Bank Leverage Regulation and Macroeconomic Dynamics

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The views expressed are those of the authors and not those of the Bank of Canada.

INTRODUCTION

- The recent financial crisis has led to important changes in global financial regulation that will become effective over the next few years
- New macroprudential policies will both strengthen regulatory constraints on bank balance sheets and make such regulation more responsive to cyclical developments
- The most prominent example is the countercyclical capital buffer introduced recently as part of Basel III
  - Impose higher ratios of capital to assets in good times, allow lower ratios in bad times

GOALS

- Assess the stabilization and welfare properties of countercyclical capital requirements

- Examine the interaction between countercyclical capital requirements and monetary policy

THIS PAPER

- Build DSGE model with banking where bank capital can mitigate asymmetric information between banks and their creditors
- Lending decisions by individual banks are assumed to affect the riskiness of the economy-wide banking sector, though banks do not internalize this impact
- Countercyclical capital requirements can reduce this riskiness
- Assess the merits of countercyclical capital requirements for the stabilization of financial and economic cycles and examine their interaction with monetary policy

FINDINGS

- Countercyclical capital requirements can stabilize economic and financial fluctuations as well as improve welfare
- These benefits depend on the nature of the shocks...
  - more sizeable when financial shocks affect the economy
  - more sizeable when fluctuations following standard macroeconomic shocks can lead to increases in the riskiness of banks
- ... AND on the conduct of monetary policy
  - more sizeable when monetary policy is set optimally in coordination with bank regulation

BRIEF LITERATURE REVIEW

- Financial frictions: Carlstrom & Fuerst (1997, 1998, 2001); BGG (1999), KM (1997), CMR (2010), Iacoviello (2005), Curdia & Woodford (2010)
  - no bank capital
- Bank capital channel: Holmstrom & Tirole (QJE, 1997), Chen (2001), Meh & Moran (2003), Meh & Moran (2010), Aikman & Paustian (2004), Gerali et al. (2010), Gertler & Karadi (2010), Gertler & Kiyotaki (2010), Brunnermeier and Sannikov (2011)
  - no regulation
- Influence of bank capital regulation: Van den Heuvel (2008), Covas and Shigeru (2010), Angeloni and Faia (2010), Dib (2010), Angelini et al. (2011), Agenor et al. (2011)

OUTLINE

1. Sketch of the model
   a. New Keynesian DSGE model based on Christiano et al. (2005) and Smets and Wouters (2007)
   b. Financial Intermediation and bank capital (HT, QJE 1997)
   c. Endogenous responses of bank monitoring intensity
   d. Endogenous banking sector riskiness
2. Impulse Response experiments: contrast responses under
   - *Time-invariant Regulation*
   - *Countercyclical Regulation*
3. Welfare Analysis
   - *Interaction between Countercyclical Capital Regulation and Monetary Policy*

MODEL

- **Final Good Sector**
  - Competitive firms assemble differentiated intermediate goods

$$Y_t = \left(\int_0^1 Y_{jt}^{\frac{\xi_p - 1}{\xi_p}} \, dj \right)^{\frac{\xi_p}{\xi_p - 1}}, \qquad \xi_p > 1$$

- **Intermediate Good Sector**
  - Monopolistically competitive firms produce differentiated intermediate goods

$$Y_{jt} = z_t k_{jt}^{\theta_k} h_{jt}^{\theta_h} {h_{jt}^e}^{\theta_e} {h_{jt}^b}^{\theta_b}, \qquad z_t \sim AR(1)$$

  - Face sticky prices à la Calvo (full indexing in s.s.)
  - No financing frictions in this sector

MODEL

- **Investment Good Sector**
  - Entrepreneurs need external funds from banks to make investments
  - Experience idiosyncratic productivity shock: $\widetilde{R} i_t$ $\widetilde{R} \in \{0, R\}$
  - Can divert resources and obtain a private return proportional to the size of the investment: $b_t i_t$
  - Diversion lowers the probability of success of the project

