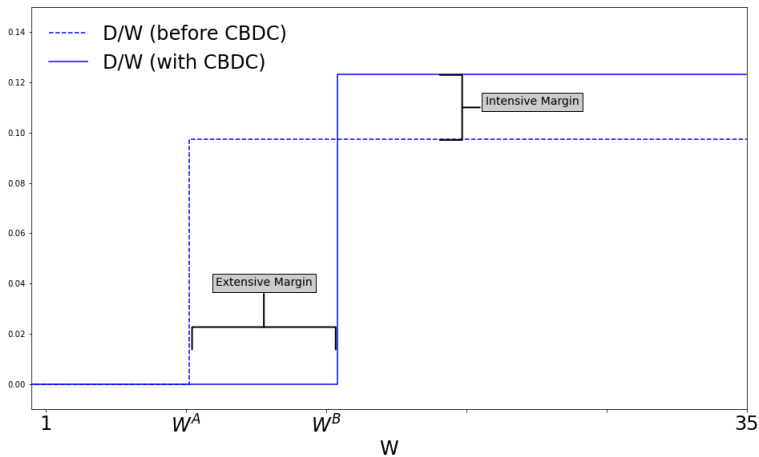
Portfolio adjustment when CBDC is introduced:



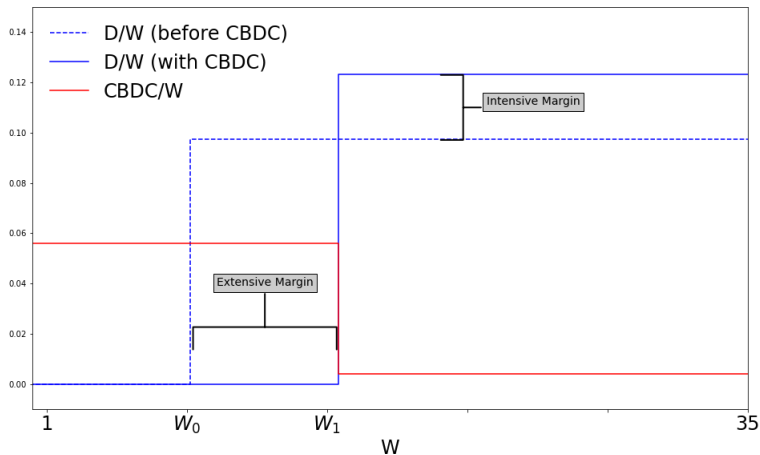
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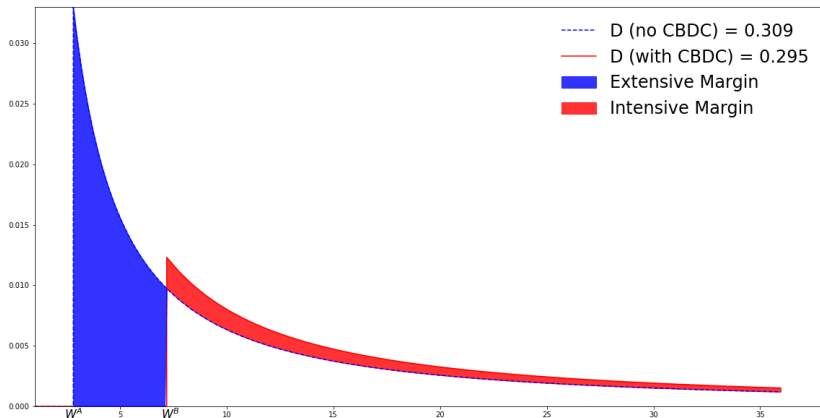


Portfolio adjustment when CBDC is introduced:



Total effect of introducing CBDC

Aggregate deposits fall by 4.5%



Results with heterog. HHs and financial inclusion

- ▶ **Under special circumstances**, the introduction of CBDC leads to a **reduction** in the amount of bank deposits
 - ▶ Financial inclusion improves (HHs now hold CBDC)
 - **Key assumptions:**
 1. access to CBDC is cheaper than bank deposits $\phi^C \ll \phi^D$
 2. Wealth distribution is unequal (large α)
 3. Low policy rate
- ▶ **Intuition:** Banks do not have enough incentives to further increase deposits rates to go after HHs who chose not to hold deposits accounts
 - ▶ Easy access to CBDC: HHs with low wealth choose to set up a CBDC account instead of a bank deposit account (*extensive margin*)
 - ▶ Unequal wealth distribution: low wealth HHs own only a small fraction of wealth
 - ▶ Fall in deposits happens for *low* policy rate
 - ▶ Low policy rate reduces the return from holding deposits and thus their advantage over CBDC

Extension: lending and wholesale funding

- ▶ The model can be easily extended, adding richness in banks' balance sheets: lending and wholesale funding

Lending is “unproductive” and given to firms outside of the economy.

Bank i lends (L_i) and uses wholesale funding (H_i) and deposits (D_i) to solve

$$\max_{D_i, H_i} \left(f + l_0 - \frac{l_1}{2} L_i \right) L_i - \left(f + \frac{h}{2} H_i \right) H_i - r_{D,i} D_i \quad (1)$$

s.t. $L_i = H_i + D_i$, with $l_0, l_1, h > 0$

From FOC, we can show that L_i increases monotonically with D_i

Note: we could reinterpret H_i as use of a CB lending facility

Model with heterog. HHs - adding lending

- ▶ Using same values for main parameters and carefully picked values for new lending parameters:
- ▶ *Qualitatively*: main results hold – the introduction of CBDC leads to a reduction in lending.
- ▶ *Quantitatively*: the drop in lending is very small and it is hard to make it large

Why is the effect of CBDC on lending quantitatively small?

Intuition from banks' objective function:

$$\max \left(f + l_0 - \frac{l_1}{2} L \right) L - \left(f + \frac{h}{2} H \right) H - (f - s) D \quad (2)$$

- ▶ If lending is less profitable (l_0 smaller or l_1 larger), banks have less incentive to react to competition from CBDC → deposit base can decrease
- ▶ But l_1/l_0 has to be below some level otherwise $H < 0$
 - If wholesale has no risk ($h = 0$), lending is constant ($L = \frac{l_0}{l_1}$) regardless of the introduction of CBDC.
 - When h is small, wholesale funding is cheaper. Banks care less about deposits, so the drop in deposits can be large, but the drop in lending is small.
 - When h is large, banks care more about deposits, so the drop in deposits is small, and the drop in lending is also small.

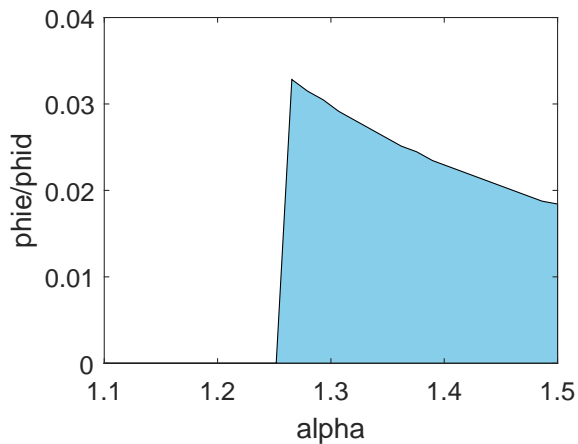
⇒ It's hard to make the drop in lending large.

Next steps:

- ▶ Discipline calibration
- ▶ CBDC design narrative and cases: easy/hard access, w./w.o. time-varying remuneration. This will try to capture what different countries/analysis may have in mind
 - ▶ Tokenized deposits?
- ▶ Extension with banks also lending to firms and using wholesale funding
- ▶ A different demand system?

Appendix: Additional results

Parameters space for disintermediation result



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