

# CBDC and Bank Capital Regulation

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**The views expressed in this presentation are those of the authors and do not necessarily reflect those of the BIS, the Spanish Treasury, the European Central Bank or the Eurosystem.**

1. Motivation
2. Empirical Evidence
3. Model: Key Features, Calibration and Transmission
4. CBDC and Bank Capital Regulation
5. Conclusion

1. **Motivation**
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- 94% of central banks exploring CBDCs (2023 BIS Survey). Why?
  - **Structural change** in payment preferences & digital technologies
  - Public money is a public good: ensure access to CB money in digitalized economy
- Key challenge: **risk of bank disintermediation**
  - Already large literature on the **effects of CBDC on banks and the macroeconomy**: E.g., Brunnermeier and Niepelt 2019, Chiu et al. 2019, Andolfatto 2021, Bachetta and Perazzi 2021, Fdez-Villaverde et al. 2021, Barrdear and Kumhof 2022, Ferrari et al. 2022, Keister and Sanches 2022, Keister and Monnet 2022, Piazzessi and Schneider 2022, Agur et al. 2022, Assenmacher et al. (2023), Abad et al 2023, Ahnert et al. 2023, Kumhof et al 2023 Bidder et al. 2024, **Burlon et al. 2024**, Niepelt 2024.
- **Role of regulation** in shaping these effects:
  - E.g., Assenmacher et al. 2021, Adalid et al. 2022, Williamson 2022, Meller and Soons 2023, Burlon et al. 2024, Muñoz and Soons 2024.
- To the best of our knowledge, **none of them assess the effects of CBDC on**:
  - **Bank riskiness and capitalization (empirically)**
  - **Optimal capital requirements** and its consequences for CBDC macro effects

- **Provide first empirical evidence** on the likely impact on **bank capitalization and bank riskiness** (exploiting digital euro announcement effects on bank stock valuations)
- Develop a euro area **quantitative macro-banking DSGE model with CBDC** featuring:
  - bank default risk → role for structural capital regulation
  - binding borrowing constraints in real and intermediation sectors → role for macroprudential (countercyclical) capital regulation
- **Answer key policy questions**
  - Does CBDC affect bank riskiness and bank capitalization?
  - Does CBDC affect optimal structural and cyclical capital requirements?
  - Can a calibrated CBDC holding limit neutralize effects of CBDC on
    - Bank disintermediation through impact on bank riskiness, and
    - Optimal capital regulation?
  - How does bank capital regulation matter to the main welfare effects of CBDC?

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- **First stage:** Estimate 3-factor Fama-French model of bank stock returns to isolate abnormal returns from CBDC news (as in Burlon, Muñoz, Smets 2024):

$$R_{b,t} = \beta_{m,b}R_{m,t} + \beta_{HML,b}R_{HML,t} + \beta_{SMB,b}R_{SMB,t} + \alpha_b + \gamma_b^{e_1}\delta_t^{e_1} + \dots + \gamma_b^{e_N}\delta_t^{e_N} + \varepsilon_{b,t}$$

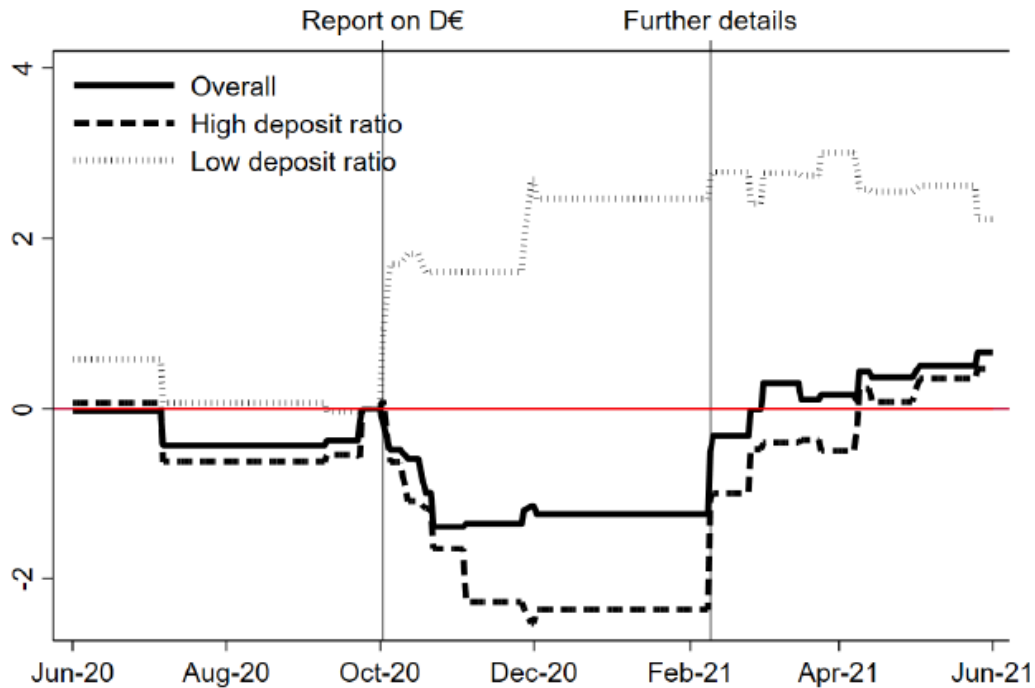
- **Second stage:** Harvest the abnormal returns to estimate a local projection model of reactions of bank capitalization and bank riskiness  $h$  periods ahead to CBDC news:

$$\Delta Y_{b,t,h} = \beta^h \hat{\Gamma}_{b,t} + \zeta^h \bar{X}_{b,t-1} + \alpha_b + \alpha_t + \varepsilon_{b,t,h}$$

where  $\alpha_b$  and  $\alpha_t$  are bank and time fixed effects and the controls  $\bar{X}_{b,t-1}$  include the lagged values of CDS spreads, capital buffers over the MDA trigger, log assets, deposit ratio, excess liquidity holdings net of TLTROs outstanding, securities holdings, ROA and NPL ratio.

# Empirical Evidence: Event study and cross-sectional analysis

Figure 2: Stock market reactions to CBDC news by euro area banks (percentage points)

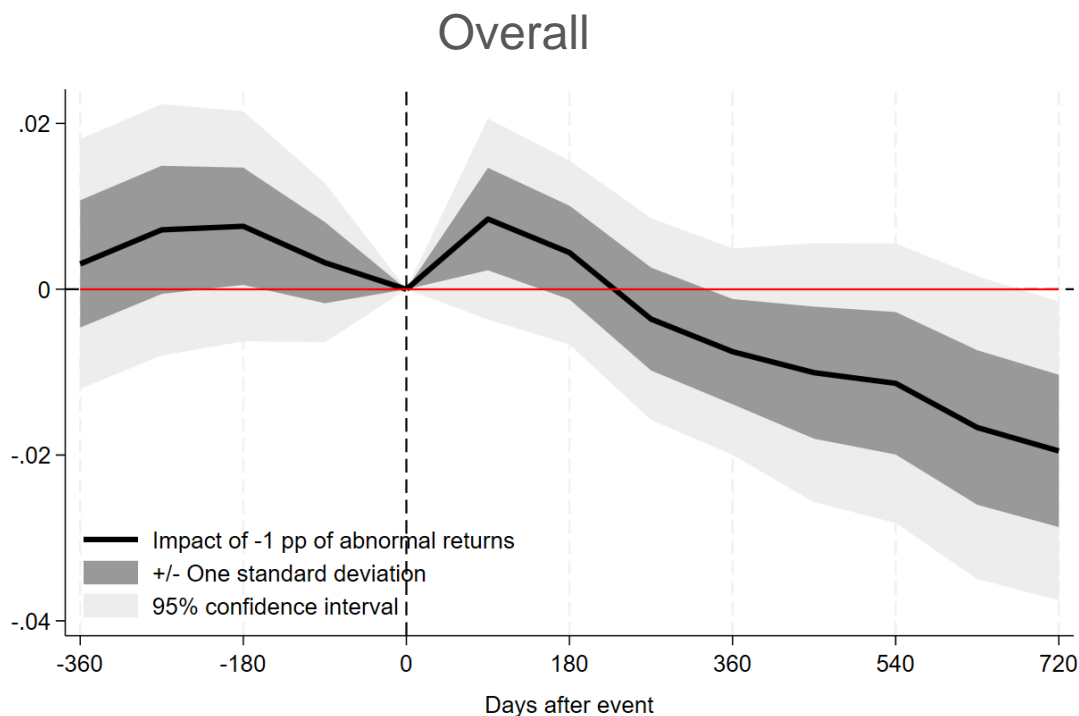


Source: Burlon et al. 2024

- Initial negative reactions related to perceived risks of deposit substitution.
- Magnitude of response dependent on deposit funding reliance.
- Recovery as information on safeguards to calibrate CBDC supply was conveyed.
- **Main takeaway:** expected impact on banks crucially depends on deposit reliance and design features aimed at controlling CBDC supply.



