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The role of bank capital in the propagation of shocks

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* This presentation reflects the views of the authors and not necessarily those of the BIS or of central banks participating in the meeting.

The Role of Bank Capital in the Propagation of Shocks

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INTRODUCTION

- In the last decade, there has been progress in building quantitative DSGE models with financial frictions that tend to fit aggregate data
- In practice, however, these models abstract from the state of the balance sheets of banks and interaction with real economy
  - Implication: Supply of funds of banks unaffected by their balance sheet
  - BGG (1999), CMR (2008), Iacoviello (2005), Jermann et Quadrini (2008)
- The current crisis has reminded us that the state of the balance sheet of banks plays an important role in economic fluctuations

GOAL OF THIS PAPER

1. We build a quantitative macroeconomic model in which bank capital matters because it mitigates an agency problem between a bank and its creditors.

2. We use the model to study how the presence of bank capital affects the transmission of shocks.

FINDINGS

1. The bank capital channel greatly amplifies and propagates the effects of technology shocks, but plays a lesser role for monetary policy shocks.
2. When the bank capital channel is active, an economy with more bank capital is better able to absorb technology shocks than an economy with less bank capital.
3. A sudden scarcity of banking capital depresses bank lending and economic activity.

LITERATURE

- Carlstrom & Fuerst (1997, 1998, 2001); BGG. (1999), CMR (2008), Cooley et. (2001), Curdia & Woodford (2008)
  - No bank capital
- Holmstrom & Tirole (QJE, 1997), Chen (2001), Meh & Moran (2003), Sunirand (2003), Aikman & Paustian (2004)
  - Market-determined capital adequacy ratio and/or not quantitative
- Van den Heuvel (2001), Gerali et al. (2009), Dib (2009)
  - Bank Capital needed for exogenous regulatory requirements

OUTLINE FOR THE REMAINING

1. Sketch of the model
   a. New Keynesian DSGE model based on CEE
   b. Financial Intermediation and bank capital (HT, QJE 1997)
2. Findings
3. Conclusion

MODEL

- **Final Good Sector**
  - Competitive firms that assemble differentiate 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**
  - Monopolistic 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 price à la Calvo
  - Full indexation to previous inflation rate if no price changes

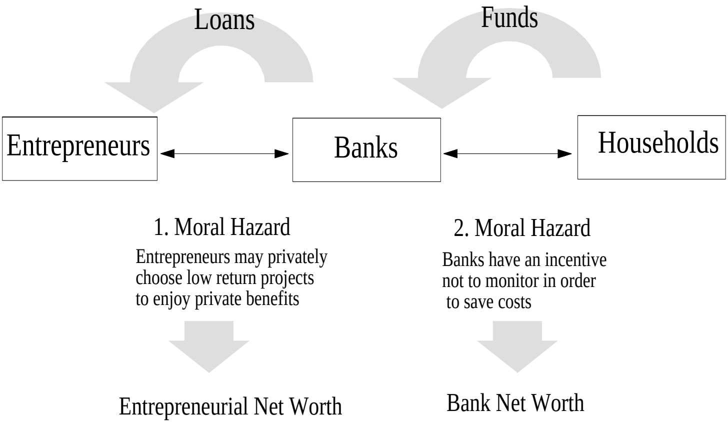
MODEL

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

- **Banking Sector**
  - Bankers are endowed with a monitoring technology
  - Cost of monitoring for investment size i_t: μi_t
  - Monitoring activity is not publicly observable $\Rightarrow$ so bankers may not monitor adequately

LENDING RELATIONSHIP

Two Sources of Moral Hazard



INVESTMENT PROJECTS

- Three types of projects available to the entrepreneur:

Project	Good	Low Priv. Ben.	High Priv. Ben.
Private benefits	0	bi_t	Bi_t
Prob. of success	α^g	α^b	α^b

- Good project is socially desirable

- Bank monitoring can eliminate only project with highest private returns

- The projects financed by an individual bank are perfectly correlated

HOUSEHOLD AND CENTRAL BANK

- **Household Sector**
  - Utility function: $u(\cdot) = \log(c_t^h - \gamma c_{t-1}^h) + \psi \log(1 - l_{it}^h) + \zeta \log(M_t^c / P_t)$
  - Habit formation in consumption
  - Monopolistic supplier of specialized labor input
  - Sticky wage à la Calvo
  - Variable capital utilization
  - Ultimate suppliers of funds to entrepreneurs via banks

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

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

OPTIMAL FINANCIAL CONTRACT

- One optimal contract will have the following structure:
  - the entrepreneur invests all his net worth
  - 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, neither party is paid anything
- Objective of the financial contract:
  - Choose project size and payment shares to maximize expected payoff to entrepreneurs subject to five constraints

