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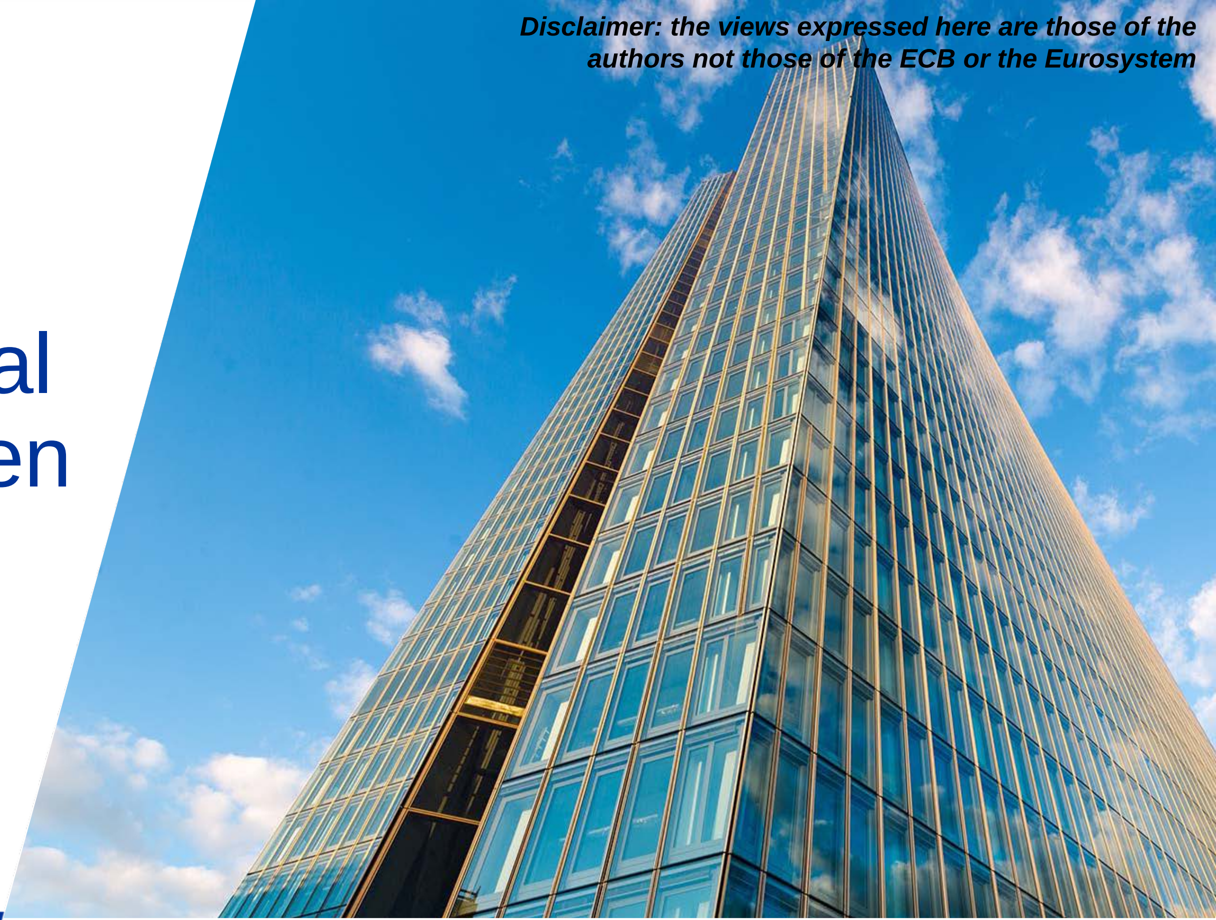
EUROPEAN CENTRAL BANK

EUROSYSTEM

Central bank digital currency in an open economy

Chief Economists' Workshop 2021

12-14 July 2021



Massimo Ferrari*, Arnaud Mehl[#] and Livio Stracca*

*ECB

[#]ECB and CEPR

Key issues

- Private accounts at central banks before World War II, but only accessible to domestic agents

- In an open economy, a CDBC is both a means of payment (for international transaction) and a safe international asset

  - What are the implications for the international transmission of shocks?
  - Do design options matter?
  - Does monetary policy need to adapt?
  - [Not in this talk: individuals at the center of capital flows, is it different?]

A model of central bank digital currencies

2-country macro model, with frictions, multiple international assets, trade in goods, imperfect risk-sharing. The home country emits a CBDC.

