The Macroeconomics of Central-Bank-Issued Digital Currencies

John Barrdear, Bank of England

Michael Kumhof, Bank of England

Fintech and Digital Currencies Conference
BIS, Basel, September 27, 2019

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 Digital Currency?

- Traditional Electronic Payment Systems - **Tiered** Ledgers:
  - Payments routed through and must be verified by specific third parties.
  - Third parties arranged in a hierarchical network.
- Digital Currencies - **Distributed** Ledgers:
  - Payments are peer-to-peer and can be verified by multiple verifiers.
  - Verifiers arranged in a peer-to-peer network.
- Bitcoin - Distributed Ledger + Alternative Monetary System.
  - BoE research rejects the monetary system of Bitcoin.
  - BoE research takes inspiration from its payment system.

3 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 the present banking system.**

4 The Model

4.1 Overview

- Based on Benes and Kumhof (2012) and Jakab and Kumhof (2015, 2018).
- The non-monetary model elements are standard New Keynesian fare.
- Households:
  - Deposits: Created by banks through loans.
  - CBDC: Created by central bank, issued via OMO or spending/lending.
  - Deposits and CBDC jointly serve as medium of exchange.
- Banks: Create new deposits by making new loans.
  - Loans are risky $\longrightarrow$ banks can make losses.
  - Deposits reduce costs of transactions $\longrightarrow$ can pay a lower interest rate.
- Government:
  - Fiscal policy.
  - Traditional monetary policy.
  - CBDC monetary policy.

4.2 Endogenous Deposits and Exogenous CBDC

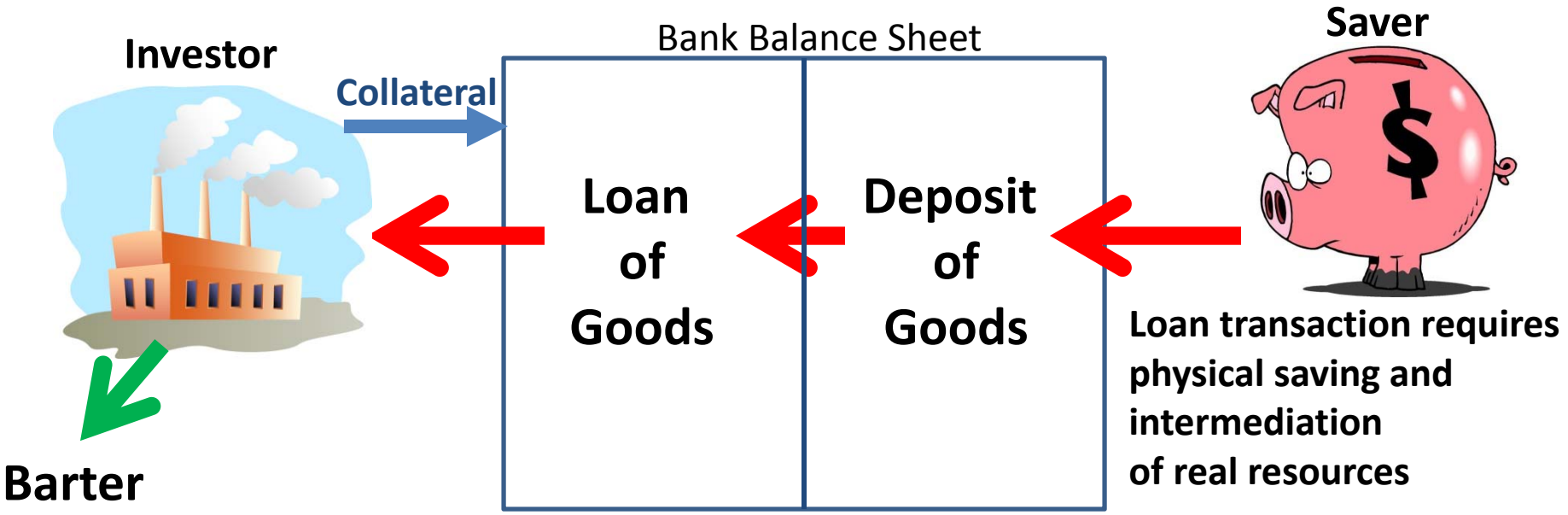
- Monetary models of the 1980s/1990s:
  1. Representative household with a demand for money.
  2. Government money (3% of all money) is the **only** money.