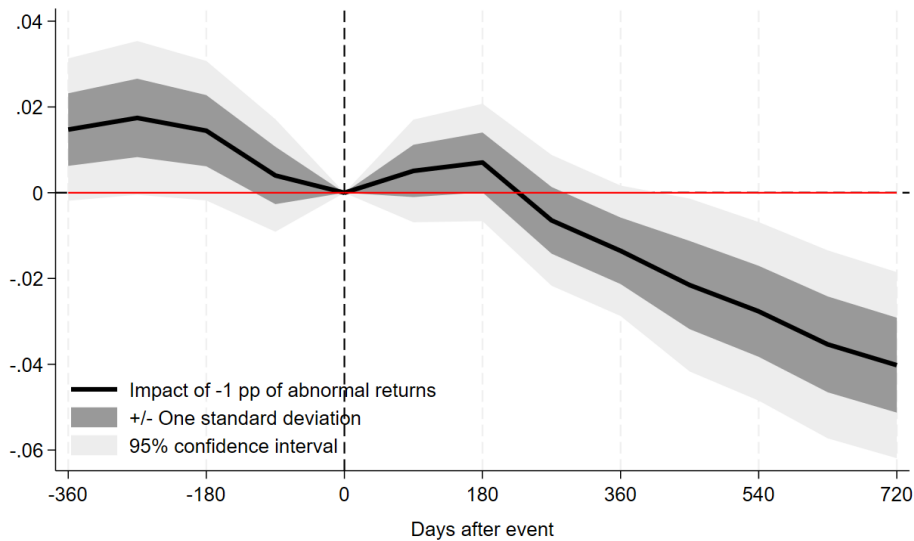
Figure 1. Impact of CBDC news on CET1 ratio (pp)



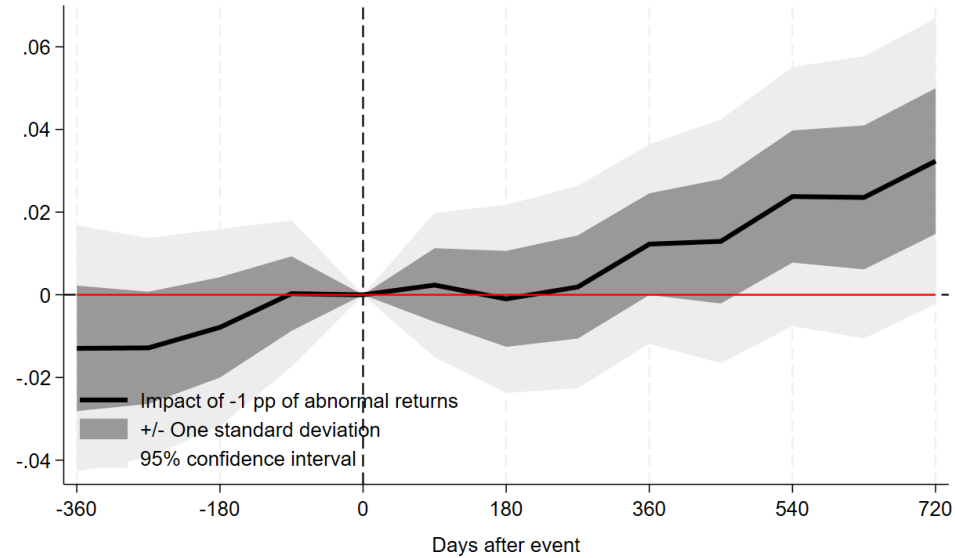
- Bank capitalisation decreases after negative funding shock from CBDC news
- Each pp of negative stock return was associated with 3 bp decrease in capital ratio

## Figure 2. Impact of CBDC news on CET1 ratio (pp) by capital buffers

Banks with low capital buffers



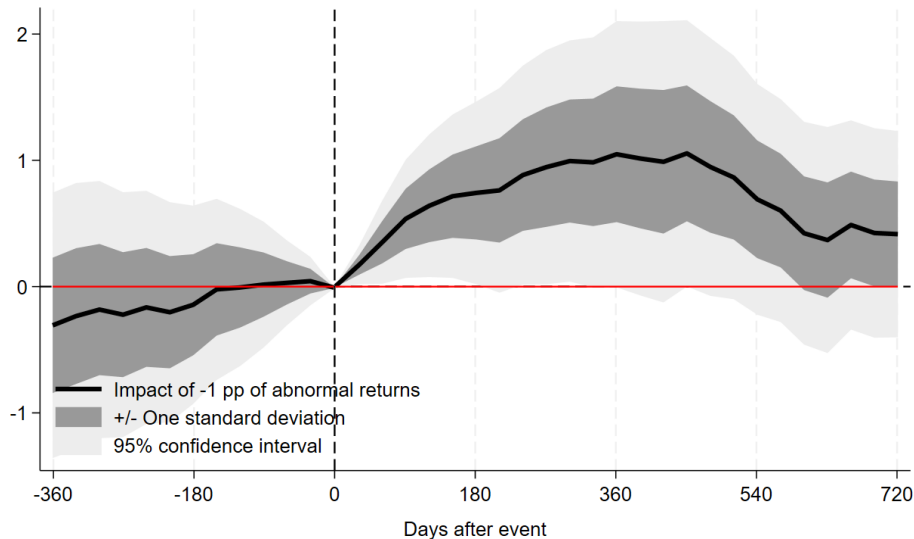
Banks with high capital buffers



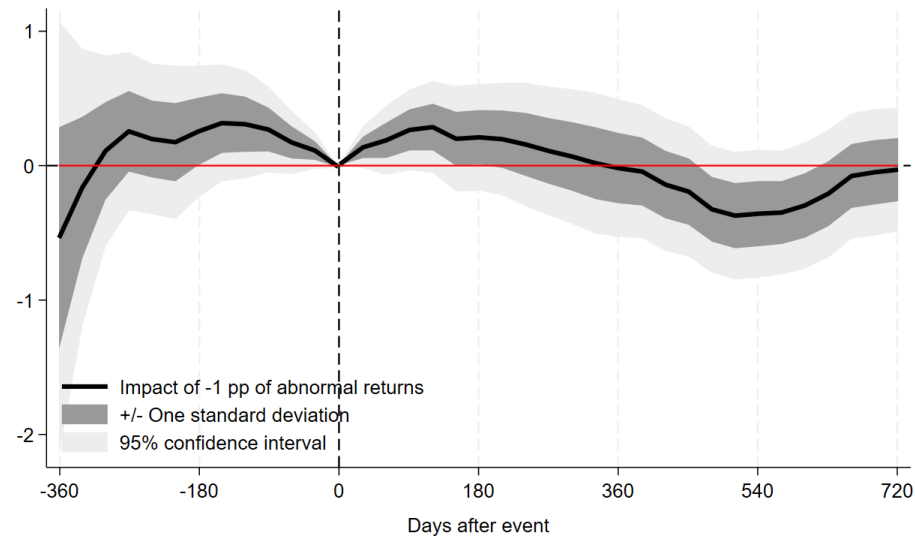
- Bank capitalisation decreases after negative funding shock from CBDC news
- Each pp of negative stock return was associated with 3 bp decrease in capital ratio
- This is driven by banks with low capital buffers (below median, ~4 pp above requirements)

## Figure 4. Impact of CBDC news on CDS spreads

Banks with low capital buffers



Banks with high capital buffers



- Bank capitalisation decreases after negative funding shock from CBDC news
- Each pp of negative stock return was associated with 3 bp decrease in capital ratio
- This is driven by banks with low capital buffers (below median, ~4 pp above requirements)
- And not a result of supervisory requirements, leading to outright lower buffers
- This impact is priced in by markets as an increase in bank riskiness (measured by CDS spreads)

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# Related Literature: Strands of the literature

- **Effects of CBDC on banks and the macro and implications of regulation**
  - E.g., Brunnermeier and Niepelt 2019, Chiu et al. 2019, Andolfatto 2021, Bachetta and Perazzi 2021, Fdez-Villaverde et al. 2021, Barrdear and Kumhof 2022, Ferrari et al. 2022, Keister and Sanches 2022, Keister and Monnet 2022, Piazzesi and Schneider 2022, Agur et al. 2022, Assenmacher et al. (2023), Abad et al 2023, Ahnert et al. 2023, Kumhof et al 2023 Bidder et al. 2024, **Burlon et al. 2024**, Niepelt 2024.
- **Quantitative Macro-finance models with bank intermediation**
  - Borrowing constraints: E.g., Kiyotaki and Moore 1997, Iacoviello 2005, Gerter and Kiyotaki 2010
  - Bank failure risk: E.g., Clerc et al. 2015, Elenev et al. 2020, **Mendicino et al. 2020**, Mendicino et al. (2024):
- Banking literature that studies **(optimal) capital requirements and its effects**
  - E.g., Van den Heuvel 2008, Admati and Hellwig, Begeau and Landvoigt 2017, Mendicino et al. 2018, Begeau 2020, Landvoigt and Nieuwerburgh 2020, Muñoz 2021.
  - [Mendicino, Caterina & Nikolov, Kalin & Suarez, Javier & Supera, Dominik, 2020. "Bank capital in the short and in the long run," Journal of Monetary Economics, Elsevier, vol. 115\(C\), pages 64-79.](#)
  - [Burlon, Muñoz and Smets \(2024\), The Optimal Quantity of CBDC in a Bank-Based Economy, AEJ:Macro, forthcoming](#)

- Monetary, closed, time-discrete, decentralized economy
- **Savers (Households)**
  - Discount future more heavily than NFCs (Iacoviello 2005)
  - Hold **deposits, CBDC** and gov. bonds (risk-free asset)
- **Financial Intermediaries**
  - Bankers: member class of HHs (Gertler and Kiyotaki 2010; Gertler and Karadi 2011)
  - Banks
    - Intermediate between patient HHs and NFCs (deposits – loans)
    - **Binding capital requirements:** 8% in the baseline
    - Modelling of **bank default risk**
      - Idiosyncratic asset return shocks (BGG 1999)
      - Aggregate risk shocks (CMR 2014)
- **Borrowers (NFCs)**
  - Entrepreneurs (Managers): **binding borrowing limits** (Kiyotaki and Moore 1998)
  - Entrepreneurial retailers: Calvo (1983) price-setters
- Final Goods Producers
- **Public Authorities**
  - Monetary authority
  - (Macro-)prudential authority
  - Deposit insurance scheme