Characteristics of different payment instruments in the model

	Scalability	Liquidity	Safety	Remuneration	International use
Cash (M2)		✓	✓		
Bonds	✓			✓	✓
Deposits	✓			✓	✓
CBDC	✓	✓	✓	✓	✓

Key mechanism: a new UIP relation

Under complete markets, the (log-linear) UIP is:

$$r_t^F - r_t^H \approx E_t[neer_t - neer_{t+1}]$$

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$$r_t^F - r_t^{H,cbdc} \approx E_t[neer_t - neer_{t+1}] + l_t^{cbdc}$$

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$$\underbrace{r_t^F - r_t^{H,cbdc}}_{\text{Interest rate differential, but } \boldsymbol{r_t^{H,cbdc}} \text{ might be constant}} \approx E_t[neer_t - neer_{t+1}] + l_t^{cbdc}$$

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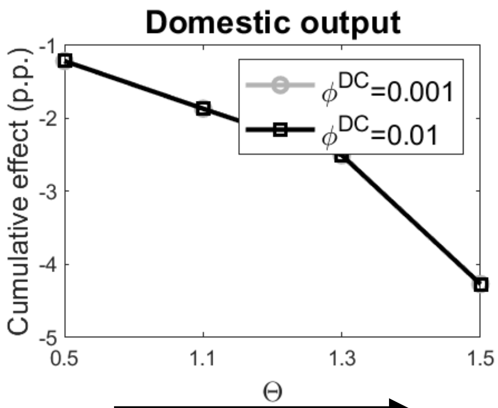
$$r_t^F - r_t^{H,cbdc} \approx E_t[neer_t - neer_{t+1}] + l_t^{cbdc}$$

➡ for the same expected appreciation, stronger effects on r_t^F and $neer_t$ because of the liquidity premium (l_t^{cbdc}) and constant remuneration ($r_t^{H,cbdc}$)

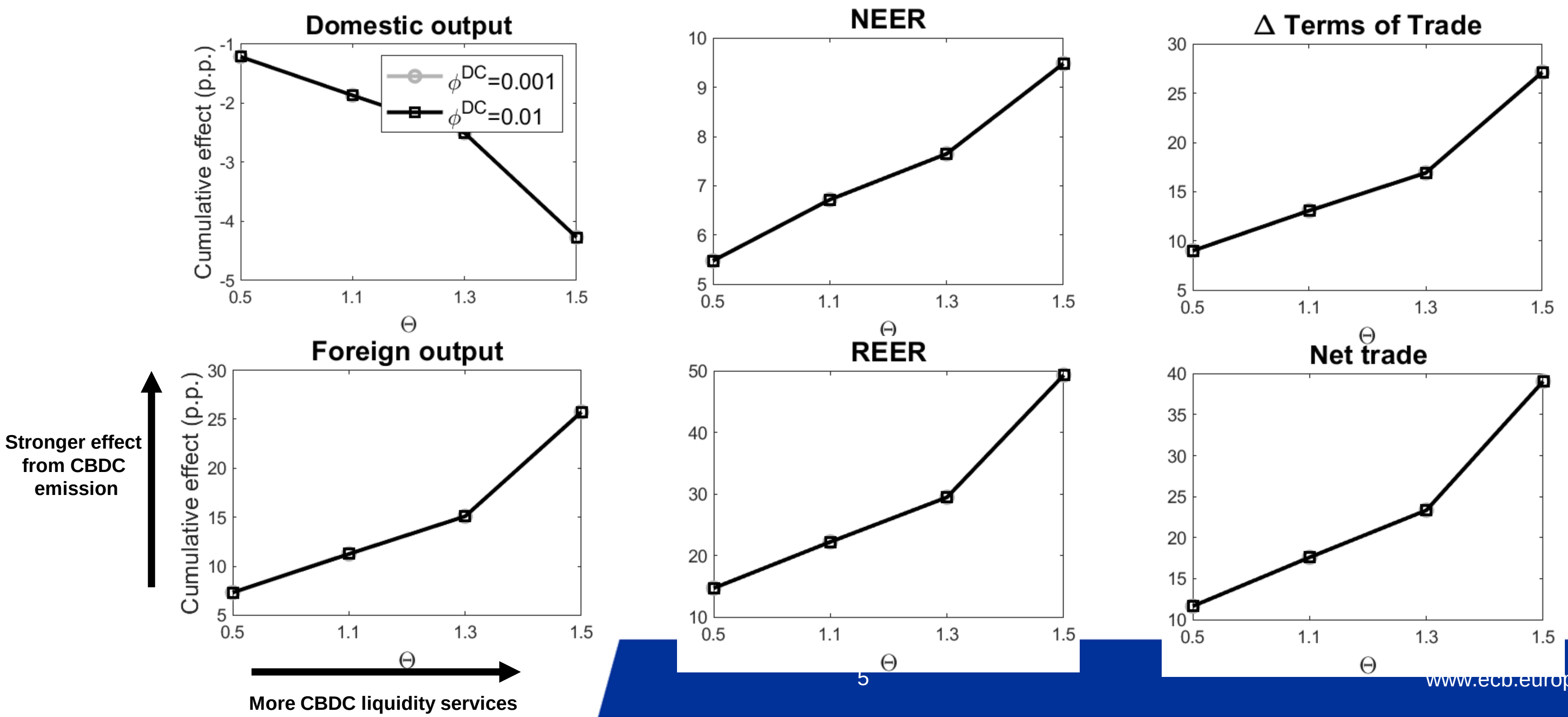
Effects on the transmission of shocks: non remunerated CBDC

