EUROPEAN CENTRAL BANK

EUROSYSTEM

Central bank digital currency in an open economy

CEBRA-CEPR-Sveriges Bank conference

on “Exchange rates and Monetary Policy”

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#ECB and CEPR

What a Central bank digital currency (CDBC) is

Liability of central bank | **Liability of private entity** | **Not a liability**

Cash	*Central bank deposit*	*Commercial bank money*	*E-money*	*Crypto-currency*
- Physical instrument - Public use	- Digital instrument - Restricted use			

Policy motivation

- Innovative payment solutions (e.g. Facebook Libra) challenges central banks to consider upgrading concept and provision of money
- Covid-19 transmission through cash
- 80% of central banks worldwide working on CBDC
- Large-scale tests of China’s Digital Currency/Electronic Payments project

Cole Porter’s 1928
“***Let’s do it***” jazz hit song

♪♫♬
“Birds do it, bees do it
Even educated fleas do it
Let's do it…” ♪♫♬

Chinese do it ♪♫♬

Swedes do it ♪♫♬

Others do it? ♪♫♬

Research motivation

- Old idea (Tobin 1987)
- Private accounts at central banks before World War II
- Growing literature, lots of technical, macro and financial stability questions
- Literature focused on *closed-economy* issues

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**

Research question

Open-economy implications of a CBDC?

- 2-country DSGE model
- CBDC included in menu of monetary assets; alternative technical features
- International transmission with vs. without CBDC of shocks
- Optimal monetary policy, welfare and implications for policy coordination