- The main problem is 2, not 1. Therefore, in our model:
  - We keep the representative household assumption.
  - Bank deposits (97% of all money) enter into TA cost technology.
  - Government money (3% of all money) is omitted entirely.

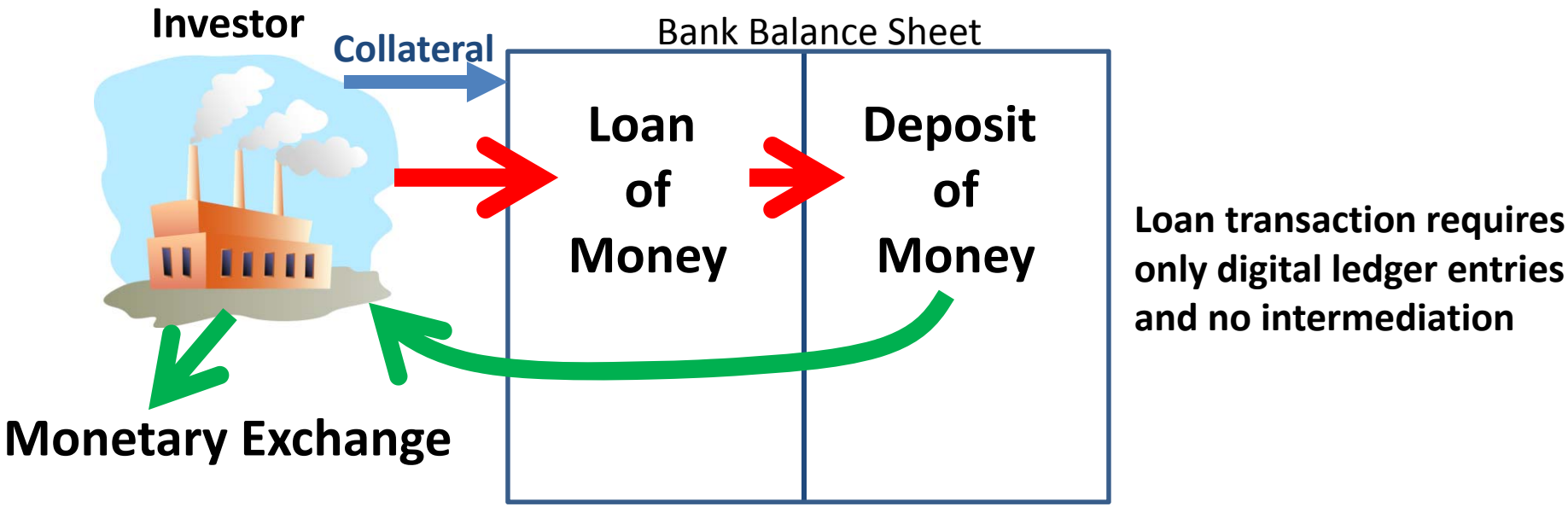
- CBDC puts exogenous government money back into the model. But:
  1. CBDC is universally accessible (unlike reserves).
  2. CBDC is interest-bearing (unlike cash).

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

4.3 Loan Issuance: Costly State Verification

- Bernanke, Gertler and Gilchrist (1999) technology.

- Important modifications:

  1. Precommited lending rates: Banks can make loan losses.

  2. Stochastic willingness to lend against collateral: New source of shocks.

4.4 Deposit Issuance: TA Cost Technologies

- Schmitt-Grohé and Uribe (2004) technology:

$$s_t^x(i) = s_t^x\left(v_t^x(i)\right) = S_t^{md} A_x v_t^x(i) + \frac{B_x}{v_t^x(i)} - 2\left(A_x B_x\right)^{\frac{1}{2}}$$

- S_t^{md} = shock to demand for total liquidity = "flight to safety".

