

# The Macroeconomics of Central-Bank-Issued Digital Currencies

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# Disclaimer

The views expressed herein are those of the authors, and should not be attributed to the Bank of England.

# 1 Introduction

- The emergence of the distributed ledger technology (DLT) and of Bitcoin was a watershed moment in the history of 'e-monies'.
- It may, for the first time, be technically feasible for central banks to offer universal access to their balance sheet.
  - Existing centralized RTGS systems: Not robust for universal access.
  - New decentralized DLT systems: Can potentially solve this problem.
- Question: Is universal access economically desirable.

## 2 What is a Central-Bank Digital Currency (CBDC)?

- **Access to the central bank's balance sheet.**
- **Availability:** 24/7.
- **Universal:** Banks, firms and households.
- **Electronic:** For resiliency reasons, probably using DLT.
- **National-currency denominated:** 1:1 exchange rate.
- **Issued only through spending or against eligible assets:** Government bonds.
- **Interest-bearing:**
  - To equate demand and supply at 1:1 exchange rate.
  - Second tool of countercyclical monetary policy.
- **Coexisting with present banking system:**
  - Banks remain the creators of the marginal unit of domestic currency.
  - The vast majority of deposits would remain with banks, and be insured.
  - Credit provision would remain the purview of existing intermediaries.

# 3 The Model

## 3.1 Overview

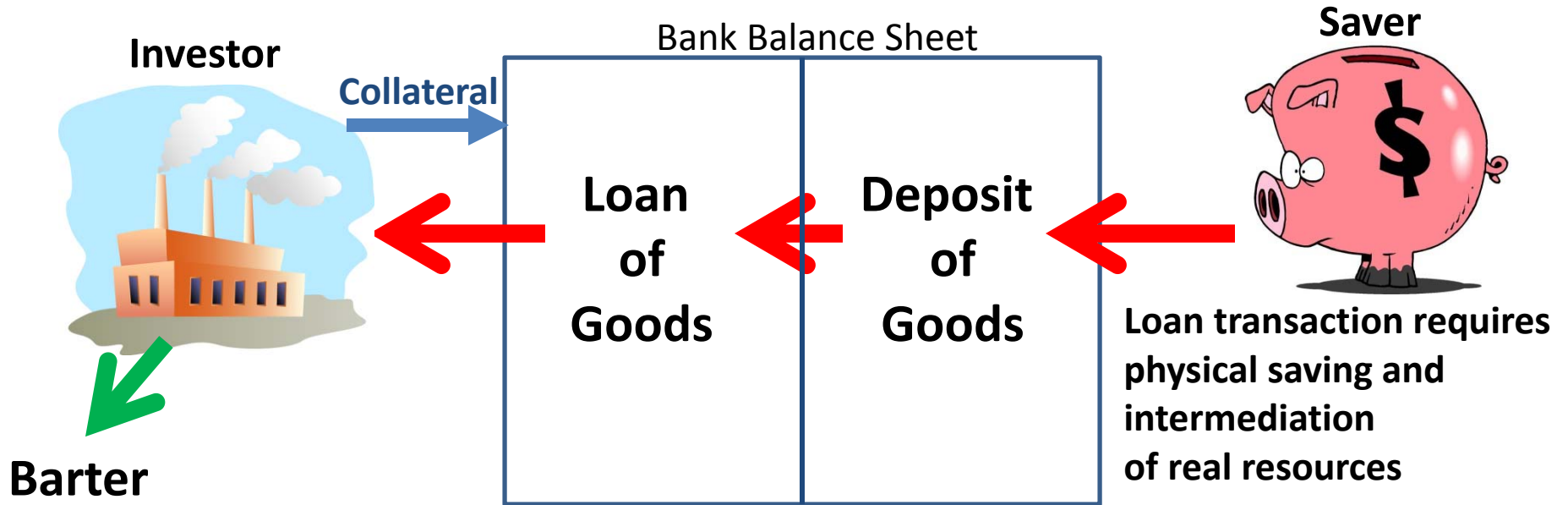
- Based on Benes and Kumhof (2012) and Jakab and Kumhof (2015).
- Households:
  - Deposits: Obtained through bank loans.
  - CBDC: Obtained in exchange for government debt.
  - Deposits and CBDC jointly generate liquidity.
- Banks: Create new deposits by making new loans.

