CBDC and Bank Capital Regulation

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Overview

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

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Motivation

- What are CBDCs?
- 91% of central banks exploring CBDCs (2024 BIS Survey) → Literature?
  - **Empirical**
    - Survey data: Huynh et al. 2020; Bijlsma et al. 2021; Abramova et al. 2022; Choi et al. 2023; Bidder et al. 2024; Nocciola and Zamora-Pérez 2024
    - Market reactions: Burlon et al. (2024)
  - **Theoretical**
    - **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, Piazessi 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.
      - Macro-CBDC models with bank risk: Bidder et al. (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 optimal capital needs (empirically)**
  - **Optimal banking regulation** and its consequences for CBDC macro effects (Burlon, Munoz and Smets (2024). "The Optimal Quantity of CBDC in a Bank-Based Economy," AEJ:Macro)

Main Contributions

- **Provide first empirical evidence** on the impact **on perceived bank riskiness and optimal capital needs** (exploiting digital euro announcement effects on bank stock valuations)

- Develop a euro area **quantitative macro-banking DSGE model with CBDC** that:
  - Captures the evidence
  - Provides rationale for **static capital regulation and dynamic capital buffers** by allowing for **externalities due to bank risk failure and collateral constraints**

- **Answer key policy questions**
  - Transmission mechanisms through which CBDC affects bank riskiness and optimal capital regulation?
  - Can a calibrated CBDC holding limit neutralize these bank (and any related macro) effects?
  - How does bank capital regulation matter to the main macro effects of CBDC?

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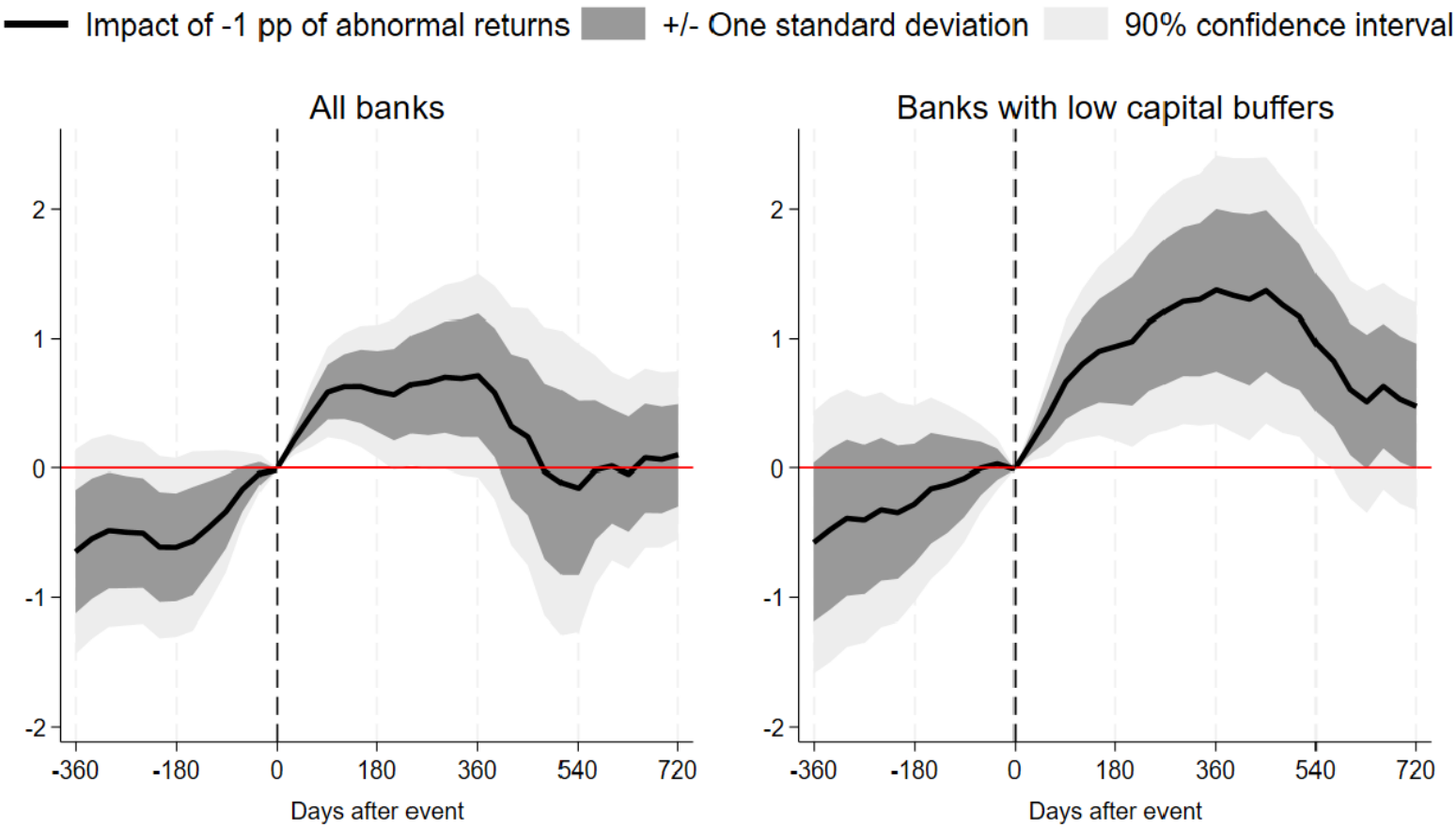
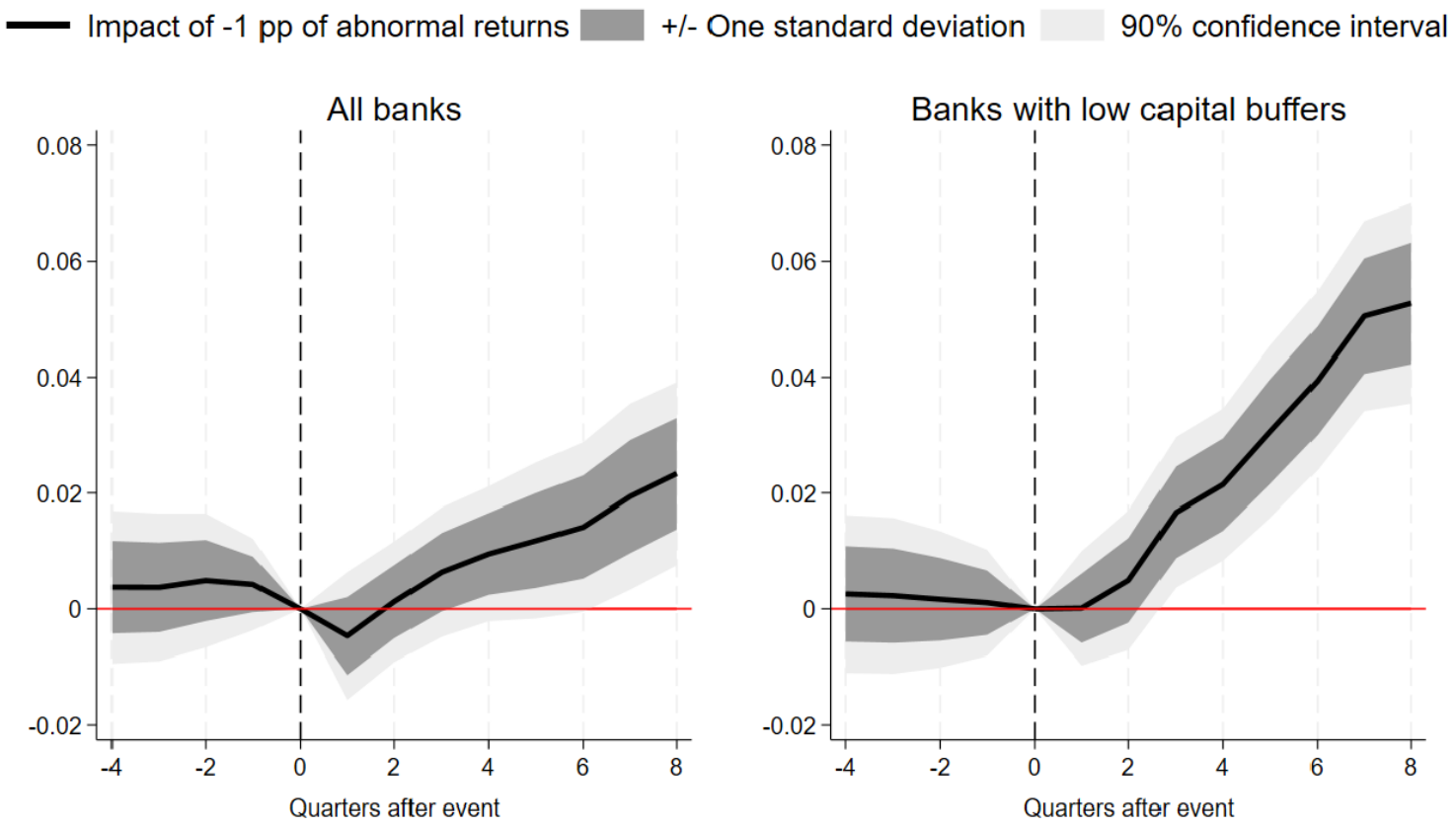
Impact of CBDC Shocks on Perceived Bank Riskiness



