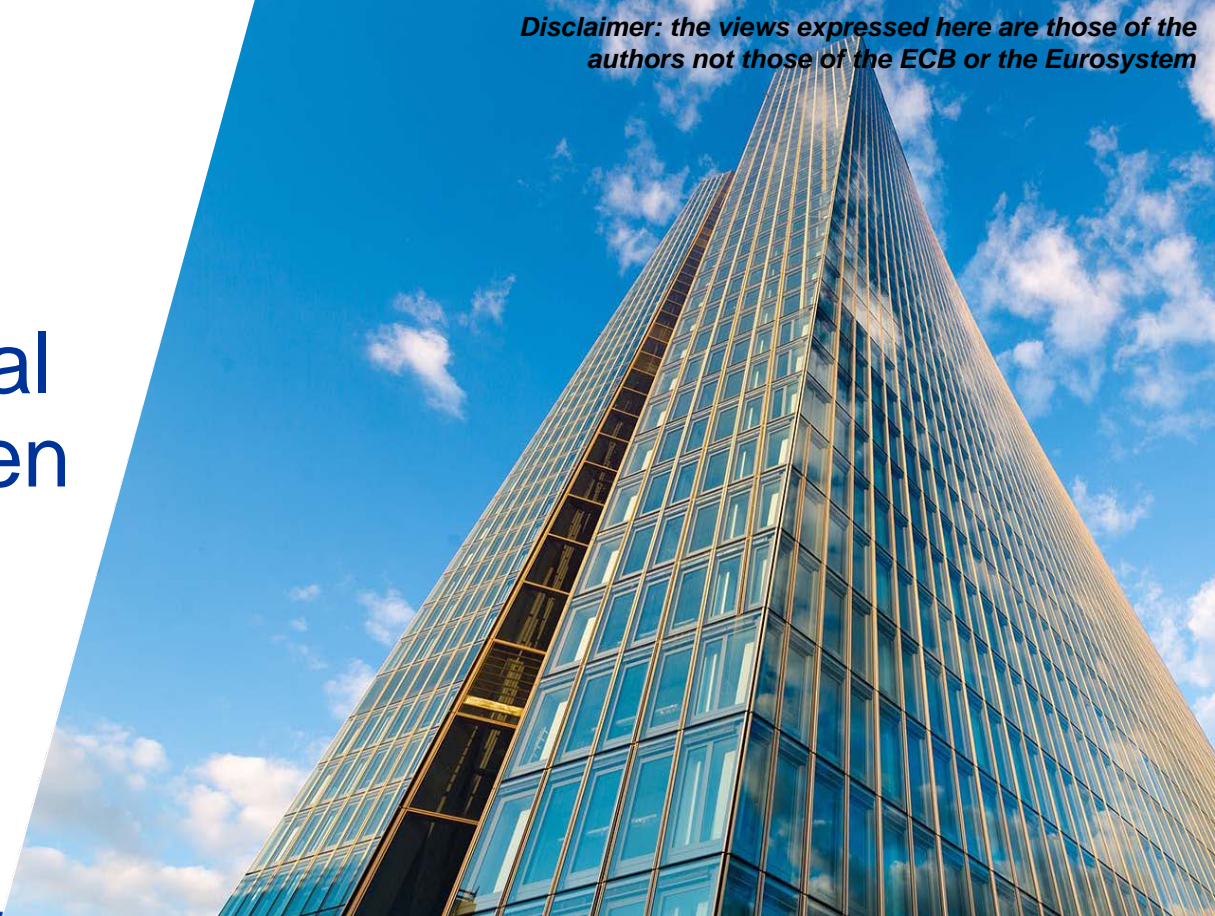




EUROPEAN CENTRAL BANK

EUROSYSTEM

Disclaimer: the views expressed here are those of the authors not those of the ECB or the Eurosystem



Central bank digital currency in an open economy

Financial Globalization and De-Globalization:
Perspectives and Prospects

3 May 2021

Massimo Ferrari*, Arnaud Mehl# and Livio Stracca*

*ECB

#ECB and CEPR

Report on a digital euro

October 2020



What a Central bank digital currency (CDBC) is

Liability of central bank

Cash

- Physical instrument
- Public use

*Central bank
deposit*

- Digital instrument
- Restricted use

What a Central bank digital currency (CBDC) is

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What a Central bank digital currency (CBDC) is

Liability of central bank

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Central bank deposit

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Liability of private entity

Commercial bank money

E-money

Not a liability

Crypto-currency



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

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

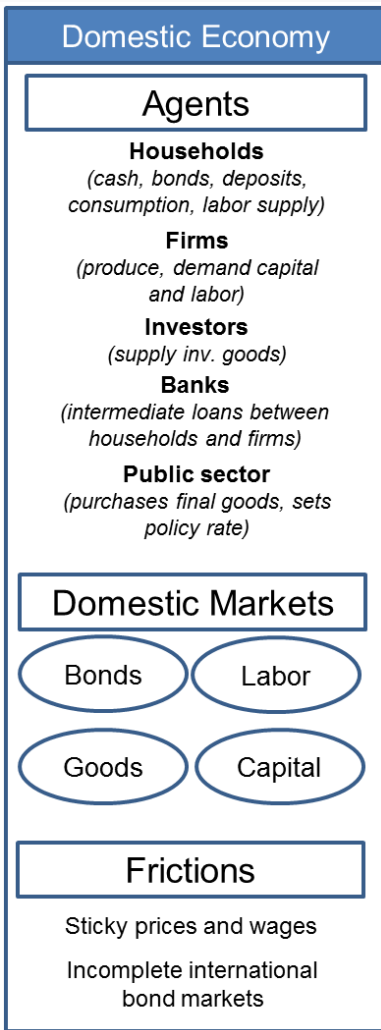
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Basic model