## Savers: Households (CBDC holders)

- The representative household seeks to maximize

$$E_0 \sum_{t=0}^{\infty} \beta_h^t (c_{h,t}, n_{h,t}, h_{h,t}, z_{h,t})$$

where

$$z_{h,t}(cbdc_{h,t}, d_t) = \left[ cbdc_{h,t}^{(\eta-1)/\eta} + d_{h,t}^{(\eta-1)/\eta} \right]^{\eta/(\eta-1)}$$

- Subject to

$$\begin{aligned} c_{h,t} + q_t(h_{h,t} - h_{h,t-1}) + cbdc_{h,t} + d_{h,t} + b_{h,t} + T_t \\ = \frac{cbdc_{h,t-1}}{\pi_t} + \tilde{R}_t^d \frac{d_{h,t-1}}{\pi_t} + R_{t-1}^b \frac{b_{h,t-1}}{\pi_t} + w_t n_{h,t} + \Omega_t \end{aligned}$$

where

$$\tilde{R}_t^d = R_{t-1}^d - (1 - \kappa)\Psi_t$$

- Prudential authority

$$\gamma_t = \rho_\gamma \gamma_{t-1} + (1 - \rho_\gamma) \left( \boxed{\gamma} + \boxed{\gamma_x} \tilde{X}_t \right)$$

- Monetary authority: CBDC supply

$$cbdc_{cb,t} \leq \boxed{\phi} \bar{Y}$$

- CBDC take-up

$$cbdc_{cb,t} \begin{cases} < \phi \bar{Y}, & \text{if } cbdc_{h,t} / \bar{Y} < \phi \\ = \phi \bar{Y}, & \text{if } cbdc_{h,t} / \bar{Y} \geq \phi \end{cases}$$

- Aggregate Demand

$$Y_t = C_t + \mu_b R_t^l l_{b,t-1} \frac{G_t(\bar{\omega}_{b,t})}{\pi_t}$$



- **Baseline scenario**

$$\phi = 0.00; \gamma = 0.08; \gamma_x = 0.00$$

- **3 key cases**

- No CBDC:  $\phi = 0.00$

- Unconstrained CBDC:  $cbdc_{h,t}/\bar{Y} < \phi$

- CBDC with holding limit:  $\phi = 0.30$

- In each case, **four sub-cases**:

- **Structural capital requirements**

$$\gamma = 0.08$$

$$\gamma = \gamma^*$$

- **Cyclical capital requirements**

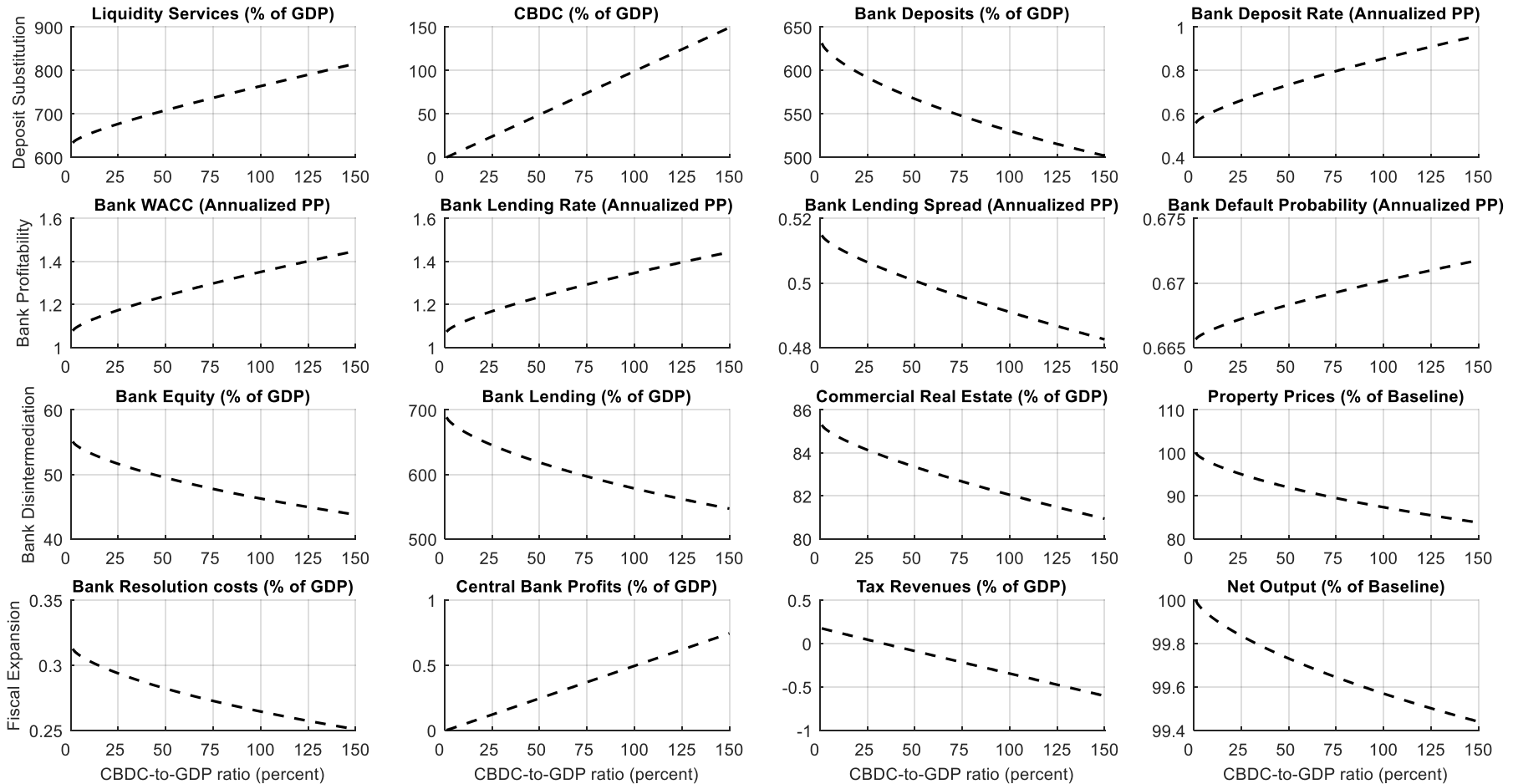
$$\gamma = 0.08; \gamma_x = \gamma_x^*$$

$$\gamma = \gamma^*; \gamma_x = \gamma_x^*$$

Table 3: Model fit

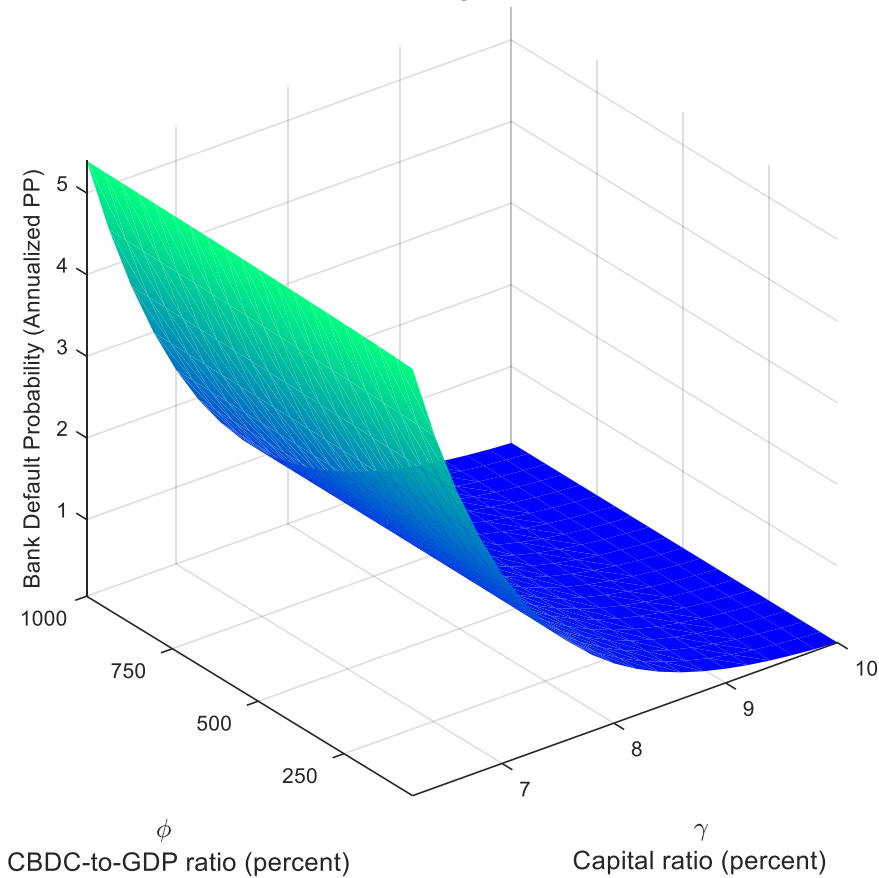
Variable	Description	Model	Data
(A) First moments			
$(\beta_h^{-1} - 1) \times 400$	Real risk-free rate	2.334	2.320
$(\bar{\rho}_b - 1) \times 400$	Bank equity return	7.056	7.066
$(\bar{R}^d - 1) \times 400$	Bank deposit rate	0.558	0.558
$\bar{F}(\bar{\omega}) \times 400$	Bank default rate	0.666	0.665
$(\bar{\pi} - 1) \times 400$	Inflation target	2.000	2.000
$\bar{v}_b$	Bank price-to-book ratio	1.030	1.148
$\bar{e}_b / \bar{l}_b$	Regulatory capital requirements	0.080	0.080
$\bar{d}_b / \bar{Y}$	Bank deposits-to-GDP ratio	6.315	6.311
$\kappa$	Share of insured deposits	0.540	0.540
$\bar{q} \bar{h}_h / \bar{Y}$	HH property wealth-to-GDP ratio	2.802	2.802
(B) Second moments			
$\sigma_Y \times 100$	Std(GDP) x 100	2.630	2.631
$\sigma_l / \sigma_Y$	Std. bank lending/Std(GDP)	3.369	3.138
$\sigma_d / \sigma_Y$	Std. bank deposits/Std(GDP)	3.369	3.123
$\sigma_{(r^l - r^d)} / \sigma_Y$	Std. bank lending spread/Std(GDP)	0.088	0.087
$\sigma_{r^l} / \sigma_Y$	Std. bank lending rate/Std(GDP)	0.148	0.122
$\sigma_{r^d} / \sigma_Y$	Std. bank deposit rate/Std(GDP)	0.103	0.043