- **Banking Sector**
  - Bankers are endowed with a monitoring technology that can limit entrepreneurs' ability to divert resources
  - Cost of monitoring for investment size i_t: $\mu_t i_t$
  - Monitoring activity is not publicly observable $\Rightarrow$ so bankers may not monitor as promised

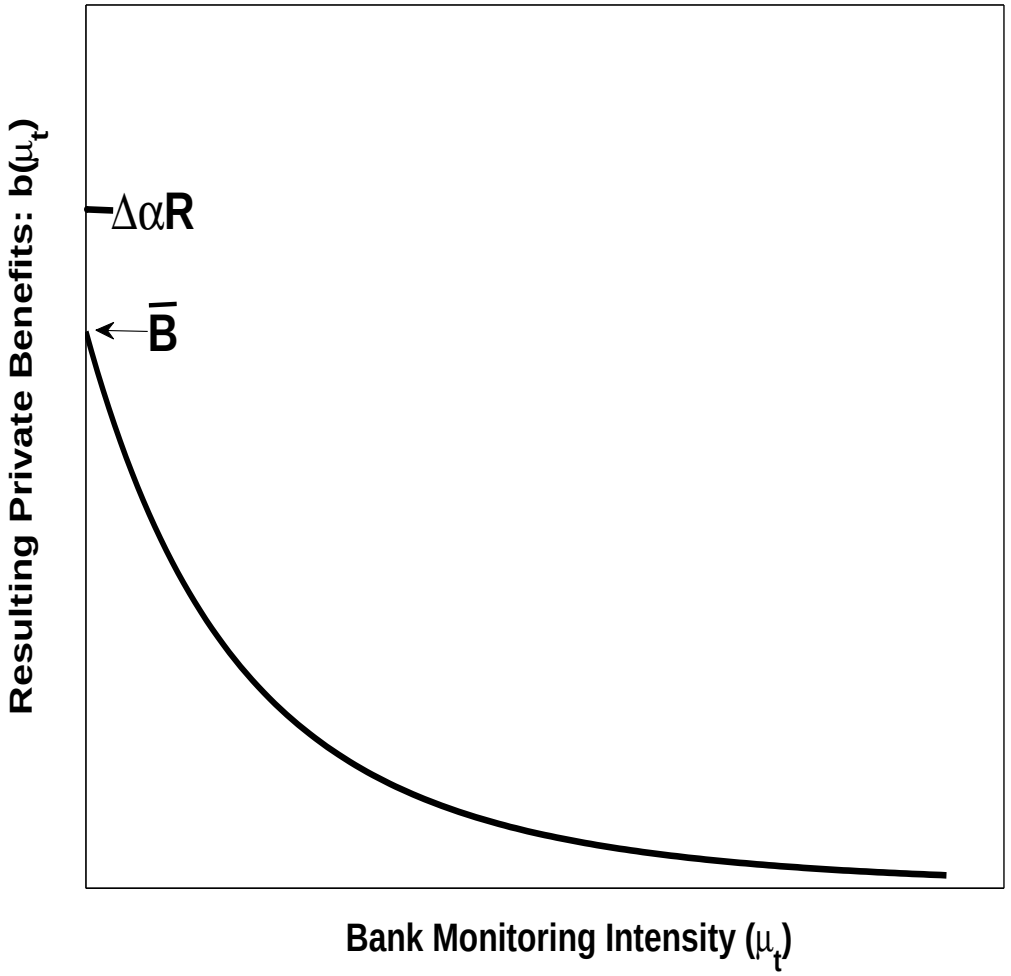
INVESTMENT PROJECTS

- Two classes of projects available to the entrepreneur:

Project Class:	No Private Benefits	Private Benefits
Private benefits accrued:	0	$b(\mu_t)\ i_t$
Prob. of success:	α_t	$\alpha_t - \Delta\alpha$

