Implications of a central bank digital currency for the operational framework of monetary policy

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Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views of the Banco de España or the Eurosystem.

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What is a central bank digital currency (CBDC)?

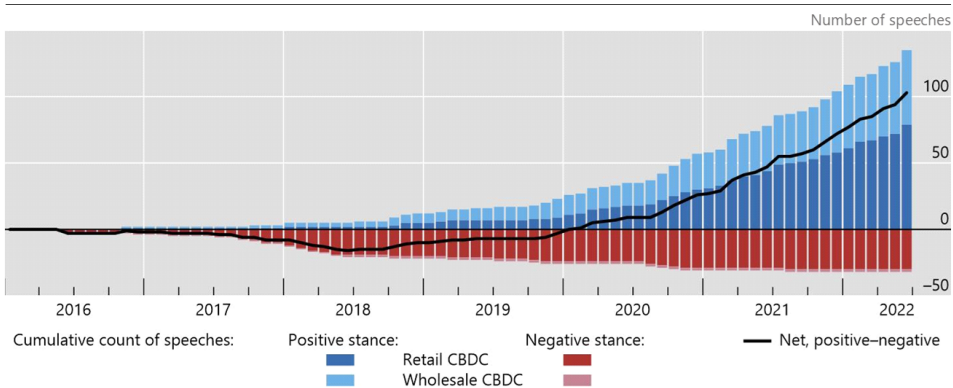
- **CBDC**: a digital liability of a central bank that is widely available to the general public

  → Think of the equivalent of a retail deposit account but with the central bank

- Many countries are investigating and developing CBDCs, some have implemented them

- Aimed at promoting **financial inclusion** and preserving **monetary sovereignty** (among other potential objectives) in an increasingly digital world

Increasing interest in CBDCs



Source: R Auer, G Cornelli and J Frost (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS working papers*, No 880, August.

THE WHITE HOUSE

BRIEFING ROOM

Executive Order on Ensuring Responsible Development of Digital Assets

MARCH 09, 2022 • PRESIDENTIAL ACTIONS

"Monetary authorities globally are exploring, and in some cases introducing, CBDCs. (...) My Administration places the highest urgency on research and development efforts into the potential design and deployment options of a United States CBDC"

PRESS RELEASE

Eurosystem launches digital euro project

14 July 2021

- Investigation phase of digital euro project to last 24 months

We should understand better its implications

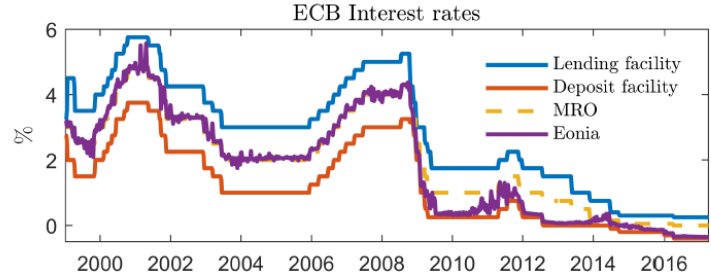
- Increasing attention from authorities and academics
- Implications remain to be fully understood: financial stability, currency competition, financial inclusion, payments & innovation...
- This paper: implications of CBDC for the **operational framework of monetary policy**

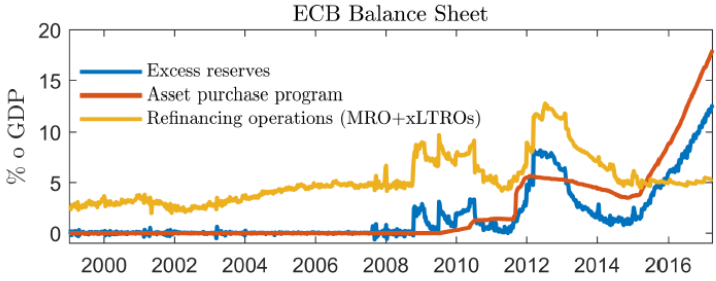
What is the operational framework?

- Monetary policy is implemented through **several instruments**:
  - **(i)** overnight lending and deposit facilities;
  - **(ii)** asset purchases;
  - **(iii)** direct lending to banks (typically subsidized below lending facility, as in TLTRO).