## 3.2 Endogenous Deposits and Exogenous CBDC

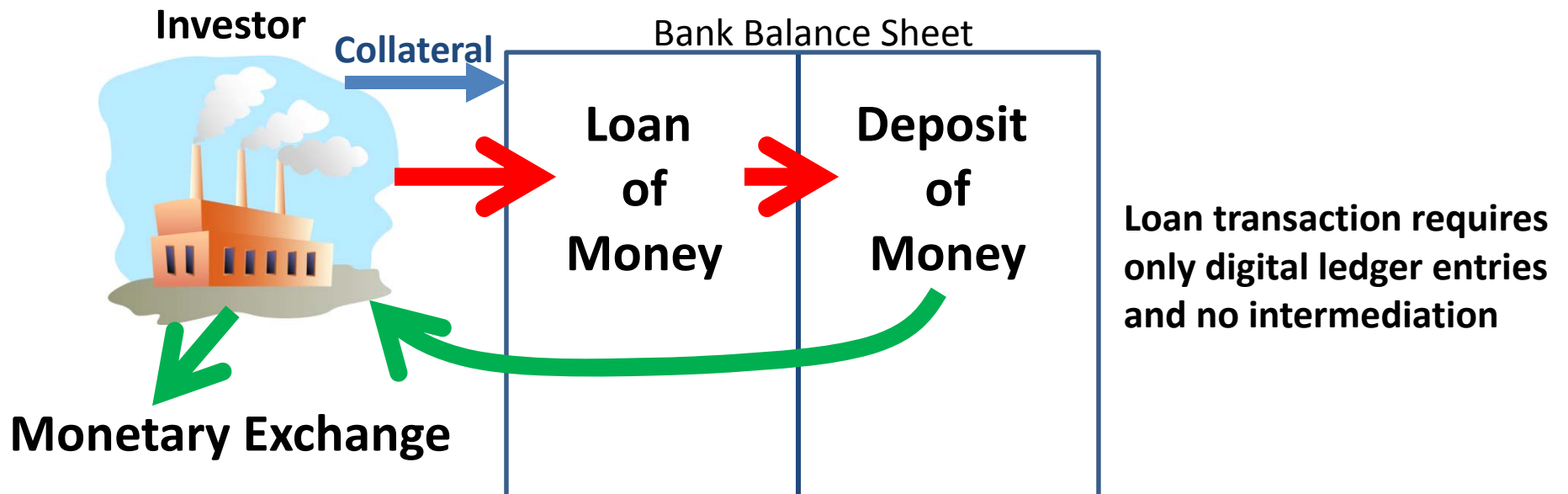
- Sidrauski-Brock monetary models of the 1980s/1990s:
  1. Representative household with a demand for money.
  2. Government exogenously supplies all money.
- The main problem is 2, not 1. Therefore, in our model:
  - Bank deposits (97% of all money) enter into TA cost technology.
  - Government money is omitted entirely.
- CBDC puts exogenous government money back into the model. But:
  1. CBDC is universally accessible (unlike reserves).
  2. CBDC is interest-bearing (unlike cash).
  3. CBDC competes with bank deposits.

