The Role of the Net Worth of Banks in the Propagation of Shocks

Preliminary

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Motivation

- A large literature quantitatively studies the role of financial factors in business cycle dynamics
- Asymmetric information between financial intermediaries and firms
  - ◇ eg., Bernanke et al., 1999; Carlstrom & Fuerst, 1997
- Limited enforcement of contracts
  - ◇ eg., Kiyotaki & Moore, 1997, Cooley, Marimon & Quadrini, 2004
- **Key Feature:** the supply of funds of financial intermediaries unaffected by their balance sheet

Evidence

- Peek & Rosengren (1997, 2000): a 1% decrease in capital ratio:
  - reduces bank lending by 6%
  - reduces investment in real estate sector
- Van den Heuvel, 2002
  - Output growth is more sensitive to shocks in US states with low levels of bank capital
- Kashyap & Stein, 2000; Kishan & Opiela, 2000
  - Liquidity, net worth affects lending by banks

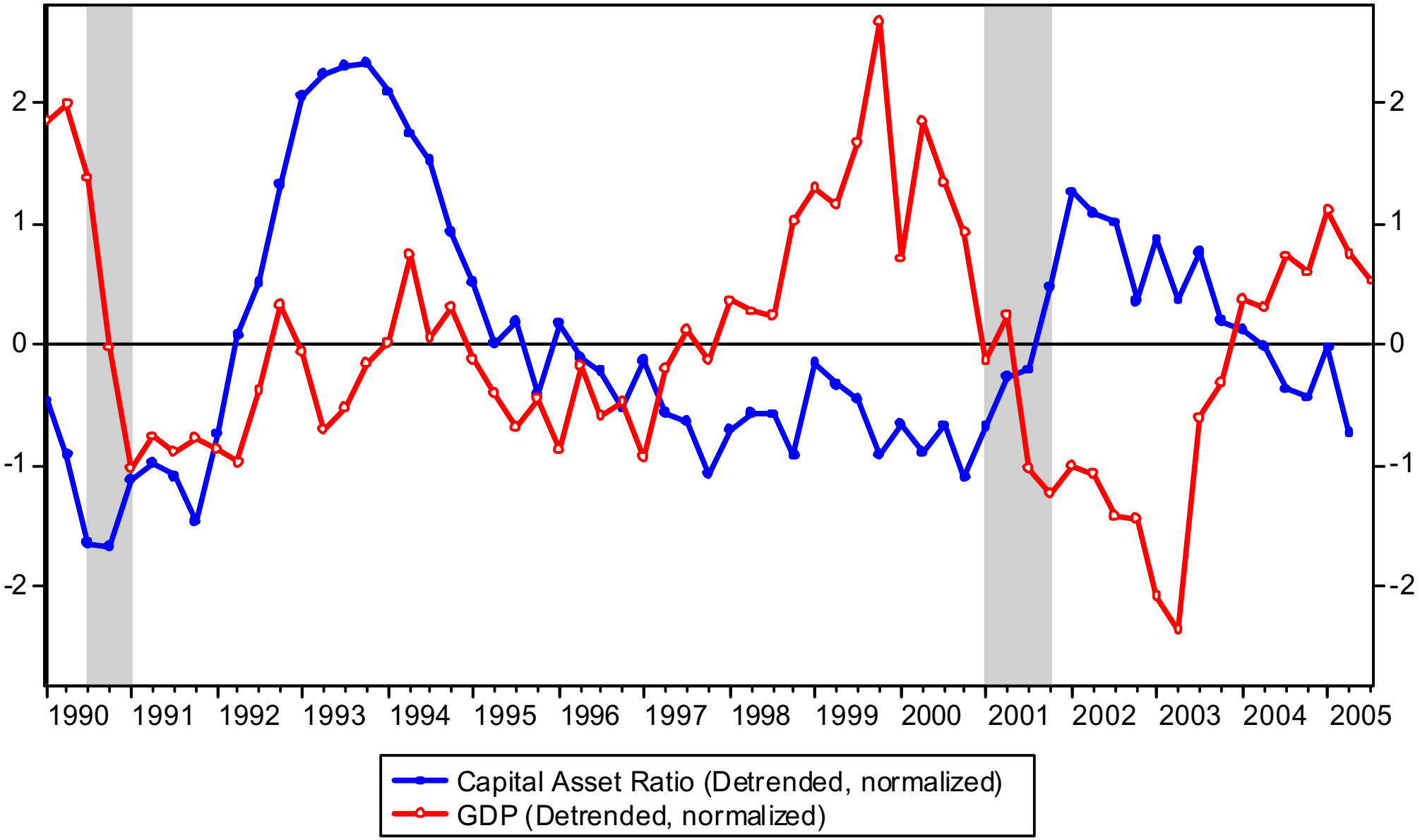
Our interpretation of the evidence

- Banks face market imperfections in attracting loanable funds
- These market imperfections may be what motivates the holding of net worth
- Important to take this into account when building models of banking and business cycles

Ratio of Bank Net Worth over Assets

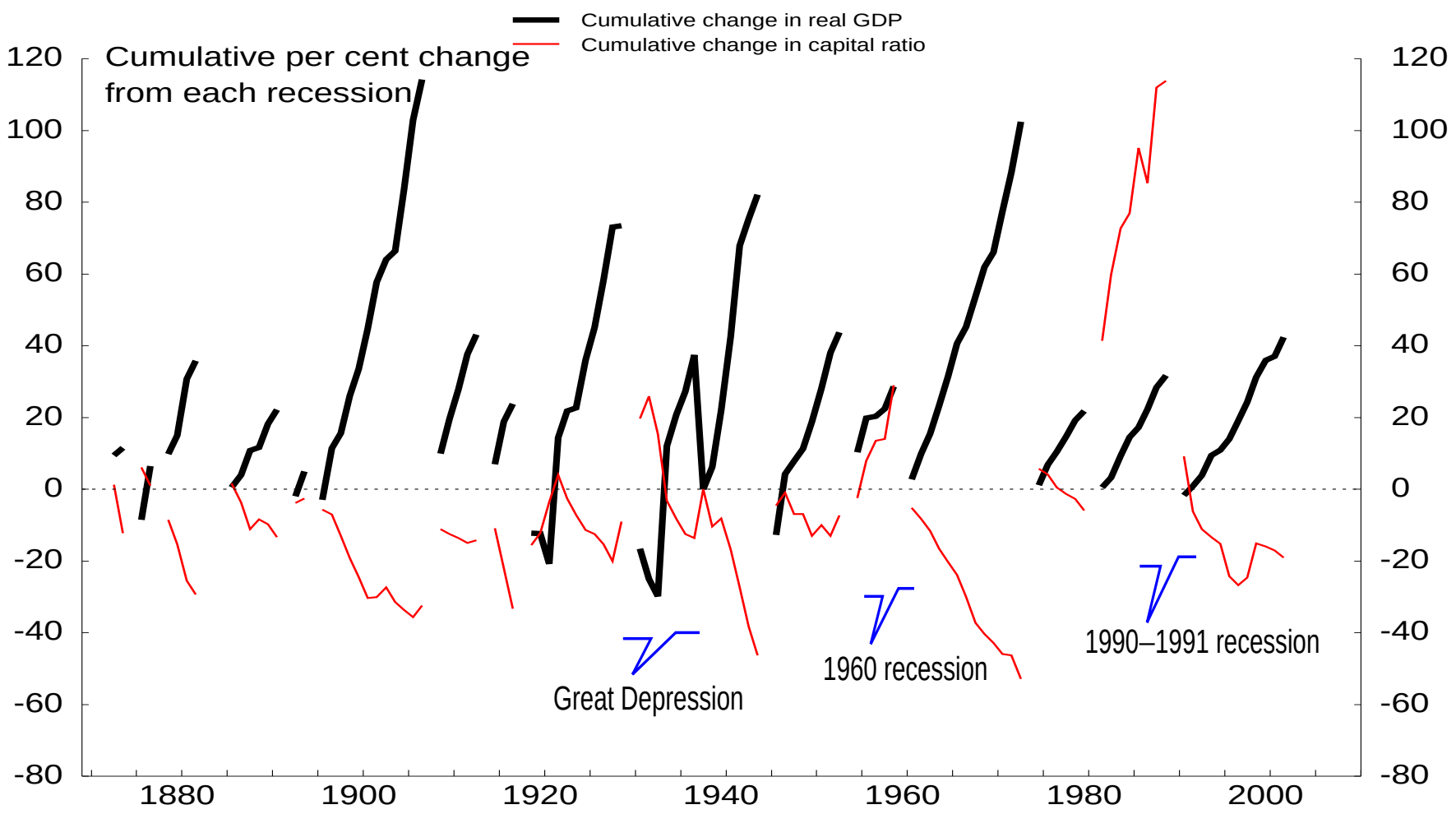
- Key banking sector indicator; subject of many policy discussions
- Business cycle fact: countercyclical