Stronger effect from CBDC emission



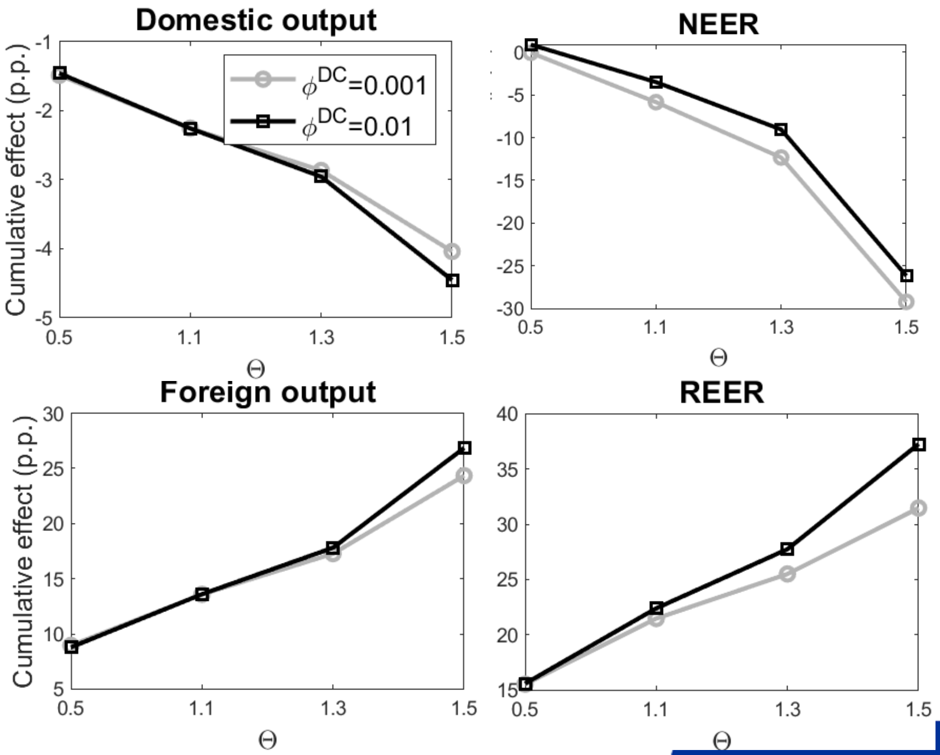
More CBDC liquidity services

Effects on the transmission of shocks: non remunerated CBDC



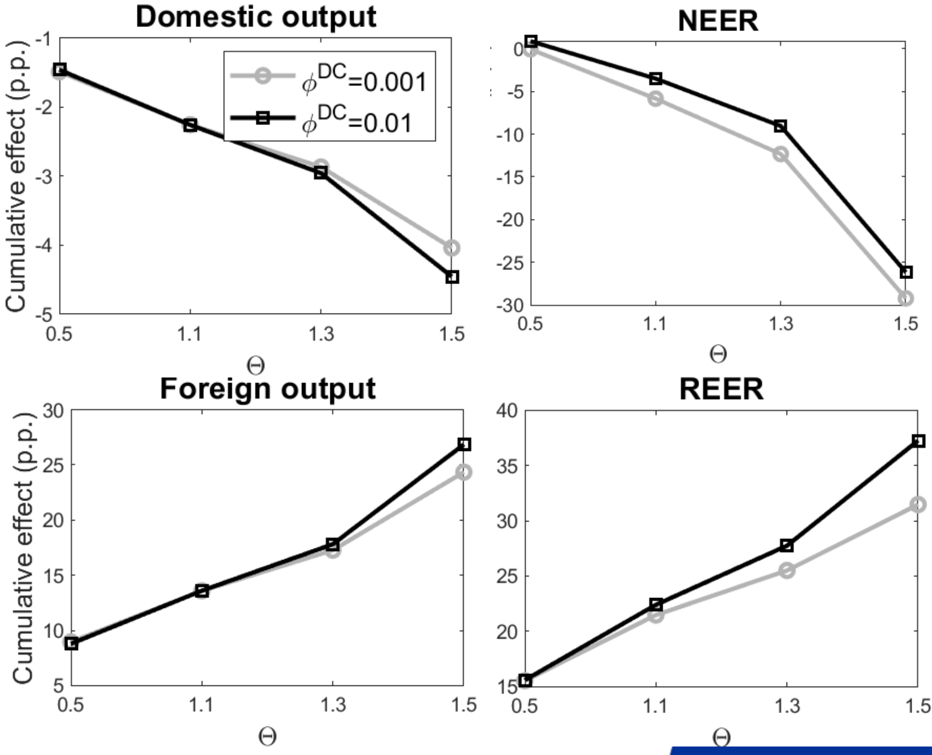
Design options matter

Fixed supply

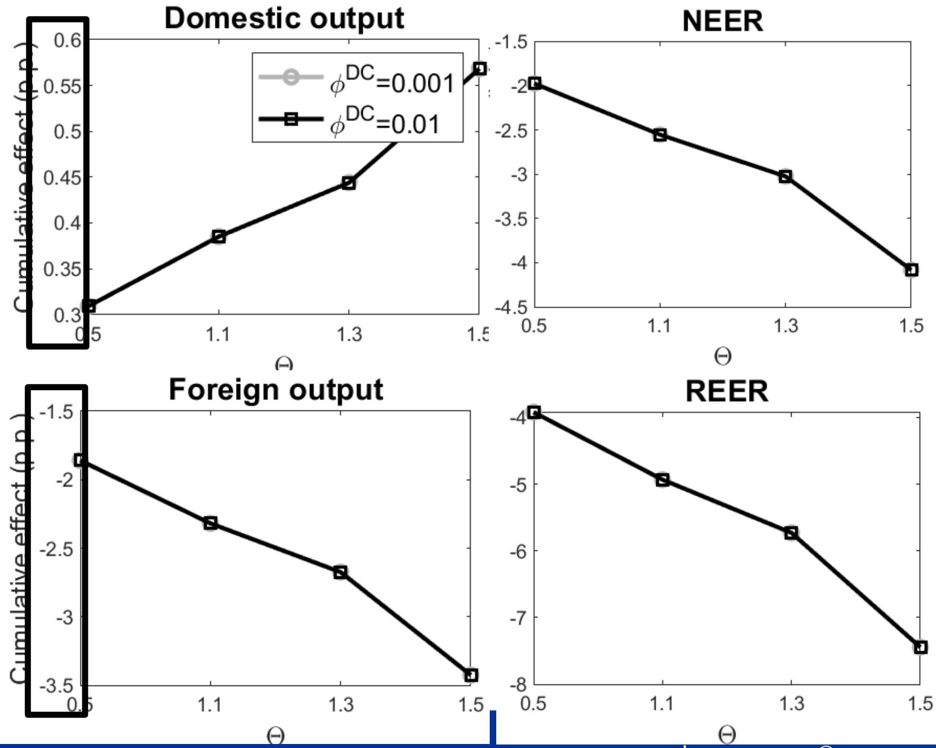


Design options matter

Fixed supply

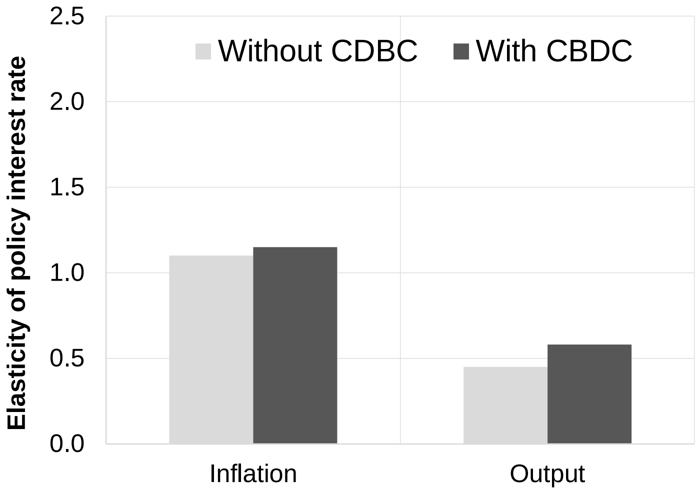


Flexible remuneration

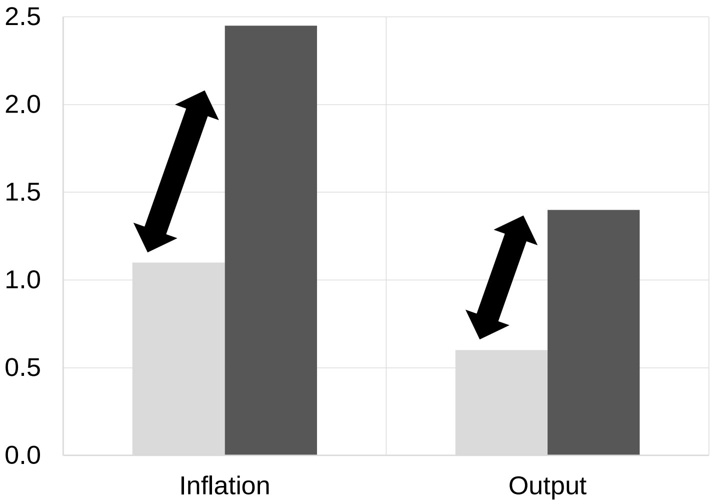


Implications for monetary policy

Domestic economy (CBDC issuer)



Foreign economy (not issuing CBDC)



Notes: model-based optimal response to output and inflation of the central bank Taylor rule in the presence and absence of CBDC under a fixed-remuneration design. The key parameters optimized are interest rate persistence, the elasticity with respect to inflation and the elasticity with respect to output. Welfare is computed as the stochastic mean of the sum of current and future utility flows of households at the second order.

