The Role of Bank Capital in the Propagation of Shocks

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

INTRODUCTION

- Huge progress in building and estimating/calibrating DSGE models with financial frictions that tend to fit quarterly aggregate data well
- In practice, however, these models abstract from the state of the balance sheets of banks and interaction with real economy
  - Feature: 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 is endogenous and matters

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

FINDINGS

- Accounting explicitly for the balance sheet position of banks in a general equilibrium model is important for aggregate fluctuations.
- Economies in which banks experience a fall in bank capital during periods of negative technological shocks face sharper and persistent declines in bank lending and economic activity
- A sudden scarcity of banking capital (equity) depresses economic activity and affects the conduct of monetary policy.

LITERATURE

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

OUTLINE

- Sketch of the model
  - New Keynesian DSGE models based on CEE and SW
  - Financial Intermediation and bank capital (HT)
- Findings
- Conclusion and Future Work

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
  - Partial indexation to previous inflation rate if no price changes

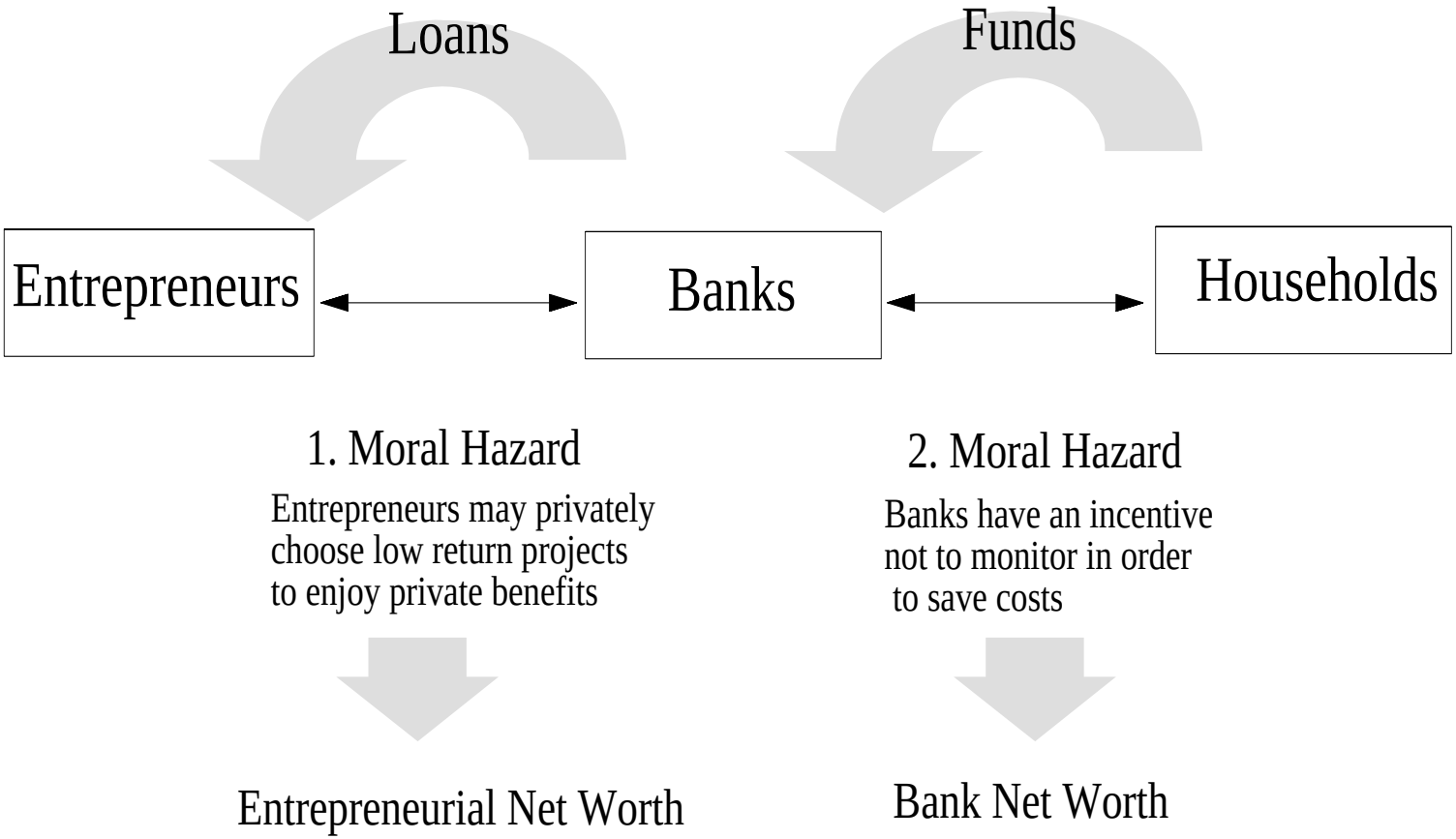
MODEL

- **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 public 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 with parameter
  - Variable capital utilization
  - Ultimate suppliers of funds to entrepreneurs via banks

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

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

Financial Contract

- 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 contract:
  Choose project size and payment shares to maximize expected payoff to entrepreneurs subject to five constraints

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: $a_t + d_t - \mu i_t \geq i_t - n_t$

Upshot of the 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 $\Delta\alpha \equiv \alpha^g - \alpha^b > 0$

- Investment Size:

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

where

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

Law of motion of bank capital & entrepreneurial net worth

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

$$A_{t+1} = (1+\widehat{r}_{t+1})\,\tau^b q_t \alpha^g R_t^b \left(\frac{A_t + N_t}{G_t}\right) + w_{t+1}^b \eta^b$$

- Entrepreneurial Net Worth

$$N_{t+1} = (1+\widehat{r}_{t+1})\,\tau^e q_t \alpha^g R_t^e \left(\frac{A_t + N_t}{G_t}\right) + w_{t+1}^e \eta^e$$

