

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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- 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
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 - 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
- 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
- The fall in excess reserves has consequences for monetary policy implementation, forcing a transition from a 'floor system' to a 'corridor system'

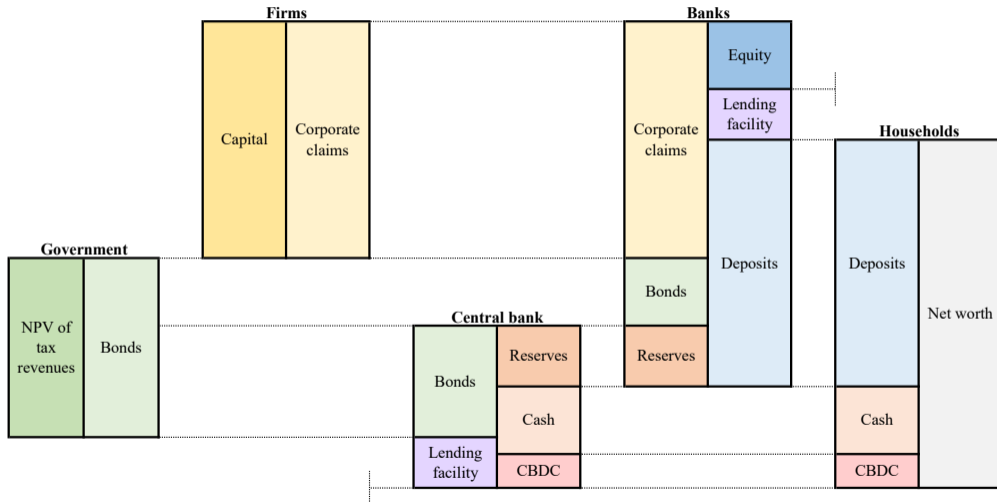
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- Non-remunerated CBDC has non-negligible contractionary effects nevertheless, by reducing households' return on their savings

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

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

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

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

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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: $Q_t^K A_t^j \leq \phi N_t^j$

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- 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 (Γ_t^B, Γ_t^L) reflect interbank market tightness $\theta_t = \Phi_t^B / \Phi_t^L$.
The less participants there are on your side, the easier for you to find a partner

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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 partner trade at the **equilibrium interbank rate**:

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

with $\varphi(\cdot) < 0$

- 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 θ_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

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

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- Balance sheet:

$$\underbrace{B_t^{G,CB}}_{\text{Bond holdings}} + \underbrace{\Phi^B(1 - \Gamma_t^B)}_{\text{Marginal lending facility}} = \underbrace{\Phi^L(1 - \Gamma_t^L)}_{\text{Deposit facility}} + \underbrace{M_t + D_t^{DC}}_{\text{Cash + CBDC}}$$

Liquidity conditions and the operational framework of monetary policy

Floor system

- Abundant liquidity conditions:
 $\theta_t = 0$
- All borrowing banks are matched with lending ones
- Most lending banks deposit at the central bank

Interbank rate set by the floor of the corridor:

$$R_t^{IB} = R_t^{DF}$$

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Corridor system

- Balanced liquidity conditions:
 $\theta_t \in (0, 1)$
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Interbank rate in the middle of the corridor:

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Interbank rate in the middle of the corridor:

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Ceiling system

- Scarce liquidity conditions:
 $\theta_t = 1$
- Most borrowing banks obtain central bank loans
- All lending banks are matched with borrowing banks

Interbank rate set by the ceiling of the corridor:

$$R_t^{IB} = R_t^{LF}$$

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3. **Quantitative exercises**
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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