# Transmission of CBDC Issuance: Steady State Effects

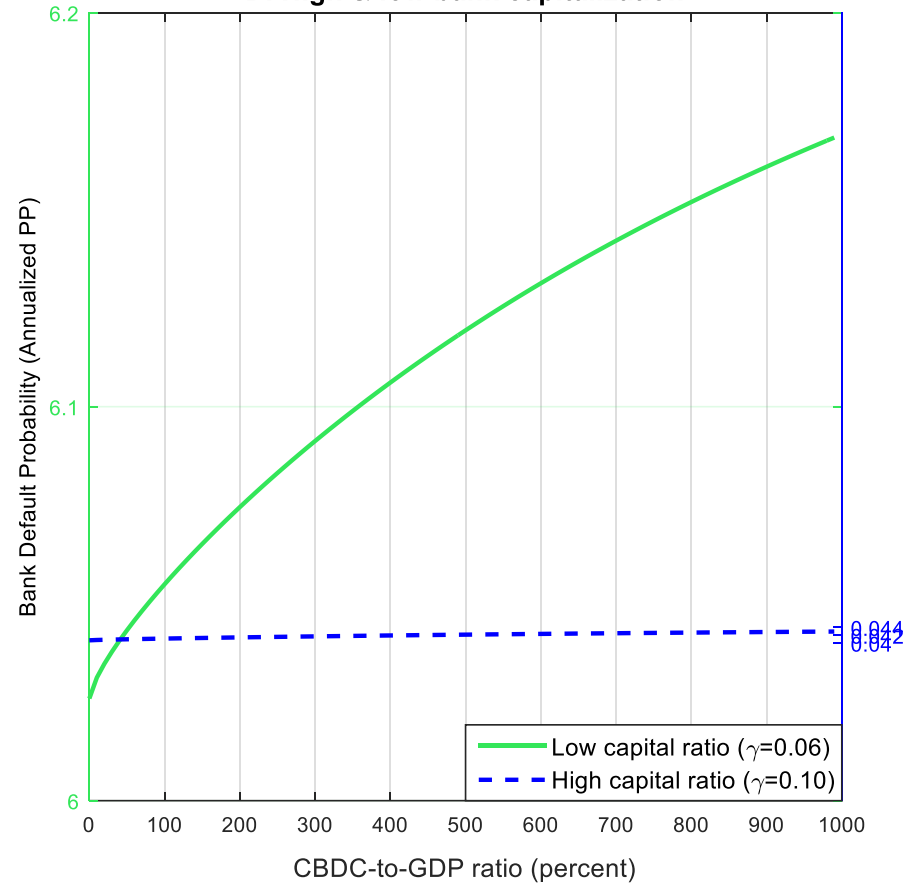


# Transmission: Steady State Effects of CBDC on Bank Riskiness

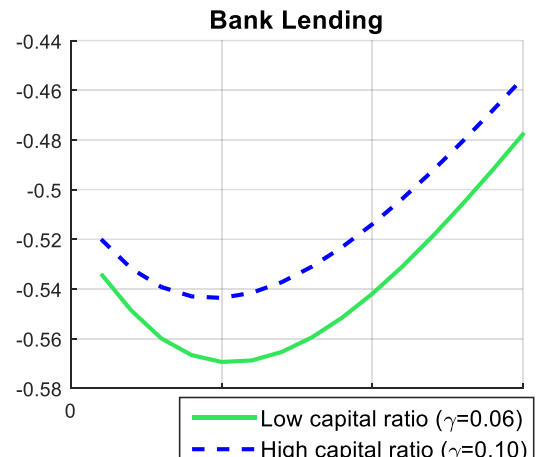
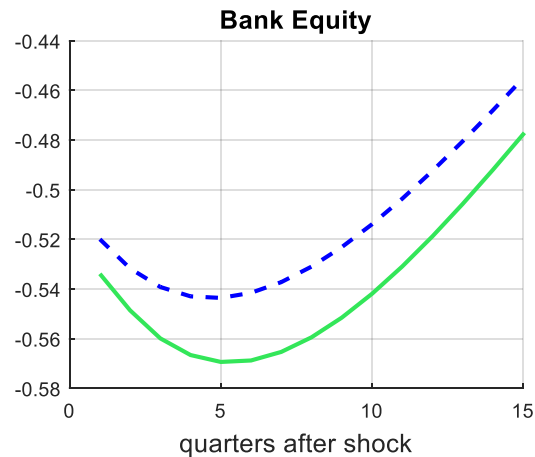
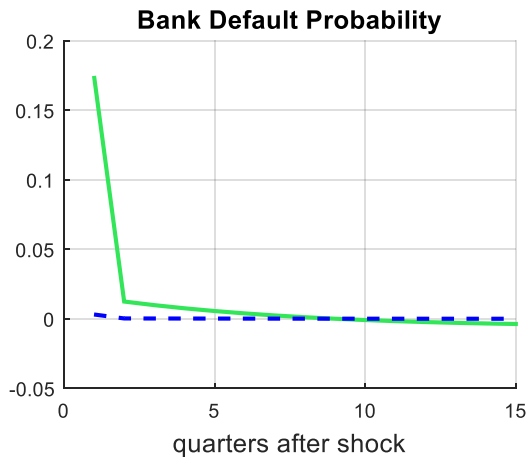
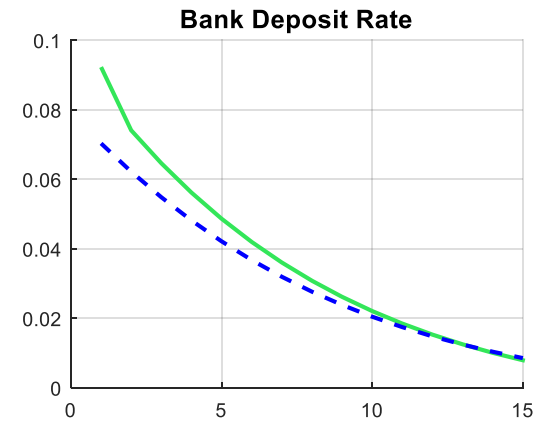
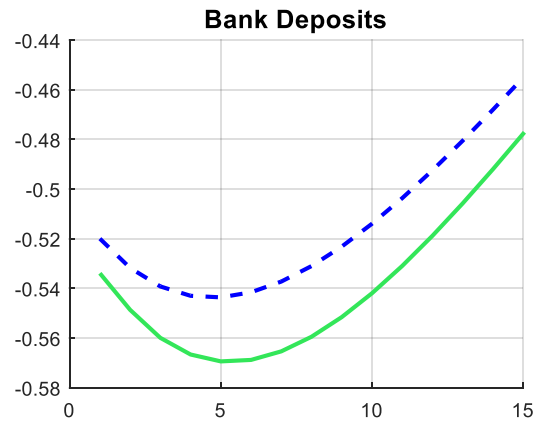
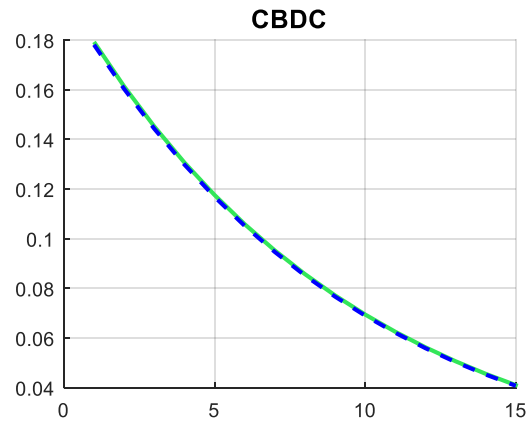
### A. Bank capitalization



### B. High & low bank capitalization



# Transmission: Banks' Response to a CBDC Issuance Shock

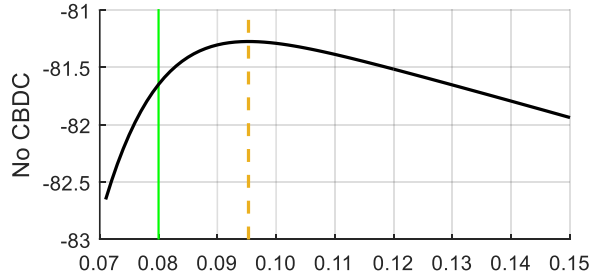


— Low capital ratio ( $\gamma=0.06$ )  
- - High capital ratio ( $\gamma=0.10$ )