- Negative CBDC shocks increase bank riskiness (measured by CDS spreads)
- One std. of lower bank stock returns around digital euro events is associated with around 10 bps of additional CDS spread after one year.
- On average, less capitalized banks are more affected by these shocks
- The impact of CBDC news tends to be reabsorbed at longer horizon.

Impact of CBDC Shocks on Optimal Bank Capital Needs



- Negative CBDC shocks increases optimal capital needs (arguably, to reabsorb the additional layer of bank risk).
- On average, optimal capital needs of less capitalized banks increase by more.
- This is consistent with findings that these shocks lowered lending volumes (Burlon et al. 2024).

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Environment

- Monetary, closed, time-discrete, decentralized economy
- **Savers** (Households)
  - Hold **deposits, CBDC** and gov. bonds (risk-free asset)
- **Financial Intermediaries** (Mendicino et al. 2020)
  - 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** (Entrepreneurs)
  - **Discount future more heavily** than HHs (Iacoviello 2005)
  - **Collateral constraints** (Kiyotaki and Moore 1998)
- Intemediate (Calvo price-setters) and Final Goods Producers
- **Public Authorities**
  - Monetary authority
  - (Macro-)prudential authority
  - Deposit insurance scheme

Savers: Households (CBDC holders)

- The representative household seeks to maximize

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

where

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

- Subject to

$$c_{h,t} + q_t(h_{h,t} - h_{h,t-1}) + cbdc_{h,t} + d_{h,t} + b_{h,t} + T_t$$
$$= R_{t-1}^{cbdc} \frac{cbdc_{h,t-1}}{\pi_t} + \widetilde{R}_t^d \frac{d_{h,t-1}}{\pi_t} + R_{t-1}^b \frac{b_{h,t-1}}{\pi_t} + w_t n_{h,t} + \Pi_t$$

where

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

Banks (Financial Intermediaries)

- The representative bank maximizes

$$E_t \left[\Lambda_{b,t+1} \max \left(\omega_{b,t+1} R^l_{t+1} l_{b,t} - R^d_t d_{b,t}, 0 \right) \right] - \upsilon_{b,t} e_{b,t}$$

- Subject to

$$l_{b,t} = e_{b,t} + d_{b,t}$$

$$e_{b,t} \geq \gamma_t l_{b,t}$$

- Threshold below which the bank defaults

$$\overline{\omega}_{b,t+1} = (1 - \gamma_t) \, R^d_t / R^l_{t+1}$$

Public Authorities

- Prudential Authority

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

- Deposit Insurance Scheme
  - Repossessed bank assets

$$(1 - \mu_b)\, \omega_{b,t+1} R^l_{t+1} \frac{l_{b,t}}{\pi_{t+1}}$$

  - HHs' total losses (due to bank failure) not covered with repossessed bank assets

$$\Psi_t \frac{d_{h,t-1}}{\pi_t} = \left[\left(R^d_{t-1} d_{b,t-1} \right) \frac{F(\overline{\omega}_{b,t})}{\pi_t} - (1 - \mu_b) R^l_t l_{b,t-1} \frac{G_t(\overline{\omega}_{b,t})}{\pi_t} \right]$$

  - Insured deposits covered with repossessed bank assets, lump-sum taxes and CB profits

$$T_t = \kappa \Psi_t \frac{d_{h,t-1}}{\pi_t} - \Omega_{cb,t}$$

  - Remaining repossessed assets devoted to "partially cover" uninsured deposits

$$(1 - \kappa)\, (1 - \mu_b) R^l_t l_{b,t-1} \frac{G_t(\overline{\omega}_{b,t})}{\pi_t}$$

Public Authorities (Cont'd)

- Monetary policy rule

$$r_t^b = \rho_r r_{t-1}^b + (1-\rho_r)\left(\overline{r}^b + \alpha_\pi \tilde{\pi}_t + \alpha_Y \tilde{y}_t\right) + e_t^r$$

- CBDC supply rule

$$cbdc_{cb,t} \leq \phi \overline{Y}$$

  - Unremunerated CBDC

$$R_t^{cbdc} = 0$$

  - CBDC take-up

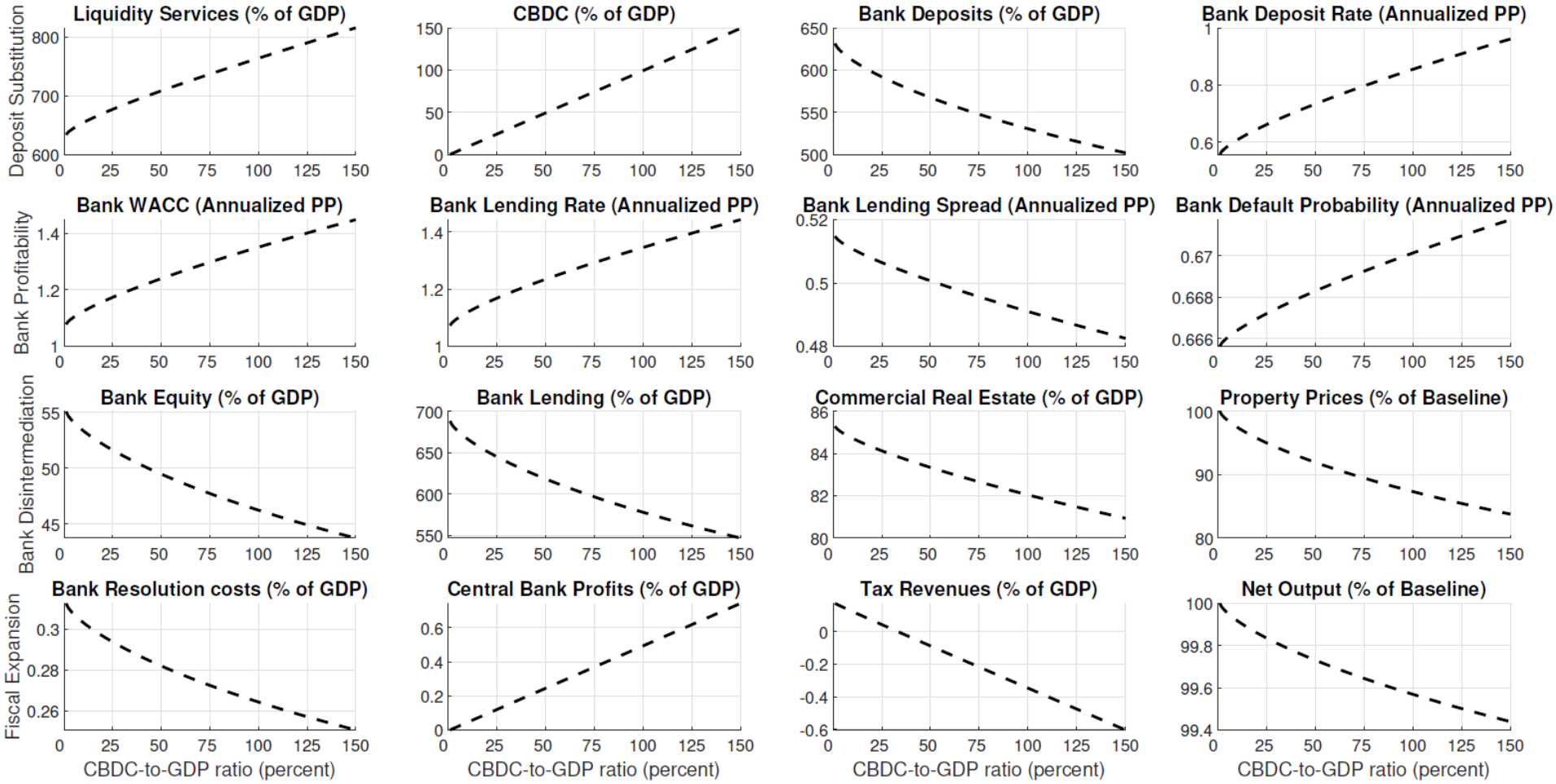
$$cbdc_{cb,t} \begin{cases} < \phi \overline{Y}, & \text{if } cbdc_{h,t}/\overline{Y} < \phi \\ = \phi \overline{Y}, & \text{if } cbdc_{h,t}/\overline{Y} \geq \phi \end{cases}$$