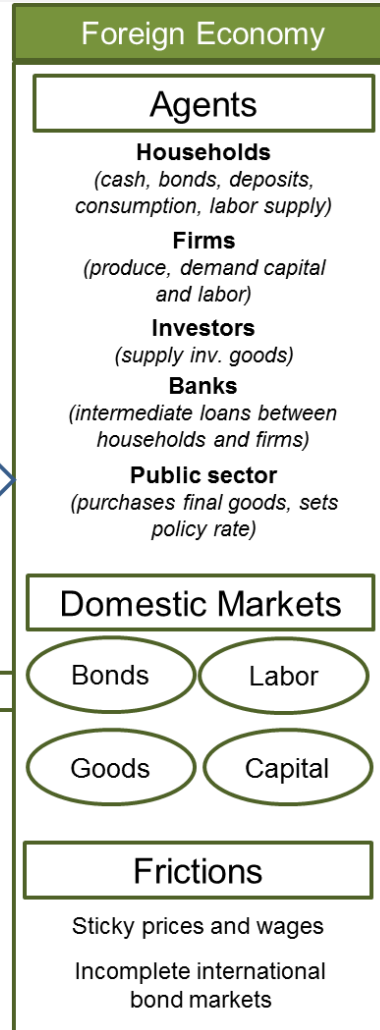
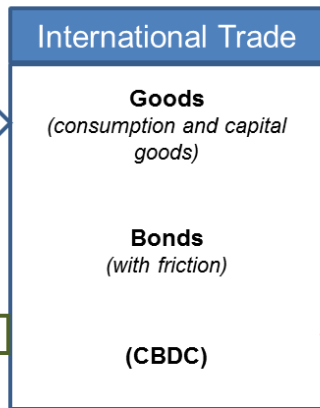
- 2-country DSGE model à la Eichenbaum, Johannsen and Rebelo (2017)
- Households
 - Unit mass, consume, save (bonds), supply labor and invest (risky loans)
 - Utility depends on consumption, labor supply and cash (Feenstra 1986)
 - Incomplete access to domestic and foreign bond markets (UIP fails)

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- 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 (\neq CBDC)



- 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



Exchange rate determination

Intuition on CBDC modelling

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

Modelling CBDC (domestic economy)

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

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

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

Modelling CBDC (foreign country)

$$\frac{\partial \mathcal{L}^*}{\partial DC_t^*} \equiv \mu^{DC,*} \left(DC_t^* / NER_t \right)^{-\sigma^{DC,*}} - \lambda_t^* \left[1 + \varphi^{DC} DC_t^* / NER_t \right] + E_t \left[\underbrace{\beta^* \lambda_{t+1}^* \frac{r_t^{DC}}{\pi_{t+1}^*} \frac{NER_t}{NER_{t+1}}}_{\text{Remuneration adjusted for exchange rate risk and inflation}} \right] = 0$$

Remuneration adjusted for exchange rate risk and inflation

Modelling CBDC (foreign country)

Cost of accessing CBDC
(e.g. capital controls)

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Utility from liquidity services
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Key mechanism

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

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$$R_t^* = R_t^{DC} \frac{NER_t}{E_t(NER_{t+1})} \left[1 - \frac{1}{\lambda_t^*} \mu^{*,dc} \left(\frac{dc_t^*}{NER_t} \right)^{-\sigma^{*,dc}} \right]^{-1}$$


Foreign bond interest rate

Key mechanism

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≠ Arbitrage condition between foreign and domestic bonds

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No role for storage costs, risk

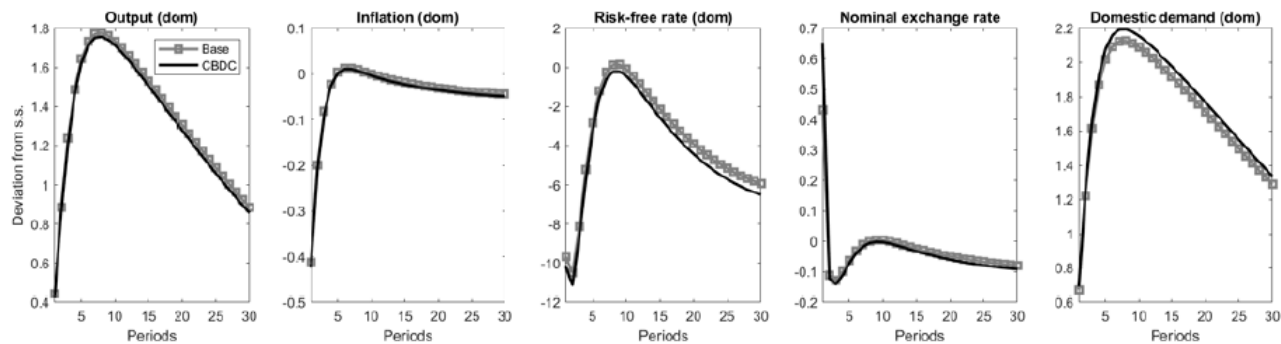
Model predictions on effect of shocks with CBDC

- 1) Larger movements in foreign bond interest rate R^*
- 2) Larger exchange rate (NER) overshooting
- 3) Stronger impact on real consumption and investment in foreign economy
- 4) Stronger spillovers of domestic economy to foreign economy