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	0.6

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

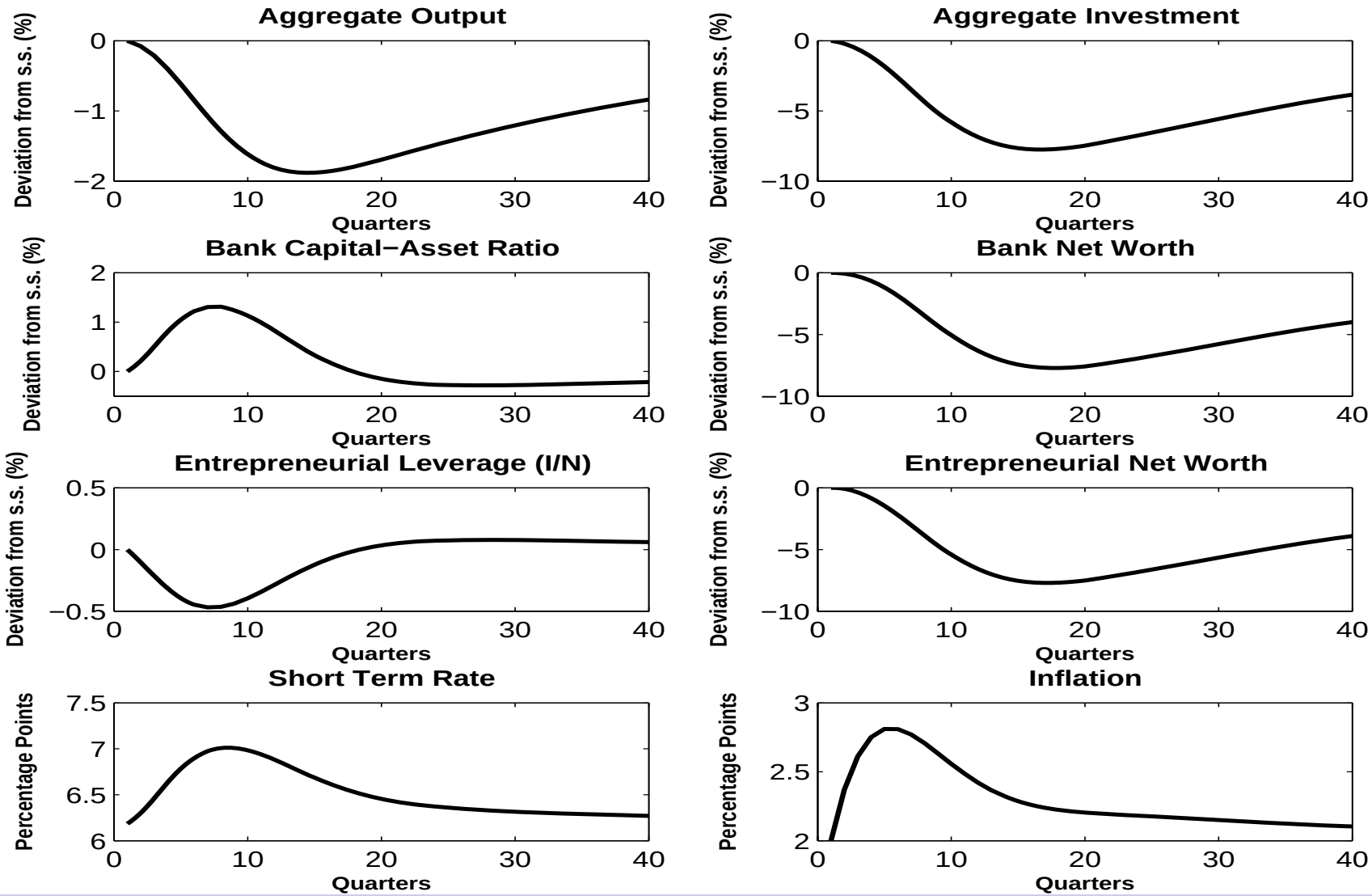
Resulting Steady-State Characteristics

CAR	I/N	BOC	ROE	I/Y	K/Y
14%	2.0	5%	15%	0.198	11.8

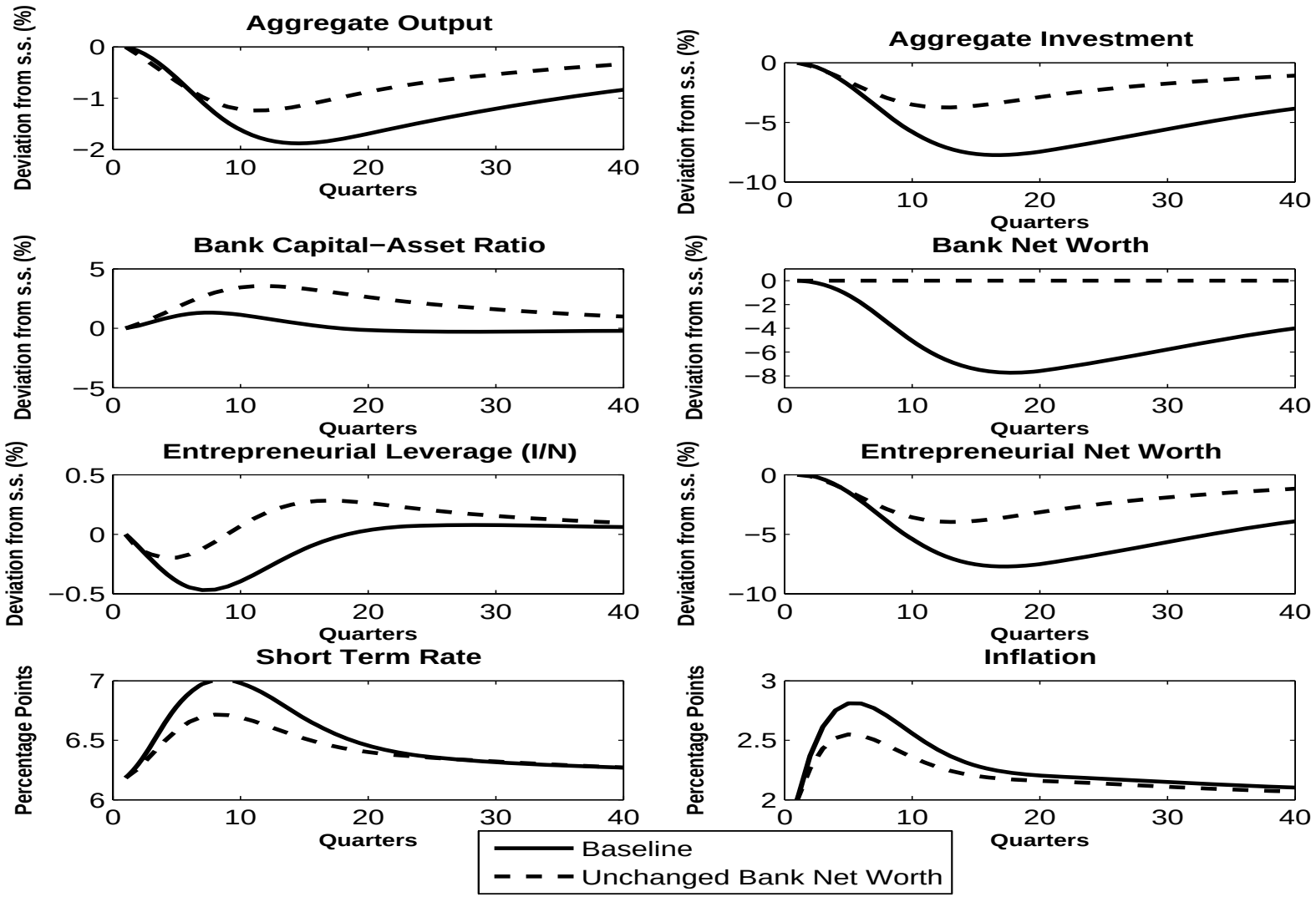
Preview of Results

- Shock to technology (intermediate good production)
- Model Simulation

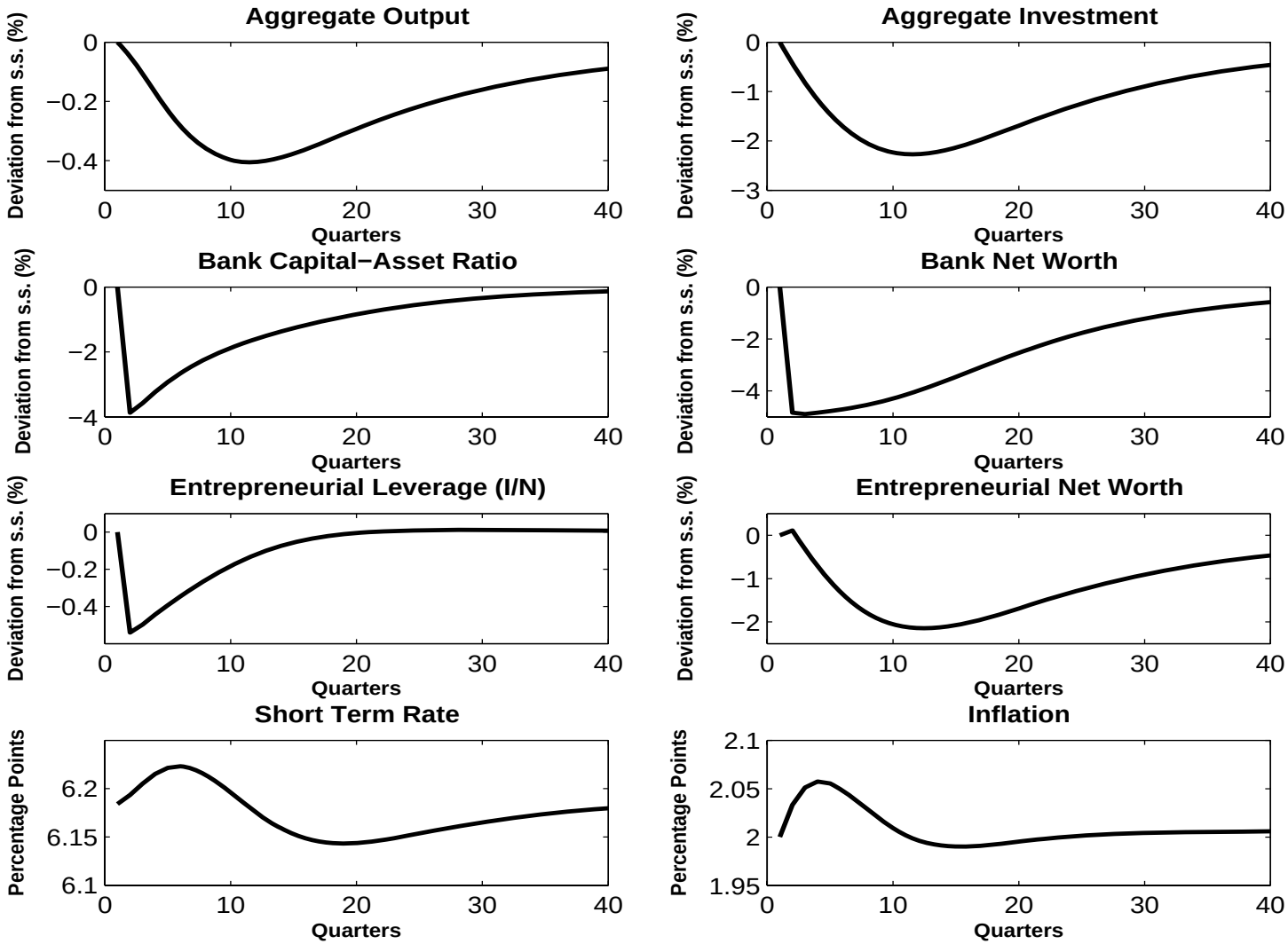
One Standard Deviation Adverse Technology Shock



Banking Net Worth in the Transmission of a Negative Technology Shock



Negative Shock to Bank Capital



Cyclical Features: Model and Data

Variable	$\frac{\sigma(X)}{\sigma(GDP)}$	*Cross-Correlation of Net Worth to Asset with:* X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}
Panel A: Model						
Net Worth to Asset Ratio	1.49	0.61	0.85	1.00	0.85	0.61
Investment	3.63	0.31	0.06	−0.22	−0.44	−0.59
GDP	1.00	0.11	−0.17	**−0.46**	−0.65	−0.73
Bank Loans	3.75	0.20	−0.07	−0.36	−0.53	−0.64
Panel B: Data						
Net Worth to Asset Ratio	0.34	0.79	0.90	1.00	0.90	0.79
Investment	4.26	−0.45	−0.42	−0.36	−0.25	−0.17
GDP	1.00	−0.36	−0.31	−0.23	−0.12	−0.07
Bank Loans (C & I)	4.52	−0.52	−0.62	−0.70	−0.69	−0.67

Conclusion

- We present a quantitative model of aggregate fluctuations in which the net worth of banks mitigates an agency problem between banks and depositors
- The cyclical features of the net worth to asset ratio of banks generated by the model are consistent with those observed in data
- The presence of the dynamics of bank capital plays an important role in the transmission of shocks

