Monetary Economics

Financial Markets and the Business Cycle

Nicola Viegi

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Introduction

Crisis shows centrality of financial market in functioning of the macroeconomy.

The Microeconomics of Banking

- The possibility of a crisis is built in the maturity transformation function of the banking system.
  - Diamond, Douglas W. And Dybvig, Philipp H., "Bank-runs, deposit insurance and liquidity“, Journal of Political Economy Vol. 91, No. 3, (1983)
  - Allen, Franklin and Gale, Douglas, "Financial Contagion“, The Journal of Political Economy, Vol. 108, No. 1, (2000)
  - Goldstein, Itay and Pauzner, Ady "Demand–Deposit Contracts and the Probability of Bank Runs“, Journal of Finance, Vol. 60, Issue 3, (2005)

The Macroeconomic of Crisis

- Financial crisis and macroeconomic crisis are connected via policies and expectations
  - Krugman, Paul. "A model of balance-of-payments crises." Journal of money, credit and banking 11.3 (1979): 311-325.
  - Obstfeld, Maurice. "Models of currency crises with self-fulfilling features." European economic review 40.3 (1996): 1037-1047.
  - Kaminsky, Graciela L., and Carmen M. Reinhart. "The twin crises: the causes of banking and balance-of-payments problems." American economic review (1999): 473-500.
  - Reinhart, Carmen M., and Kenneth S. Rogoff. This time is different: eight centuries of financial folly. princeton university press, 2009.

Credit Market Imperfection

- This lecture - Credit Market Imperfections and the Macroeconomy
  - Stiglitz Joseph and Andrew Weiss (1981), "Credit Rationing in Markets with Imperfect Information" The American Economic Review, Vol. 71, No. 3
  - Kiyotaki, Nobuhiro & Moore, John (1997), "Credit Cycles", Journal of Political Economy 105 (2): 211–248
  - Bernanke, Ben S. & Gertler, Mark & Gilchrist, Simon, (1999). "The financial accelerator in a quantitative business cycle framework," in: J. B. Taylor & M. Woodford (ed.), Handbook of Macroeconomics, edition 1, volume 1, chapter 21, pages 1341-1393 Elsevier.
- Stiglitz Weiss Model: the basic framework
- Kyotaki and Moore - Financial Cycle in a Real Macroeconomic Model
- Bernanke, Gertler and Gilchrist - Financial Cycle in a New Keynesian Framework

Credit Market Imperfection - the Stiglitz Weiss Model

- Simple Question - "Why Credit is Rationed?"
- Not a simple answer (although the model is simple - One Bank, Many Firms)
  - Need possibility of default (Risk)
  - Need Asymmetric Information (Uncertainty)

Expected Value of Investment Project

$$p_i R_i^s + (1 - p_i) R^f = R$$

Firm needs borrowing $B = K - W$
The Bank gets $(1 + r)B$ in case of success and R^f in case of failure.
Assume that $R_i^s > (1 + r)B > R^f$ for all i.
Asymmetric info: entrepreneur knows his p_i the bank does not (Only the overall distibution of p_i, $g(p_i)$).
Expected Profits (if risk neutral)

$$\begin{aligned} Firm &: \quad E(\pi_i) = p_i \left[R_i^s - (1 + r)B \right] \\ Bank &: \quad E(\pi_b) = (1 + r)B \int_0^p p_i g(p_i)\, dp_i + R^f \int_0^p (1 - p_i)\, g(p_i)\, dp_i \end{aligned}$$

where p is the threshold probability to go to the bank

Credit Market Imperfections

- Firm expected payoff π_i :