Outline

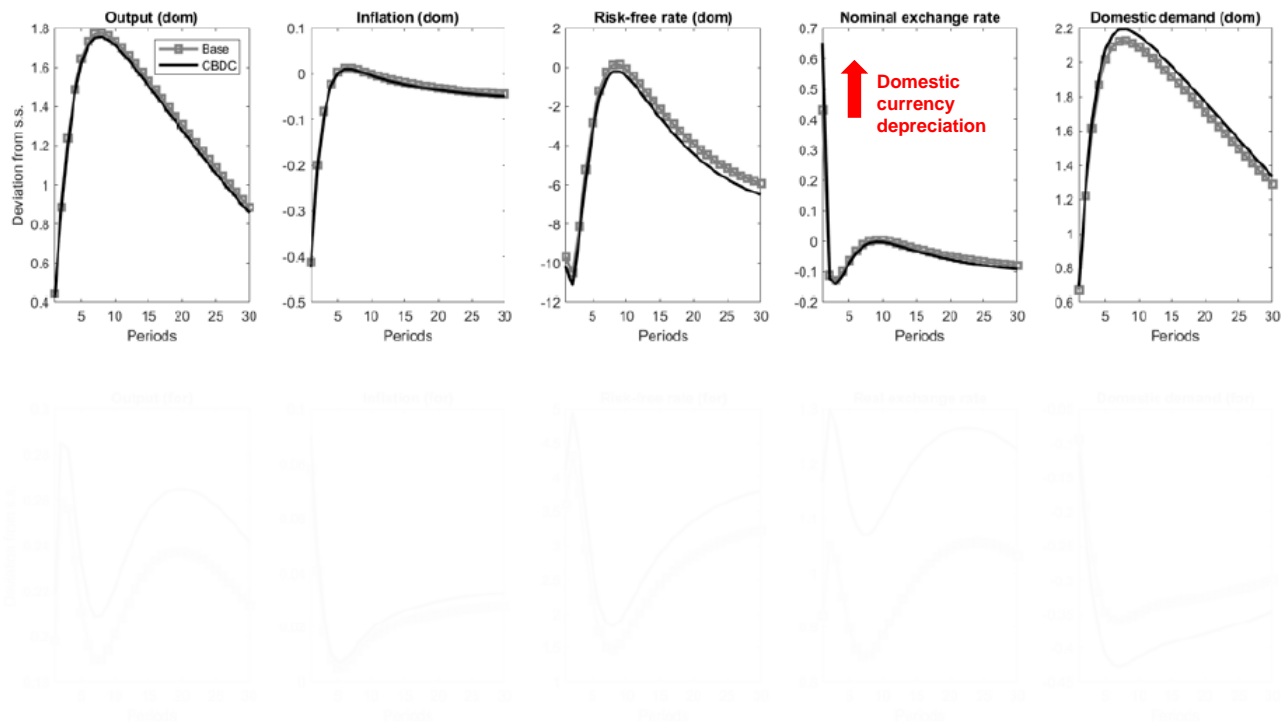
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Effect of a positive domestic TFP shock



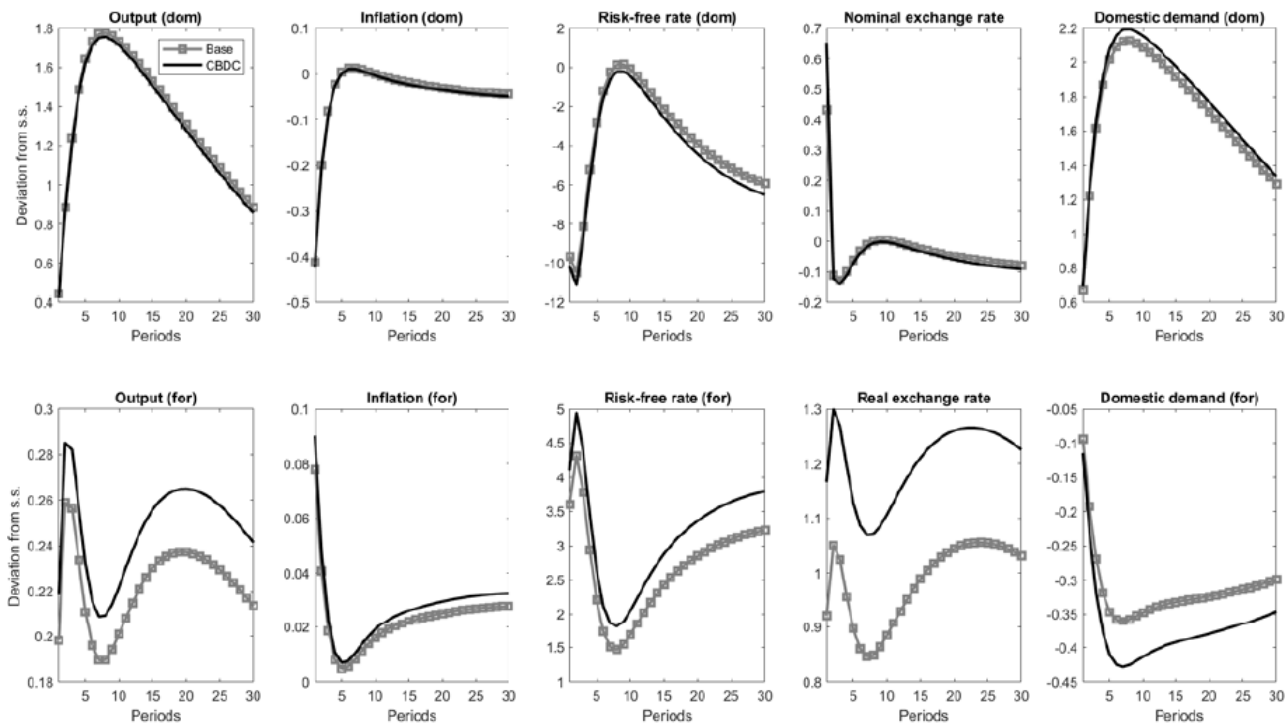
Notes: IRFs in deviation from steady-state to a 1-standard deviation expansionary total factor productivity shock in the domestic economy.