- Velocity:

$$v_t^x(i) = \frac{e_t^x(i)}{f_t^x(i)}$$

  - $e_t^x(i)$ = sector-specific expenditure.
  - $f_t^x(i)$ = sector-specific monetary transaction balances = composite:
    1. Bank deposits.
    2. CBDC.

- Monetary Distortion Markups = Liquidity Taxes:

$$\tau_{x,t}^{liq} = 1 + s_t^x + s_t^{x'} v_t^x$$

  - **Their effects are equivalent to consumption and capital income taxes!**
  - **It is through these quasi-tax-rates that banks affect the real economy, not through intermediation of "loanable funds"!**
  - **With sufficiently low interest semi-elasticities of money demand (such as cash-in-advance), liquidity shortages can nevertheless be a very tight constraint.**

- What is the Distortion?
  - Shortage, relative to the Friedman rule, of liquidity.
  - This can never be completely eliminated because the cost of creating bank deposits can never go to zero.

4.5 The Liquidity-Generating Function (LGF)

- Deposits: Schmitt-Grohé and Uribe (2004)
  - Transactions cost technology: Money reduces transactions costs.
  - Difference: "Money" = bank deposits + CBDC, not cash + reserves.

- Functional form:

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

- CBDC enters like government debt.
- But it is much cheaper.

4.6 Fiscal Policy

4.6.1 Government Budget Constraint

$$b_t^g + m_t^g = r_t b_{t-1}^g + r_{m,t} m_{t-1}^g + g_t + tr f_t - \tau_t$$

4.6.2 Fiscal Policy Rule

- Overall Deficit Ratio:

$$gdx_t^{rat} = 100\frac{g\check{d}x_t}{g\check{d}p_t} = 100\frac{B_t^g + M_t^g - B_{t-1}^g - M_{t-1}^g}{GDP_t}$$

  - **Relevant stock change: Government Debt + CBDC.**
  - Insulates budget from potentially highly volatile CBDC seigniorage flows.

- Rule for Deficit Ratio:

$$gdx_t^{rat} = gdx_{ss}^{rat} - 100d^{gdp}\ln\left(\frac{g\check{d}p_t}{gdp_{ss}}\right)$$

4.7 Monetary Policy

4.7.1 Monetary Policy - The Policy Rate

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

Steady state nominal interest rate (model-specific expression)

4.7.2 Monetary Policy - CBDC

- Why not target monetary aggregates? The 1980s debate versus CBDC.

- Three arguments against targeting monetary aggregates:
  1. Problems in defining the relevant aggregate: Does not apply to CBDC.
  2. Problems in controlling the aggregate: Does not apply to CBDC.
  3. Lower benefits of controlling the aggregate: Poole (1970).
     - Volatility increases if money demand shocks are important.
     - This argument does apply in our model, but much more weakly than in Poole (1970).
     - Reason: Banks remain the creators of the marginal unit of money.

- To study the third argument, we need to define CBDC policy rules.

Quantity Rule for CBDC

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

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

Price Rule for CBDC

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

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

5 Steady State Effects of the Transition to CBDC

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

- Results:

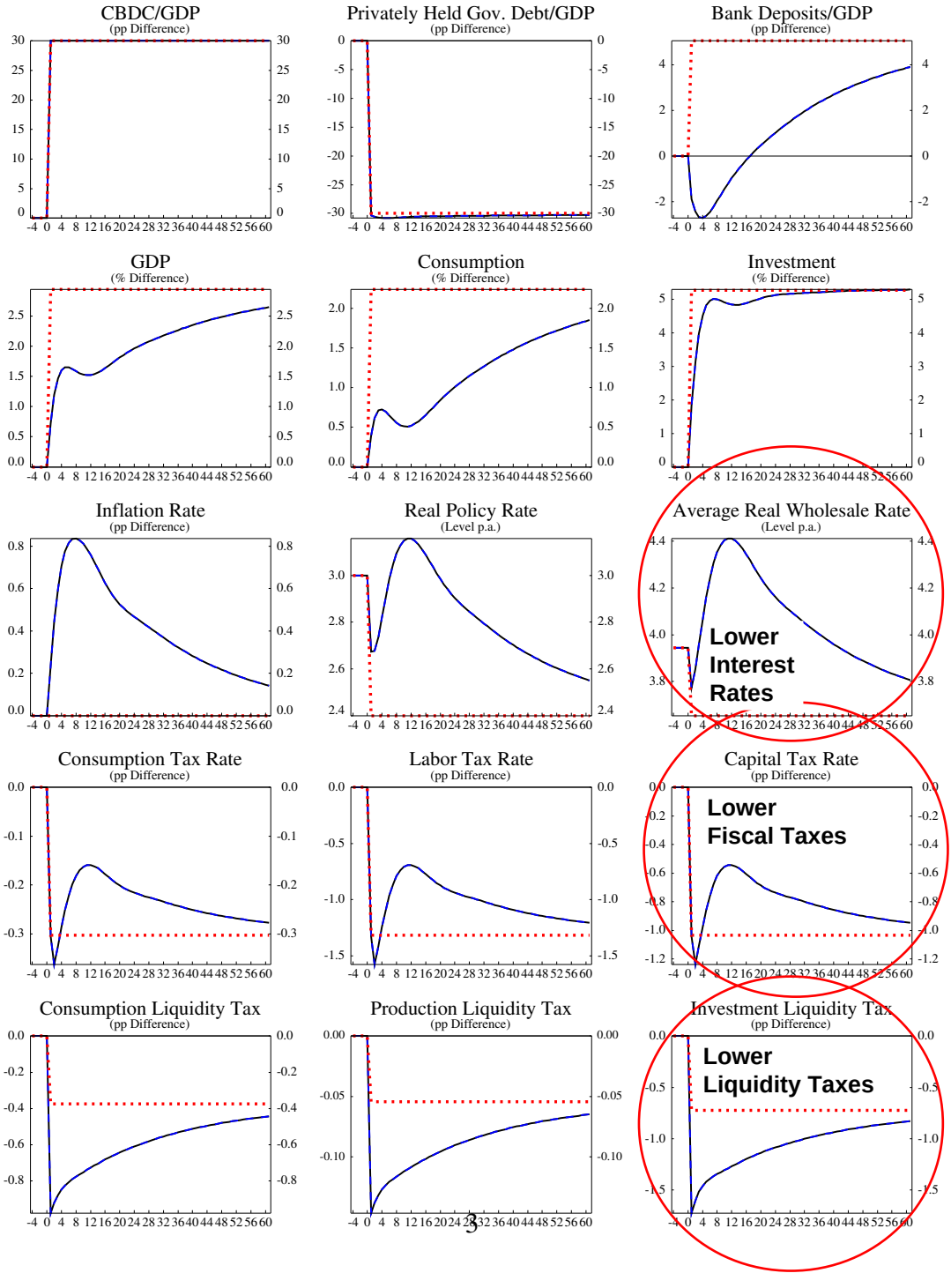
	Steady State Output Effect
1. Lower Real Policy Rates	+1.8%
2. Higher Deposit Rates Relative to Policy Rates	-0.9%
3. Reductions in Fiscal Tax Rates	+1.1%
4. Reductions in Liquidity Tax Rates	+0.9%
Total	+2.9%

The Main Factors Explained

1. **Lower real interest rates:**
   - Assumption: CBDC issued against government debt.
   - CBDC is not defaultable, government debt is.
   - CBDC carries a lower interest rate than government debt.

2. **Lower distortionary taxes:**
   - Much larger central bank balance sheet.
   - Therefore much larger seigniorage flows.
   - Also: Lower interest costs (see above).
   - Assumption: Seigniorage is used to reduce distortionary taxes.