Net Worth to Asset Ratio



Net Worth to Asset Ratio: Canada

Figure 3: Economic booms and the capital ratio
(annual, 1870 to 2002)



Sources: Bank of Canada (1950-2004), Leacy (1983), Statistics Canada (2004), Urquhart (1986), and authors' calculations

Cyclical Properties of the Net Worth to Asset Ratio: 1990:1 - 2005:2

		Cross-Correlation of Ratio with:				
Variable	$\frac{\sigma(X)}{\sigma(GDP)}$	X_{t-2}	X_{t-1}	X_t	X_{t+1}	X_{t+2}
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

Objective

- A framework with a double moral hazard problem:
  - entrepreneurs and bankers
  - bankers and households
- This framework is embedded into a quantitative model of aggregate fluctuations
- The model is used address two questions

1. are movements in capital-asset ratios consistent with the evidence?
2. how does bank net worth affect the transmission of shocks?

Findings

- The model replicates cyclical features in the ratio of net worth to asset
  1. countercyclicality
  2. volatility
  3. autocorrelation
- The model replicates persistence in output

Policy Implications

- Debate: Market Forces should play a bigger role in regulating banks
- 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?

Literature

- Carlstrom & Fuerst (1997, 1998, 2001); Bernanke et al. (1999)
  - One source of moral hazard, no bank net worth
- Holmstrom & Tirole (1997), Chen (2001), Meh & Moran (2003), Sunirand (2003), Aikman & Paustian (2004)
  - Not quantitative
- Van den Heuvel (2001)
  - Movements in Bank Capital regulatory-driven

Rest of the Talk

- Financial Contract
- Rest of the Model
- Findings
- Conclusion and Future Work

Economic Environment

- Three types of agents: households, bankers and entrepreneurs
  - households are risk averse, bankers and entrepreneurs risk neutral
  - bankers are endowed with a monitoring technology
  - entrepreneurs can produce capital goods
- Consumption Good:

$$F(K_t, N_t) = z_t K_t^{\theta} H_t^{1-\theta}$$

$$z_{t+1} = \rho_z z_t + \epsilon_{t+1}$$

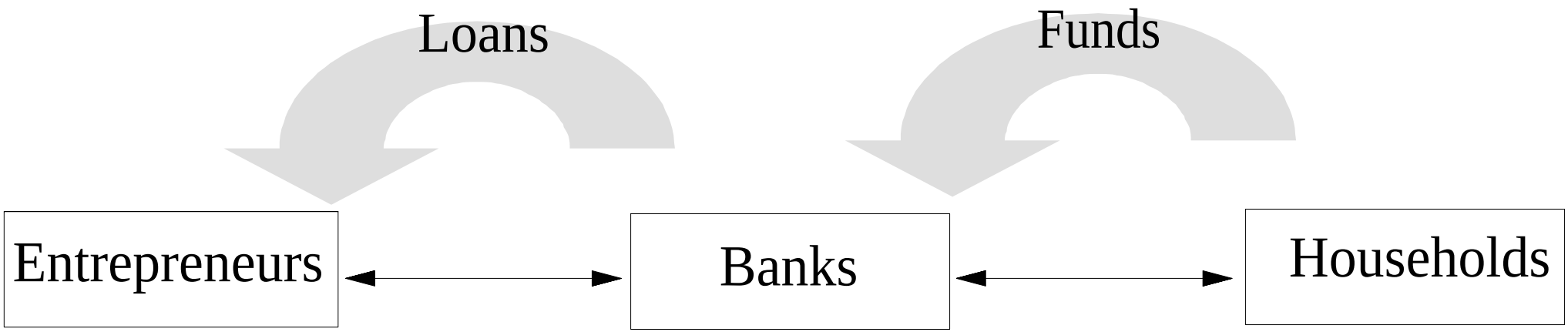
Capital Good Sector Production

- Capital Good: produced by entrepreneurs

$$f(i_t) = \widetilde{R}\, i_t$$

$$\widetilde{R} = \{0, R\}$$

Two Sources of Moral Hazard



1. Moral Hazard

Entrepreneurs may privately choose low return projects to enjoy private benefits

Entrepreneurial Net Worth

2. Moral Hazard

Banks have an incentive not to monitor in order to save costs

Bank Net Worth

Households

- Optimization Problem:

$$\max_{c_t^h, h_t, x_t, k_{t+1}^h} E_0 \sum_{t=0}^{\infty} \beta^t log(c_t^h) + \psi(1 - h_t),$$