Calibration: Data Targets and Model Fit

- Banking literature that studies **(optimal) capital requirements and its effects**
  - E.g., Van den Heuvel 2008, Admati and Hellwig 2013, Clerc et al. 2015, Begenau and Landvoigt 2017, Mendicino et al. 2018, Abad 2019, Elenev et al. 2020, Begenau 2020, Landvoigt and Nieuwerburgh 2020, Muñoz 2021, Mendicino et al. (2024).
  - ➢ Mendicino, Nikolov, Suarez & Supera (2020), "Bank capital in the short and in the long run," Journal of Monetary Economics, 115(C), 64-79.

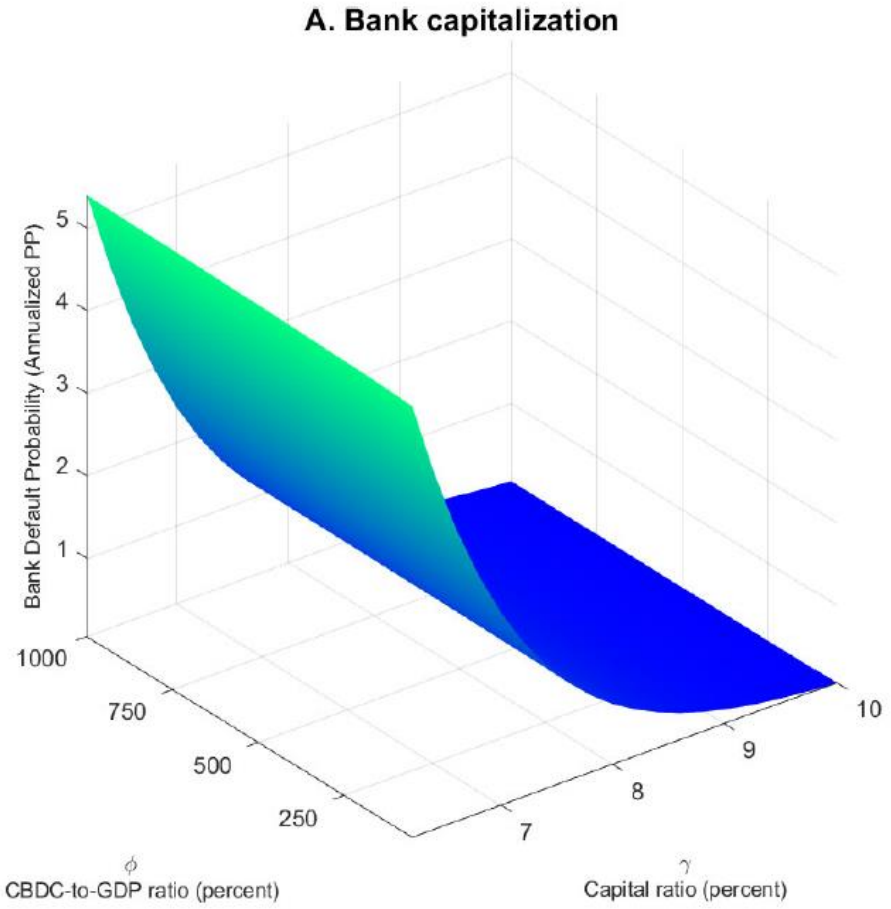
Variable	Description	Model	Data
(A) First moments			
$(\beta_h^{-1} - 1)x\ 400$	Real risk-free rate	2.334	2.320
$(\overline{\rho_b} - 1)\ x\ 400$	Bank equity return	7.056	7.066
$\left(\overline{R^d} - 1\right)\ x\ 400$	Bank deposit rate	0.558	0.558
$\overline{F}(\overline{\omega})x\ 400$	Bank default rate	0.666	0.665
$(\overline{\pi} - 1)x\ 400$	Inflation target	2.000	2.000
$\overline{v_b}$	Bank price-to-book ratio	1.030	1.148
$\overline{e}_b/\overline{l}_b$	Regulatory capital requirements	0.080	0.080
$\overline{d}_b/\overline{Y}$	Bank deposits-to-GDP ratio	6.315	6.311
κ	Share of insured deposits	0.540	0.540
μ_b	Complementary of recovery rate	0.300	0.300
$\overline{cbdc}_{cb}/\overline{Y}$	CBDC-to-GDP ratio	0.000	0.000
$\overline{q}\overline{h}_h/\overline{Y}$	HH property wealth-to-GDP ratio	2.802	2.802
(B) Second moments			
$\sigma_Y\ x\ 100$	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

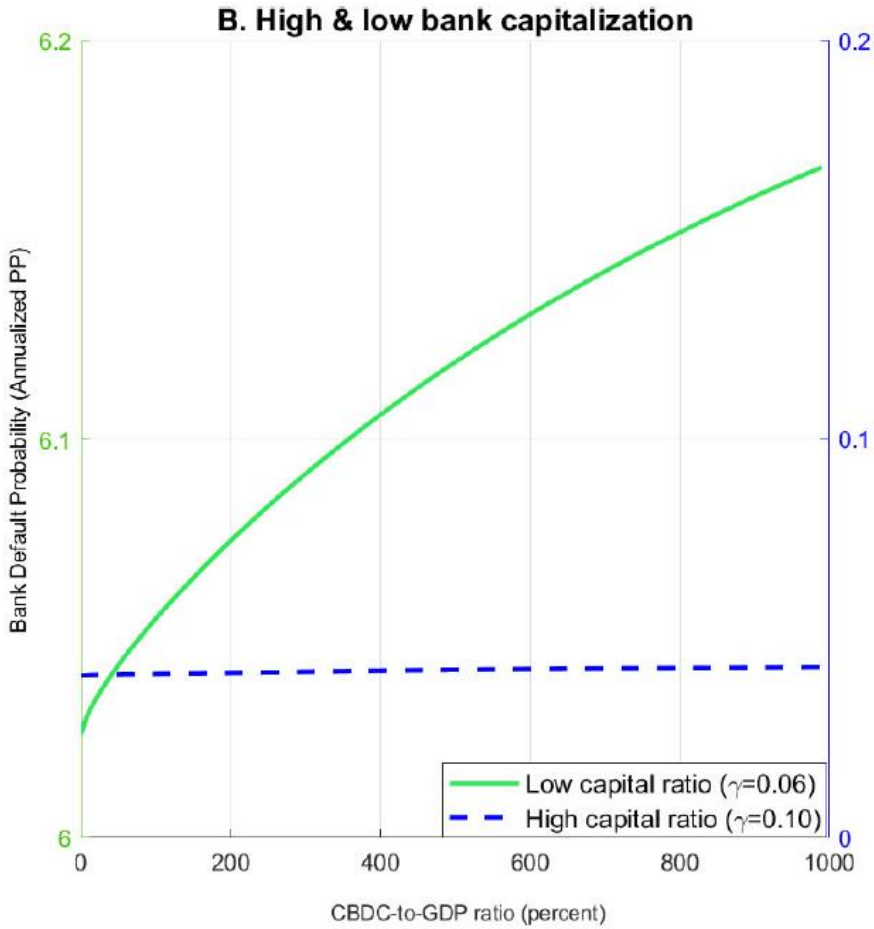
Transmission of CBDC Issuance: Steady State Effects