Effect of a positive domestic TFP shock



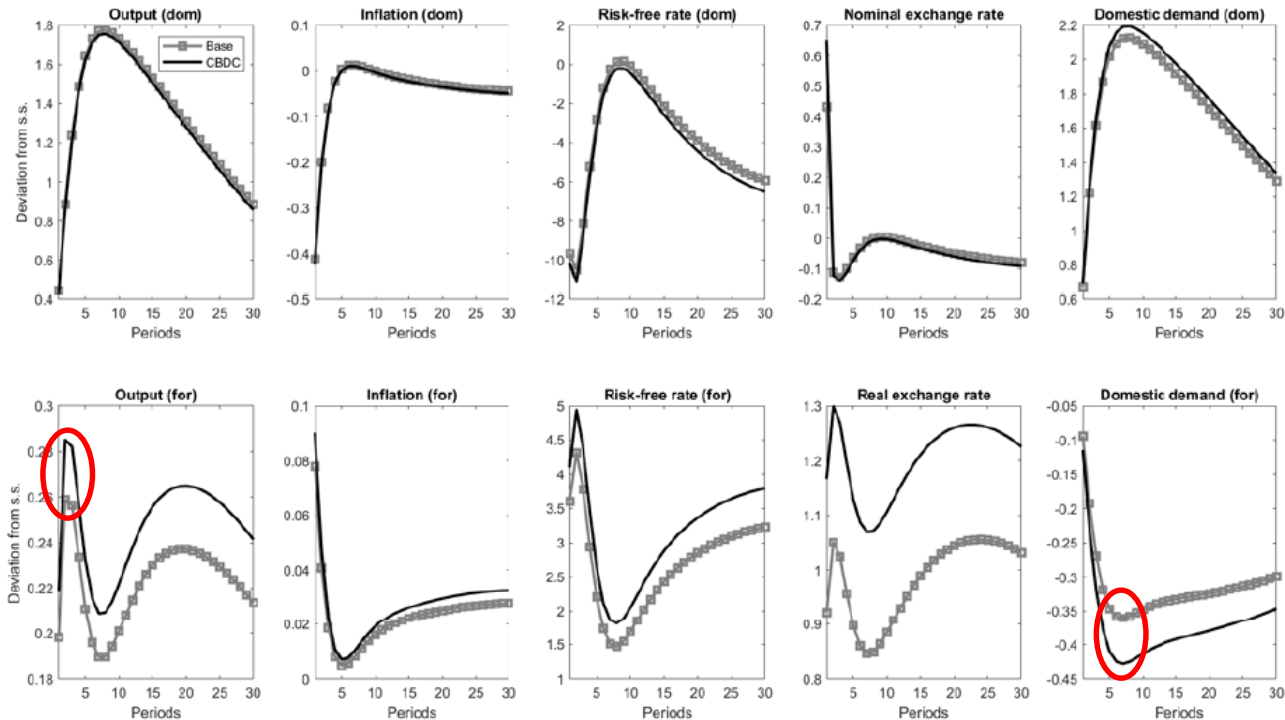
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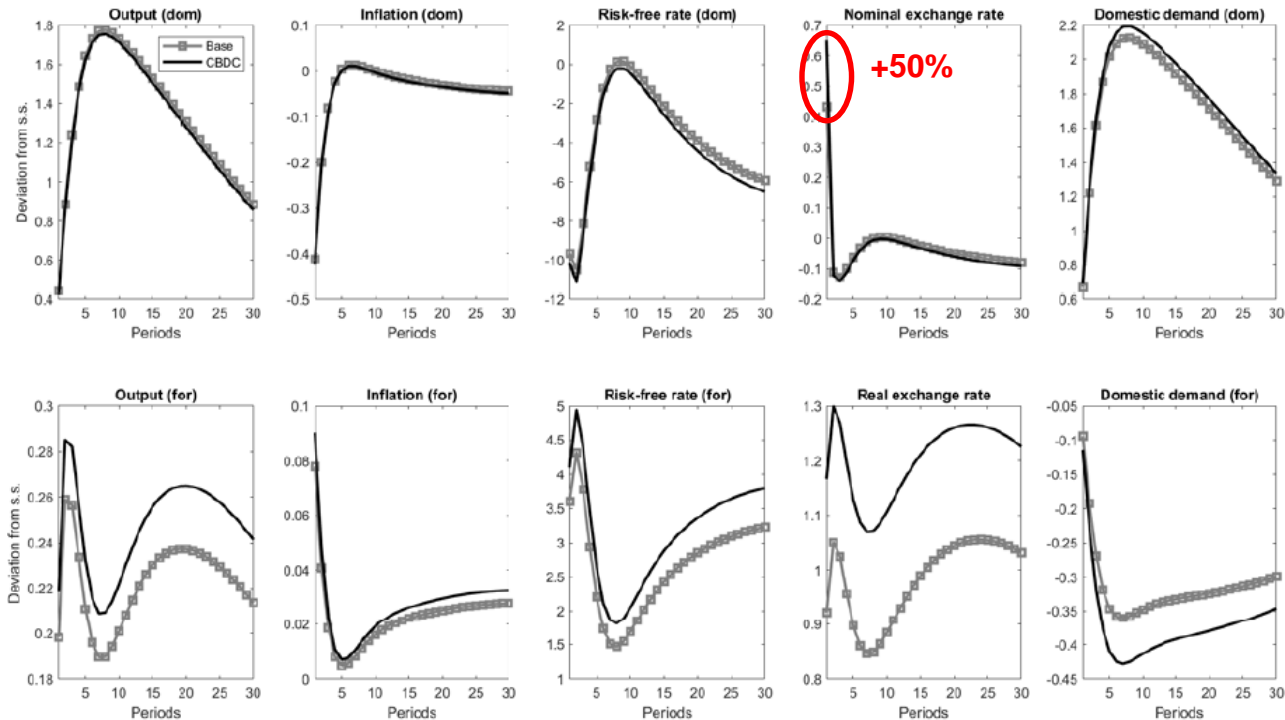
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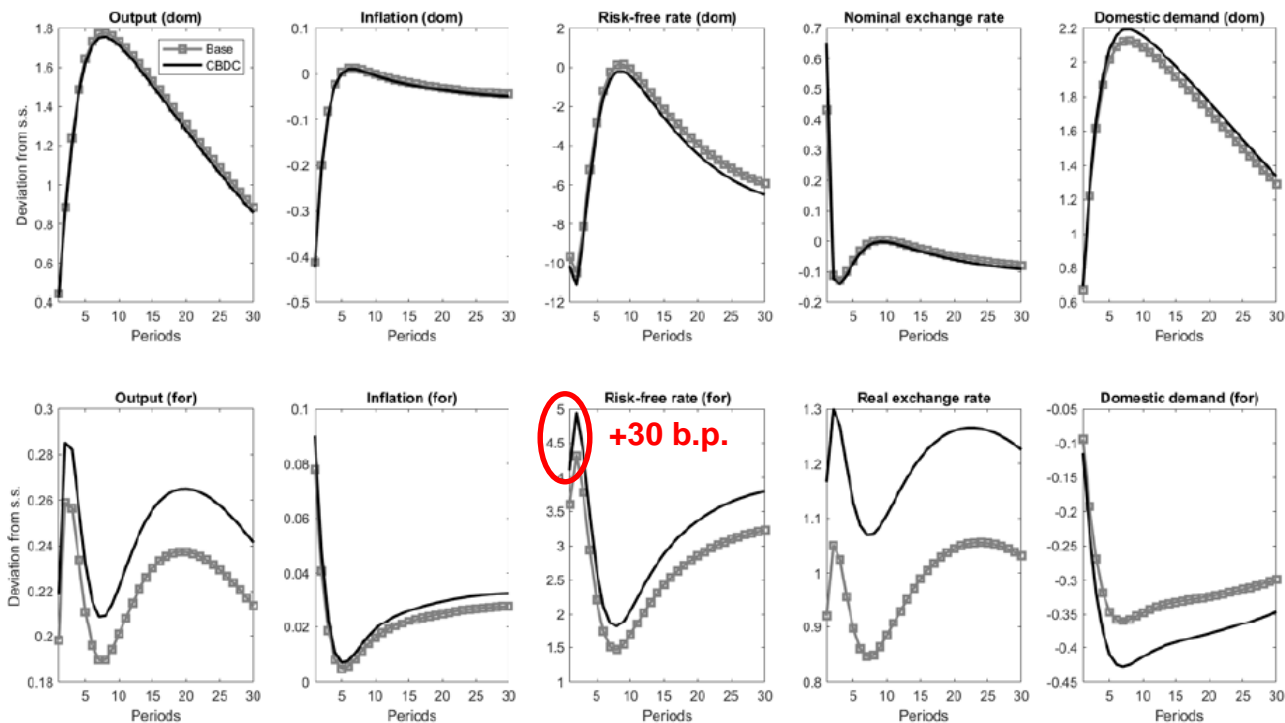