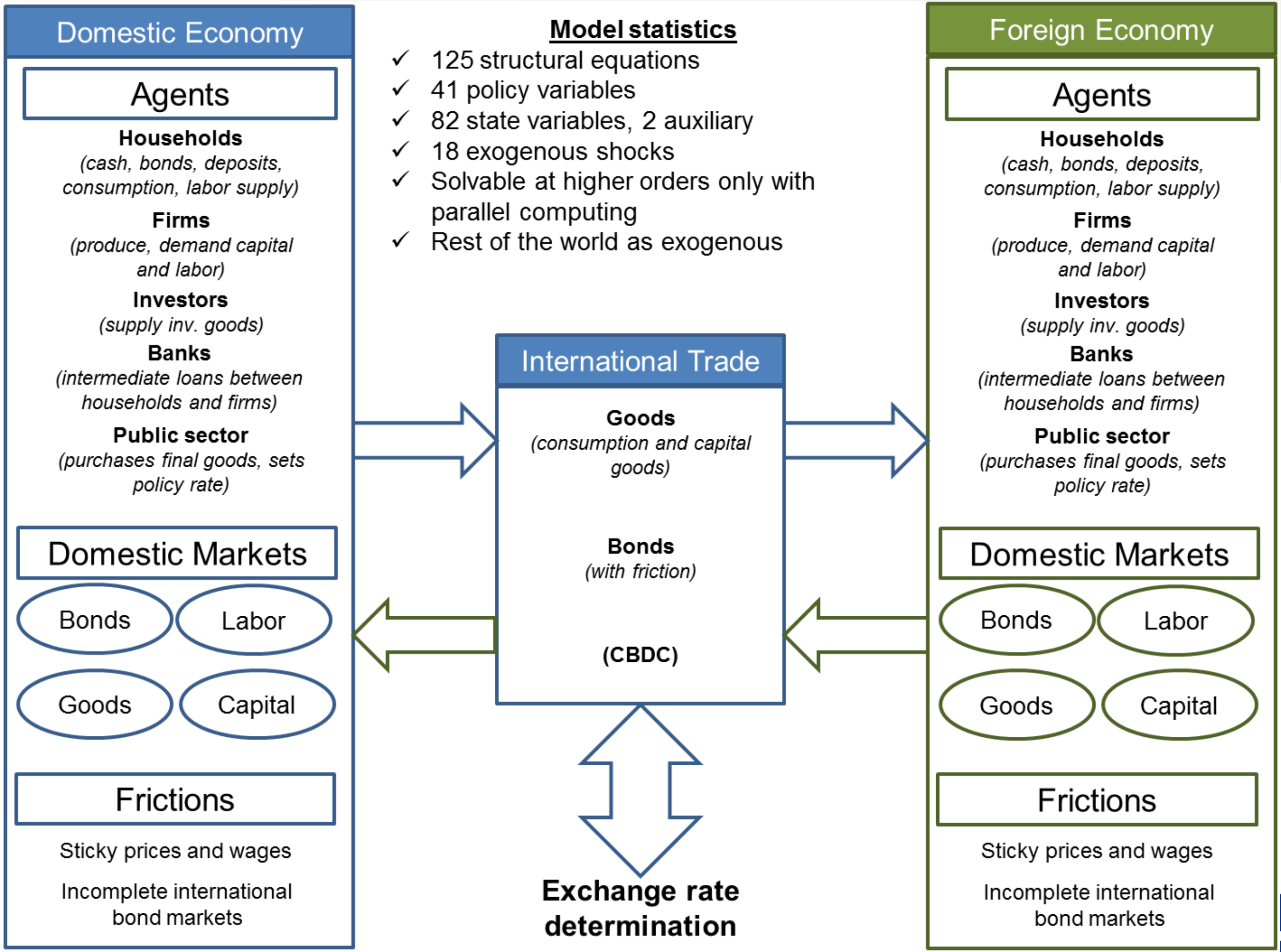
Conclusions

- CBDC amplifies international spillovers of shocks
- Technical design features matter
  - Capital controls and flexible CBDC interest rate reduce spillovers
  - Quantitative restrictions less effective than price flexibility
- CBDC increases asymmetries in the international monetary system
- CBDC reduces monetary policy autonomy in foreign economy
  - Foreign central bank need to be twice more reactive to shocks
- Next steps: what about the international use of currencies?

Background

Basic model

- 2-country DSGE model à la Eichenbaum, Johannsen and Rebelo (2017)
- Households
  - Unit mass, consume, save (bonds), supply labor and invest (risky loans)
  - Utility depends on consumption, labor supply and cash (Feenstra 1986)
  - Incomplete access to domestic and foreign bond markets (UIP fails)
- Firms
  - Produce final goods sold domestically and abroad
  - Monopolistic competition, sticky Calvo-prices and wages
  - Demand loans to invest
- Financial sector
  - Issues loans to firms
  - Financed through household deposits
  - Returns on loans are risky (≠ CBDC)


Domestic Economy
Agents
Households
(cash, bonds, deposits, consumption, labor supply)
Firms
(produce, demand capital and labor)
Investors
(supply inv. goods)
Banks
(intermediate loans between households and firms)
Public sector
(purchases final goods, sets policy rate)
Domestic Markets
Bonds
Labor
Goods
Capital
Frictions
Sticky prices and wages
Incomplete international bond markets
Model statistics
✓ 125 structural equations
✓ 41 policy variables
✓ 82 state variables, 2 auxiliary
✓ 18 exogenous shocks
✓ Solvable at higher orders only with parallel computing
✓ Rest of the world as exogenous
International Trade
Goods
(consumption and capital goods)
Bonds
(with friction)
(CBDC)
Exchange rate determination
Foreign Economy
Agents
Households
(cash, bonds, deposits, consumption, labor supply)
Firms
(produce, demand capital and labor)
Investors
(supply inv. goods)
Banks
(intermediate loans between households and firms)
Public sector
(purchases final goods, sets policy rate)
Domestic Markets
Bonds
Labor
Goods
Capital
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Sticky prices and wages
Incomplete international bond markets