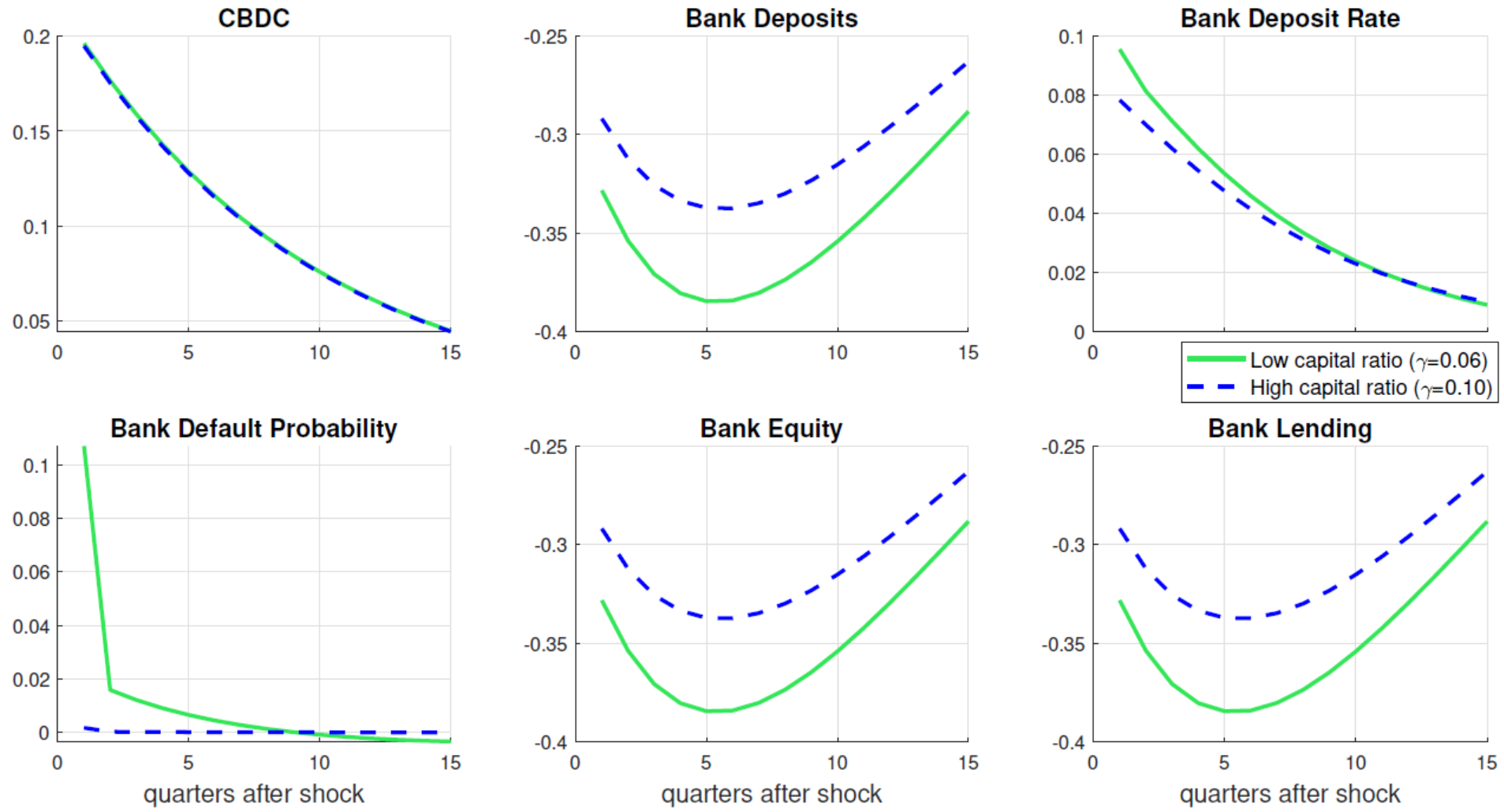
Transmission: Steady State Effects of CBDC on Bank Riskiness