3. **Lower transactions costs:**
   - Modern money is 95%+ created by private banks.
   - This is costly: Spreads, regulation, bank market power, collateral.
   - You can therefore never reach the Friedman rule.
   - But with CBDC you can get much closer.

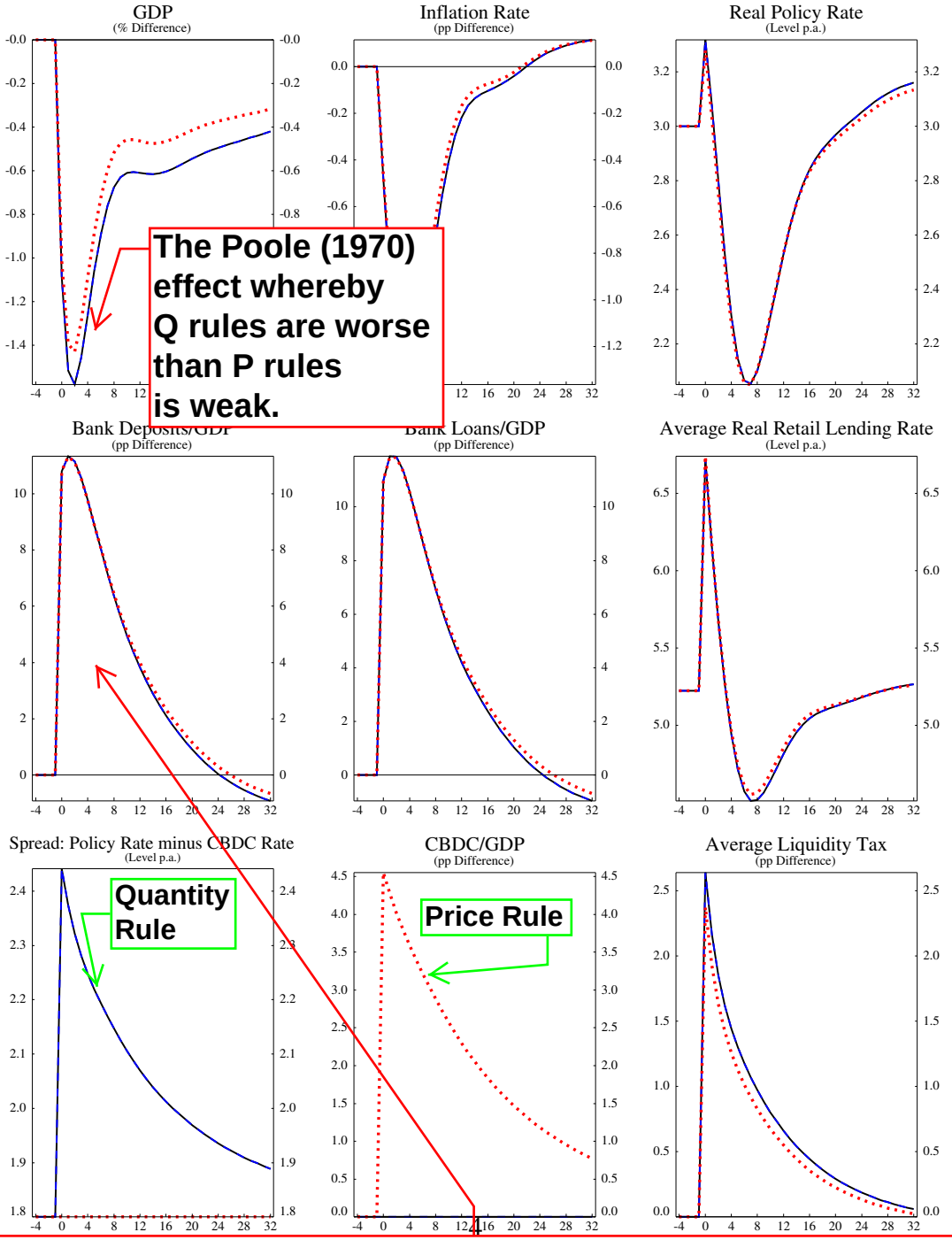


Transition to Steady State with CBDC

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

6 Quantity Rules or Price Rules for CBDC?

A Poole (1970) contractionary money demand shock.