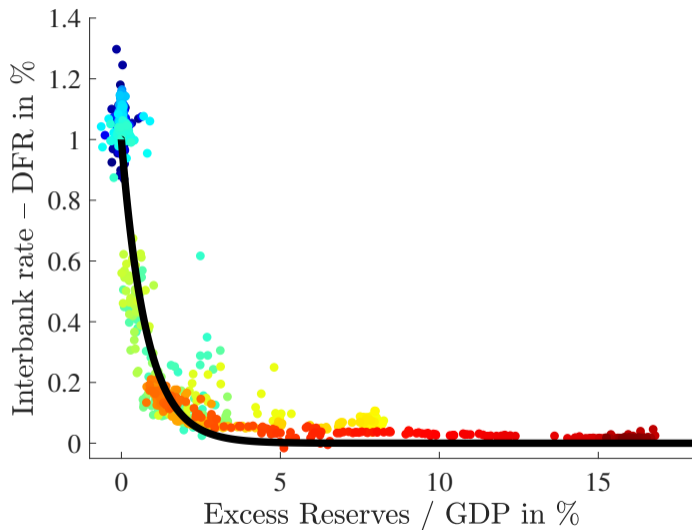
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- We calibrate the interbank matching function to fit the relationship between excess reserves and interest rates observed in the data

Calibration – Excess reserves and interbank rates



Calibration – Balance sheets

Commercial banks balance sheet

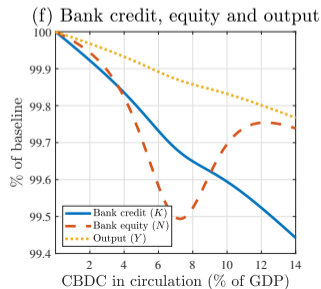
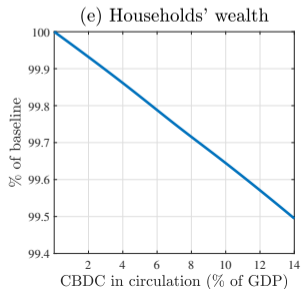
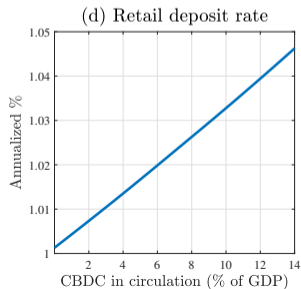
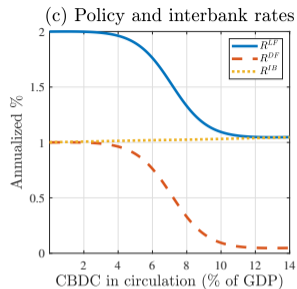
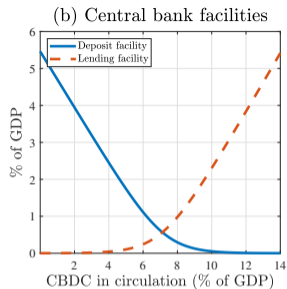
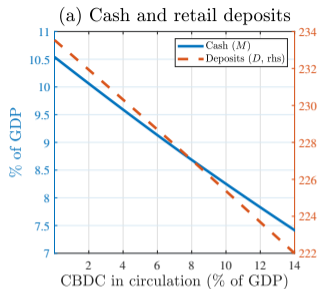
Assets		Liabilities	
Loans	64.9.2% (206.9%)	Equity	7.9% (25.1%)
Govt. bonds	14.5% (46.3%)	Deposits	73.3% (233.5%)
Interbank claims	18.8% (60.0%)	Interbank liabilities	18.8% (60.0%)
Central bank reserves	1.7% (5.5%)	Central bank loans	0.0% (0.0%)
Total assets	100% (318.7%)	Total liabilities	100% (318.7%)