POLICY IMPLICATIONS

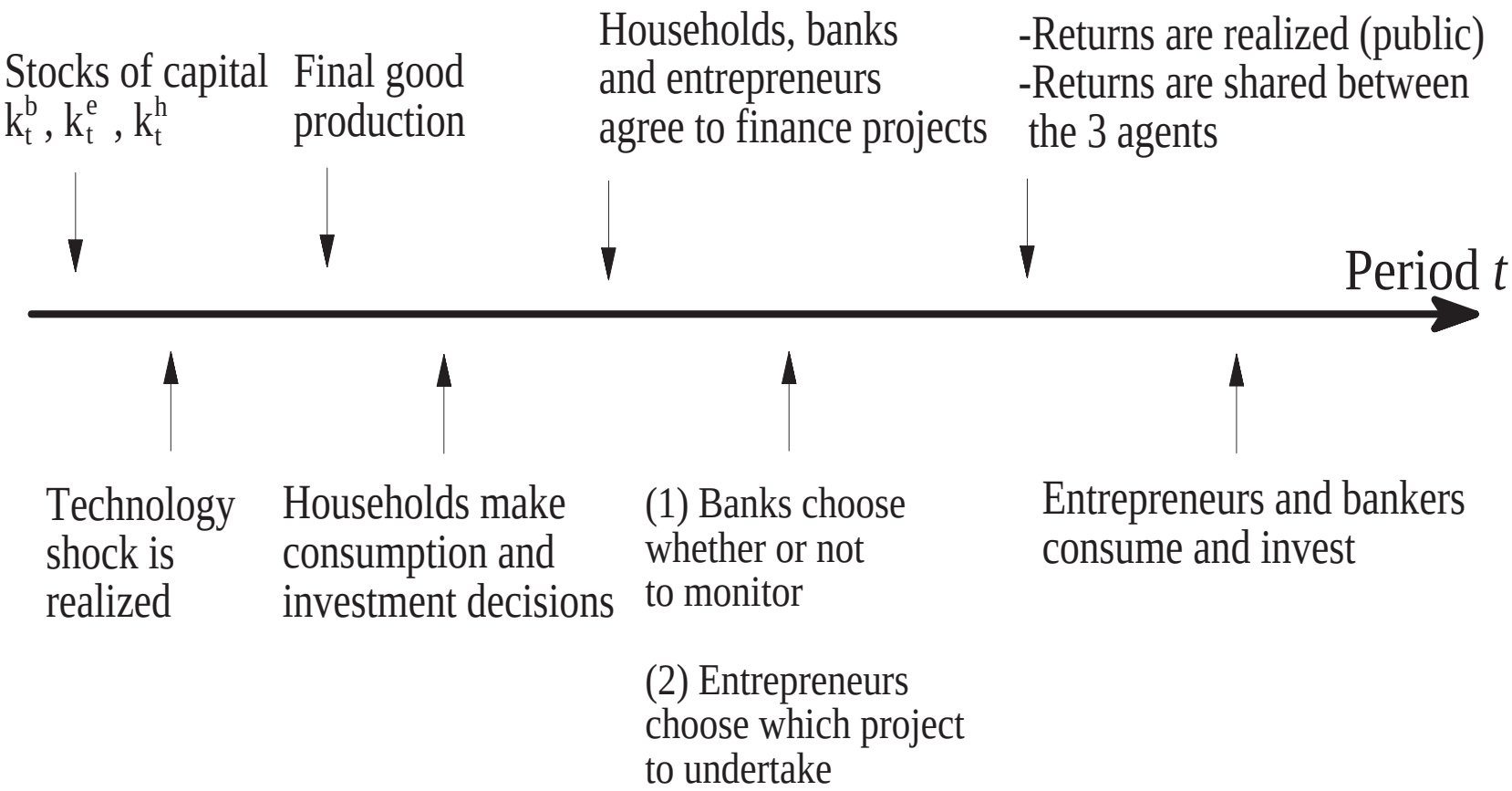
- Our Model: Net Worth to Asset Ratio is market determined
- Can be brought to bear on policy discussions: how should bank net worth to asset ratio react to shocks?