Figure 5: Implications of bank capitalization for CBDC effects on bank riskiness





Transmission: Banks' Response to a CBDC Issuance Shock



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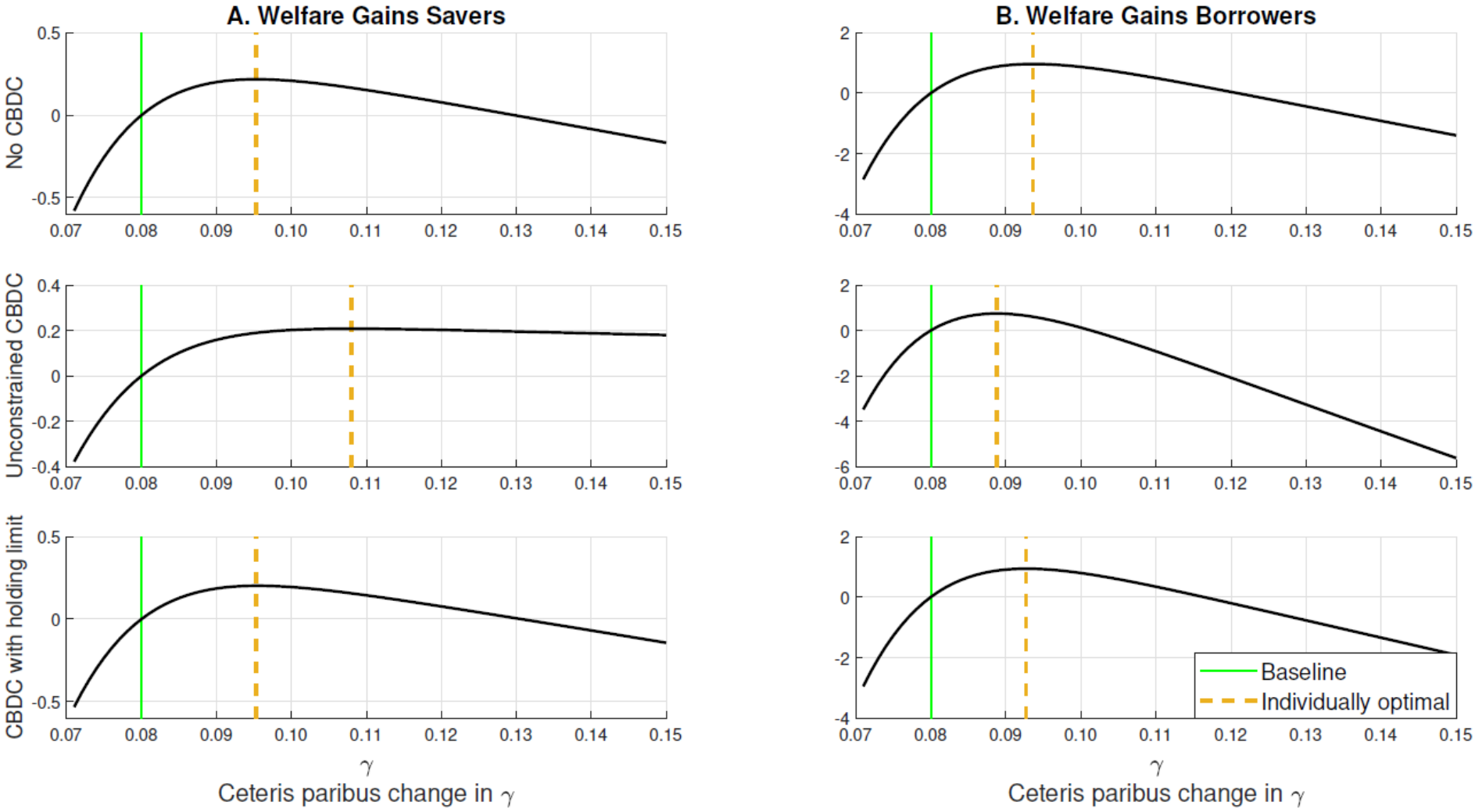
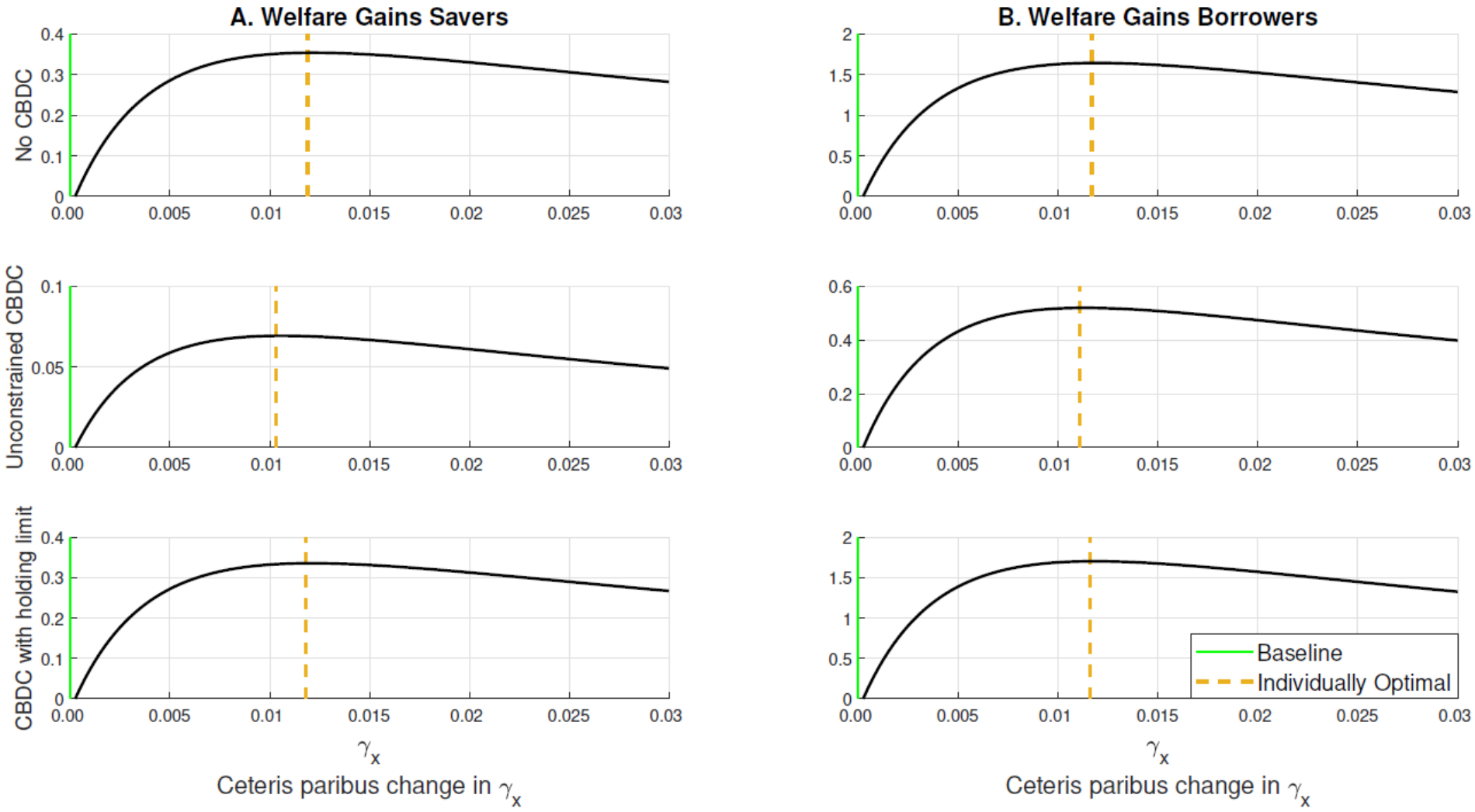
Welfare gains: Static Capital Requirements