OPTIMAL FINANCIAL CONTRACT, continued

- Incentive constraint of bankers: $q_t \alpha^g R_t^b i_t - \mu i_t \geq q_t \alpha^b R_t^b i_t$
- Incentive constraint of entrepreneurs: $q_t \alpha^g R_t^e i_t \geq q_t \alpha^b R_t^e i_t + q_t b i_t$
- Participation constraint of bankers: $q_t \alpha^g R_t^b i_t \geq (1 + r_t^a) a_t$
- Participation constraint of households: $q_t \alpha^g R_t^h i_t \geq (1 + r_t^d) d_t$
- Resource constraint: $a_t + d_t - \mu i_t \geq i_t - n_t$

OPTIMAL FINANCIAL CONTRACT, continued

- Incentive constraint of bankers: $q_t \alpha^g R_t^b i_t - \mu i_t \geq q_t \alpha^b R_t^b i_t$
- Incentive constraint of entrepreneurs: $q_t \alpha^g R_t^e i_t \geq q_t \alpha^b R_t^e i_t + q_t b i_t$
- Participation constraint of bankers: $q_t \alpha^g R_t^b i_t \geq (1 + r_t^a) a_t$
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OPTIMAL FINANCIAL CONTRACT, continued

- Incentive constraint of bankers: $q_t \alpha^g R_t^b i_t - \mu i_t \geq q_t \alpha^b R_t^b i_t$
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- Participation constraint of bankers: $q_t \alpha^g R_t^b i_t \geq (1 + r_t^a) a_t$
- Participation constraint of households: $q_t \alpha^g R_t^h i_t \geq (1 + r_t^d) d_t$
- Resource constraint: $a_t + d_t - \mu i_t \geq i_t - n_t$

UPSHOT OF THE OPTIMAL CONTRACT

- Payments:

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

where $\quad \Delta\alpha \equiv \alpha^g - \alpha^b > 0$

- Investment Size:

$$i_t = \underbrace{(1/G_t)}_{\text{'entrepreneurial leverage'}} \times \underbrace{a_t + n_t}_{\text{internal funds}}$$

where

$$G_t \equiv 1 + \mu - \frac{q_t \alpha^g}{1 + r_t^d} \left(R - \frac{b}{\Delta\alpha} - \frac{\mu}{\Delta\alpha q_t} \right)$$

NOTE: $\mu, \mathbf{b} \uparrow \Rightarrow \mathbf{i_t} \downarrow$, $\quad \mathbf{r_t^d} \uparrow \Rightarrow \mathbf{i_t} \downarrow$, $\quad \mathbf{q_t} \uparrow \Rightarrow \mathbf{i_t} \uparrow$

MARKET-DETERMINED CAPITAL ADEQUACY RATIO

- The capital adequacy ratio is market determined:

$$CAR_t = \frac{\mu}{\mu + q_t \Delta\alpha \left(\frac{1+r_t^a}{1+r_t^d}\right)\left(R - \frac{b}{\Delta\alpha} - \frac{\mu}{\Delta\alpha q_t}\right)}$$

- When $\mu = 0 \Rightarrow CAR_t = 0$ (bank capital Not needed)
  - $\mu \uparrow \Rightarrow CAR_t \uparrow$
  - $q_t \downarrow$ (recession) $\Rightarrow CAR_t \uparrow$
  - $r_t^a \uparrow$ (scarcity of bank capital) $\Rightarrow CAR_t \downarrow$

Law of motion of bank capital & entrepreneurial net worth

- Bank Capital (Bank equity or Bank net worth)
  - Build bank capital mainly from retained earnings

$$A_{t+1} = [r_{t+1} + q_{t+1}(1-\delta)]\,\tau^b \alpha^g R_t^b \left(\frac{A_t + N_t}{G_t}\right) + w_{t+1}^b \eta^b$$

- Entrepreneurial Net Worth

$$N_{t+1} = [r_{t+1} + q_{t+1}(1-\delta)]\,\tau^e \alpha^g R_t^e \left(\frac{A_t + N_t}{G_t}\right) + w_{t+1}^e \eta^e$$