- Currently CBs in advanced economies operate a **floor system**, satiating commercial banks with reserves, so that interbank rates are close to the deposit facility rate

What is the operational framework?





How does CBDC affect the operational framework?

- Introducing CBDC could **reduce excess reserves** (by reducing the amount of bank deposits), thus changing the conditions in the interbank market

- Questions:

  (i) What are the general equilibrium implications of CBDC adoption in a floor system?

  (ii) What are the implications of using different instruments to compensate for the fall in reserves?

  (iii) What are the consequences of different CBDC designs for MP transmission?

What we do

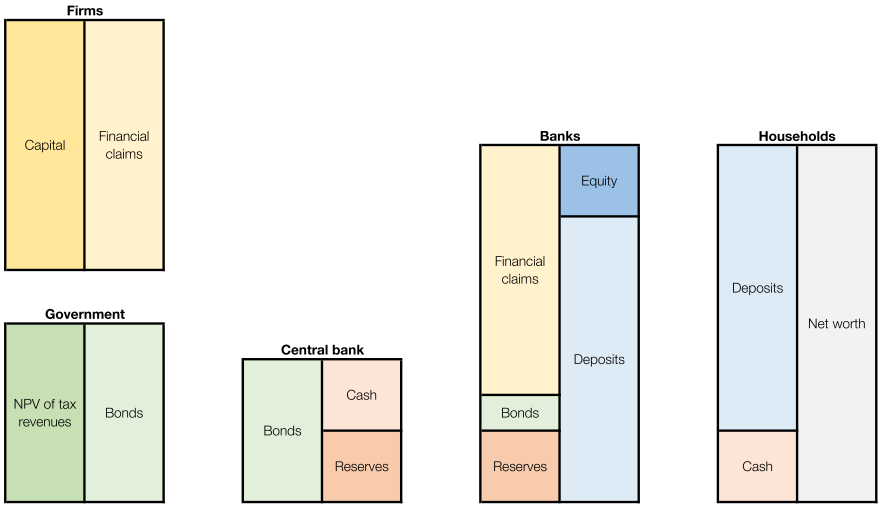
- We introduce CBDC in a **realistic model of MP transmission**, which includes:
  - **(i)** heterogeneous banks that:
    - borrow from households and lend to firms,
    - lend/borrow in an OTC interbank market,
    - can access CB facilities;
  - **(ii)** a CB with all the tools discussed above;
  - **(iii)** households with preferences for liquid asset holdings (cash, CBDC and deposits);
  - **(iv)** a standard NK block.
- We calibrate the model to replicate the Eurosystem balance sheet in the medium-term
- We explore alternative scenarios about CBDC take-up and different policy options by CB

What we find

- Absent other measures, a large takeup leads to a corridor or even a "ceiling" system with a **structural lack of reserves**
- This can be avoided if the CB engages in further asset purchases or provides lending at interbank rates, without any macro consequence
- Depending on its remunaration, CBDC may decrease bank credit and increase equilibrium rates
- If CB **subsidizes lending** even below interbank rates, it can compensate for the increase in bank funding costs and **stimulate credit** and output

Outline

Model overview



Households

- Instantaneous utility function:

$$U(C_t, L_t, H_t) = \log(C_t) + \vartheta \log(L_t) - g(H_t),$$

where

$$L_t \equiv \left[(D_t)^{\frac{\varepsilon-1}{\varepsilon}} + \eta_M (M_t)^{\frac{\varepsilon-1}{\varepsilon}} + \eta_{DC} \left(D_t^{DC} \right)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

with $\varepsilon > 1$.

- Liquidity services in the utility function with imperfect substitution across assets as in Drechsler et al. (2017), Di Tella and Kurlat (2017) and Wang (2022), among others.