- Project with no private benefits is socially desirable
- The projects financed by an individual bank are perfectly correlated
- If $\mu_t = 0$ then $b(\mu_t) = \overline{B}$
- Bank monitoring at intensity μ_t reduces entrepreneur moral hazard (their ability to divert resources) to $b(\mu_t)$

BANK MONITORING and MORAL HAZARD



$$b(\mu_t) = \overline{B}\left(1+\chi\mu_t\right)^{-\varepsilon^b}, \varepsilon^b > 1, \chi > 0$$

HOUSEHOLD AND CENTRAL BANK

- **Household Sector**
  - Utility function:
    $u(\cdot) = \log(c_t^h - \gamma c_{t-1}^h) - \psi \frac{l_{it}^{h\,1+\eta}}{1+\eta} + \zeta \log(M_t^c / P_t)$
  - Monopolistic supplier of specialized labor input (sticky wages)
  - Variable capital utilization decision
  - Ultimate suppliers of funds to entrepreneurs via banks

- **Central Bank**
  - Sets monetary policy according to a Taylor Rule

$$r_t^d = \rho_r r_{t-1}^d + (1-\rho_r)\left[\rho_\pi(\pi_t - \overline{\pi}) + \rho_y \hat{y}_t\right] + \epsilon_t^{mp}$$

FINANCIAL CONTRACT

- Contract will have the following structure:
  - the entrepreneur invests all his net worth (n_t)
  - if success, R is distributed among the entrepreneur, the banker and the households: $R = R_t^e + R_t^b + R_t^h$
  - if failure, no party is paid anything
- Objective of the financial contract:
  - Choose project size, monitoring intensity, and payment shares to maximize expected payoff to entrepreneurs subject to six constraints

FINANCIAL CONTRACT II: CONSTRAINTS

- Incentive compatibility constraints

$$\text{(bankers):}\ \ q_t \alpha_t R_t^b i_t - \mu_t i_t \geq q_t(\alpha_t - \Delta\alpha) R_t^b i_t$$

$$\text{(entrepreneurs):}\ \ q_t \alpha_t R_t^e i_t \geq q_t(\alpha_t - \Delta\alpha) R_t^e i_t + q_t b(\mu_t)\, i_t$$

- Participation constraints

$$\text{(bankers):}\ \ q_t \alpha_t R_t^b i_t \geq (1 + r_t^a) a_t$$

$$\text{(investors):}\ \ q_t \alpha_t R_t^h i_t \geq (1 + r_t^d) d_t$$

- Flow of funds constraint: $a_t + d_t - \mu_t i_t \geq i_t - n_t$

- Regulatory constraint on leverage: $i_t - n_t \leq \gamma_t^g\, a_t$

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FINANCIAL CONTRACT: SOLUTION

- Payments:

$$R_t^e = \frac{b(\mu_t)}{\Delta\alpha}; \quad R_t^b = \frac{\mu_t}{q_t\Delta\alpha}; \quad R_t^h = R - \frac{b(\mu_t)}{\Delta\alpha} - \frac{\mu_t}{q_t\Delta\alpha}$$

- Amounts invested:

$$d_t/i_t = \frac{q_t\alpha_t}{1+r_t^d}\left(R - \frac{b(\mu_t)}{\Delta\alpha} - \frac{\mu_t}{q_t\Delta\alpha}\right).$$

$$a_t/i_t = \frac{\alpha_t\mu_t}{(1+r_t^a)\Delta\alpha},$$

- NOTE:
  - Bank capital (a_t) affects the amount of debt (deposits) that banks can attract from investors

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- NOTE:
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REGULATION

- Investment size:

$$i_t = \gamma_t^g a_t + n_t$$

- Monitoring intensity solves this constraint:

$$\gamma_t^g = 1 + (1 + r_t^a)\Big[\left(\frac{q_t}{1 + r_t^d}\right)\left(\frac{\Delta\alpha R - b(\mu_t) - \mu_t/q_t}{\mu_t}\right) - \frac{\Delta\alpha}{\alpha_t}\Big]$$