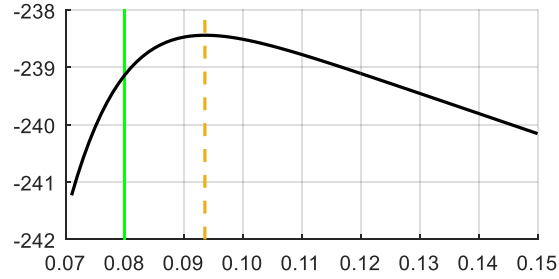
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# Structural Capital Requirements

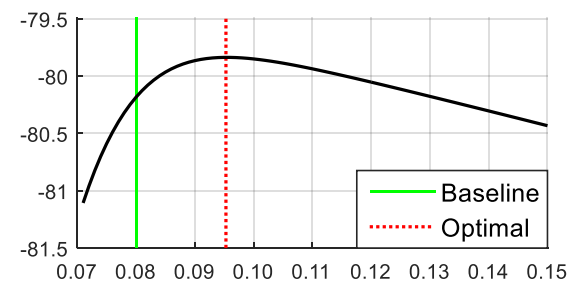
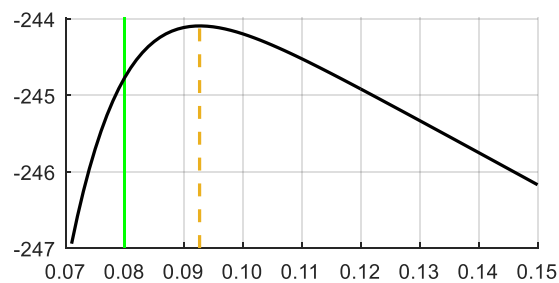
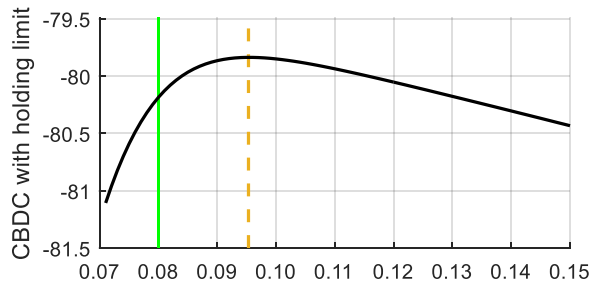
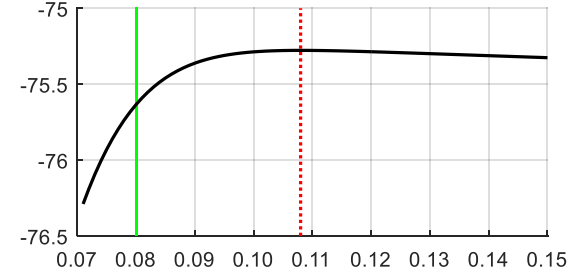
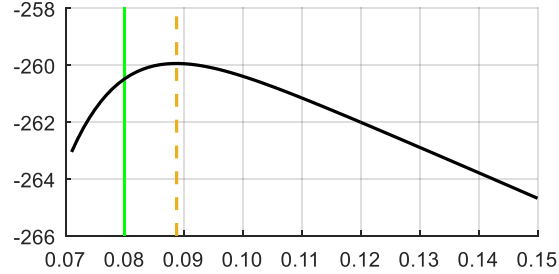
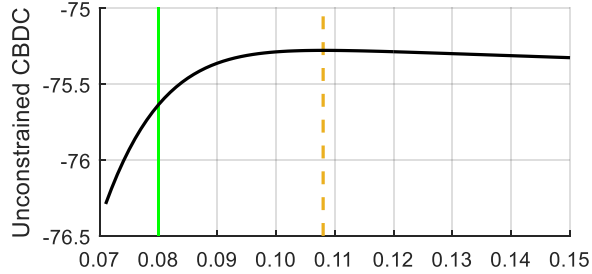
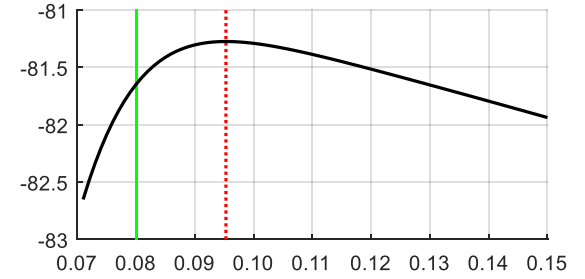
**A. Welfare Savers**



**B. Welfare Borrowers**



**C. Social Welfare**



Ceteris paribus change in  $\gamma$

Ceteris paribus change in  $\gamma$

Ceteris paribus change in  $\gamma$

Table 4: Welfare gains of CBDC and structural capital requirements

Scenario	CBDC Adoption ( $CBDC_t \times 100 / Y_t$ )	Capital Requirement ( $\gamma \times 100$ )	Welfare Gains ( $\lambda \times 100$ )	Bank Riskiness ( $\bar{F}(\bar{\omega}) \times 400$ )
<b>A) No CBDC</b>				
(i) $\gamma$ (baseline)	0.00%	8.0%	0.000%	0.6656 <i>pp</i>
(ii) $\gamma^*$ (optimal)	0.00%	9.5%	0.217%	0.0868 <i>pp</i>
<b>B) Unconstrained CBDC</b>				
(i) $\gamma$ (baseline)	196.51%	8.0%	3.549%	0.6732 <i>pp</i>
(ii) $\gamma^*$ (optimal)	204.80%	10.8%	3.764%	0.0114 <i>pp</i>
<b>C) CBDC with holding limit</b>				
(i) $\gamma$ (baseline)	30.00%	8.0%	0.852%	0.6675 <i>pp</i>
(ii) $\gamma^*$ (optimal)	30.00%	9.5%	1.056%	0.0872 <i>pp</i>