Modelling CBDC (domestic economy)

$$U_t(C_t, L_t, M_t, DC_t) \equiv \frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \frac{\chi (L_t)^{1+\psi}}{1+\psi} + \frac{\mu^{\$}(M_t)^{1-\sigma^{\$}}}{1-\sigma^{\$}} + \frac{\mu^{DC}(DC_t)^{1-\sigma^{DC}}}{1-\sigma^{DC}}$$

$$\mu^{DC} = \mu^{\$}\Theta;\ \sigma^{DC} = \sigma^{\$} + \sigma^{\$}(1-\Theta) \qquad \Theta = \begin{cases} = 0 & \text{no utility per se (like deposits)} \\ = 1 & \text{same utility as cash} \\ > 0, \neq \{0,1\} & \text{utility from hybrid instrument} \end{cases}$$

Modelling CBDC (domestic economy)

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$$\frac{\partial \mathcal{L}}{\partial DC_t} \equiv \frac{\mu^{DC}(DC_t)^{-\sigma^{DC}}}{\lambda_t} = 1 - E_t\left[\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{r_t^{DC}}{\pi_{t+1}}\right]$$

(r_t^{DC} fixed or flexible)

Modelling CBDC (foreign country)

$$\frac{\partial \mathcal{L}^*}{\partial DC^*_t} \equiv \underbrace{\mu^{DC,*}\left({DC^*_t}/{NER_t}\right)^{-\sigma^{DC,*}}}_{\substack{\text{Utility from liquidity services} \\ \text{(e.g. export/import payments)}}} - \lambda^*_t \overbrace{\left[1 + \varphi^{DC}\, {DC^*_t}/{NER_t}\right]}^{\substack{\text{Cost of accessing CBDC} \\ \text{(e.g. capital controls)}}} + E_t \underbrace{\left[\beta^* \lambda^*_{t+1} \frac{r_t^{DC}}{\pi^*_{t+1}} \frac{NER_t}{NER_{t+1}}\right]}_{\substack{\text{Remuneration adjusted for exchange} \\ \text{rate risk and inflation}}} = 0$$

Key mechanism

Arbitrage condition between foreign bonds and CBDC (FX-adjusted) remuneration

$$\underbrace{R_t^* = R_t^{DC} \frac{NER_t}{E_t(NER_{t+1})}}_{\textit{CBDC remuneration}} \underbrace{\left[1 - \frac{1}{\lambda_t^*}\mu^{*,dc}\left(\frac{dc_t^*}{NER_t}\right)^{-\sigma^{*,dc}}\right]^{-1}}_{\textit{CBDC liquidity mark-up}}$$

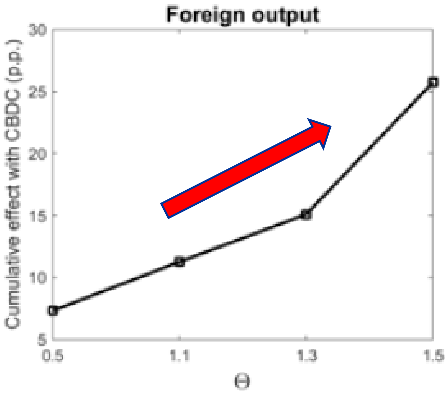
≠ Arbitrage condition between foreign and domestic bonds

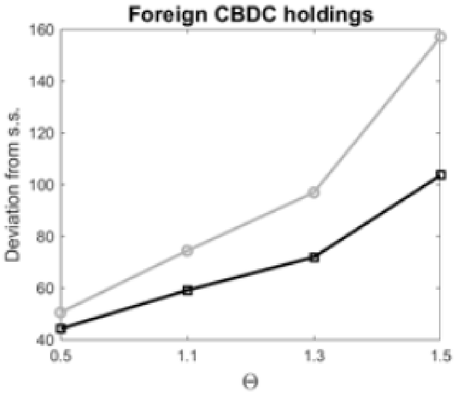
$$R_t^* \approx R_t \frac{NER_t}{E_t(NER_{t+1})}$$

No role for storage costs, risk

Liquidity, capital controls and storage costs

Higher CBDC liquidity mark-up Θ
Tighter capital controls (black line)





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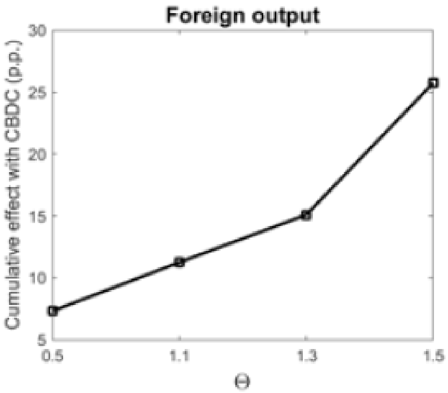