# Intermediation of Loanable Funds (ILF) versus Financing Through Money Creation (FMC)

## Intermediation of Loanable Funds Model



## Financing Through Money Creation Model



**Deposits and loans are predetermined variables**

## Key Difference ILF-FMC: Budget Constraints

- Budget Constraints in **ILF** Model: Saver + Borrower Household

- Saver Household

$$\Delta deposits_t^s = income_t^s - spending_t^s$$

- Borrower Household

$$-\Delta loans_t^b = income_t^b - spending_t^b$$

- Budget Constraint in **FMC** Model: Representative Household only

$$\Delta deposits_t^r - \Delta loans_t^r = income_t^r - spending_t^r$$

- Budget Constraint in **FMC+CBDC** Model: Representative Household only

$$\Delta deposits_t^r - \Delta loans_t^r + \Delta CBDC_t^r = income_t^r - spending_t^r$$

**Deposits and loans are jump variables**



### 3.3 Banks

- Loans: Bernanke, Gertler and Gilchrist (1999) costly state verification.
- Deposits: Schmitt-Grohé and Uribe (2004) transactions cost technology.
- Monetary Distortion = Liquidity Taxes:

$$\tau_t^{liq} = 1 + s_t + s'_t v_t$$

- **Equivalent to consumption taxes and capital income taxes.**
- **Banks' effect on the real economy:**
  - \* **Through these taxes.**
  - \* **Not through intermediation of “loanable funds”.**

### 3.4 The Liquidity-Generating Function (LGF)

- Combines the liquidity generated by bank deposits and CBDC.

- Functional form:

$$f_t^x = \left( (1 - \gamma)^{\frac{1}{\epsilon}} (Deposits_t)^{\frac{\epsilon-1}{\epsilon}} + \gamma^{\frac{1}{\epsilon}} (T^{fintec} CBDC_t)^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$$

- Market clearing: Interest rates on loans, deposits and CBDC adjust.

### 3.5 Monetary Policy - The Policy Rate

$$i_t = (i_{t-1})^{i_i} \left( \frac{x\pi_{tgt}^p (1 + \phi_b (b_t^{rat} - \bar{b}^{rat}))}{\beta_u} \right)^{(1-i_i)} \left( \frac{\pi_{4,t+3}^p}{(\pi_{tgt}^p)^4} \right)^{\frac{(1-i_i)i_{\pi^p}}{4}}$$

## 3.6 Monetary Policy - CBDC

### 3.6.1 Quantity Rule for CBDC

$$m_t^{rat} = m_{tgt}^{rat} S_t^{ms} - 100 m_{\pi p} E_t \ln \left( \frac{\pi_{4,t+3}^p}{(\pi_{tgt}^p)^4} \right)$$

- Fix the quantity of CBDC, let CBDC interest rate clear the market.
- $m_{\pi p} > 0$ : Removes CBDC from circulation in a boom.