# Cyclical Capital Requirements

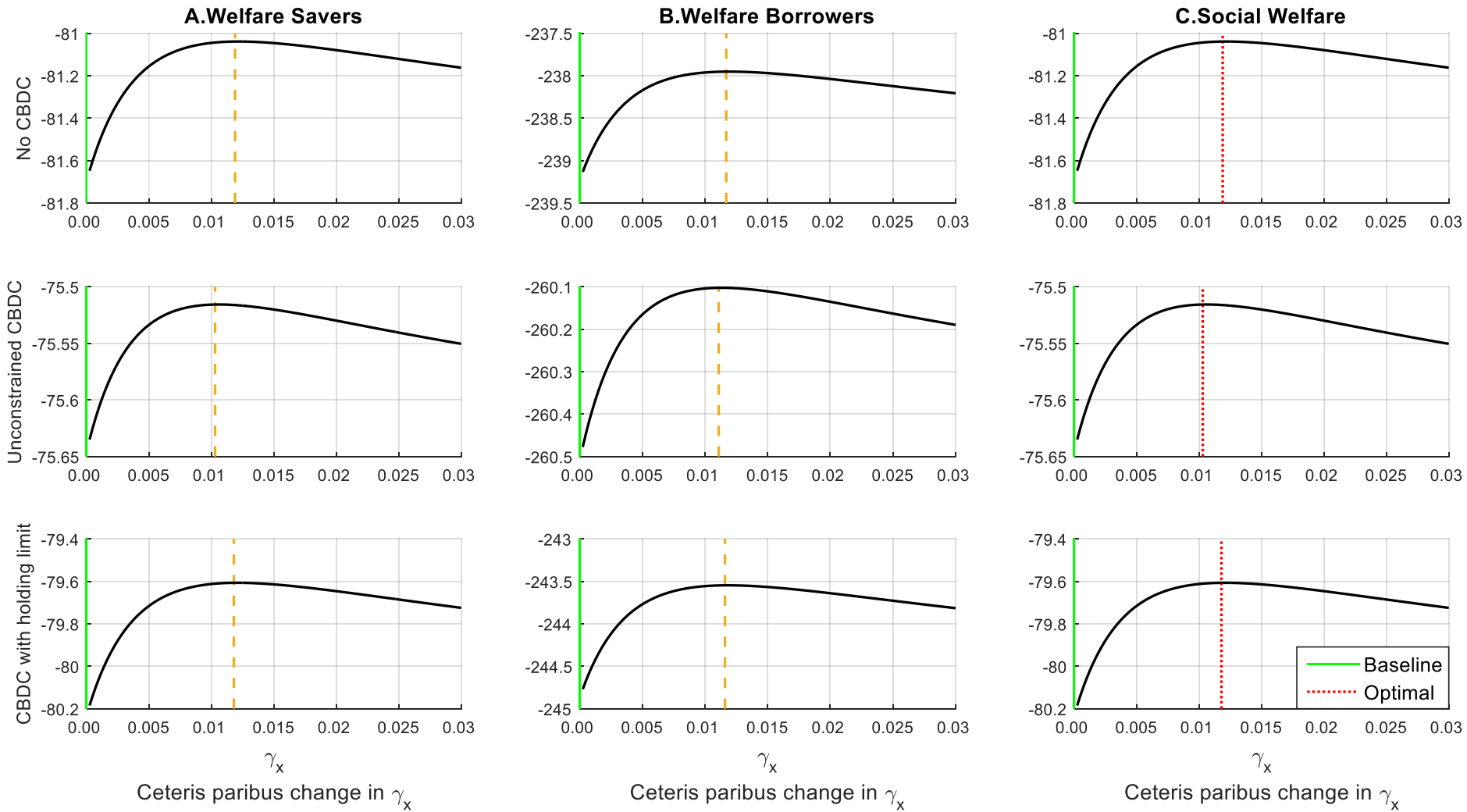
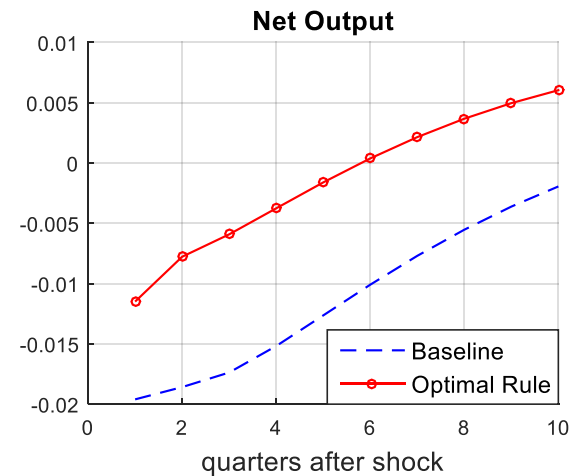
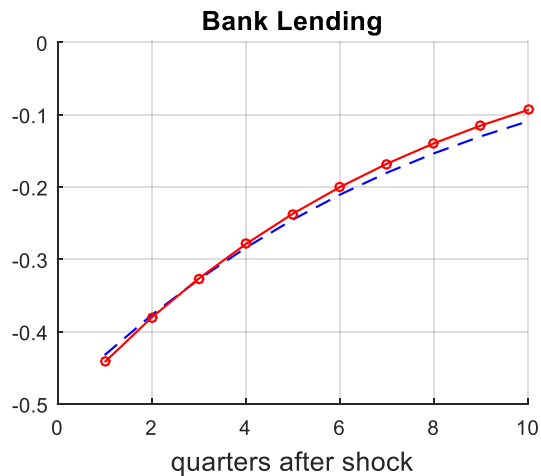
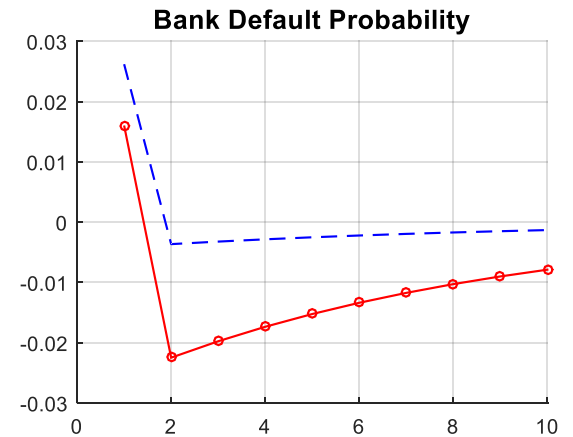
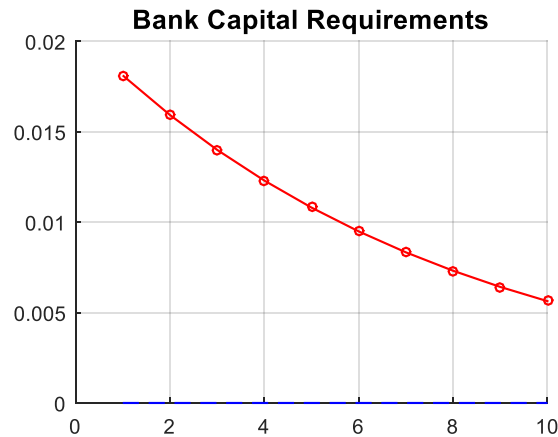
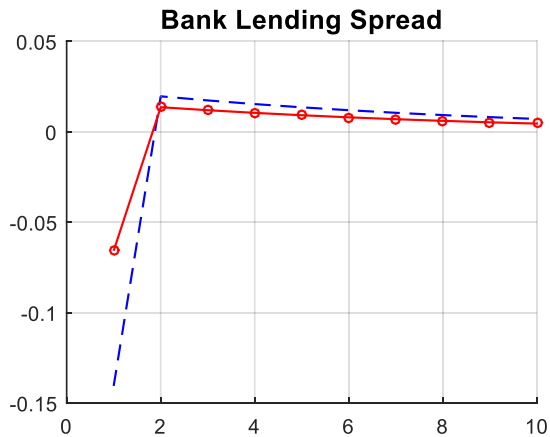


Table 5: Welfare gains of CBDC and cyclical capital requirements

Scenario	CBDC Adoption ( $CBDC_t \times 100 / Y_t$ )	Capital Requirement ( $\gamma \times 100$ )	CCyB ( $\gamma_x$ )	Welfare Gains ( $\lambda \times 100$ )
<b>A) No CBDC</b>				
(i) $\gamma$ (baseline)	0.00%	8.0%	0.0119	0.354%
(ii) $\gamma^*$ (optimal)	0.00%	7.76%	0.0113	0.361%
<b>B) Unconstrained CBDC</b>				
(i) $\gamma$ (baseline)	196.51%	8.0%	0.0103	3.621%
(ii) $\gamma^*$ (optimal)	204.80%	10.80%	0.0000	3.764%
<b>C) CBDC with holding limit</b>				
(i) $\gamma$ (baseline)	30.00%	8.0%	0.0118	1.191%
(ii) $\gamma^*$ (optimal)	30.00%	7.71%	0.0111	1.200%

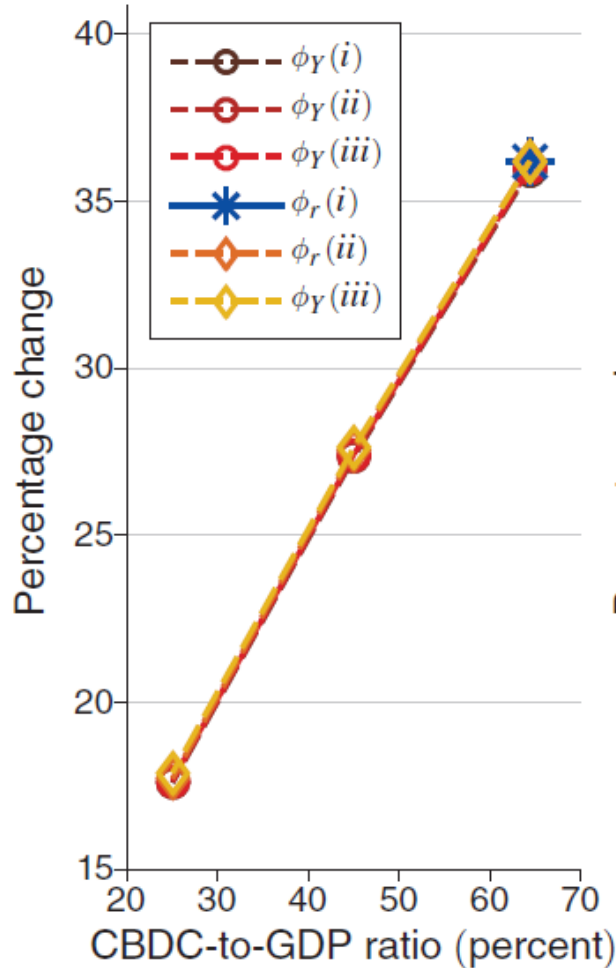
# Optimal Capital Requirements: IRFs to a Financial Shock