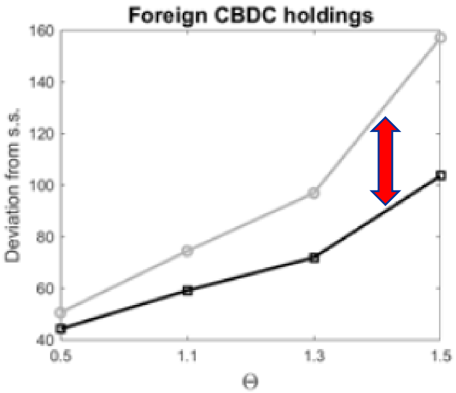

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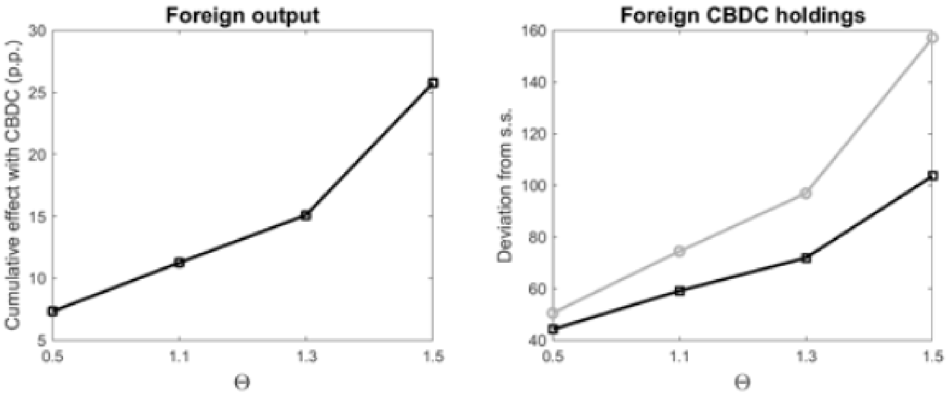
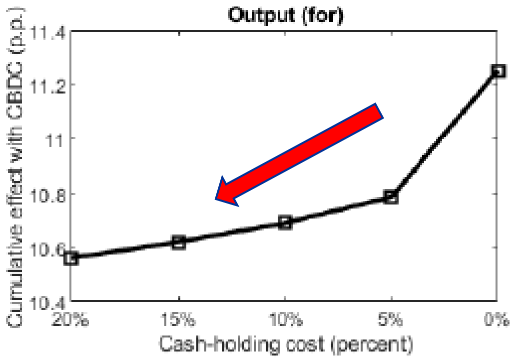
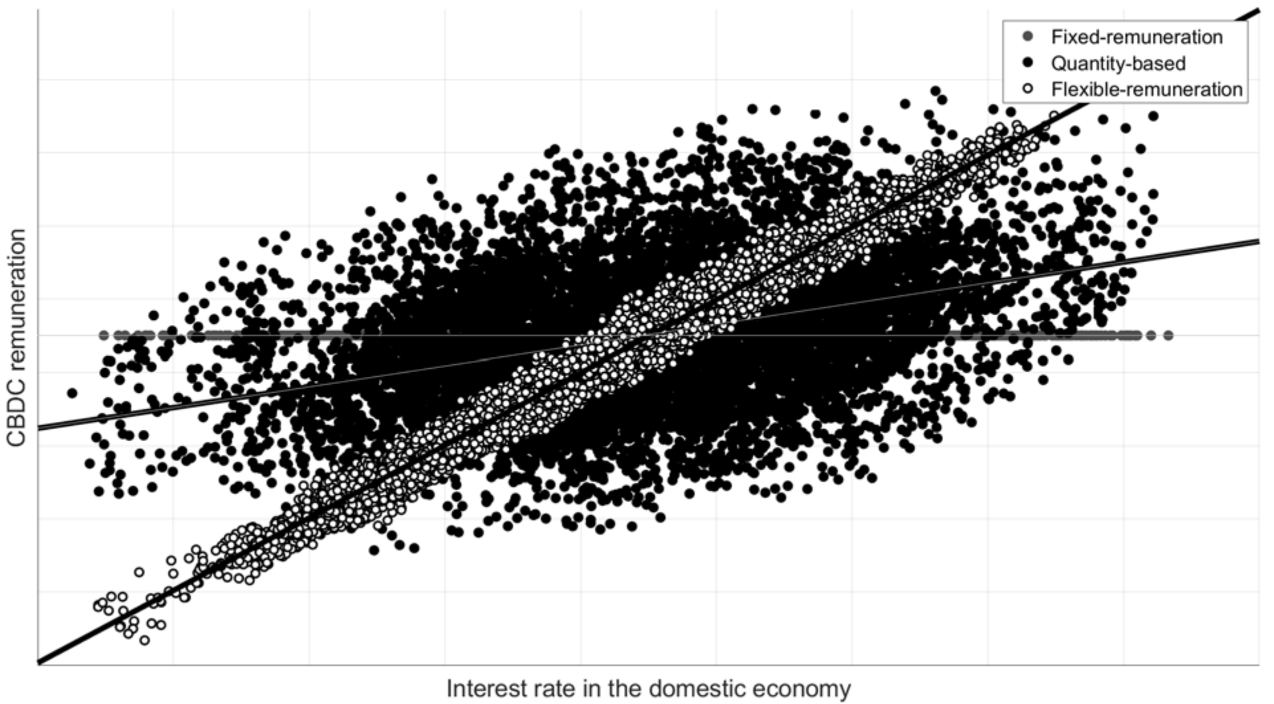