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

Shock to Demand for Total Liquidity

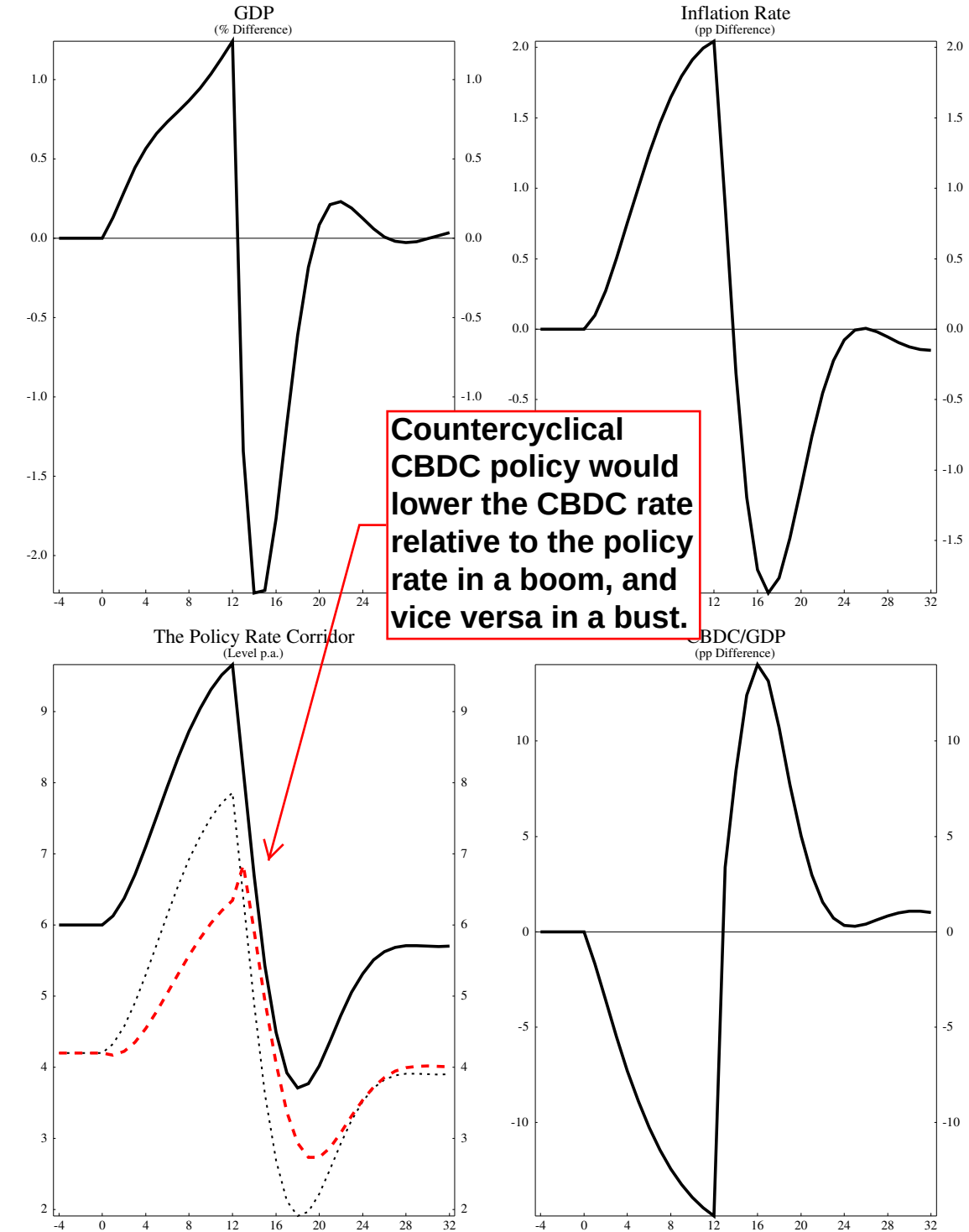
solid line = quantity rule ; dotted line = price rule