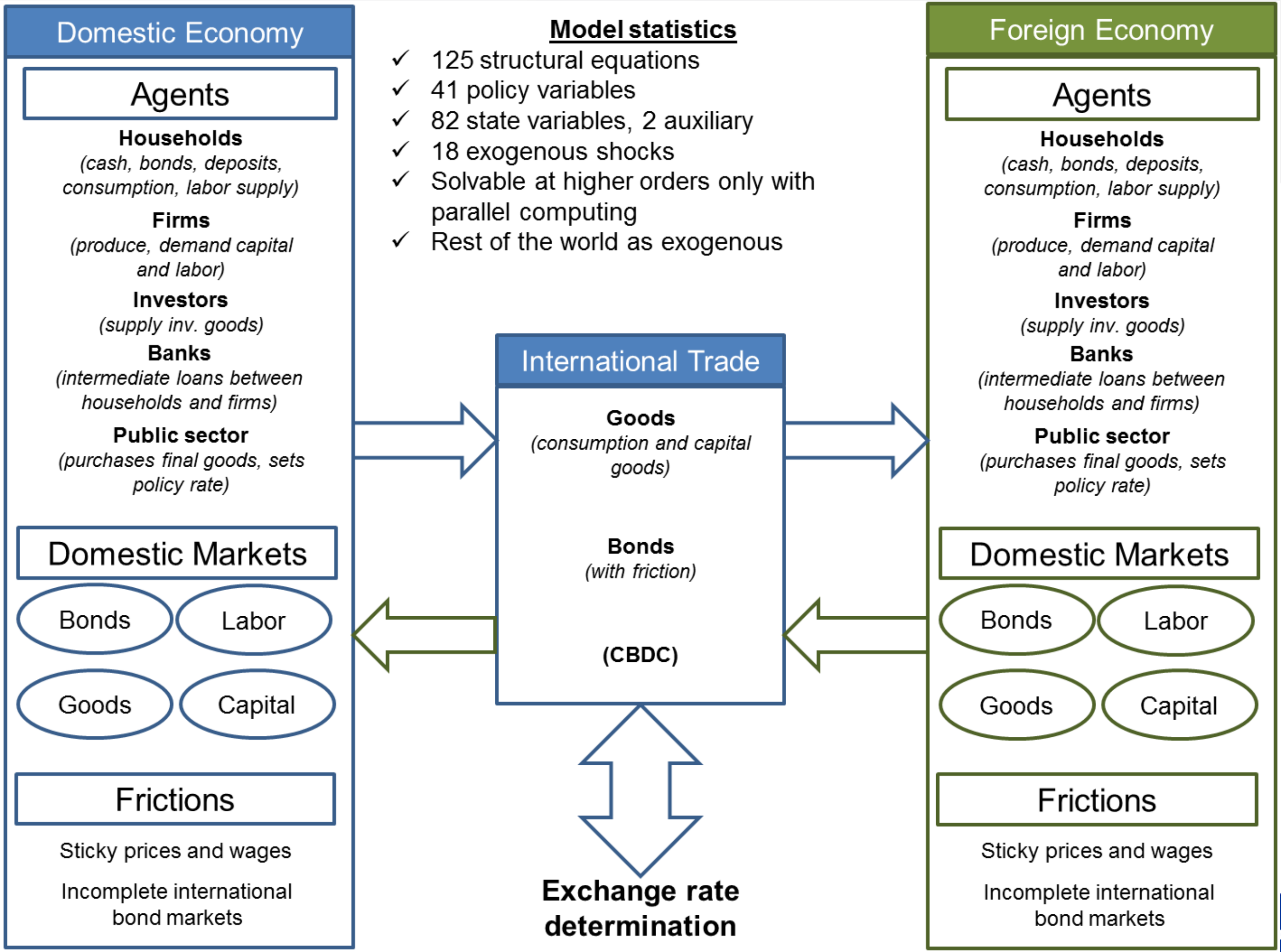
Key findings

- 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

Outline

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
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Incomplete international bond markets

Intuition on CBDC modelling

	Scalability	Liquidity	Safety	Interest rate	International use
Cash		✓	✓		
Bonds	✓		✓	✓	✓
Deposits	✓			✓	
CBDC	✓	✓	✓	✓	✓

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)

$$\frac{\partial \mathcal{L}^*}{\partial DC^*_t} \equiv \overbrace{\mu^{DC,*}\left({DC^*_t}/{NER_t}\right)^{-\sigma^{DC,*}}}^{\text{Utility from liquidity services (e.g. export/import payments)}} - \lambda^*_t \overbrace{\left[1 + \varphi^{DC}\, {DC^*_t}/{NER_t}\right]}^{\text{Cost of accessing CBDC (e.g. capital controls)}}$$

$$+ E_t\left[\underbrace{\beta^* \lambda^*_{t+1} \frac{r_t^{DC}}{\pi^*_{t+1}} \frac{NER_t}{NER_{t+1}}}_{\text{Remuneration adjusted for exchange rate risk and inflation}}\right] = 0$$