Higher cash storage costs



The CBDC rate channel



Notes: the chart plots the simulated series for the domestic bond interest rate and the CBDC interest rate for three possible CBDC designs (fixed interest rate, quantity-based and flexible (Taylor-rule-type) interest rate).

Optimal monetary policy in presence of a CBDC

- Maximize household utility using central bank policy rate as instrument

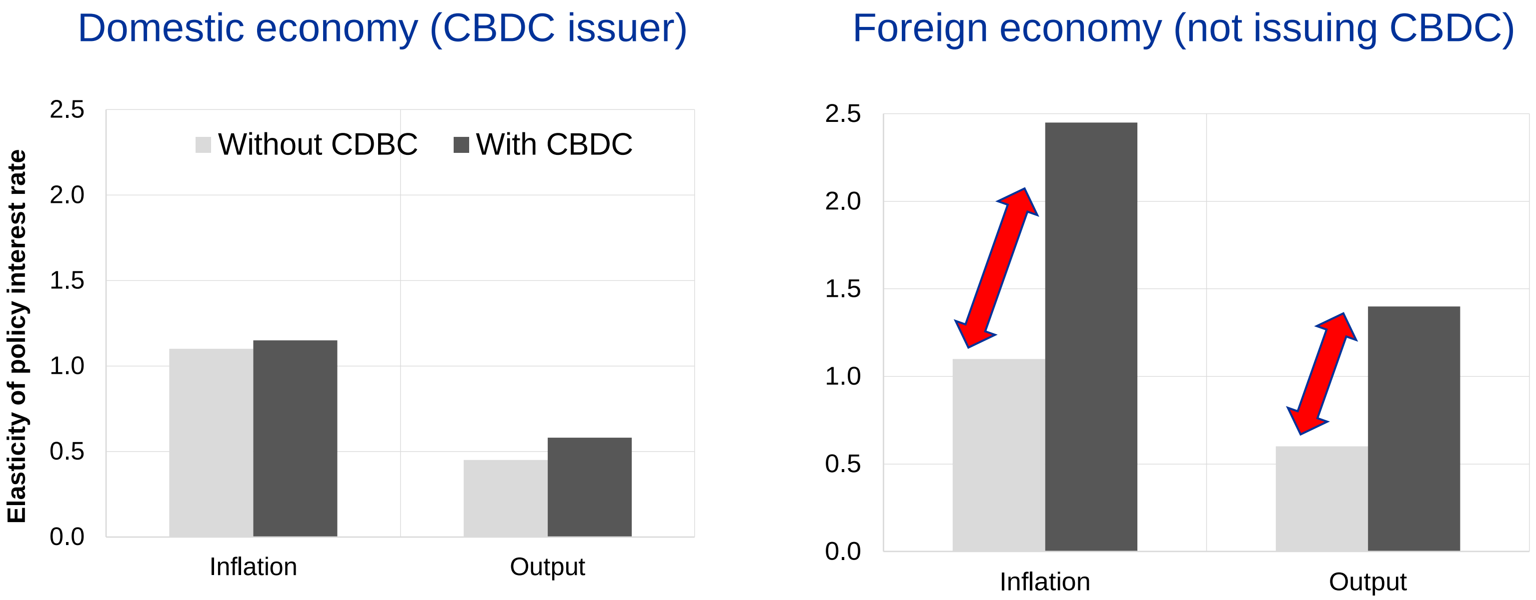
$$\max_{\gamma,\theta_\pi,\theta_y} E_t \sum_{j=0}^{\infty} \beta^j U_{t+j} \ \ s.t.$$

$$r_t = [r_{t-1}]^\gamma \left[(\pi_t)^{\theta_\pi}(y_t)^{\theta_y}\right]^{1-\gamma}$$

- Choose optimal γ, θ_y and θ_π to maximize welfare

- Non-linear optimization problem with second-order solution

CBDC reduces foreign monetary policy autonomy



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How we fit in the literature

- CBDC in domestic non-DSGE models

  (Agur et al. 2019; Brunnermeier and Niepelt, 2019; Andolfatto, 2018; Fernandez-Villaverde et al. 2020)

- CBDC in domestic DSGE models

  (Barrdear and Kumhof 2016)

- Open-economy DSGE models on CBDC or cryptocurrencies

  (George et al. 2018, Benigno et al. 2019)

→ **Two-country DSGE model on CBDC**