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

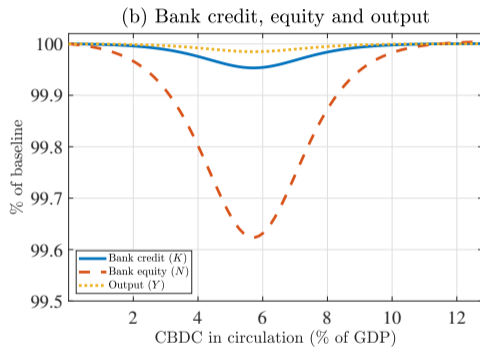
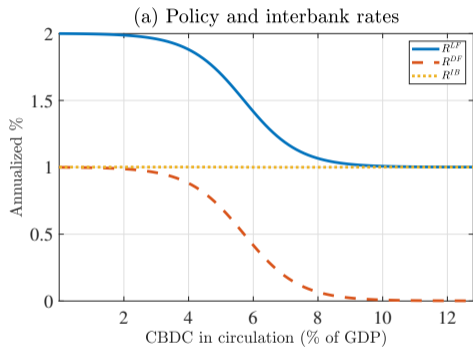
- We show the existence of a **“wealth neutral”** remuneration rate of CBDC (\bar{R}^{DC}) as in Brunnermeier and Niepelt (2019)
 - It is the one that keeps constant households' overall return on savings

Equivalence result

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

The resulting increase in CB seigniorage distorts lending decisions and breaks the equivalence

Equivalence result – Wealth-neutral remuneration of CBDC

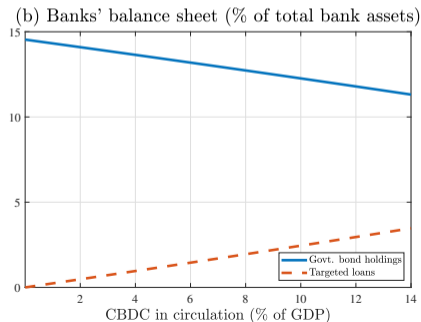
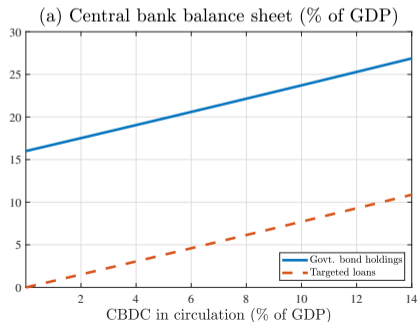


Compensating policies: Preserving the floor system

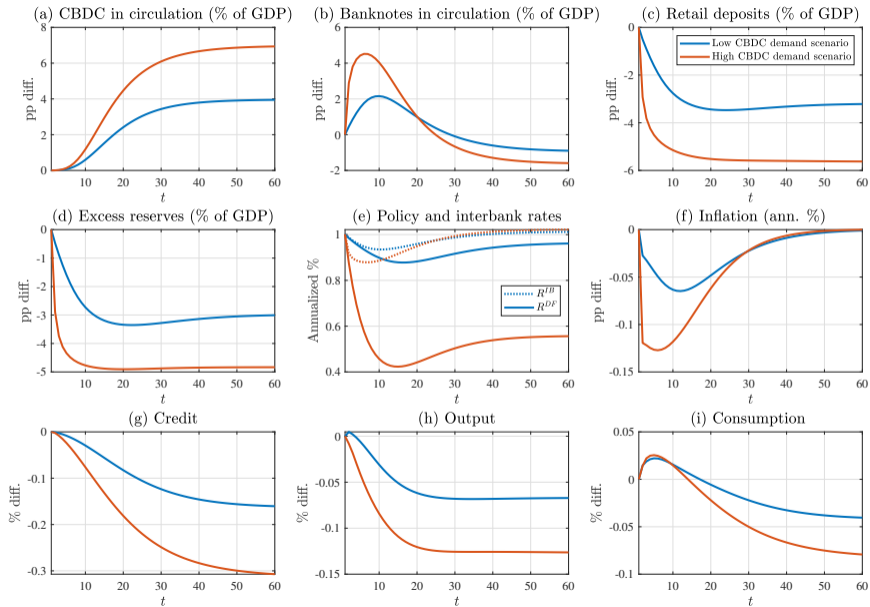
- **Asset purchases:**
 - Increase in CB bond holdings necessary to keep reserves at their pre-CBDC level?
- **Targeted loans:**
 - Banks can borrow funds at the DFR up to an allowance proportional to their loan portfolio
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Transitional dynamics: Gradual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



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- 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!