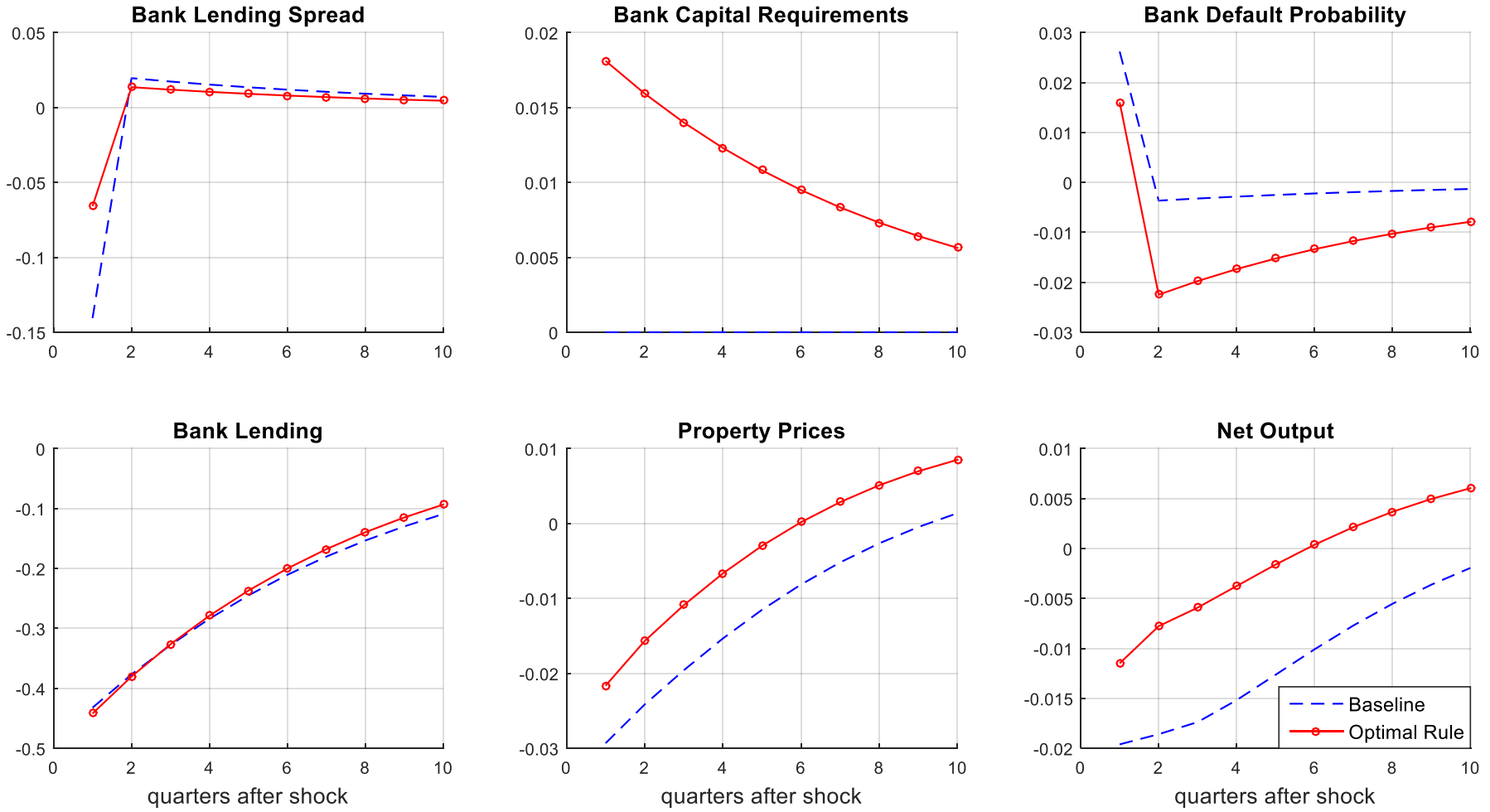


Welfare Gains: Dynamic Capital Buffers

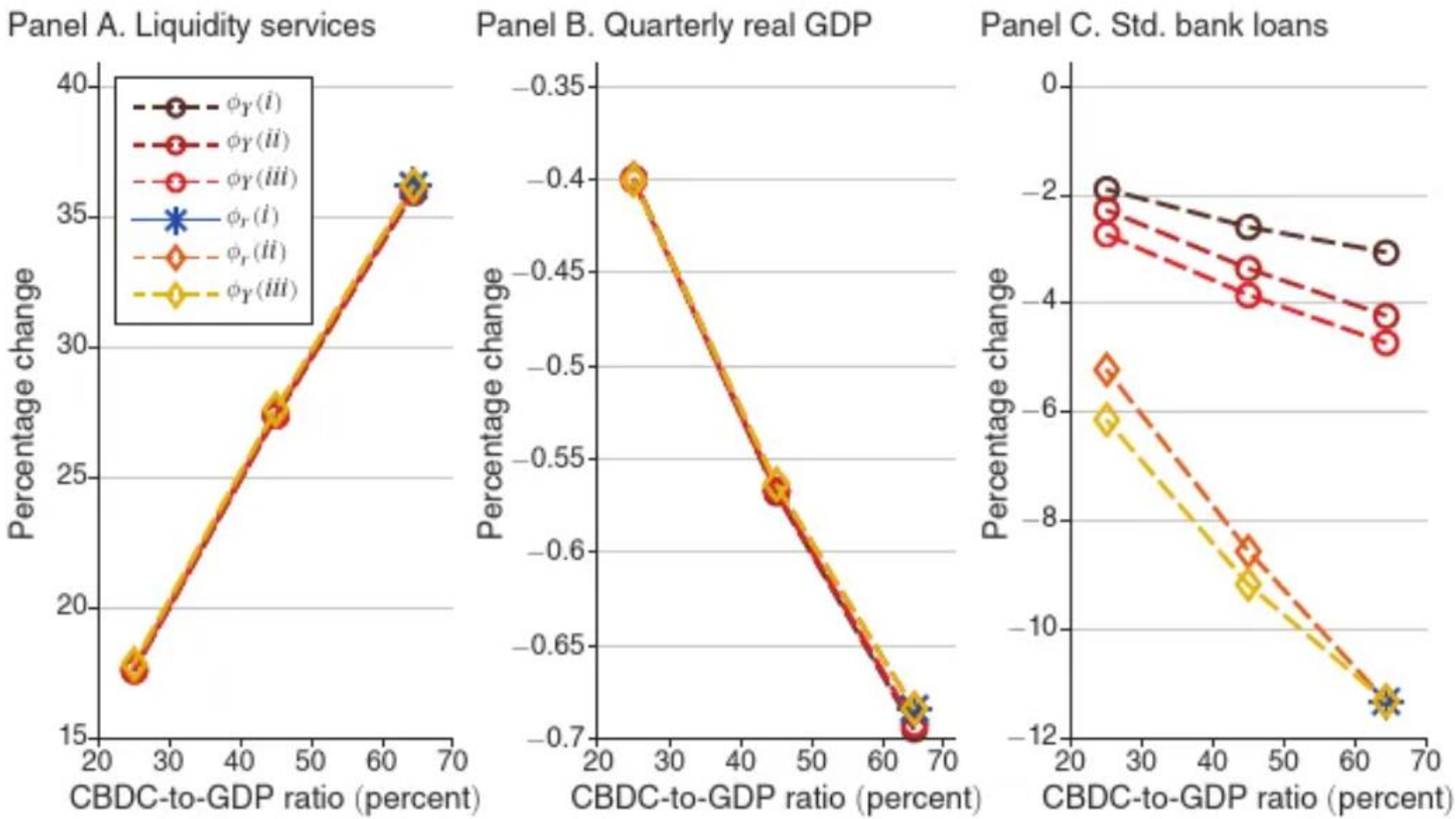


Munoz and Smets (2024). "The positive neutral countercyclical capital buffer."