Key mechanism

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

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

≠ 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

Model predictions on effect of shocks with CBDC

1) Larger exchange rate (*NER*) overshooting

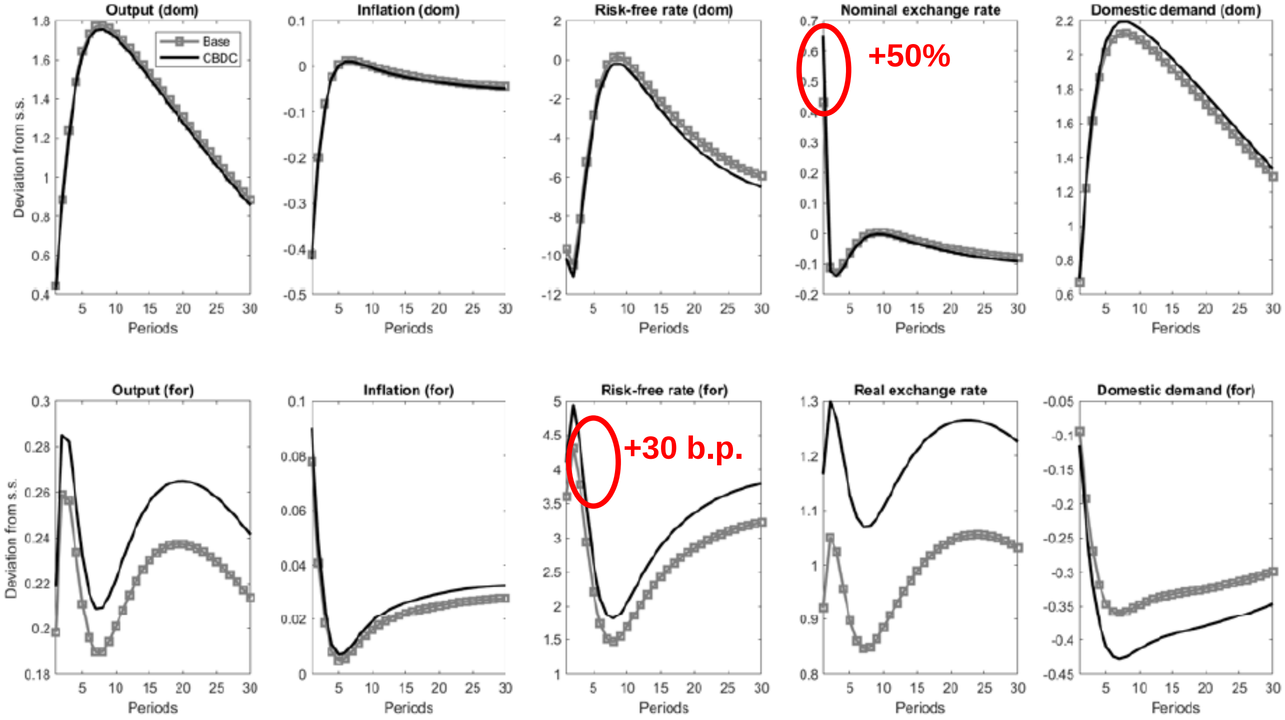
2) Larger movements in foreign bond interest rate *R**