Banks

- Based on Arce, Nuño, Thaler and Thomas (2020)
- Continuum of banks operating in different islands indexed by $j \in [0, 1]$
  - **(i)** Start with some after-dividend equity N_t^j and issue deposits D_t^j at rate R_t^D
  - **(ii)** Draw idiosyncratic productivity $\omega_t^j \overset{iid}{\sim} F(\omega)$
  - **(iii)** Make portfolio choice:
    - Finance firms' physical capital A_t^j with return $\omega_t^j R_t^K$
    - Purchase govt. bonds $b_t^{G,j}$ with return R_{t+1}^G
    - Gross borrowing B_t^+ and lending B_t^- in interbank mkt at effective rates R_t^B, R_t^L
    - Subject to leverage constraint: $Q_t^K A_t^j \leq \phi N_t^j$
  - **(iv)** Banks that found no partner in the interbank mkt access standing facilities of the CB
- Balance sheet:

$$\underbrace{Q_t^K A_t^j}_{\substack{\text{Claims} \\ \text{on firms}}} + \underbrace{B_t^{-,j}}_{\substack{\text{IB} \\ \text{lending}}} + \underbrace{b_t^{G,j}}_{\substack{\text{Govt.} \\ \text{bonds}}} = \underbrace{B_t^{+,j}}_{\substack{\text{IB} \\ \text{borrowing}}} + \underbrace{D_t^j}_{\text{Deposits}} + \underbrace{N_t^j}_{\text{Equity}}$$

Interbank market

- Decentralized, OTC market: search frictions $\rightarrow$ market does not automatically clear (similar to Afonso and Lagos, 2012, and Bianchi and Bigio, 2021)
- Matching probabilities (Γ_t^B, Γ_t^L) reflect interbank market tightness θ_t
  $\rightarrow$ The less participants there are on your side, the easier for you to find a partner
- Banks that do not find a partner can lend to (or borrow from) the CB deposit (lending) facility at rate R_t^{DF} (R_t^{LF})
- Banks that find a parter trade at the **equilibrium interbank rate**:

$$R_t^{IB} = \varphi(\theta_t) R_t^{DF} + [1 - \varphi(\theta_t)] R_t^{LF},$$

with $\varphi'(\cdot) < 0$

Central bank

- The central bank sets the two policy rates (R_t^{DF}, R_t^{LF}) such that:

  (i) corridor width is constant

  $$R_t^{LF} = R_t^{DF} + \chi$$

  (ii) Interbank market rate (the **"operational target"**) follows a Taylor rule with inertia

  $$R_t^{IB} = \rho R_{t-1}^{IB} + (1-\rho)[\overline{R} + \nu \pi_t]$$

- Balance sheet:

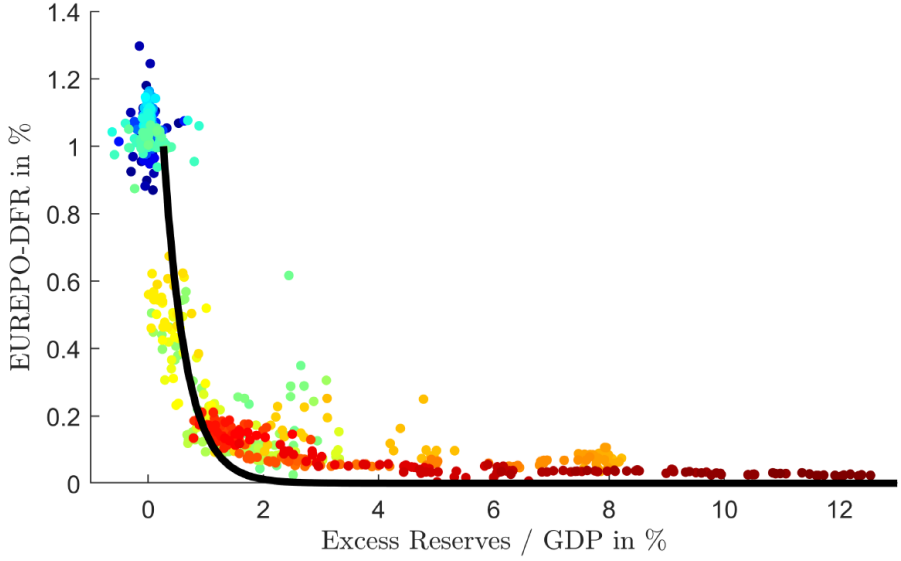
$$\underbrace{b_t^{G,CB}}_{\substack{\text{Bond}\\ \text{holdings}}} + \underbrace{\Phi^B(1-\Gamma_t^B)}_{\text{CB loans}} = \underbrace{\Phi^L(1-\Gamma_t^L)}_{\text{CB reserves}} + \underbrace{M_t + D_t^{DC}}_{\text{Cash + CBDC}}$$

How can the CB balance sheet influence interbank market conditions?