Optimal Capital Requirements: IRFs to a Financial Shock

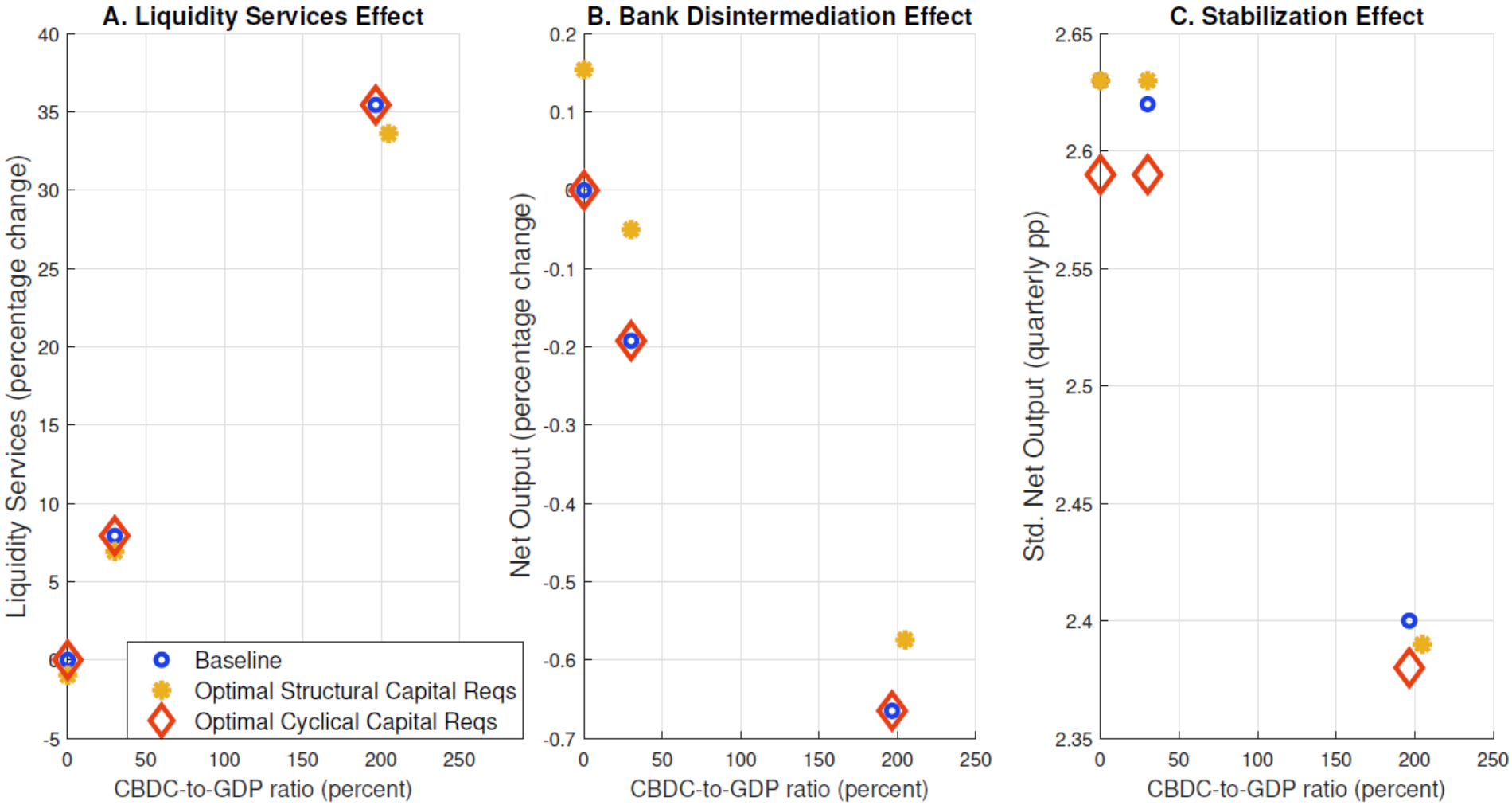


CBDC Effects: Burlon et al. (2024)



Source: Burlon et al. 2024

CBDC Effects: the Role of Capital Regulation



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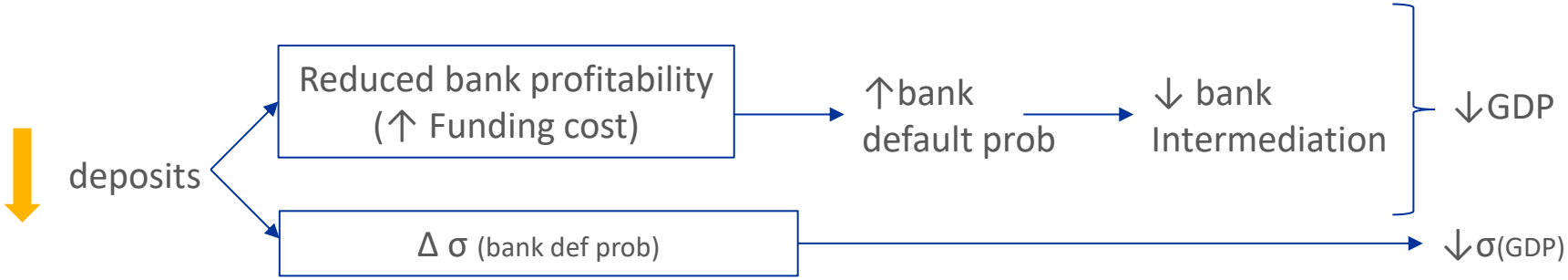
Conclusion

- **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**
  - Moderate, but crucially depends on **bank capitalization**
  - Can be neutralized via calibrated **CBDC holding limit**
- **Optimal capital requirements**
  - **Static**: Increasing or decreasing with CBDC ← trade-off (cost bank risk failure vs bank disintermediation)
  - **Dynamic:** Decreasing ← stabilization role of CBDC

Thank you

Empirical Strategy

- **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):

$$R_{b,t} = \alpha_b + \beta_{m,b} R_{m,t} + \beta_{HML,b} R_{HML,t} + \beta_{SMB,b} R_{SMB,t} + \sum_{e=1}^{E} \gamma_b^e D_t^e + \varepsilon_{b,t}$$

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

$$\Delta^h \text{CDS spread}_{b,t} = \xi^h \hat{\Gamma}_{b,t} + \delta^h X_{b,t-1} + \alpha_b^h + \alpha_t^h + \varepsilon_{b,t}^h$$

$$\Delta^h \text{Capitalization}_{b,q} = \zeta^h \hat{\Gamma}_{b,q} + \delta^h X_{b,q-1} + \alpha_b^h + \alpha_q^h + \varepsilon_{b,q}^h$$

Borrowers: Entrepreneurs

- The representative entrepreneur seeks to maximize

$$E_0 \sum_{i=0}^{\infty} \beta_e^i \left[\log \left(c_{e,t+i} \right) \right]$$

- Subject to a sequence of budget constraints

$$c_{e,t} + R_t^l \frac{l_{e,t-1}}{\pi_t} + q_t (h_{e,t} - h_{e,t-1}) = r_t^h h_{e,t-1} + l_{e,t}$$

- and a property collateral constraint (Iacoviello 2005)

$$l_{e,t} \leq m_t E_t \left[\frac{q_{t+1}}{R_{t+1}^l} h_{e,t} \pi_{t+1} \right]$$