3) Stronger impact on real consumption and investment in foreign economy

4) Stronger spillovers of domestic economy to foreign economy

Outline

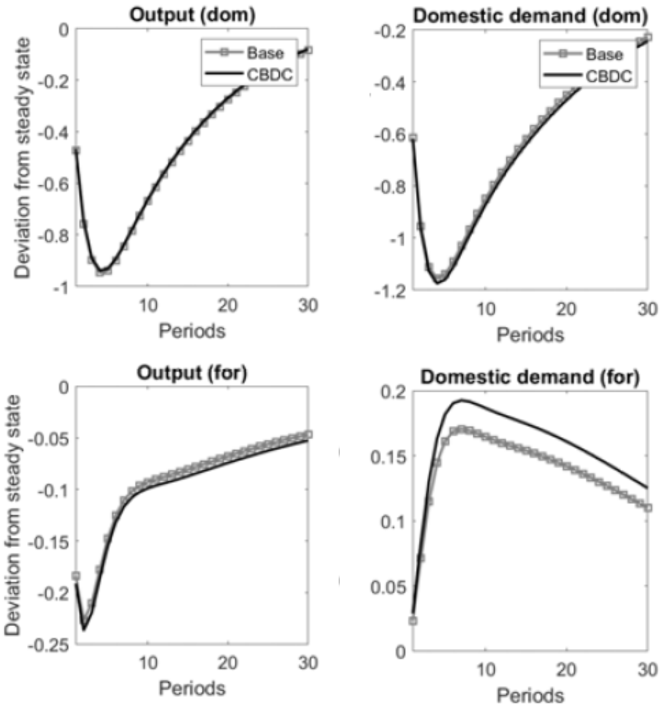
Effect of a positive domestic TFP shock



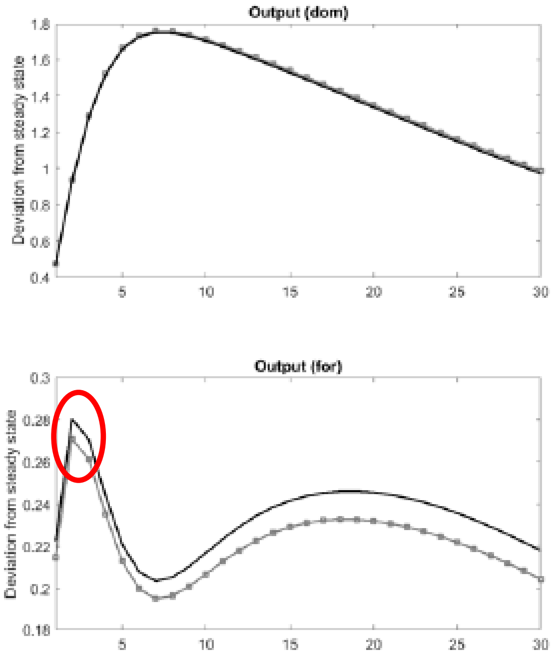
Notes: IRFs in deviation from steady-state to a 1-standard deviation expansionary total factor productivity shock in the domestic economy.