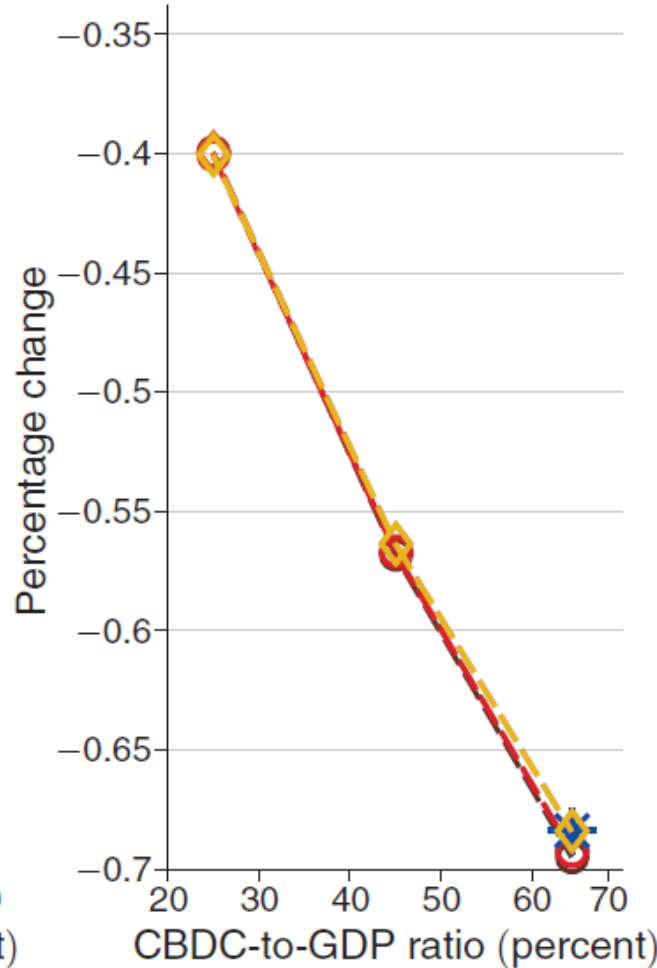
--- Baseline  
—○— Optimal Rule

# CBDC Effects (Burlon et al. 2024)

Panel A. Liquidity services



Panel B. Quarterly real GDP



Panel C. Std. bank loans

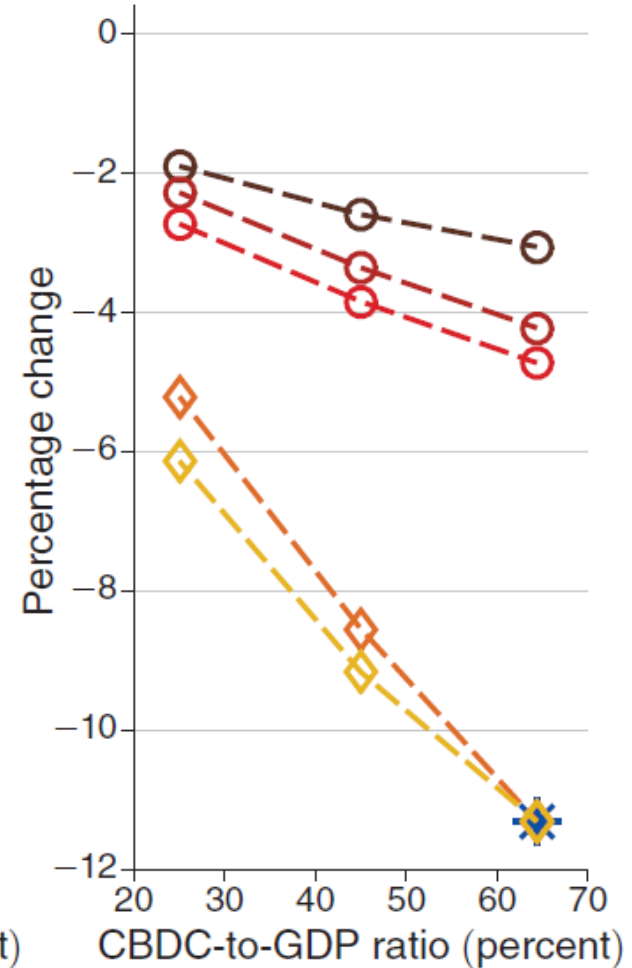
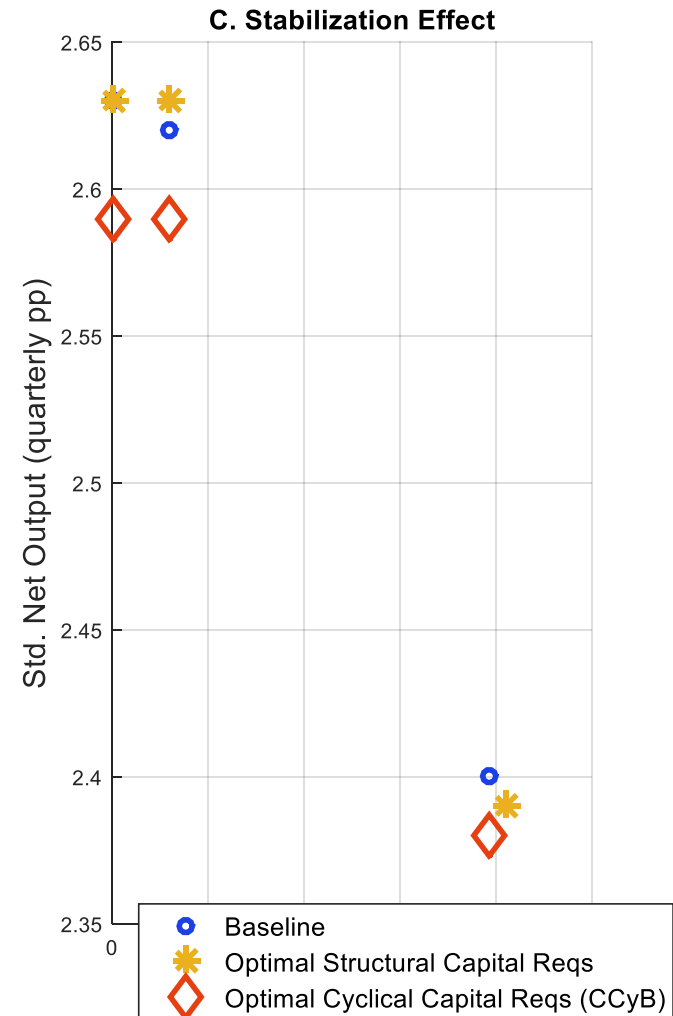
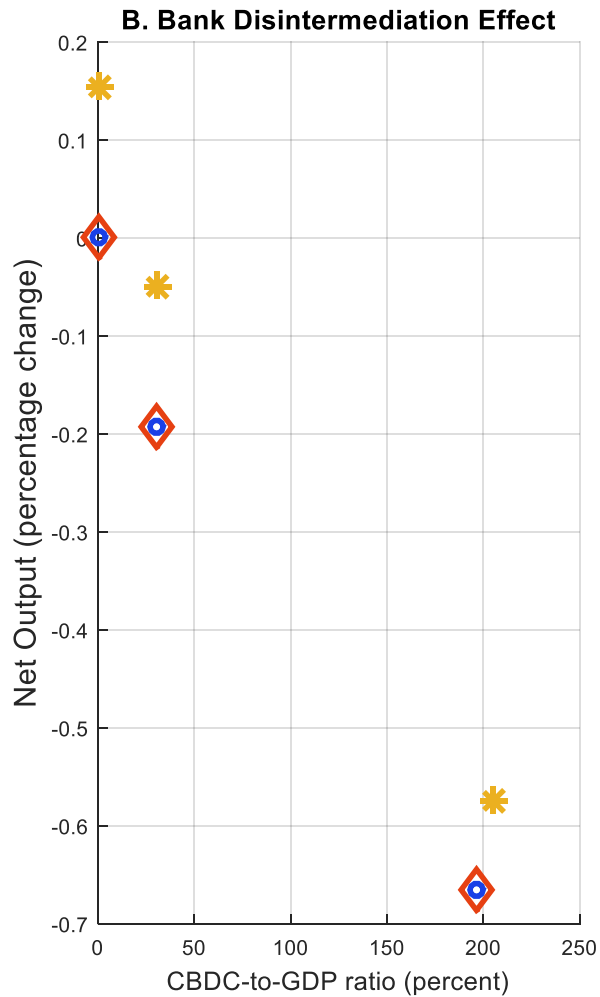
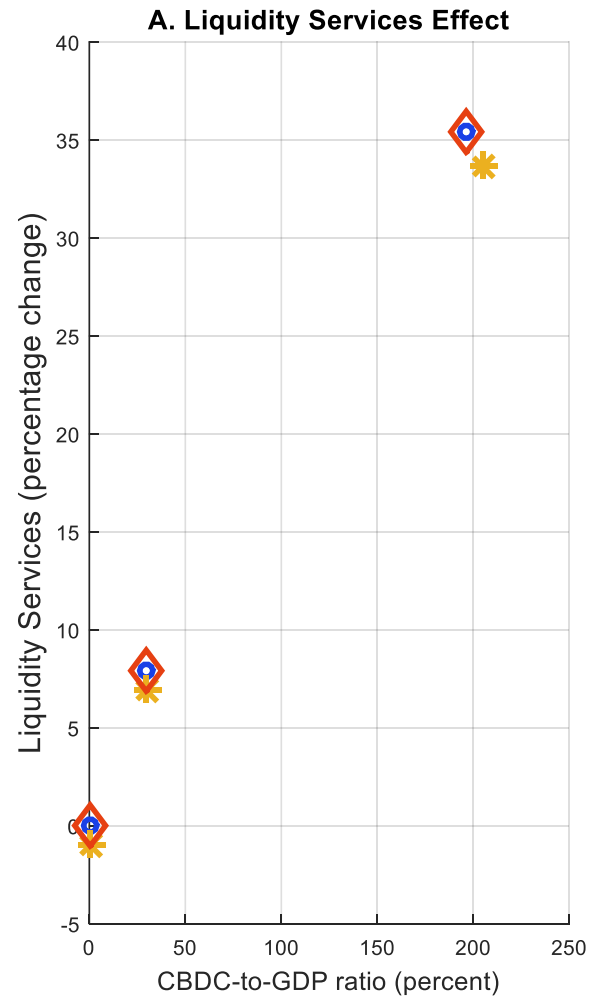