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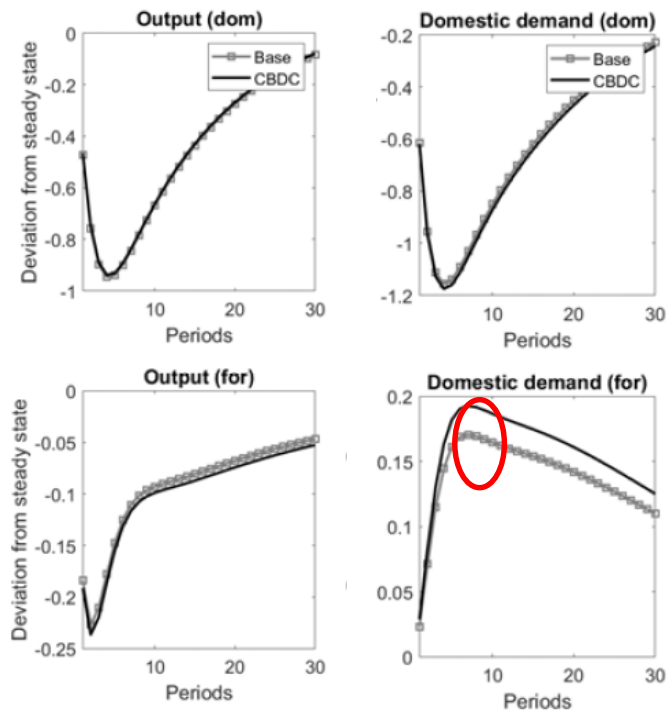
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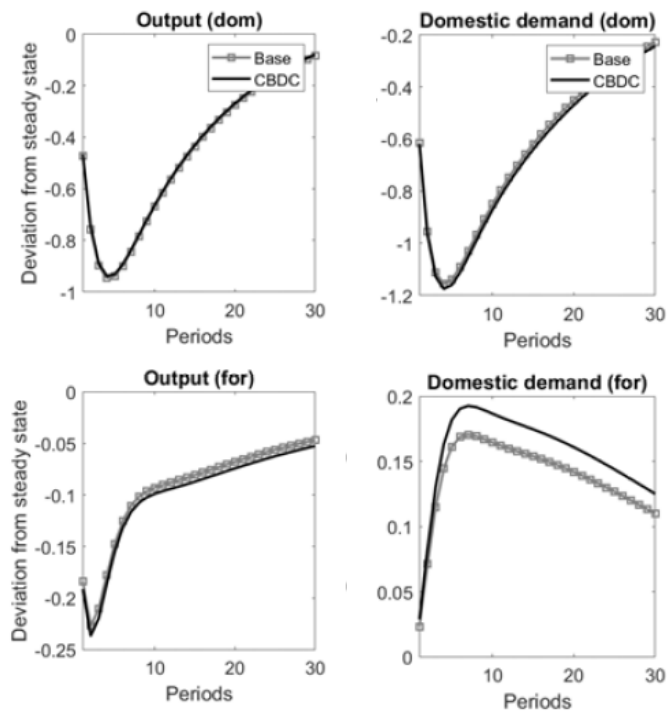
Robustness and extensions