Robustness and extensions

Monetary policy shock

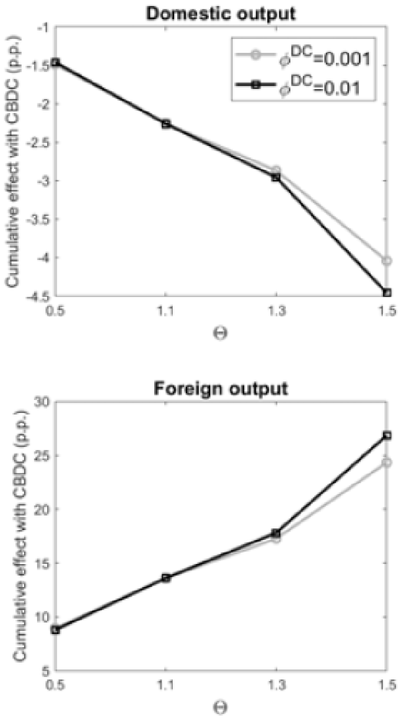


Estimated model – TFP shock

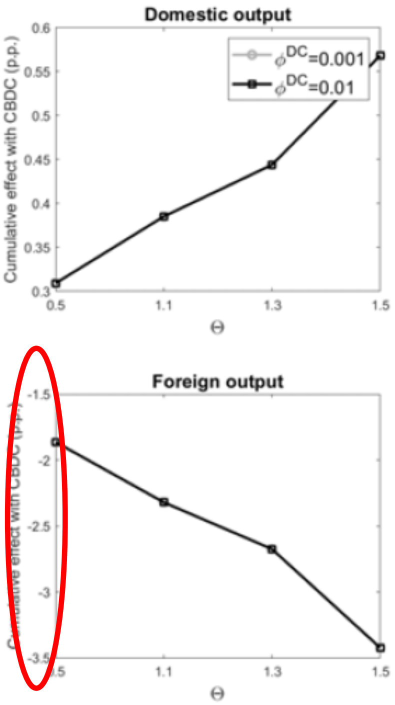


Robustness and extensions

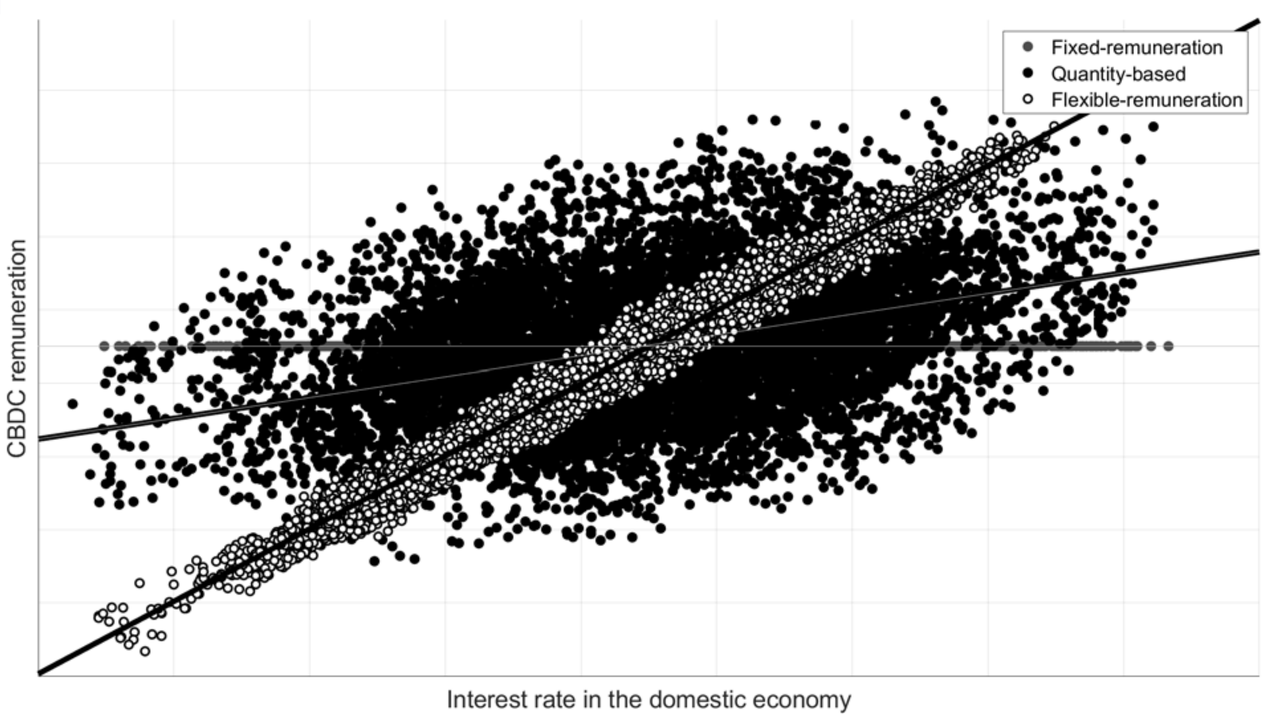
CBDC with fixed supply



CBDC with Taylor-rule interest rate



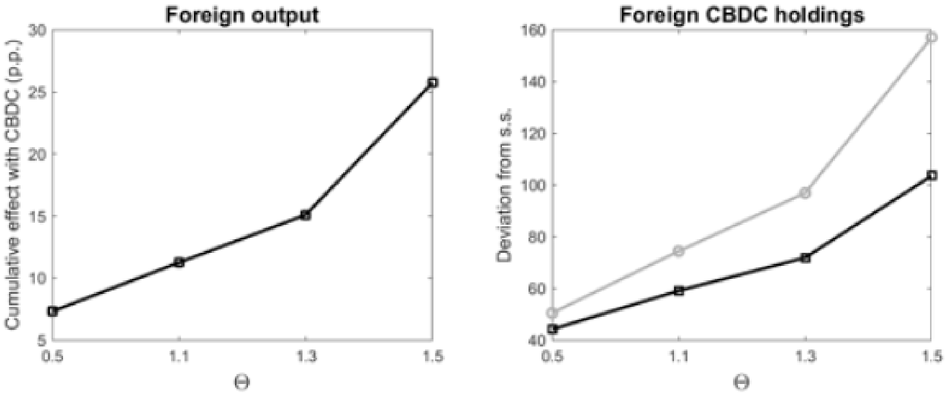
Robustness and extensions



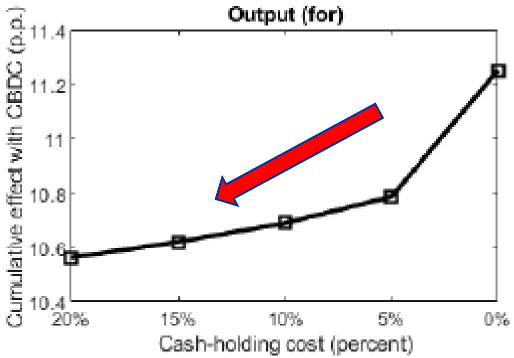
Notes: the chart plots the simulated series for the domestic bond interest rate and the CBDC interest rate for three possible CBDC designs (fixed interest rate, quantity-based and flexible (Taylor-rule-type) interest rate).

Robustness and extensions

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