### 3.6.2 Price Rule for CBDC

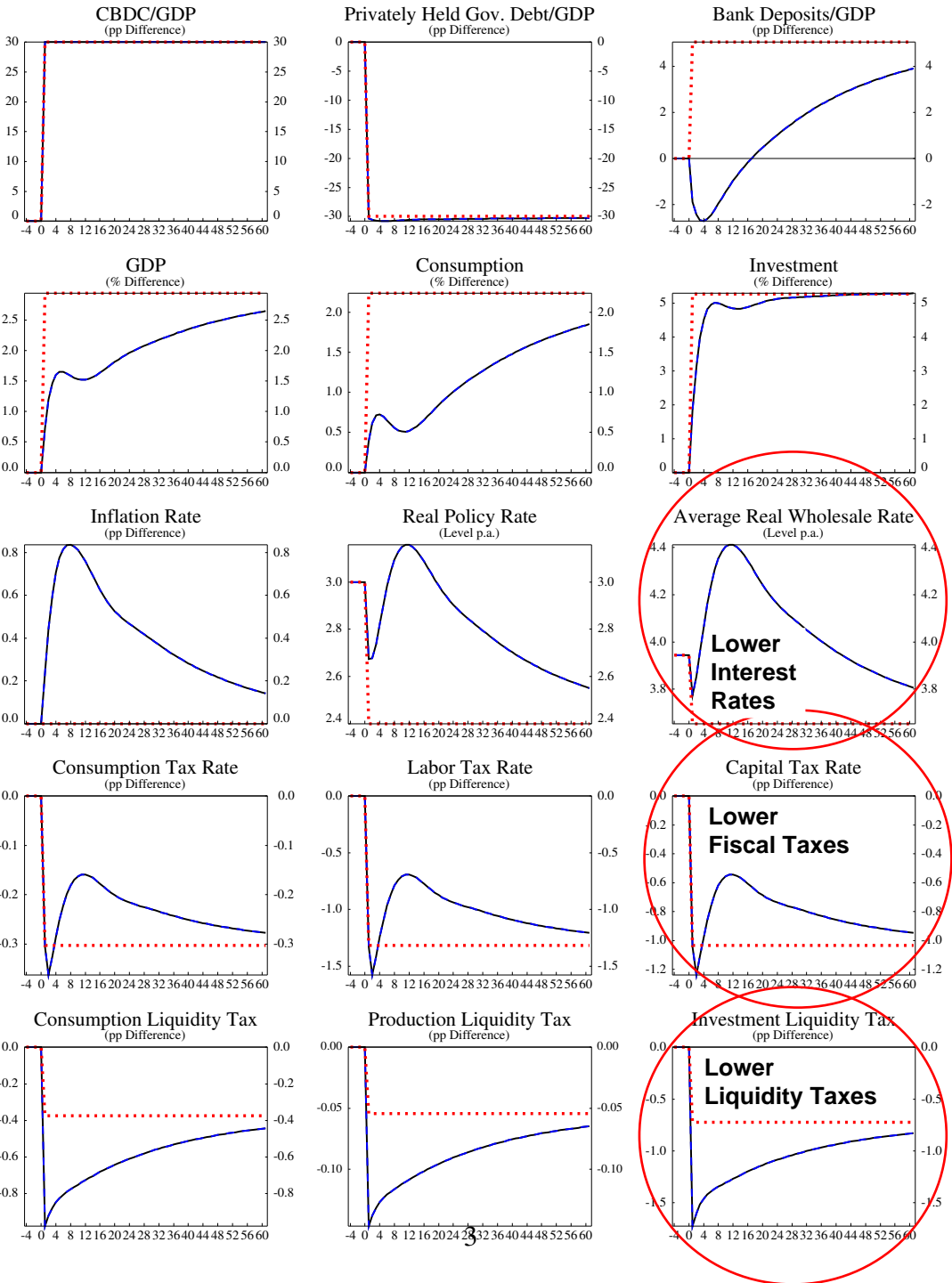
$$i_{m,t} = \frac{i_t}{sp} \left( \frac{\pi_{4,t+3}^p}{(\pi_{tgt}^p)^4} \right)^{-i_{\pi p}^m}$$

- Fix interest rate on CBDC, let the quantity of CBDC clear the market.
- $i_{\pi p}^m > 0$ : Makes CBDC less attractive in a boom.

## 4 Steady State Effects of the Transition to CBDC

- Assumptions:
  - Issue CBDC against government debt.
  - Magnitude: 30% of GDP.
- Results:

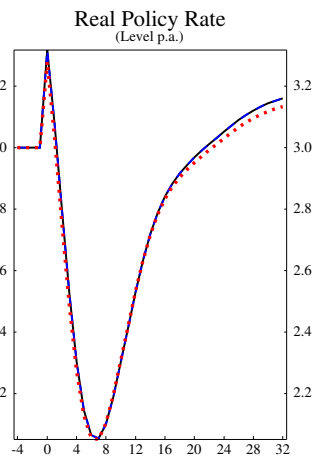
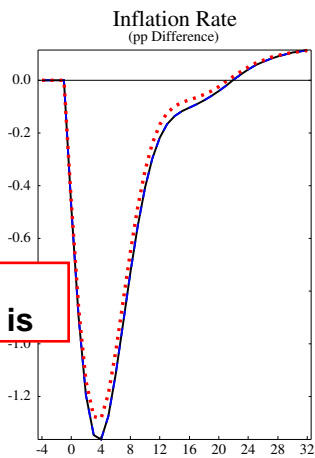
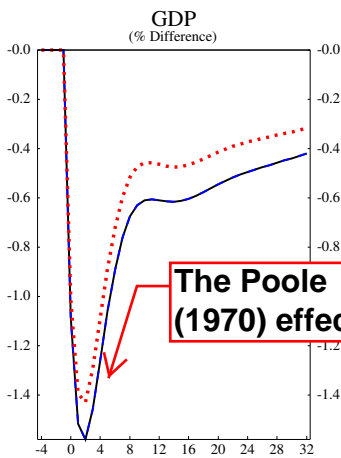
	<b>Steady State Output Effect</b>
1. Lower Real Policy Rates	+1.8%
2. Higher Deposit Rates Relative to Policy Rates	-0.9%
3. Reductions in Fiscal Tax Rates	+1.1%
4. Reductions in Liquidity Tax Rates	+0.9%
<b>Total</b>	<b>+2.9%</b>



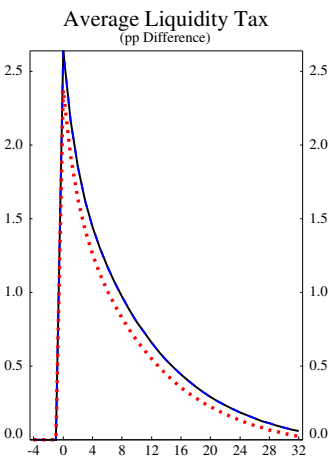
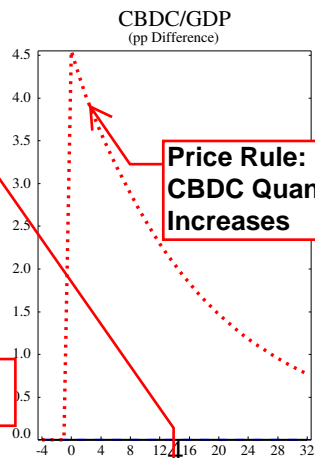
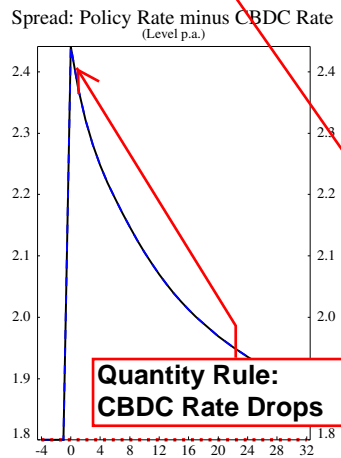
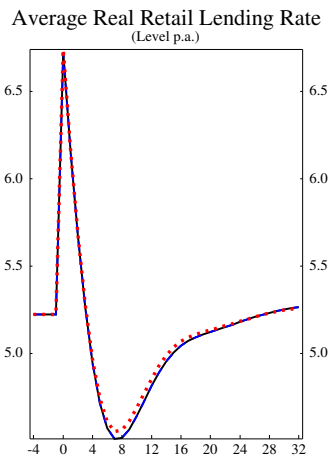
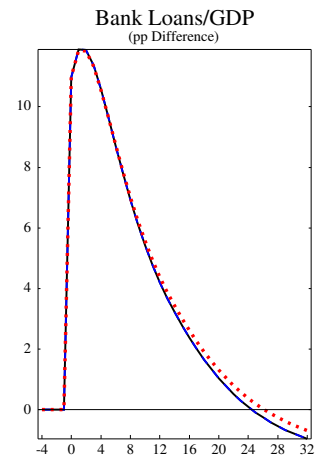
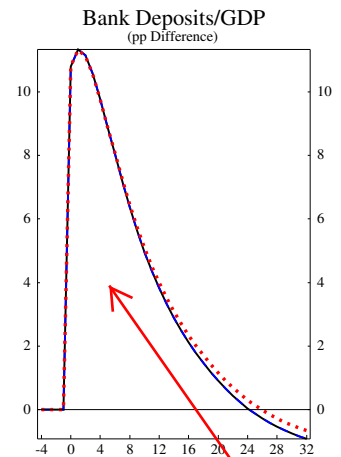
## Transition to Steady State with CBDC