- Consider an increase in CB asset purchases:

  1. The CB increases its holdings of govt. bonds (and reduces holdings of banks)
  2. Banks use these spare funds to increase their lending in the interbank market
  3. Excess liquidity is deposited at the central bank as reserves
  4. Equilibrium interbank market rates go down (as market tightness decreases)

Excess reserves and interbank rates



Outline

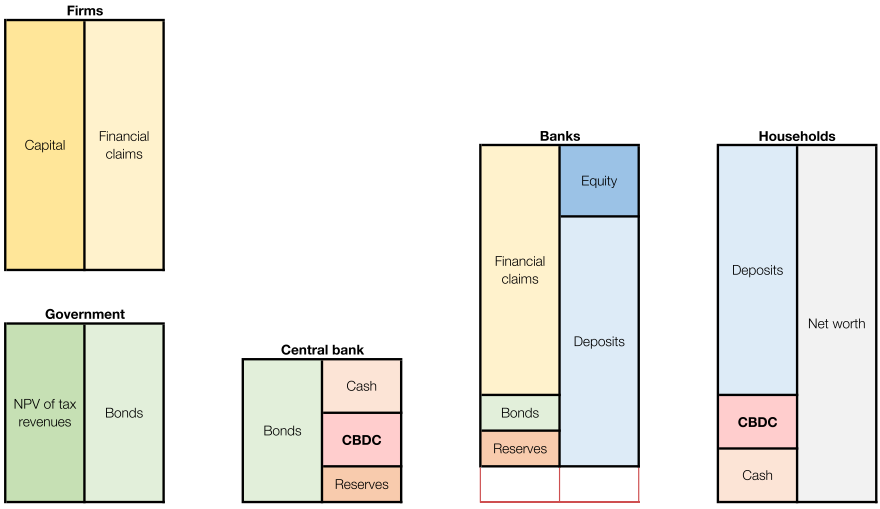
Quantitative exercises

- Calibration
- **'Neutral rate' CBDC**: there exists a (positive) remuneration rate for which the introduction of CBDC is neutral for macro allocations ▸ Details
  - Implications for the operational framework of monetary policy
  - Additional policies to preserve a floor system
- **Unremunerated CBDC**
  - Implications for macroeconomic outcomes
  - Additional policies to stimulate credit

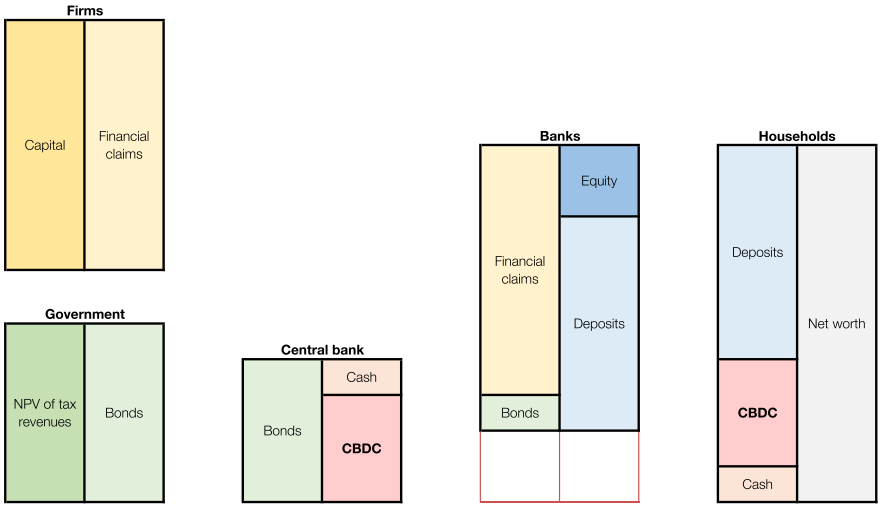
Calibration

- We replicate the Eurosystem and EA banking sector balance sheets
- We use the ECB SMA forecasts of policy rates and balance sheet size in the medium run
  - $R^{DF} = 1\%$, $R^{LF} = 1.75\%$
  - APP + PEPP = 15% of EA GDP
- The elasticity of substitution between the different types of liquid assets (ε) held by the household is taken from Wang (2022) [based on the estimated deposit rate pass-through of policy rate shocks in 2000-2008]
- We calibrate the interbank matching function to fit the relationship between excess reserves and interest rates observed in the data