REMARKS

- The distribution of bank capital across banks does not matter in equilibrium
  - Tracking aggregate bank capital is sufficient to assess economy- wide lending capacity
- In equilibrium, the probability of default in the banking sector is given by $1 - \alpha_t$
  - This measures the riskiness of the whole banking sector

Endogenous Riskiness of the Banking Sector (1)

- Evidence suggests that risks to banking sector are rising in the upswing, a time when traditional measures of individual bank risk are low (BCBS 2010, Crockett, 2000)
- Modelling endogenous banking sector riskiness, especially in a macroeconomic environment, is a complex task and is the subject of ongoing research
- We simply assume that the probability of banking sector stress depends on *endogenous aggregate* variables
  - Specifically, probability of default in the banking sector increases with the bank credit to GDP ratio (credit gap)

Endogenous Riskiness of the Banking Sector (2)

- Functional form:

$$1 - \alpha_t \quad = \quad (1 - \alpha_{ss}) + \left(\widehat{BLY}_t\right)^{\varsigma}$$

$\widehat{BLY}_t$: Deviation of aggregate bank lending/GDP from trend

ς: Sensitivity parameter

- Each individual bank does not internalize its impact on the banking sector riskiness when it chooses its leverage (externality)

- Countercyclical capital regulation could limit the riskiness of the banking sector

Endogenous Riskiness of the Banking Sector (3)

- Examine how accounting for such a link between the riskiness of the banking sector and aggregate endogenous variables would affect:
  - optimal stabilization policies
  - interaction between macroprudential and monetary policies
- If one believes that a relationship of this type is important, analysis based on this simple approach may be more useful than one that ignores the endogenous banking sector risk

REGULATORY POLICY

- Constraint on bank leverage may be non-constant

$$\gamma_t^g = \gamma^g + \omega \widehat{BLY}_t$$

$\omega = 0$: time-invariant capital regulation
$\omega < 0$: countercyclical capital regulation

LAW OF MOTION FOR BANK CAPITAL AND ENTREPRENEURIAL NET WORTH

- Bank Capital (Bank equity or Bank net worth)
  - is built from retained earnings

$$A_t = \kappa_t \left[r_t + q_t(1-\delta)\right] \tau^b \alpha_t \frac{1}{q_{t-1}\Delta\alpha_t} \mu_{t-1} I_{t-1} + w_t^b \eta^b$$

  - κ_t: Shock to Bank capital. A low value creates scarcity

- A similar process for Entrepreneurial Net Worth:

$$N_t = \left[r_t + q_t(1-\delta)\right] \tau^e \alpha_t R_t^e I_{t-1} + w_t^e \eta^e$$

PARAMETERIZATION

- conventional for parameters common to other NK frameworks
- mix of previous calibrations and s.s. targets for parameters related to banking and entrepreneurial sector
- steady-state leverage
  - $\gamma^g = 10$ (ie. 10% capital-asset ratio)
- link between monitoring and private benefits