solid line = actual transition ; dotted line = change in long-run steady state

## **5 Quantity Rules or Price Rules for CBDC?**



**The Poole**  
**(1970) effect is**



**Quantity Rule:**  
**CBDC Rate Drops**

**Price Rule:**  
**CBDC Quantity**  
**Increases**

**Liquidity demand is mostly satisfied by instantaneous creation of bank deposits through loans. But CBDC can help.**

**Shock to Demand for Total Liquidity**

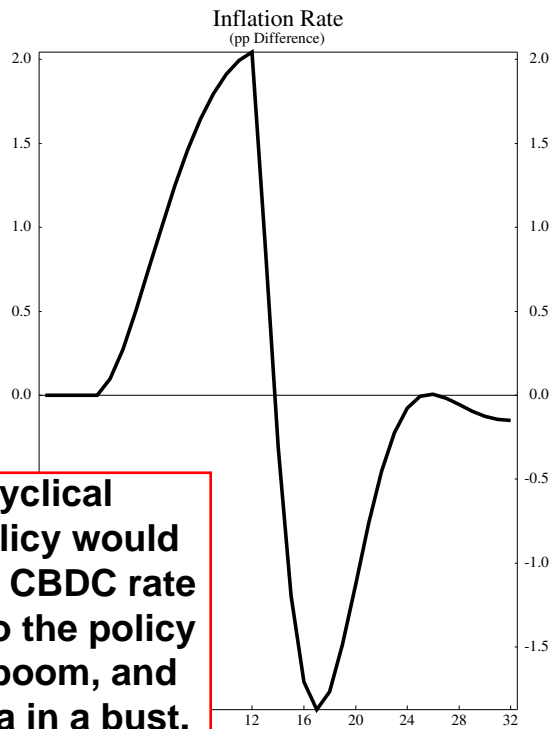
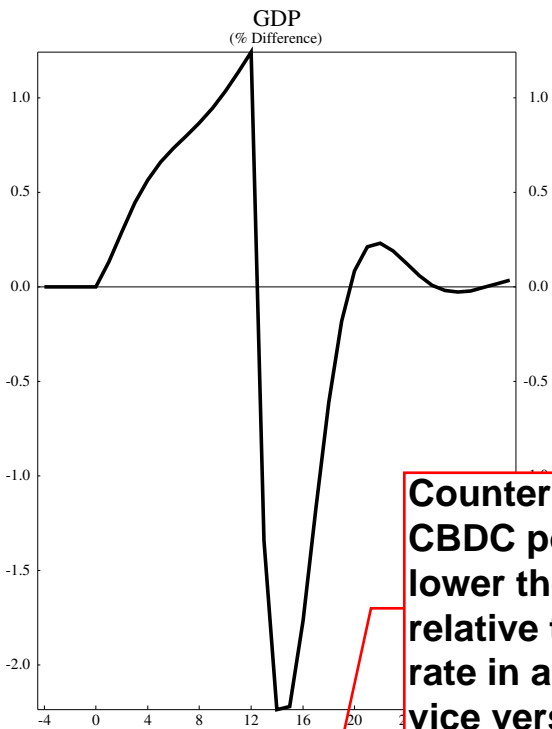
solid line = quantity rule ; dotted line = price rule