Aggregation and Net Output

- Real estate supply is fixed

$$\overline{H} = h_{h,t} + h_{e,t}$$

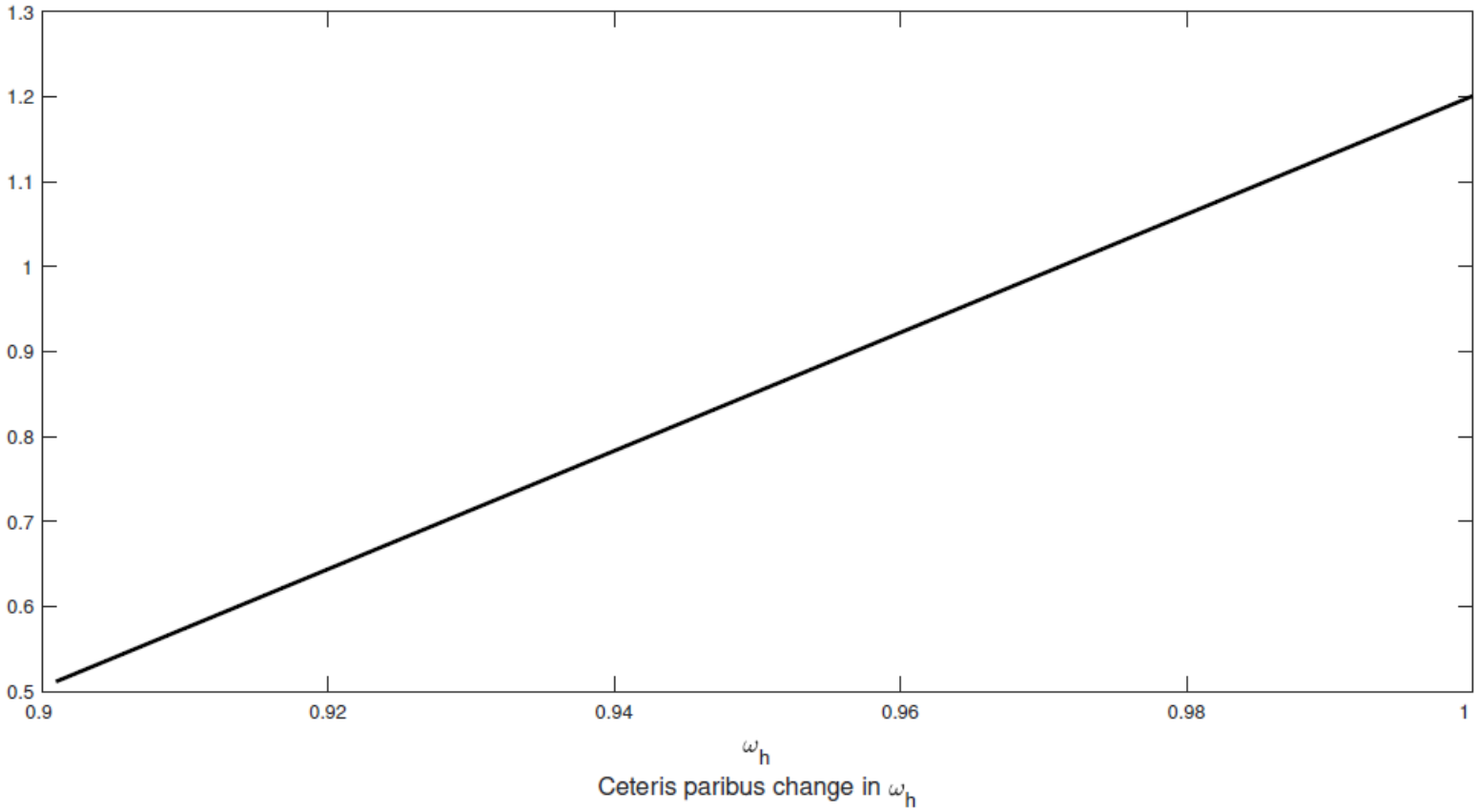
- Aggregate demand

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

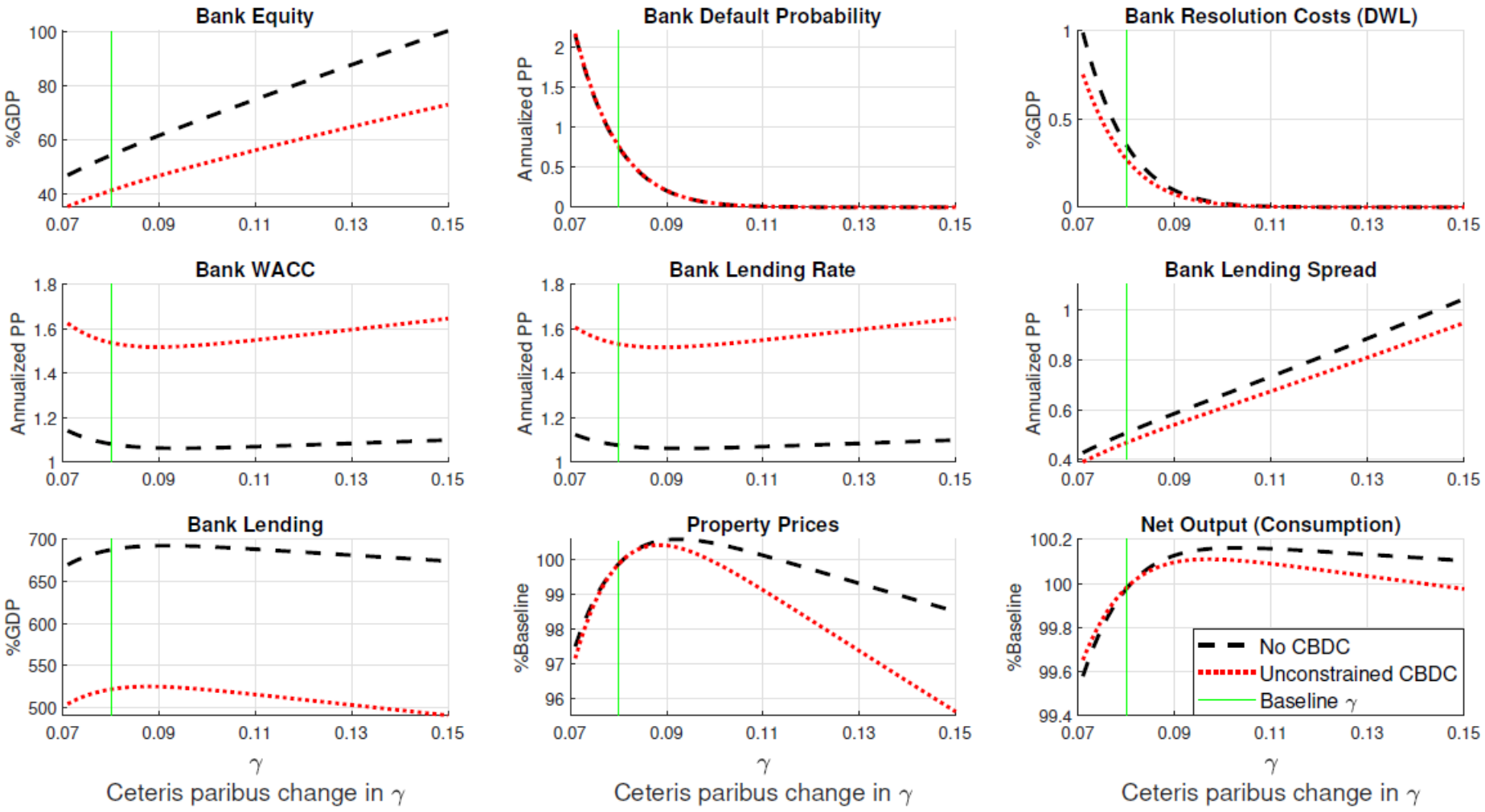
- Net output

$$\widetilde{Y}_t = Y_t - \mu_b R_t^l l_{b,t-1} \frac{G_t(\overline{\omega}_{b,t})}{\pi_t}$$

Background Material (Cont'd I)



Background Material (Cont'd II)



Scenarios

- **Baseline scenario**

$$(\text{i.e., } \phi = 0; \gamma = 0.08; \gamma_x = 0; \rho_\gamma = 0)$$

- **3 CBDC regimes**

  - No CBDC: $\phi = 0.00$
  - Unconstrained CBDC: $cbdc_{h,t}/\overline{Y} < \phi$
  - CBDC with holding limit: $\phi = 0.30$

- **2 capital regulation scenarios**:

  - Baseline capital regulation

$$(\text{i.e., } \gamma = 0.08; \gamma_x = 0; \rho_\gamma = 0)$$

  - Optimal capital regulation

$$\arg\max_{\Theta} V_0 = \omega_h V_0^h + (1 - \omega_h) V_0^e$$

Welfare Gains: Optimal Structural Capital Requirements

	CBDC Adoption $(CBDC_t x100/Y_t)$	Capital Requirement $(\gamma x100)$	Welfare Gains $(\lambda x100)$	Bank Riskiness $\left(\overline{F}(\overline{\omega})x400\right)$
CBDC Regime & Scenario				
A) No CBDC				
(i) γ (baseline)	0.00%	8.0%	0.000%	0.6656 *pp*
(ii) γ^* (optimal)	0.00%	9.5%	0.217%	0.0868 *pp*
B) Unconstrained CBDC				
(i) γ (baseline)	196.51%	8.0%	3.549%	0.6732 *pp*
(ii) γ^* (optimal)	204.80%	10.8%	3.764%	0.0114 *pp*
C) CBDC with holding limit				
(i) γ (baseline)	30.00%	8.0%	0.852%	0.6675 *pp*
(ii) γ^* (optimal)	30.00%	9.5%	1.056%	0.0872 *pp*

Welfare Gains: Optimal Cyclical Capital Requirements

	CBDC Adoption $(CBDC_t x100/Y_t)$	Capital Requirement $(\gamma x100)$	CCyB (γ_x^*)	Welfare Gains $(\lambda x100)$
Scenario				
A) No CBDC				
(i) γ (baseline)	0.00%	8.0%	0.0119	0.354%
(ii) γ^* (optimal)	0.00%	7.76%	0.0113	0.361%
B) Unconstrained CBDC				
(i) γ (baseline)	196.51%	8.0%	0.0103	3.621%
(ii) γ^* (optimal)	204.80%	10.80%	0.0000	3.764%
C) CBDC with holding limit				
(i) γ (baseline)	30.00%	8.0%	0.0118	1.191%
(ii) γ^* (optimal)	30.00%	7.71%	0.0111	1.200%

Optimal Capital Requirements: IRFs to a CBDC Supply Shock