$$\varepsilon^b = 10, \chi = 15$$

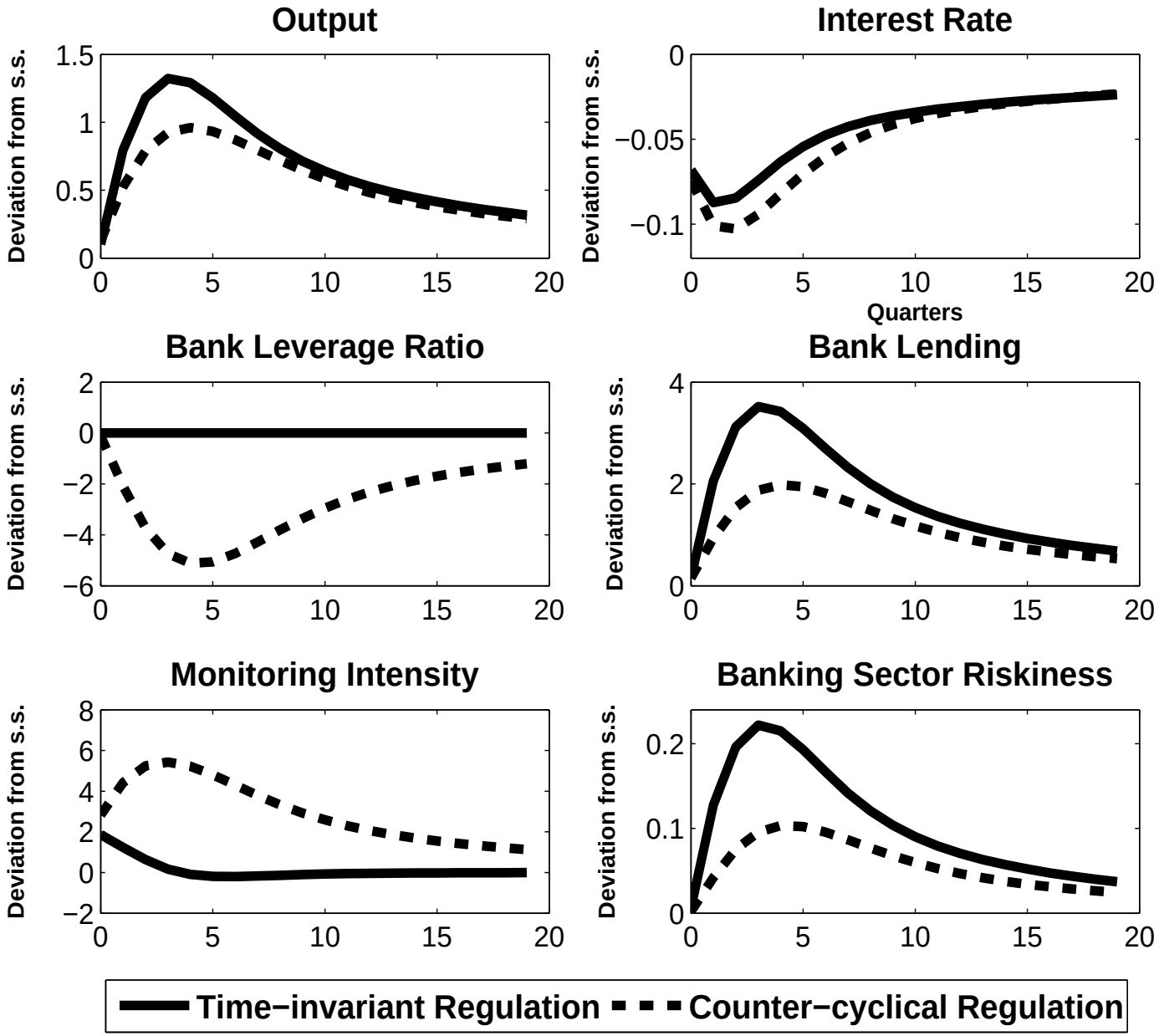
- Probability of banking default sensitivity parameter
  - $\varsigma = 0.1$ (conservative number)

RESULTS

1. Business Cycle Implications of Regulation
   - Standard Macroeconomic Shocks (Productivity)
   - Financial (Bank Capital) Shocks
2. Welfare Analysis
   - Interaction between monetary policy and countercyclical capital requirements