Future Work

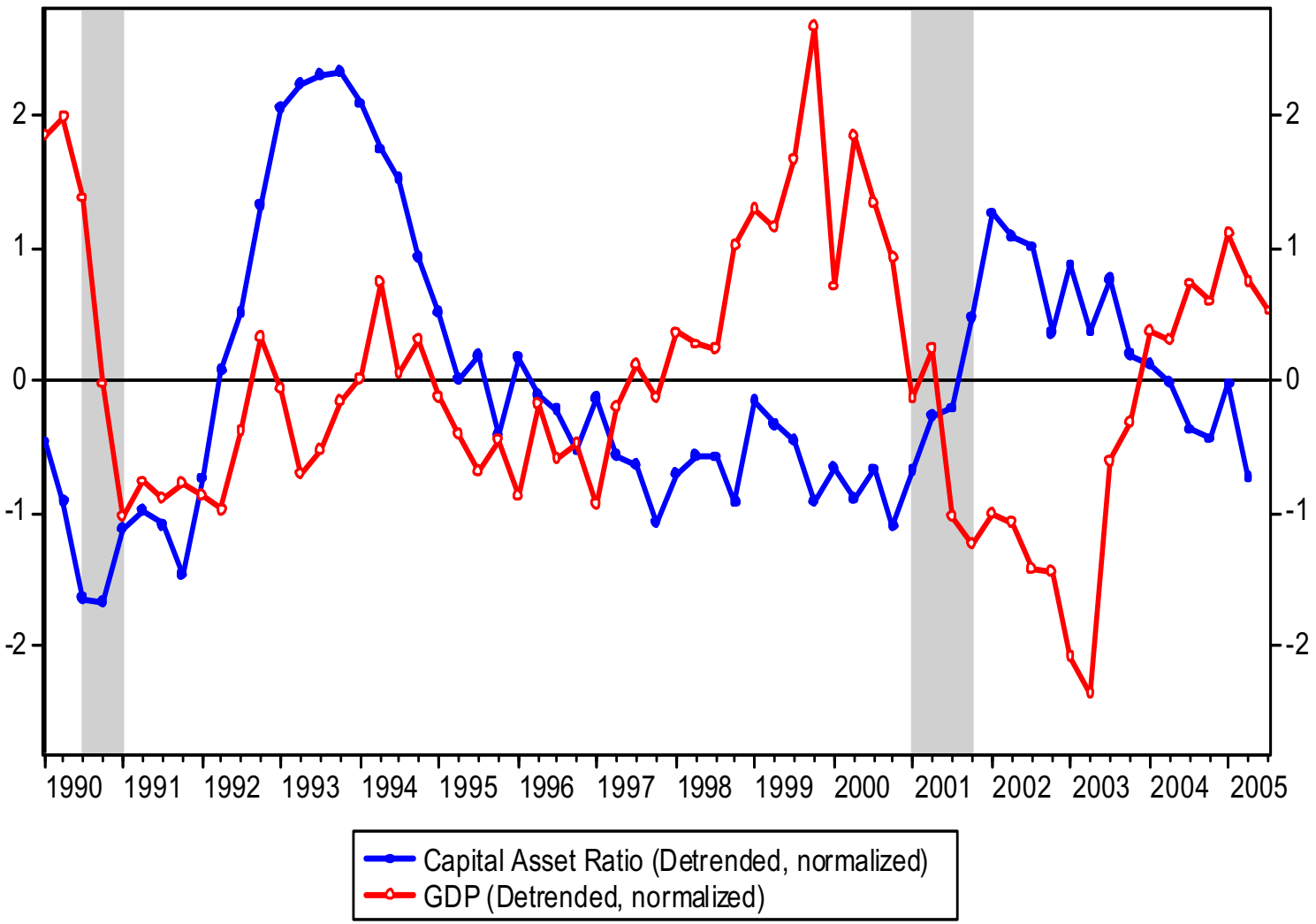
- Interaction between market and regulatory discipline on banks

- Endogenous external bank equity (eg., Jermann & Quadrini, 2008).

Timing of Events Within a Period



BANK CAPITAL TO ASSET RATIO



Banking Net Worth in the Transmission of a Monetary Tightening