- *with respect to*

$$c_t^h + q_t x_t \leq r_t k_t^h + w_t h_t$$

$$k_{t+1}^h = (1 - \delta) k_t^h + x_t,$$

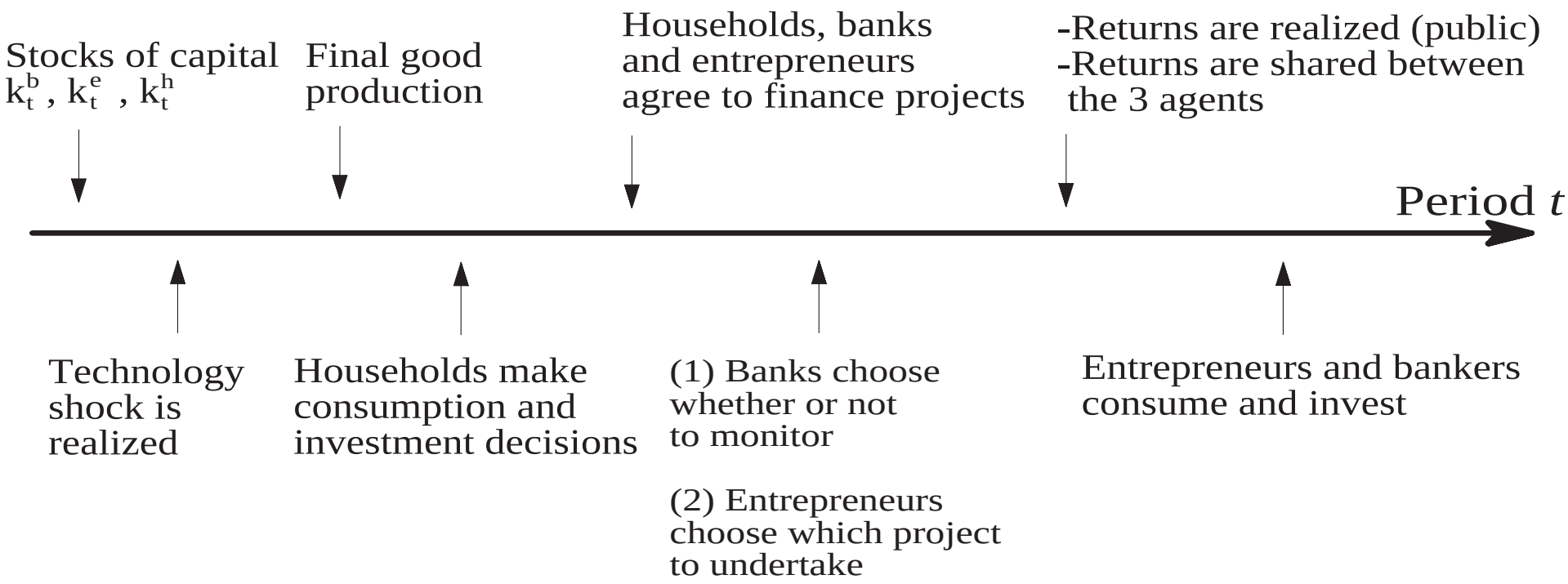
Investment Projects

- 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 is private and costly (μi_t)
- The projects financed by an individual bank are perfectly correlated

Timing of Events Within a Period



Financial Contract

- Consider one-period contracts that lead entrepreneurs to choose the good project
- 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 constraints 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 constraints 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

$$q_t \alpha^g R_t^b i_t \geq R_t^a a_t$$

- Participation constraint of households

$$q_t \alpha^g R_t^h i_t \geq q_t x_t$$

- Resource constraint

$$a_t + (q_t x_t) + n_t = (1 + \mu) i_t$$

Upshot of the Contract

- Shares:

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

- Project Size

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

where

$$G_t \equiv 1 + \mu - q_t \alpha^g R_t^h$$

Bankers and Entrepreneurs

- Discount future more than households
- Bank net worth and Entrepreneurial net worth:

$$a_t = [r_t + q_t(1-\delta)]\, k_t^b$$

$$n_t = [r_t + q_t(1-\delta)]\, k_t^e$$

- Budget Constraints

$$c_t^b + q_t k_{t+1}^b = R_t^b i_t$$

$$c_t^e + q_t k_{t+1}^e = R_t^e i_t$$

Bankers and Entrepreneurs

- Choice of next period's assets:
- Bankers:

$$q_t = \tau_b \, \beta \, E_t \left[(r_{t+1} + q_{t+1}(1-\delta)) \;\; \alpha^g \, \frac{R^b_{t+1}}{G_{t+1}} \right]$$

- Entrepreneurs:

$$q_t = \tau_e \, \beta \, E_t \left[(r_{t+1} + q_{t+1}(1-\delta)) \;\; \alpha^g \, \frac{R^e_{t+1}}{G_{t+1}} \right]$$

Aggregation

- Aggregate Investment and Net Worth:

$$I_t = \frac{N_t + A_t}{G_t};$$

- Aggregate Net Worth:

$$\begin{aligned} A_t &= \left[r_t + q_t(1-\delta)\right] K_t^b \left(I_{t-1}\right) \\ N_t &= \left[r_t + q_t(1-\delta)\right] K_t^e \left(I_{t-1}\right) \end{aligned}$$

Market Clearing Conditions

- Labor markets:

$$H_t = \eta^h h_t$$

- Final goods market:

$$Y_t = C_t^h + C_t^e + C_t^b + (1 + \mu_t) I_t$$

- Capital goods market:

$$K_{t+1} = (1 - \delta) K_t + \alpha^g R I_t$$

Calibration

Preferences and Consumption Good Production

β	ψ	δ	θ	ρ_z
0.99	3.0	0.02	0.4	0.95

Investment Good Production

α^g	R	α^b	μ	b	τ_e	τ_b
0.99	1.01	0.69	0.07	0.25	0.97	0.98

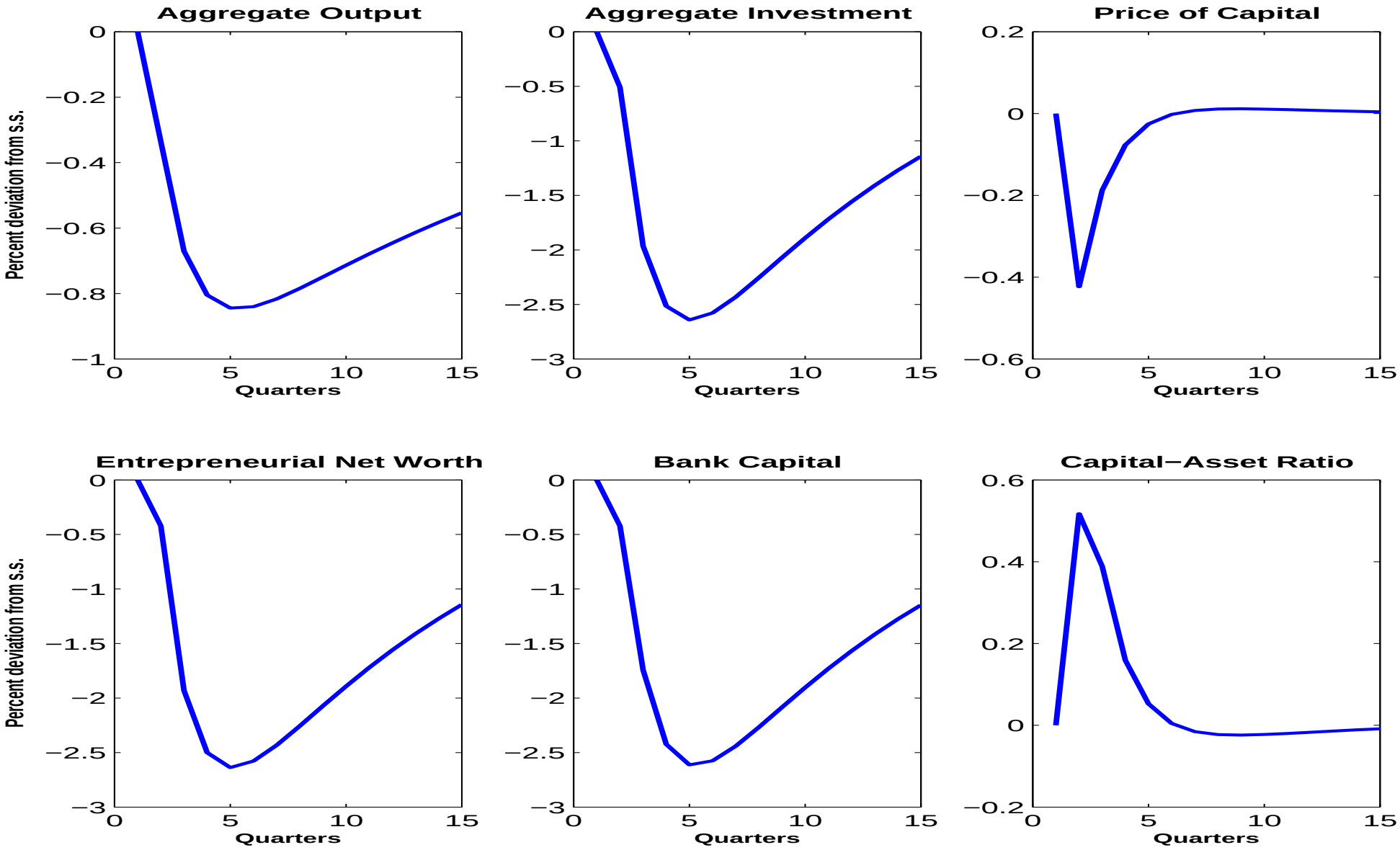
Resulting Steady-State Characteristics

ROE	CA	IC	I/Y	Share
15%	13%	4%	0.22	0.005

Preview of Results

- Shock to technology (consumption good production)
- Model Simulation (only technology shocks)