FIGURE 8. LIQUIDITY SERVICES, BANK DISINTERMEDIATION AND STABILIZATION EFFECTS

Source: Burlon et al. 2024

# CBDC Effects: the Role of Capital Regulation

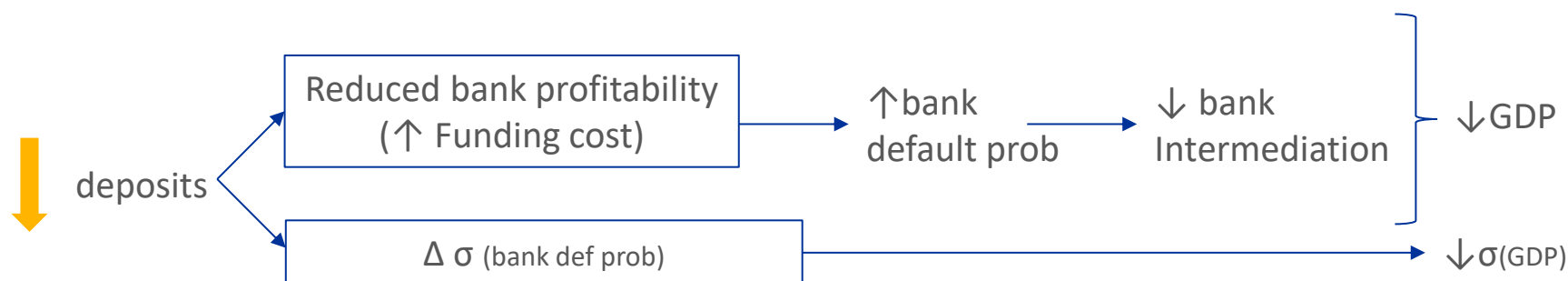


1. Motivation
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4. CBDC and Bank Capital Regulation
5. **Conclusion**

- **Empirical Evidence on impact of digital euro news on banks**

- Potentially negative funding shocks from CBDC put pressure on bank capitalisation and riskiness
- Less healthy banks the most sensitive to this, bearing risk of financial amplification
- Impacts so far small due to careful communication about calibration of holding limits

- **Role of bank riskiness (and capital regulation) in CBDC transmission**



- **Impact of CBDC on bank riskiness**

- Crucially depends on **bank capitalization**
- Can be neutralized via calibrated **CBDC holding limit**

- **Optimal capital requirements**

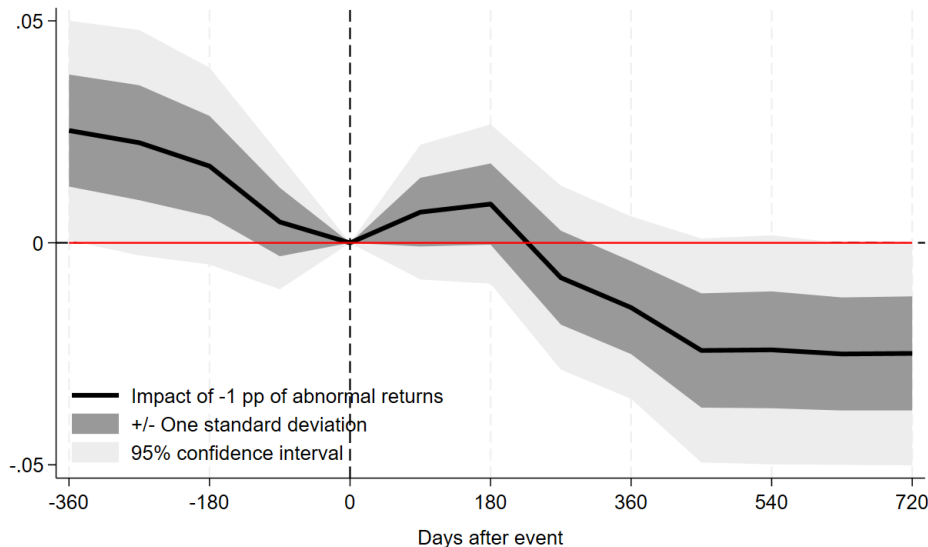
- **Structural:** Increasing or decreasing with CBDC ← trade-off (fiscal expansion vs bank disintermediation)
- **Cyclical:** Decreasing ← stabilization role of CBDC

**Thank you**

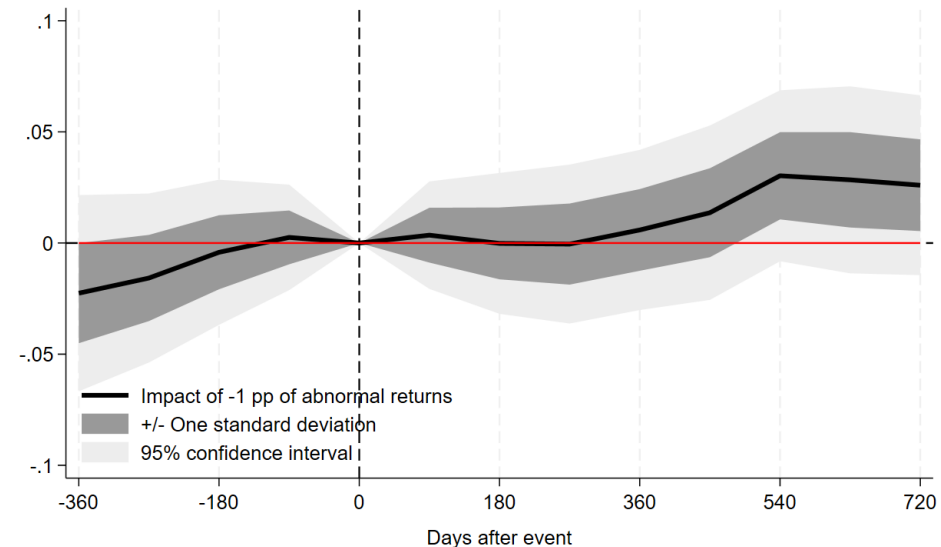


## Figure 3. Impact of CBDC news on buffer above MDA trigger (pp)

Banks with low capital buffers



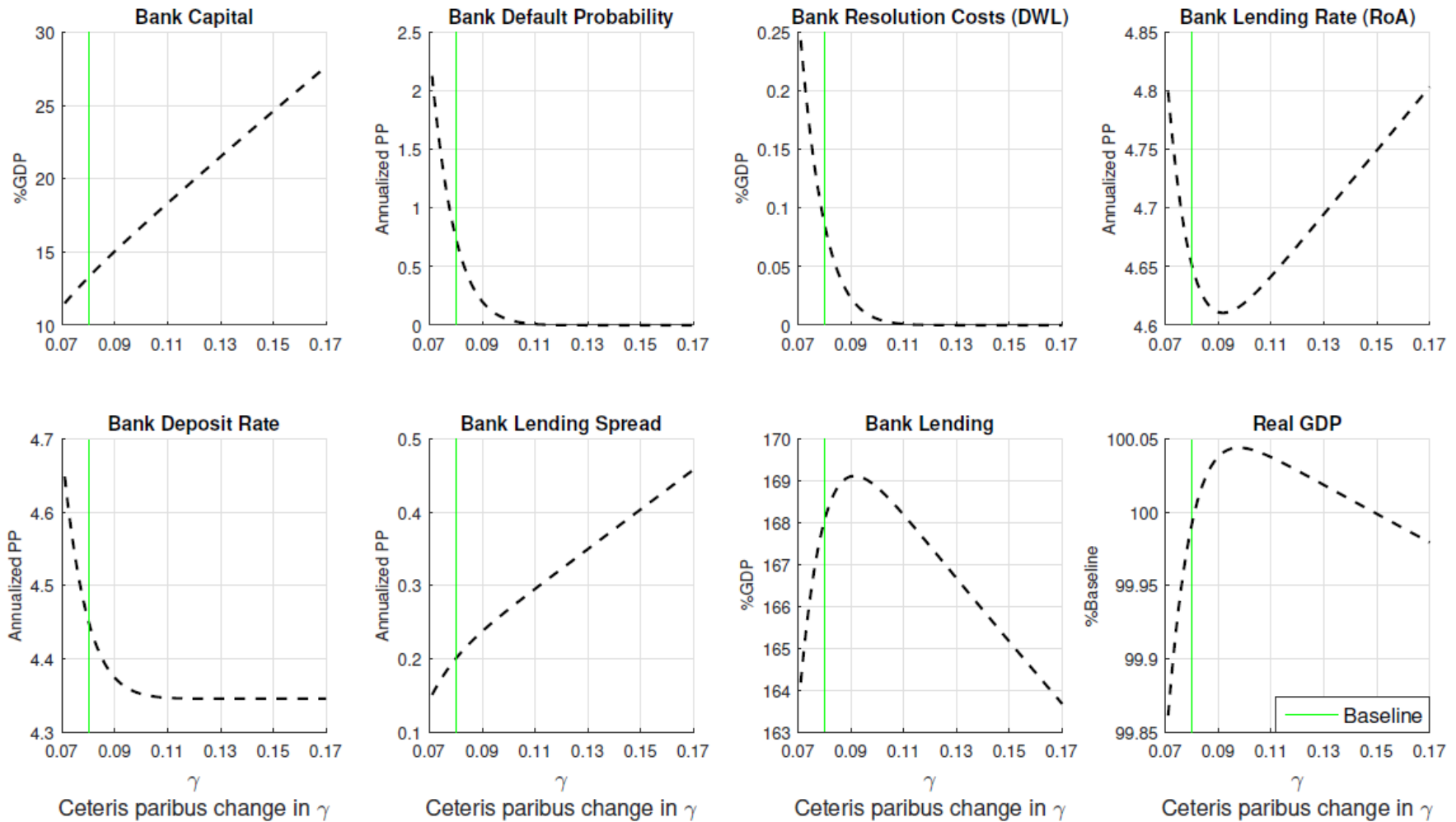
Banks with high capital buffers



- Bank capitalisation decreases after negative funding shock from CBDC news
- Each pp of negative stock return was associated with 3 bp decrease in capital ratio
- This is driven by banks with low capital buffers (below median, ~4 pp above requirements)
- And not a result of supervisory requirements, leading to outright lower buffers

# Transmission of CBDC Issuance: Steady State Effects

Figure 2: Transmission mechanisms and steady state effects of capital requirement:



Source: Muñoz and Smets 2024