Monetary policy shock

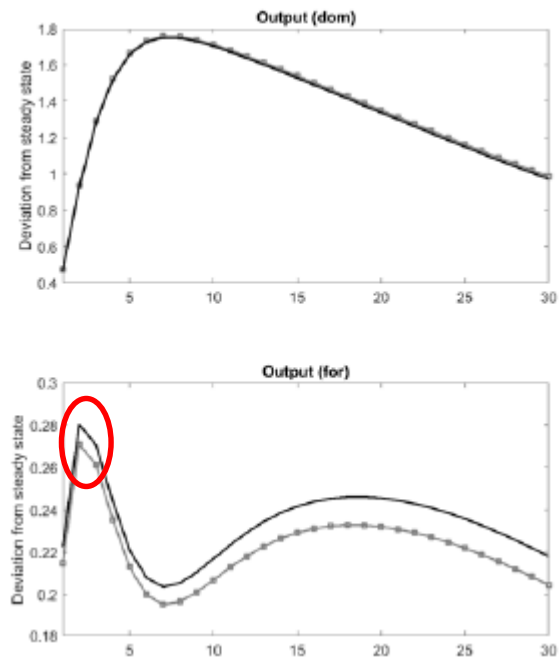


Robustness and extensions

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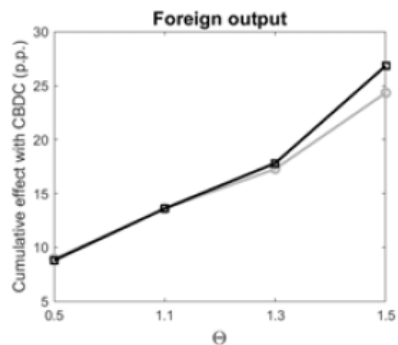
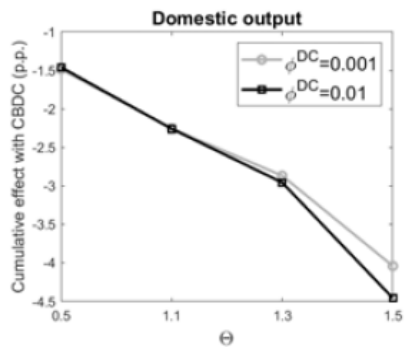


Estimated model – TFP shock



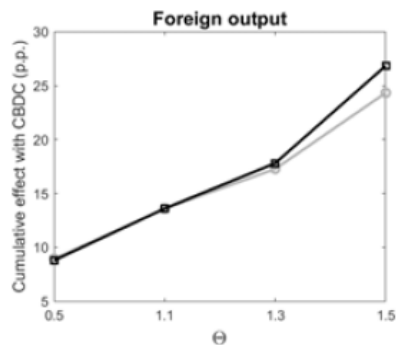
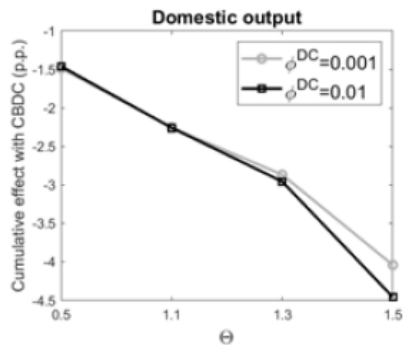
Robustness and extensions

CBDC with fixed supply

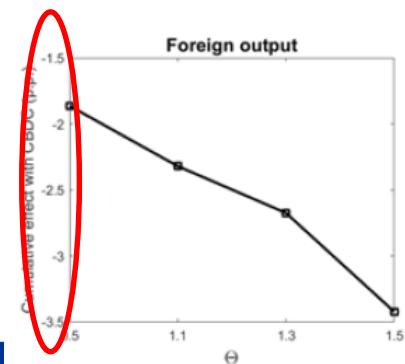
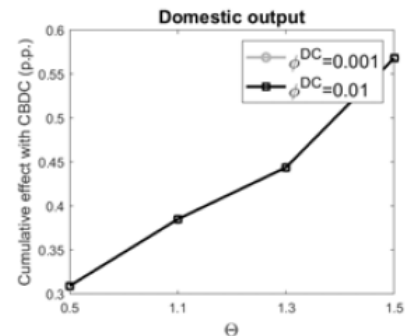