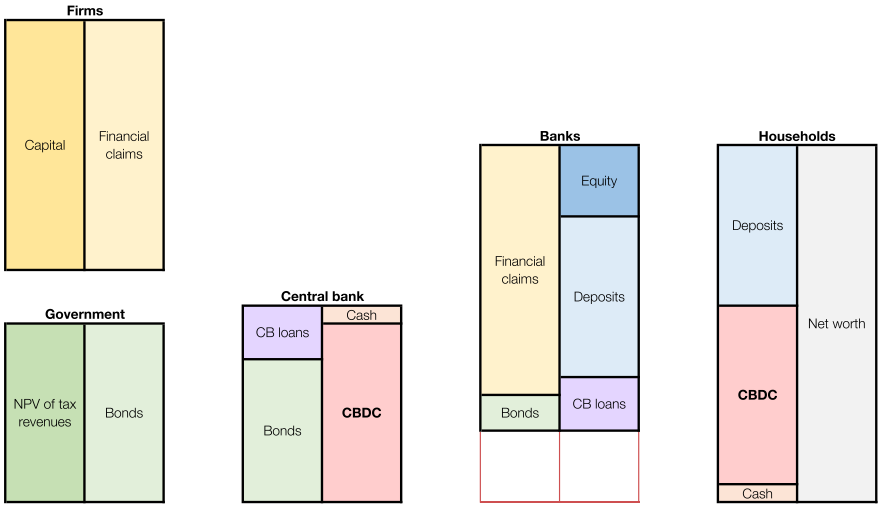
Introduction of a CBDC – floor system



Introduction of a CBDC – corridor system



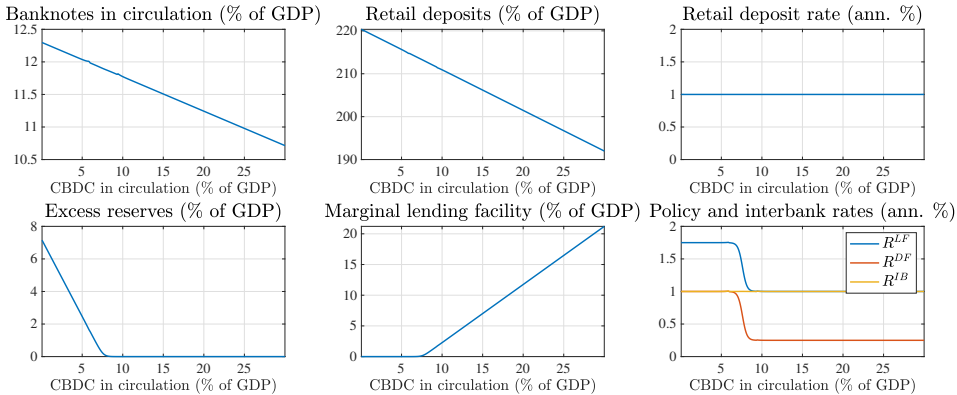
Introduction of a CBDC – ceiling system



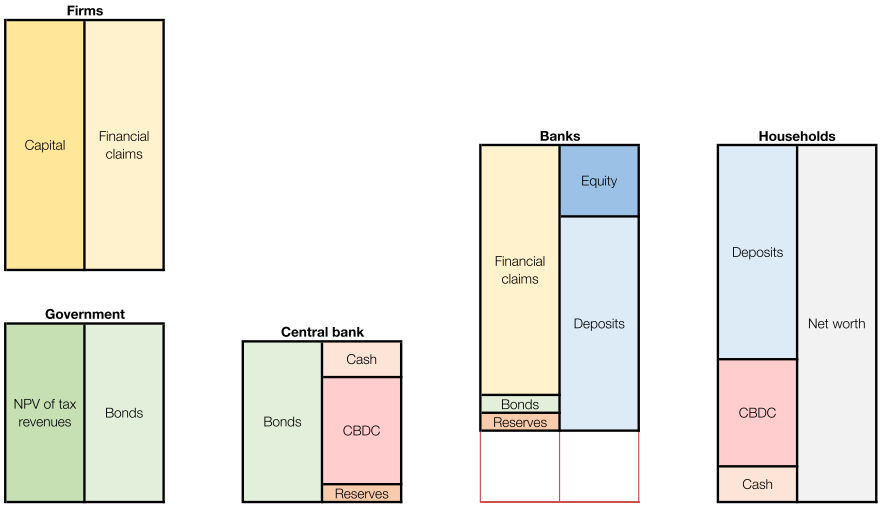
How does the introduction of a CBDC influence interbank market conditions?

1. Households substitute from bank deposits (and cash) to CBDC holdings
2. Banks' available funds decrease and they cut their lending in the interbank market
3. Aggregate excess reserves at the CB go down
4. Equilibrium interbank market rates go up (as market tightness increases)

Introduction of a 'neutral rate' CBDC – quantitative results

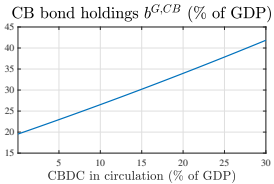


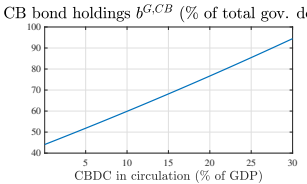
