# CBDC and the operational framework of monetary policy

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### Motivation

- CBDC: a digital liability of a central bank widely available to the general public
- Increasing attention from authorities and academics
- Implications remain to be fully understood: financial stability, currency competition, financial inclusion, payments & innovation...

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- 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**, its broader macroeconomic effects, and their interrelation

# This paper

- We introduce CBDC in a realistic NK model of MP transmission, with:
  - households with preferences for different liquid assets (cash, deposits, and CBDC)
  - heterogeneous banks trading with each other in a frictional interbank market
  - a central bank that implements monetary policy by affecting conditions in that market
- The calibrated model replicates the main monetary and financial aggregates in the EA

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  - a central bank that implements monetary policy by affecting conditions in that market
- The calibrated model replicates the main monetary and financial aggregates in the EA
- We try to answer the following questions:
  - Would a CBDC-induced 'deposit crunch' lead to a 'credit crunch'?
  - How does this depend on the operational framework of monetary policy?
  - What are the consequences for monetary policy implementation?

# Main findings

- CBDC adoption leads to a reduction in banks' deposit funding, which is absorbed by:
  - A reduction in excess reserves, for a moderate CBDC adoption
  - An increase in the recourse to central bank credit, for larger CBDC adoption
- Thus, even large reductions in deposit funding have rather small effects on credit
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- The fall in excess reserves has consequences for monetary policy implementation, forcing a transition from a 'floor system' to a 'corridor system'
- Non-remunerated CBDC has non-negligible contractionary effects nevertheless, by reducing households' return on their savings

# Outline

- 1. Introduction
- 2. The model
- 3. Quantitative exercises
- 4. Concluding remarks

## Model overview



### Households

• Instantaneous utility function:

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

where

$$L_{t} \equiv \left[ \left( D_{t} \right)^{\frac{\varepsilon-1}{\varepsilon}} + \eta_{M} \left( M_{t} \right)^{\frac{\varepsilon-1}{\varepsilon}} + \eta_{DC} \left( D_{t}^{DC} \right)^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

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.
- Reduced form representation of preference heterogeneity (eg, wrt privacy) along the cross-section of households

- 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  $R_t^D$ 

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  - (ii) Learn idiosyncratic productivity  $\omega_t^j \stackrel{iid}{\sim} F(\omega)$  of firms within their island
  - (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  $B_t^{+,j}$  and lending  $B_t^{-,j}$  in IB mkt at effective rates  $R_t^B$ ,  $R_t^L$
    - Subject to leverage constraint:  $Q_t^{\mathsf{K}} \mathcal{A}_t^j \leq \phi \mathcal{N}_t^j$

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    - Subject to leverage constraint:  $Q_t^{\kappa} A_t^j \leq \phi N_t^j$
  - (iv) Banks that found no partner in the IB mkt access standing facilities of the CB
- Notation:  $\Phi_t^B = \int B_t^{+,j} dj$ ,  $\Phi_t^L = \int B_t^{-,j} dj$  (agg. amount of borrowing and lending orders)

## Interbank market

- Decentralized, OTC market: search frictions → market does not automatically clear (similar to Afonso and Lagos, 2012, and Bianchi and Bigio, 2021)
- Matching probabilities  $(\Gamma_t^B, \Gamma_t^L)$  reflect interbank market tightness  $\theta_t \equiv \Phi_t^B / \Phi_t^L$ .
  - $\rightarrow\,$  The less participants there are on your side, the easier for you to find a partner

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- 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  $arphi'(\cdot) < 0$ 

• The position of the interbank rate  $R_t^{IB}$  within the policy rates corridor  $[R_t^{DF}, R_t^{LF}]$  depends on the supply of excess liquidity (via interbank market tightness  $\theta_t$ )

### **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

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• Balance sheet:



# Liquidity conditions and the operational framework of monetary policy

#### Floor system

- Abundant liquidity conditions:  $\theta_t \rightarrow 0$
- All borrowing banks are matched with lending ones
- Most lending banks deposit at the central bank
- ightarrow Interbank rate set by the floor of the corridor:  $R_t^{IB} \approx R_t^{DF}$

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- $\label{eq:linear_state} \begin{array}{l} \rightarrow \mbox{ Interbank rate in the middle of } \\ \mbox{ the corridor:} \\ R^{IB}_t \in (R^{DF}_t, R^{LF}_t) \end{array}$

# Liquidity conditions and the operational framework of monetary policy

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• Scarce liquidity conditions:  $\theta_t \rightarrow 1$ 

Ceiling system

- Most borrowing banks obtain central bank loans
- All lending banks are matched with borrowing banks
- → Interbank rate set by the ceiling of the corridor:  $R_t^{IB} \approx R_t^{LF}$

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# Calibration

- We replicate the Eurosystem and EA banking sector balance sheets in the medium run
- We use the ECB SMA forecasts (April '22) of policy rates and balance sheet size
  - $R^{DF} = 1\%$
  - APP + PEPP = 16% of EA GDP

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- We calibrate the interbank matching function to fit the relationship between excess reserves and interest rates observed in the data

## Calibration – Excess reserves and interbank rates



## **Calibration – Balance sheets**

Commercial banks balance sheet					
Assets		Liabilities			
Loans	64.9.2% (206.9%)	Equity	7.9% (25.1%)		
Govt. bonds	14.5% (46.3%)	Deposits	73.3% (233.5%)		
Interbank claims	18.8% (60.0%)	Interbank liabilities	18.8% (60.0%)		
Central bank reserves	1.7% (5.5%)	Central bank loans	0.0% (0.0%)		
Total assets	100% (318.7%)	Total liabilities	100% (318.7%)		

#### **Commercial banks balance sheet**

#### Central bank balance sheet

Assets		Liabilities	
Govt. bonds	100% (16.0%)	Cash	65.9% (10.5%)
Lending to banks	0.0% (0.0%)	Reserves from banks	34.1% (5.5%)
Total assets	100% (16.0%)	Total liabilities	100% (16.0%)

Note: Values in parenthesis denote % of GDP

## Long-run implications of introducing (non-remunerated) CBDC



## Equivalence result

- We show the existence of a "wealth neutral" remuneration rate of CBDC (R<sup>DC</sup>) as in Brunnermeier and Niepelt (2019)
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  - It is the one that keeps constant households' overall return on savings
- Importantly, equivalence requires that the CB operates a floor (or a ceiling) system
- In a corridor system, productive banks that fail to find a match in the IB market are forced to borrow from the CB at a higher rate
  - ightarrow The resulting increase in CB seigniorage distorts lending decisions and breaks the equivalence

### Equivalence result – Wealth-neutral remuneration of CBDC



# Compensating policies: Preserving the floor system

- Asset purchases:
  - Increase in CB bond holdings necessary to keep reserves at their pre-CBDC level?
- Targeted loans:
  - Banks can borrow funds at the DFR up to an allowance proportional to their loan portfolio
  - Max allowance necessary to keep reserves at their pre-CBDC level?

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## Transitional dynamics: Gradual introduction of a CBDC



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## **Concluding remarks**

- Introduction of a CBDC in a realistic model of MP transmission
- CBDC-induced 'deposit crunch' does not lead to 'credit crunch'
- Results reflect the impact on the operational framework of monetary policy
- We characterize the policies necessary to compensate the reduction in excess reserves
- We also highlight how results depend on CBDC design features (especially remuneration)

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### Thank you!