Negative Technology Shock



Cyclical Features: Data and Model

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: Data						
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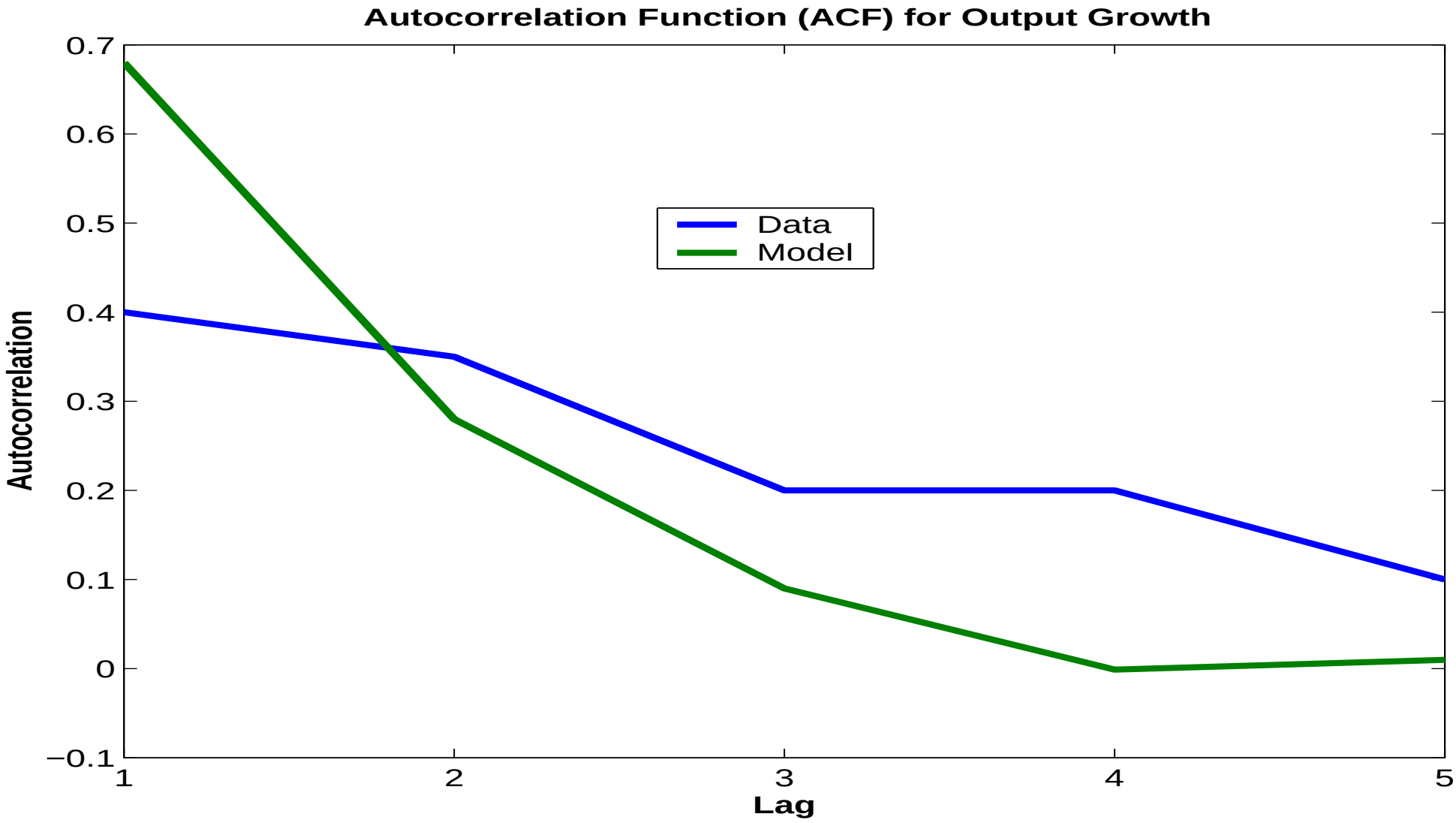
Panel A: Model						
Net Worth to Asset Ratio	0.21	0.24	0.61	1.00	0.61	0.24
Investment	2.45	0.03	−0.06	−0.24	−0.43	−0.50
GDP	1.00	−0.02	−0.11	−0.27	−0.38	−0.42
Bank Loans	2.49	0.01	−0.10	−0.30	−0.45	−0.50

ACF for Output Growth: Data and Model



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 bank capital affects the transmission of shocks
  - the model exhibits significant persistence

Future Work

- Interaction between market and regulatory discipline on banks
- Heterogeneity in bank size and capital-asset ratio