Maintaining the floor system with asset purchases

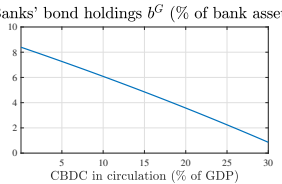


Maintaining the floor system with asset purchases

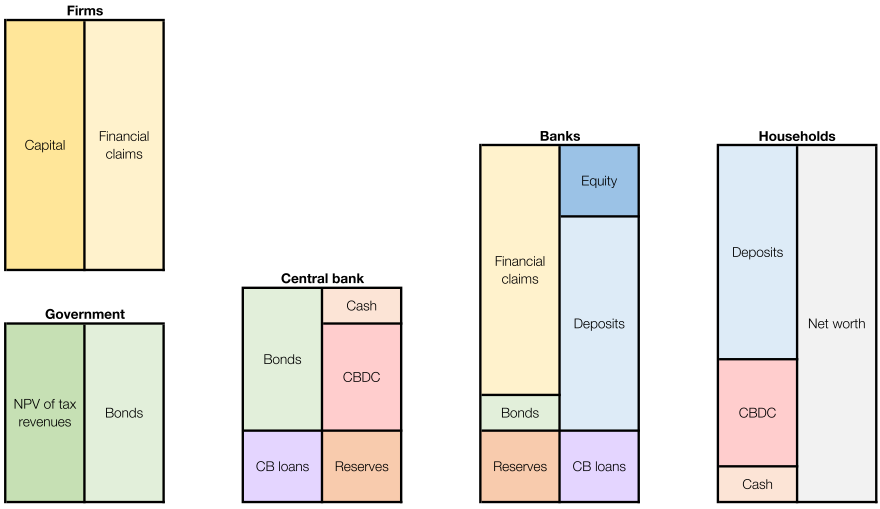
- Increase in CB bond holdings necessary to keep reserves at their pre-CBDC level?





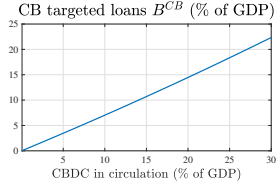


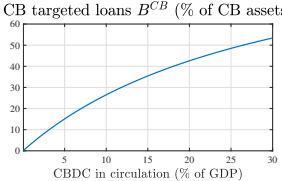
Maintaining the floor system with CB loans

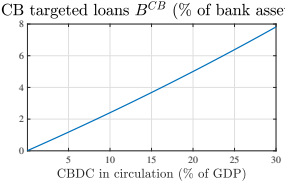


Maintaining the floor system with CB loans

- Banks are offered funds B_t^{CB} at the DFR ($R_t^{CB} = R_t^{DF}$)
- Can borrow up to an allowance proportional to their loan portfolio: $B_t^{CB,j} \leq \psi Q_t^K A_t^j$
- Max allowance necessary to keep reserves at their pre-CBDC level?