7 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 demand do not affect bank deposits:
     - Central bank sells CBDC only against government debt.
     - **Not** against bank deposits: No unconditional LoLR guarantee.
     - CBDC purchases among non-banks are irrelevant.
  2. CBDC policy rules can further discourage volatile CBDC demand.
     - Quantity rule:
       * CBDC supply fixed, CBDC interest rate clears the market.
       * **Lower political bound on CBDC rate?** Switch to price rule.
     - Price rule:
       * CBDC supply endogenous, CBDC quantity clears the market.
       * **Running out of government bonds?** Switch to other securities.

8 Countercyclical CBDC Rules

A boom-bust credit cycle.

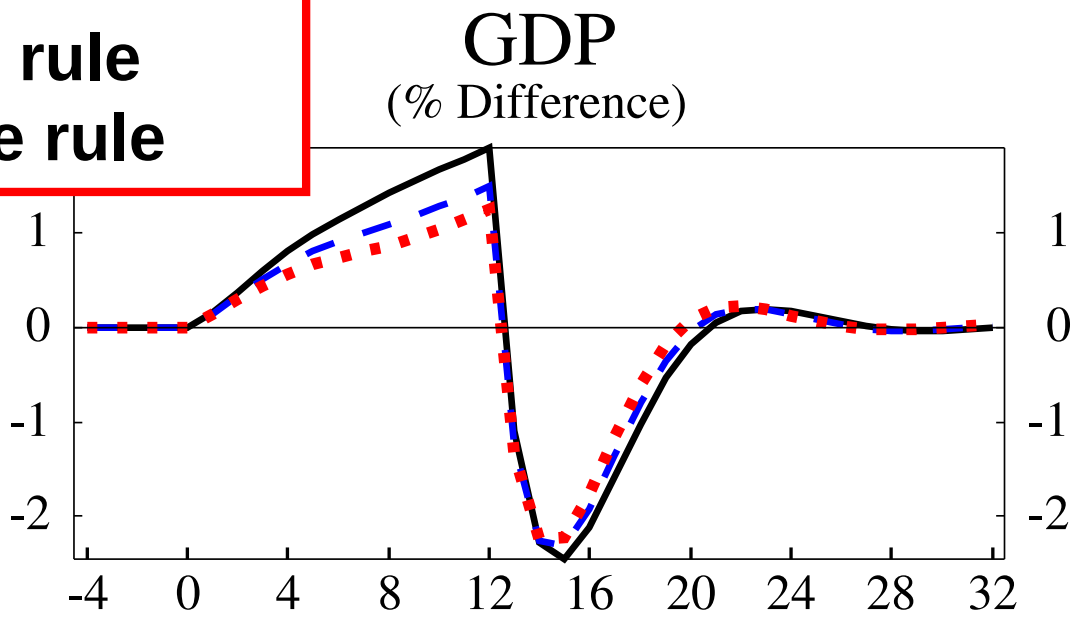


Credit Cycle Shock - Price Rule - Policy Rate Corridor

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 = c'cyclical rule
- Dotted line = aggressive rule



9 Conclusions

- CBDC has significant benefits $\Longrightarrow$ further research is worthwhile.

1. Steady state efficiency:
   - Lower interest rates, higher seigniorage, more and cheaper liquidity.
   - Increase in steady-state GDP could be as much as 3%.
2. Business cycle stability:
   - Second policy instrument.
   - Improved ability to stabilize inflation and the business cycle.
3. Financial stability:
   - CBDC should reduce many financial stability risks.
   - But if it is not designed well it may introduce others.
   - The "run risk" can be mostly eliminated by sound system design.

- Critical issue: Design of a smooth transition.

Thank you!