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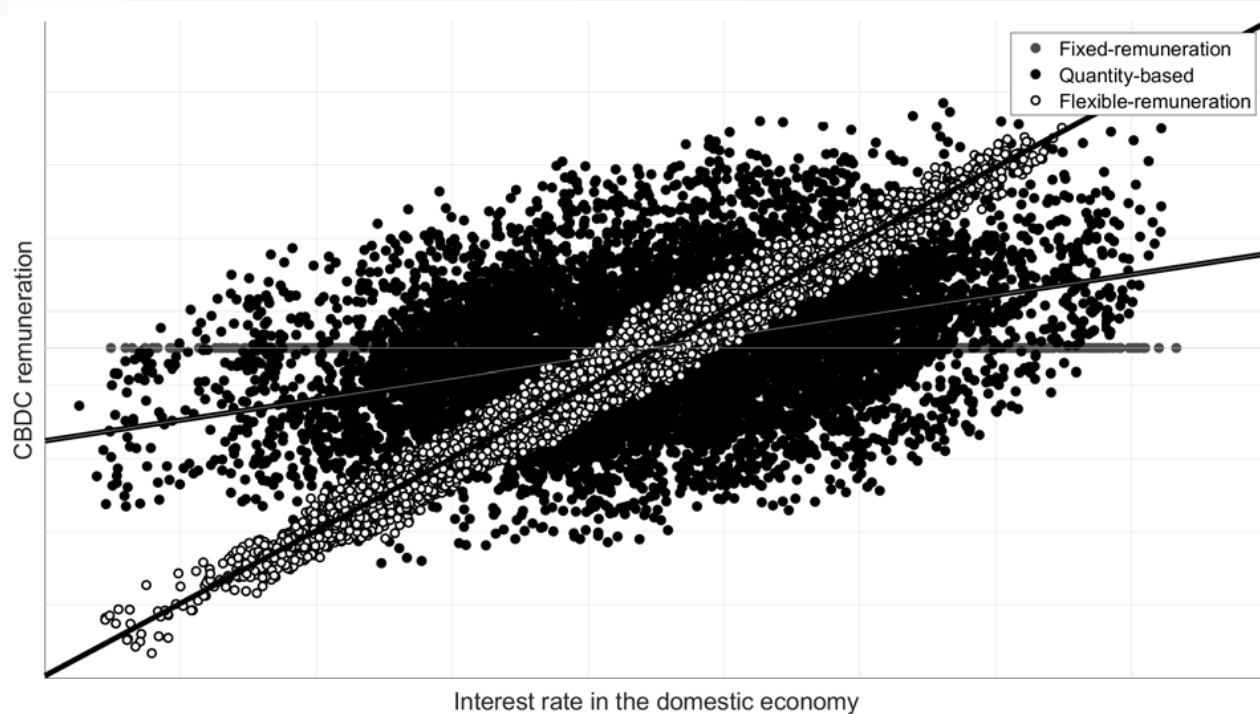
CBDC with fixed supply



CBDC with Taylor-rule interest rate



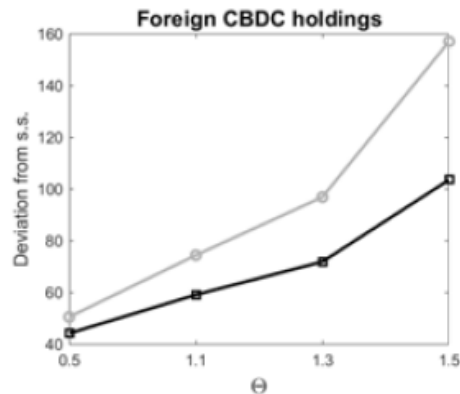
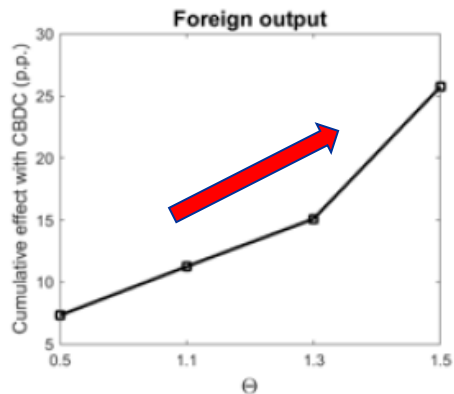
Robustness and extensions



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).

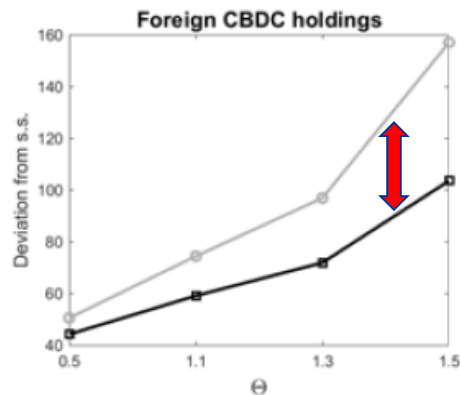
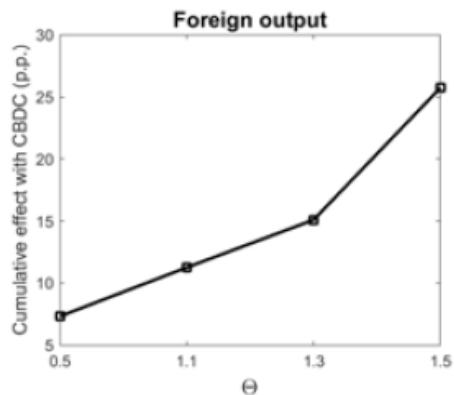
Robustness and extensions

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



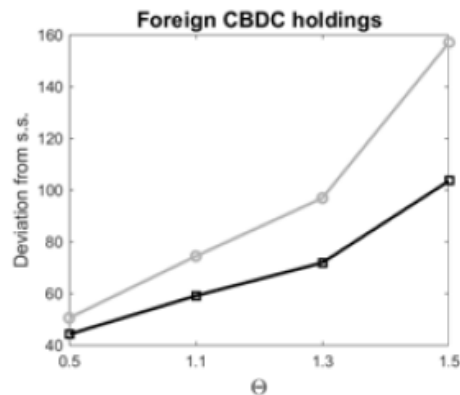
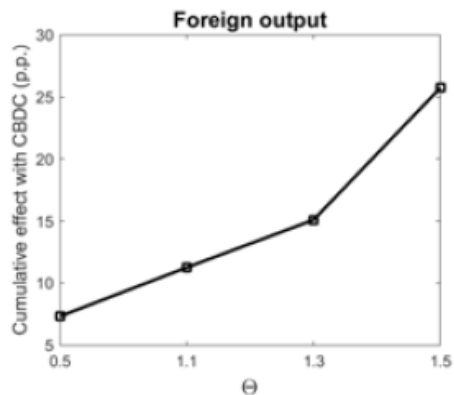
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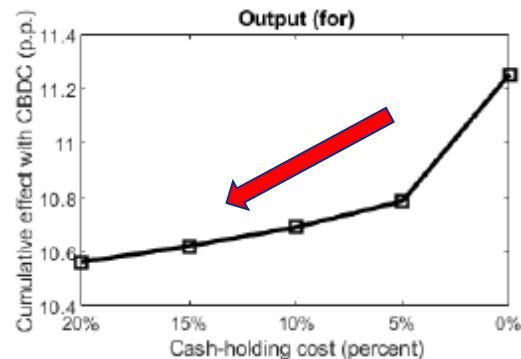