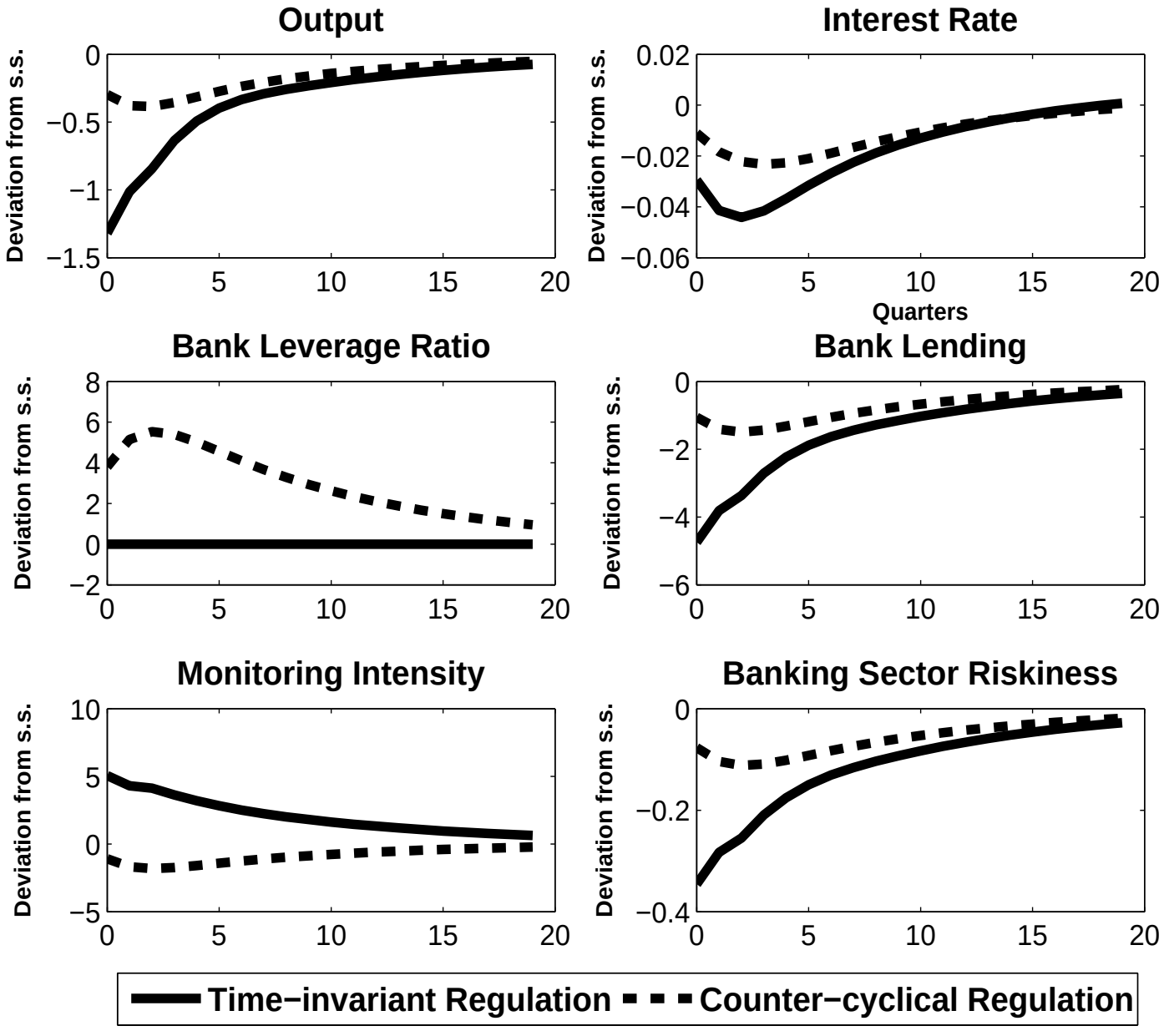
Impulse Responses Following a Favorable Technology Shock

Technology: Time-invariant vs. Countercyclical Regulation



Impulse Responses Following a Negative Shock to Bank Capital

Bank Capital: Time-invariant versus Countercyclical



Welfare Analysis

Technology shocks: Countercyclical Capital Buffers Can Be Good, Can Be Better If Coordinated with MP, But Play Supporting Role

Case	Policy Mix		Policy Coef.		Welfare Gain
	Monetary Policy	Regulation Policy	ρ_π	ω	Relative to case (i)
(i)	Calibrated	Time-Invariant	1.5	0.0	—
(ii)	Calibrated	Optimized	1.5	-3.0	0.060%
(iii)	Optimized	Optimized	2.9	-10.0	0.300%
(iv)	Calibrated	Optimized in (iii)	1.5	-10.0	0.053%