CALIBRATION

Table 1: Baseline Parameter Calibration

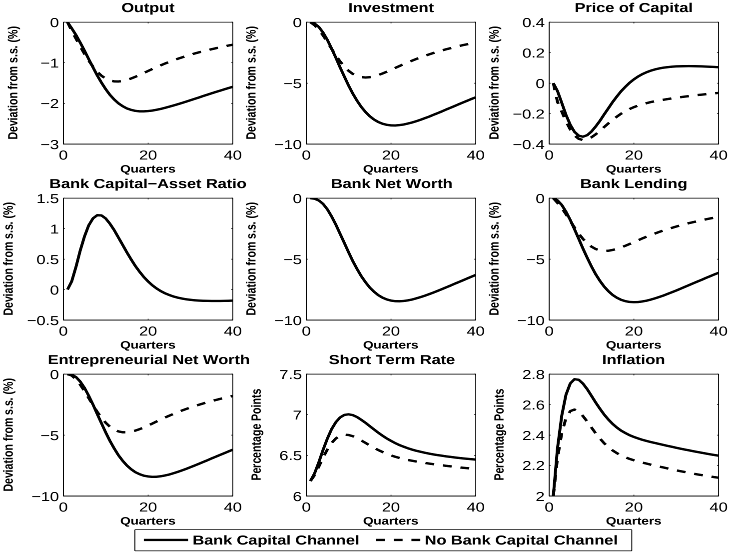
Household Preferences and Wage Setting						
γ	ζ	ψ	β	ξ_w	ϕ_w	
0.65	0.027	4.0	0.99	21	0.64	
Capital Good Production and Financing						
μ	α^g	α^b	R	b	τ_e	τ_b
0.025	0.99	0.75	1.21	0.16	0.78	0.72
Resulting Steady-State Characteristics						
CAR	I/N	BOC	ROE	I/Y	K/Y	
14%	2.0	5%	15%	0.198	11.8	

PREVIEW OF FINDINGS

1. Technology shock
2. Technology shock with more bank capital
3. Bank capital shock

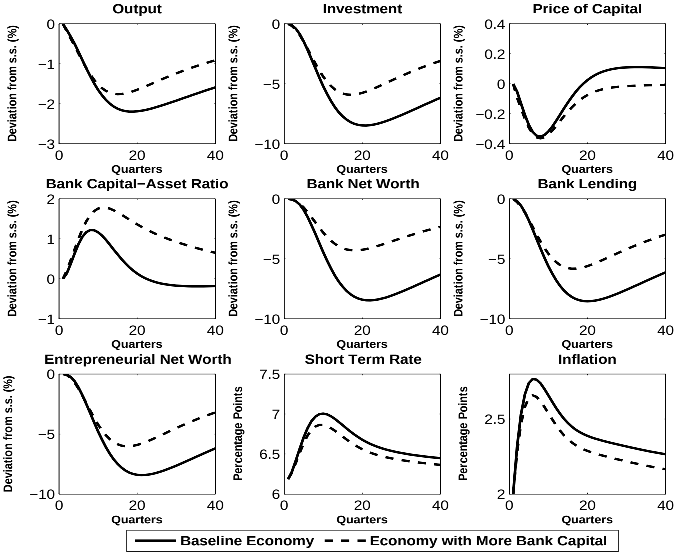
1. Response to Negative Technology Shock

One Standard Deviation Adverse Technology Shock



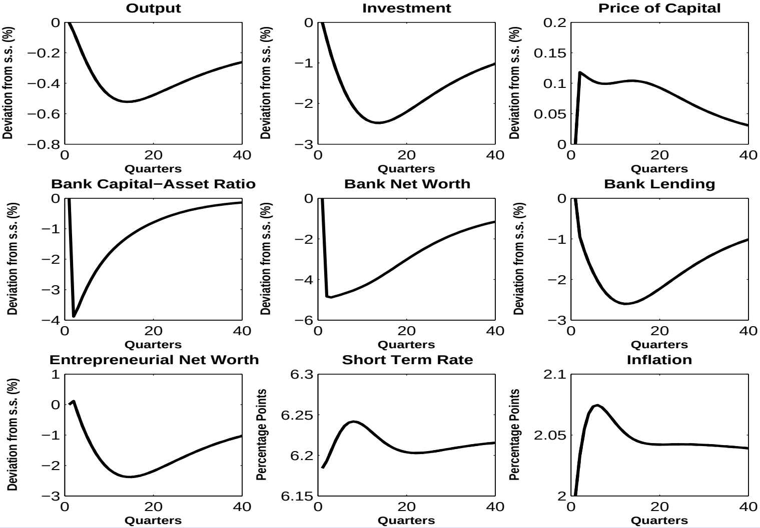
2. Response to Technology Shock with More Bank Capital

Negative Technology Shock: Eco. with More Bank Capital



3. Response to Bank Capital Shock

Negative Shock to Bank Capital



CONCLUSION

- We presented a DSGE model in which bank capital mitigates an agency problem between banks and their creditors
- The cyclical features of the bank capital-asset ratio generated by the model are broadly consistent with those observed in data
- The bank capital channel amplifies and propagates the effects of technology shocks, but plays a lesser role for monetary policy shocks