CBDC remuneration and equivalence result

- So far we have focused on a **"wealth neutral"** remuneration rate of CBDC ($\bar{R}^{DC}$) as in Brunnermeier and Niepelt (2019) ▸ Details
  - It solves:

$$R^D D + M = R^D D' + M' + \bar{R}^{DC} D^{DC}$$

- In the remaining we will focus on an **unremunerated** CBDC
  - Without additional policies, lower overall returns on savings decrease households' wealth

Unremunerated CBDC – Macroeconomic effects

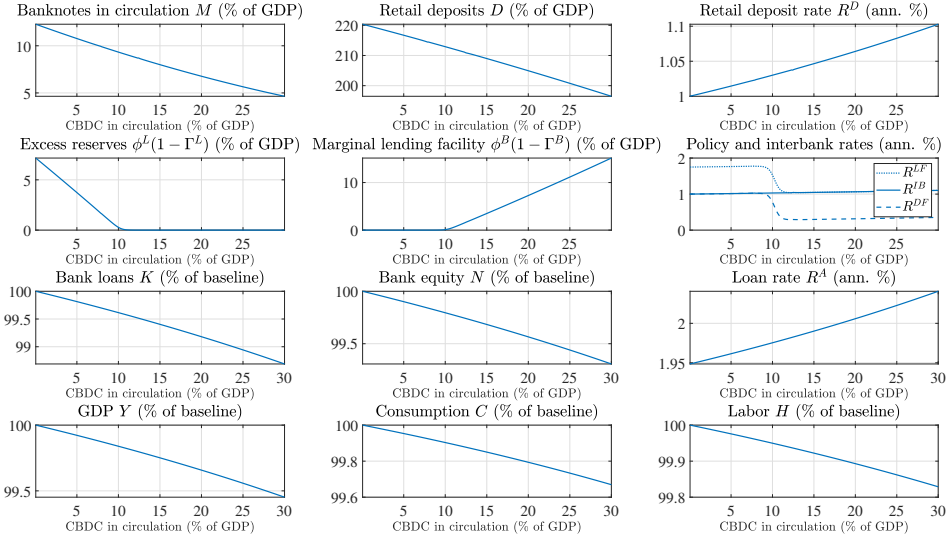
- A substitution from retail deposits into **unremunerated** CBDC lowers aggregate return on households' savings

  $\rightarrow$ Households' wealth decreases as a result

- Given that households' savings are ultimately invested (via banks) in the aggregate stock of physical capital, this has a **contractionary effect**

- Since the MPK is decreasing, a lower capital stock increases equilibrium interest rates

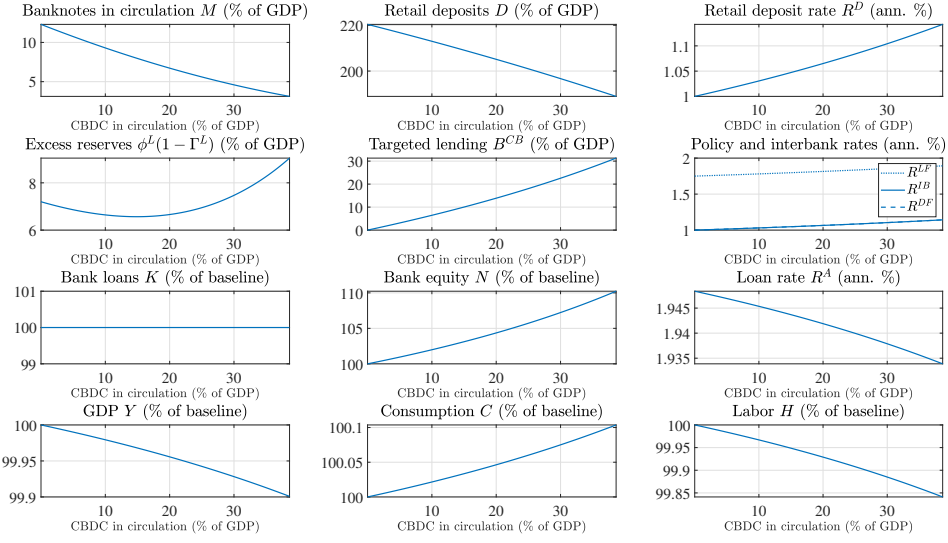
Introduction of an unremunerated CBDC – quantitative results