Bank Capital Shocks: Countercyclical Capital Buffers Can Be Good, Play a Key Role

Case	Policy Mix		Policy Coef.		Welfare Gain
	Monetary Policy	Regulation Policy	ρ_π	ω	Relative to case (i)
(i)	Calibrated	Time-Invariant	1.5	0.00	—
(ii)	Calibrated	Optimized	1.5	-10.00	0.062%
(iii)	Optimized	Optimized	3.0	-8.25	0.064%
(iv)	Calibrated	Optimized in (iii)	1.5	-8.25	0.062%

Both Types of Shocks: Countercyclical Capital Buffers Continue to Be Beneficial

Case	Policy Mix		Policy Coef.		Welfare Gain
	Monetary Policy	Regulation Policy	ρ_π	ω	Relative to case (i)
(i)	Calibrated	Time-Invariant	1.5	0.0	—
(ii)	Calibrated	Optimized	1.5	-4.5	0.117%
(iii)	Optimized	Optimized	2.9	-10.0	0.363%
(iv)	Calibrated	Optimized in (iii)	1.5	-10.0	0.115%

Importance of Endogenous Riskiness of Banking

Technology Shocks and Weak Endogeneity of Bank Risk ($\varsigma = 0.01$): Benefits from Countercyclical Capital Buffers Fall

Case	Policy Mix		Policy Coef.		Welfare Gain
	Monetary Policy	Regulation Policy	ρ_π	ω	Relative to case (i)
(i)	Calibrated	Time-Invariant	1.5	0.00	—
(ii)	Calibrated	Optimized	1.5	-0.75	0.005%
(iii)	Optimized	Optimized	2.7	-1.50	0.192%
(iv)	Calibrated	Optimized in (iii)	1.5	-1.50	-0.001%

Bank Capital Shocks and Weak Endogeneity of Bank Risk ($\varsigma = 0.01$): Benefits from Countercyclical Capital Buffers Remain

Case	Policy Mix		Policy Coef.		Welfare Gain
	Monetary Policy	Regulation Policy	ρ_π	ω	Relative to case (i)
(i)	Calibrated	Time-Invariant	1.5	0.00	—
(ii)	Calibrated	Optimized	1.5	-7.50	0.059%
(iii)	Optimized	Optimized	3.0	-5.25	0.063%
(iv)	Calibrated	Optimized in (iii)	1.5	-5.25	0.058%

CONCLUSION

- Build a DSGE model with a bank capital channel to assess the merits of countercyclical capital requirements and their interaction with monetary policy
- Our results suggest that countercyclical capital buffers can stabilize economic and financial fluctuations as well as improve welfare
- These benefits depend on the nature of the shocks...
  - more sizeable when financial shocks affect the economy
  - more sizeable when fluctuations following standard macroeconomic shocks can lead to increases in the riskiness of banks
- ... and on the conduct of monetary policy
  - more sizeable when monetary policy is set optimally in coordination with bank regulation

FUTURE RESEARCH

- Monetary policy reacting explicitly to credit and other financial variables
- Improve on the endogeneization of the risk-taking channel (fire sale, search for yield)

PARAMETERIZATION (con't)

- $\overline{B}$, maximum private benefits, set below the gain in return from choosing good project
- $\chi = 15$ chosen to match equilibrium monitoring costs to average bank operating costs (3 to 5 per cent of assets)
- ε^b linked to shirking and the premium paid by entrepreneurs.
  - $\varepsilon^b = 10$ results in a premium of 300 basis points over the deposit rate (Gerali et al (2010), Angeloni and Faia (2010))
- banking sector prob. of default $= 1$ per cent in steady state
  - $\varsigma = 0.1$, conservative value for sensitivity of default probability
  - challenging since by design $1 - \alpha_t$ rises when measured default probabilities (e.g. from CDS, TED spreads) would be low