Robustness and extensions

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Higher cash storage costs



Optimal monetary policy in presence of a CBDC

- Maximize household utility using central bank policy rate as instrument

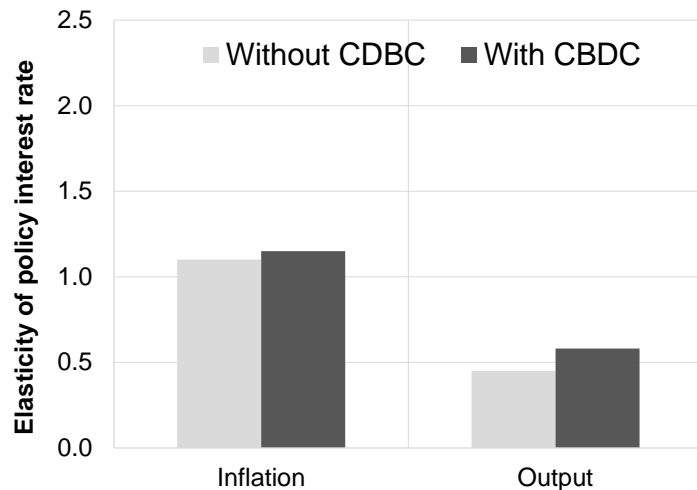
$$\max_{\gamma, \theta_\pi, \theta_y} E_t \sum_{j=0}^{\infty} \beta^j U_{t+j} \text{ s.t.}$$

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

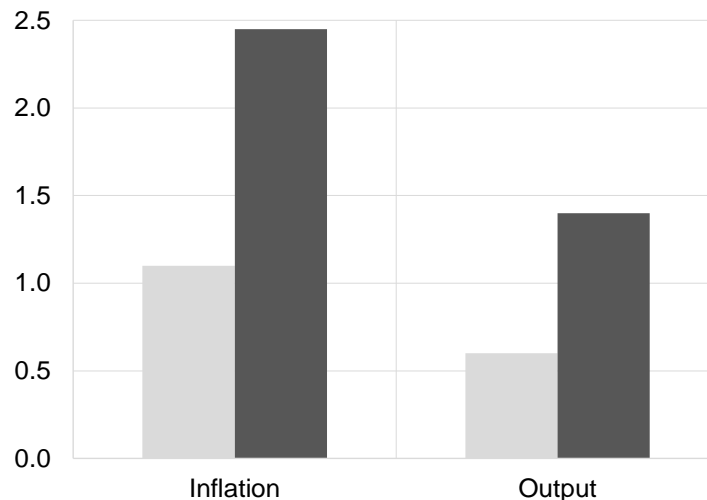
- Choose optimal θ_y and θ_π to maximize welfare
- Non-linear optimization problem with second-order solution

CBDC reduces foreign monetary policy autonomy

Domestic economy (CBDC issuer)



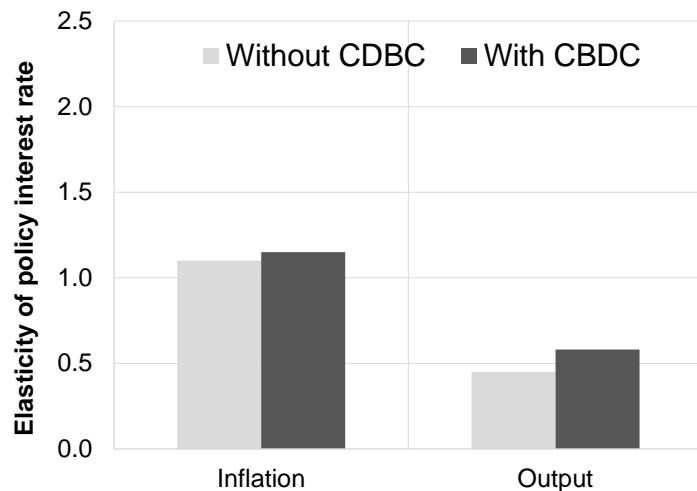
Foreign economy (not issuing CBDC)



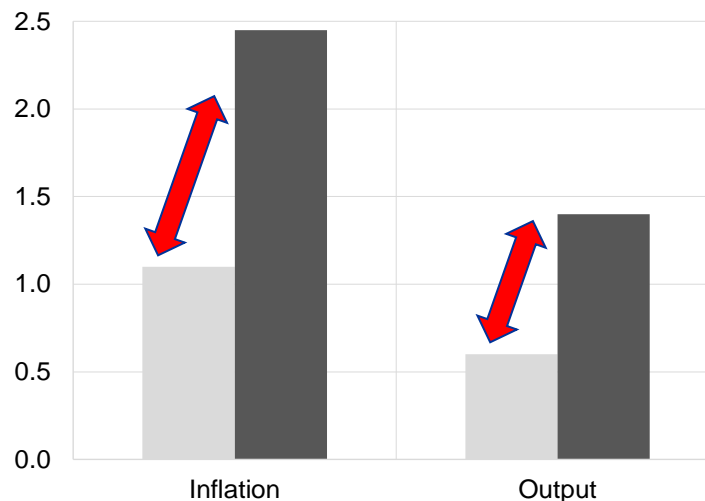
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