Higher cash storage costs



Optimal monetary policy in presence of a CBDC

- Maximize household utility using central bank policy rate as instrument

$$\max_{\gamma,\theta_\pi,\theta_y} E_t \sum_{j=0}^{\infty} U_{t+j} + \beta U_{t+j+1} \; s.t.$$

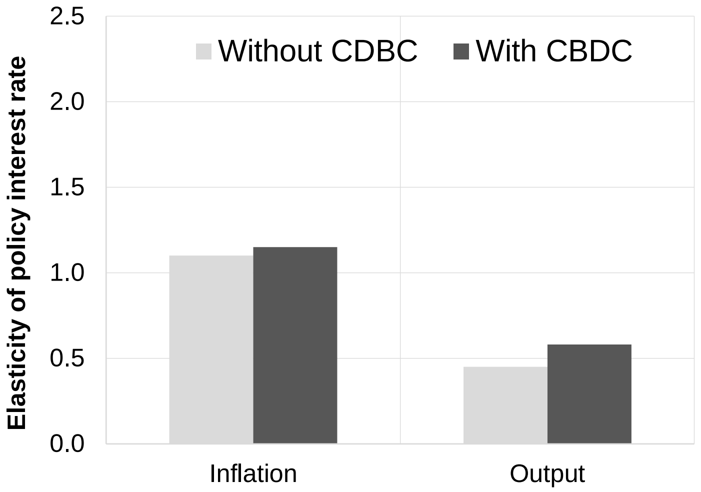
$$r_t = [r_{t-1}]^\gamma \left[(\pi_t)^{\theta_\pi} (y_t)^{\theta_y}\right]^{1-\gamma}$$

- Choose optimal θ_y and θ_π to maximize welfare

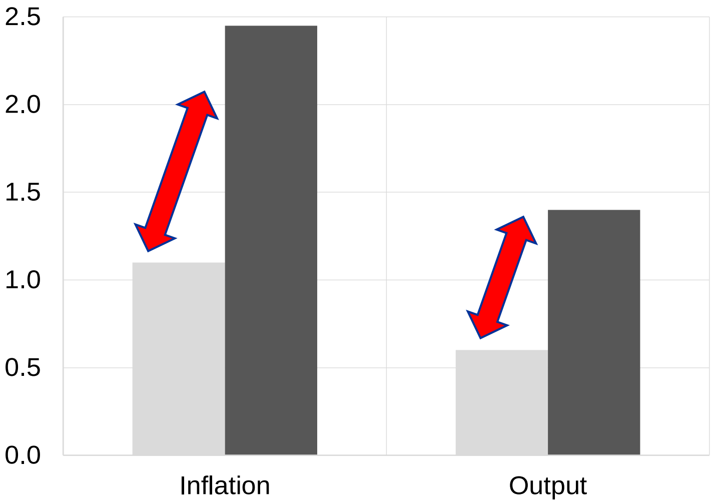
- Non-linear optimization problem with second-order solution

CBDC reduces foreign monetary policy autonomy

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

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