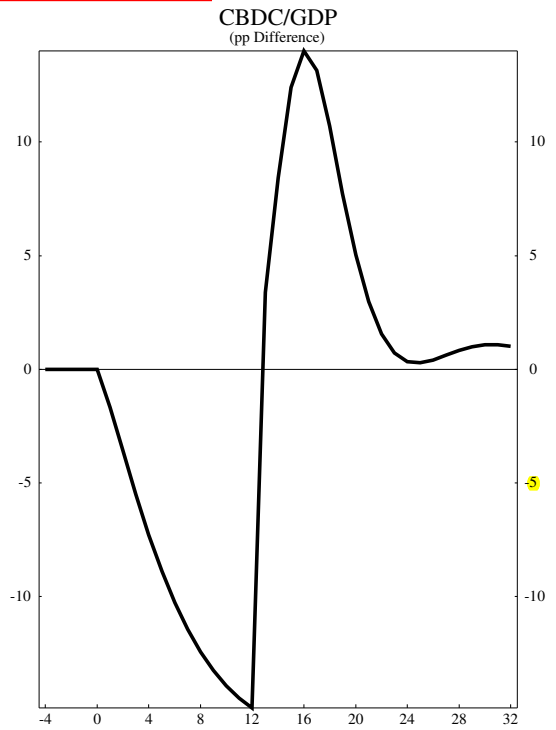
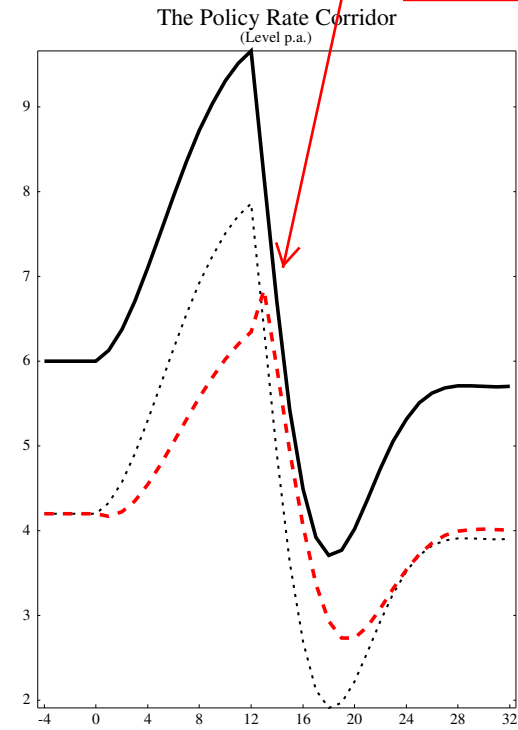
## 6 Financial Stability: CBDC Bank Runs?

- There is no easy way to run from bank deposits to CBDC in aggregate.
- Two reasons:
  1. Aggregate increases in CBDC do not affect bank deposits:
    - Central bank sells CBDC only against government debt.
    - Not against bank deposits.
    - CBDC purchases among non-banks are irrelevant.
  2. CBDC policy rules can further discourage volatile CBDC demand.

## **7 Countercyclical CBDC Rules**



**Countercyclical  
CBDC policy would  
lower the CBDC rate  
relative to the policy  
rate in a boom, and  
vice versa in a bust.**

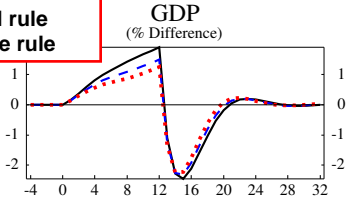


**Credit Cycle Shock - Price Rule - Policy Rate Corridor**

Bottom Left: Nominal Policy and CBDC Rates

Solid Line = Policy Rate, Dotted Line = Policy Rate minus Fixed Spread, Dashed Line = CBDC Rate

- Solid line = fixed rule
- Dashed line = cyclical rule
- Dotted line = aggressive rule



## 8 Conclusions

- CBDC has significant benefits  $\implies$  further research is worthwhile.
- Increase in steady-state GDP could be as much as 3%.
- Improved ability to stabilize inflation and the business cycle.
- Should reduce some FS risks, but may introduce others.
- The design of a successful transition is the critical issue.