Targeted (subsidized) lending

- Maintaining the floor system via additional asset purchases or CB lending at the interbank rate is **neutral** for allocations and prices
- However, **subsidized lending** (at rates below R^{IB}) is effective at stimulating credit supply
- We introduce targeted subsidized lending remunerated at $R_t^{CB} = R_t^{DF} - \chi^{CB}$
- We calibrate the **necessary allowance** ψ conditional on CBDC take up that keeps **lending constant** at its baseline level (with **remuneration 1pp below the DFR**)

Introduction of a CBDC – targeted lending



Additional results

- Different design options:
  - (Tiered) remuneration
  - Holding limits
  - ...
- Alternative calibrations
  - Pre-crisis corridor system
  - Post-crisis negative rates and ZLB
  - ...
- Transitional dynamics

Outline

Concluding remarks

- Introduction of a CBDC in a realistic model of MP transmission
- CBDC decreases bank intermediation and aggregate excess reserves
- We analyze different policies aimed at maintaining the floor system
- We also highlight how results depend on CBDC design features (especially remuneration)

Thank you!

Background materials

CBDC remuneration and equivalence result

- We show the existence of a **"wealth neutral"** remuneration rate of CBDC ($\bar{R}^{DC}$) as in Brunnermeier and Niepelt (2019)
  - It solves:

$$R^D D + M = R^D D' + M' + \bar{R}^{DC} D^{DC},$$

where X and X' are the steady-state before and after CBDC is introduced, so that

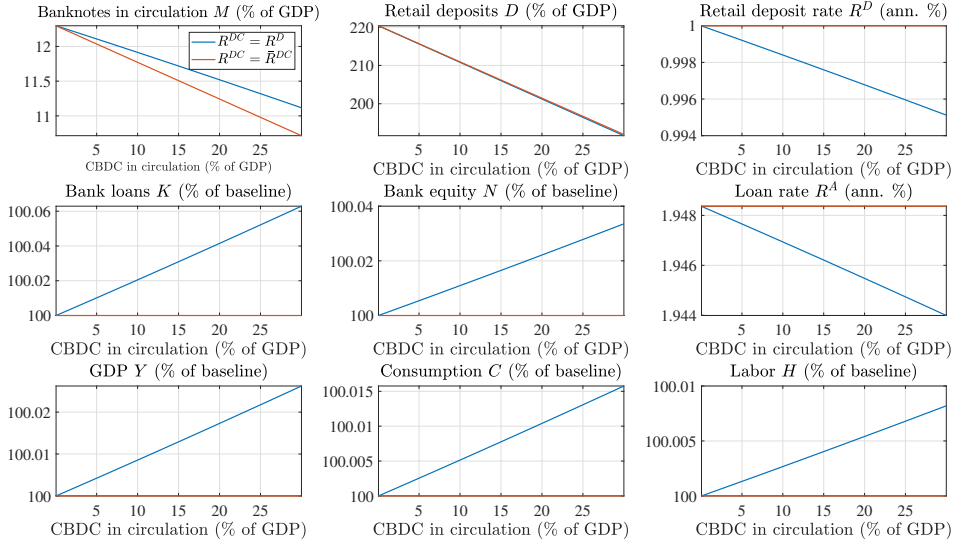
$$\bar{R}^{DC} = \frac{R^D \Delta D + \Delta M}{\Delta D + \Delta M}$$

where $\Delta X = X' - X$ (and since $D^{DC} = \Delta D + \Delta M$)

- Given CES preferences for liquidity, $\bar{R}^{DC}$ remains constant when η_{DC} changes

▸ Back 1 ▸ Back 2

CBDC remuneration and equivalence result



Corridor vs. floor system