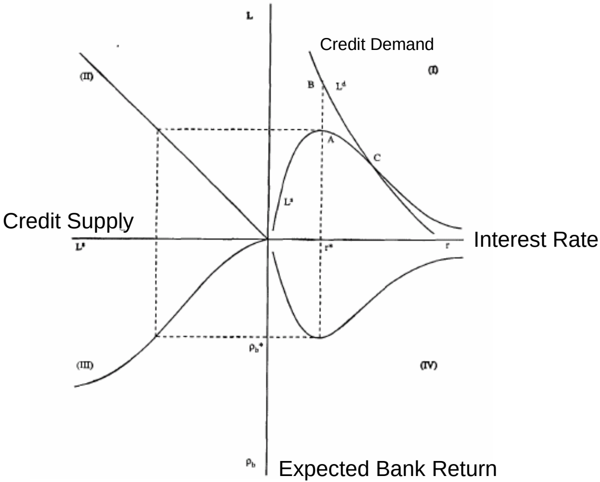
$$E(\pi_i) = R - R^f - p_i \left[(1+r)B - R^f \right]$$

Decreasing in p_i high risk investors are willing to pay more for a loan, but then $dp/dr < 0$.
Impact on Banks

$$\frac{dE\left(\pi_b\right)}{dr} = B\int_0^p p_i g\left(p_i\right)dp_i + \left(\frac{dp}{dr}\right)\left[\left(1+r\right)Bpg\left(p\right) + R^f\left(1-p\right)g\left(p\right)\right]$$

Optimal Respone of the Bank - Collateral

Credit Market Imperfections



Interest rate signal of riskness: without collateral there in credit for high interest rates

Credit Market Imperfection and the Business Cycle - the Kyotaki Moore model

- Credit Market Imperfections in a general equilibrium model
  - it produces comovement of amount of credit, asset prices and aggregate output,
  - it creates a propagation mechanism that produces persistence and amplification of a shock,
  - it produces procyclical productivity even if technology does not change,
  - it is able to explain cross-industry comovements.
- Quite Complex

Credit Market Imperfection and the Business Cycle - the Kyotaki Moore model

- Two types of decision makers, with different time preference rates: "patient" (Gatherers) and "impatient." (Farmers)
- The knowledge of the "farmers" is an essential input to their own investment projects
- Farmers cannot be forced to work, and therefore they cannot sell off their future labor to guarantee their debts.
- Lenders have no way to confiscate the value of the investment if farmers choose not to pay back their debts.
- Loans will only be made if they are backed by some other form of capital which can be confiscated in case of default.
- Farmers must provide real estate as collateral if they wish to borrow.
- If for any reason the value of real estate declines, so does the amount of debt they can acquire.
- This feeds back into the real estate market, driving the price of land down further
- This positive feedback is what amplifies economic fluctuations in the model.

Credit Cycles - A graphical Representation

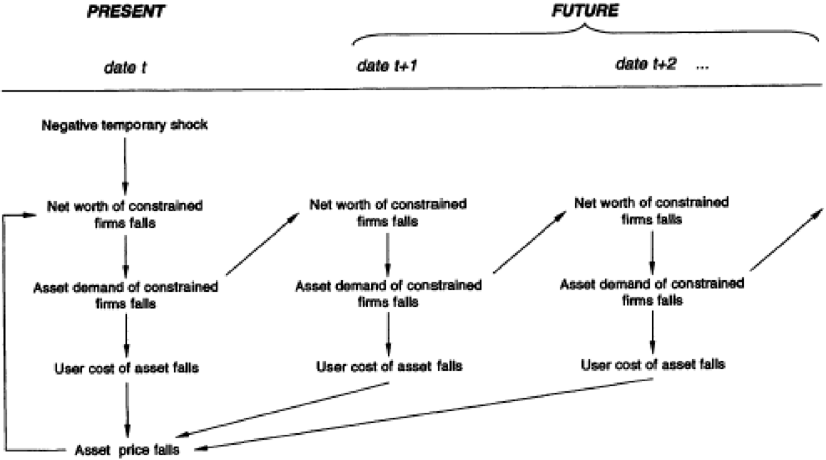


FIG. 1

Credit Market Imperfection and the Business Cycle - The Bernanke et al (1999) Model

"How does one go about incorporating financial distress and similar concepts into macroeconomics? While it seems that there has always been an empirical case for including credit-market factors in the mainstream model, early writers found it difficult to bring such apparently diverse and chaotic phenomena into their formal analyses. As a result, advocacy of a role for these factors in aggregate dynamics fell for the most part to economists outside the US academic mainstream, such as Hyman Minsky, and to some forecasters and financial market practitioners." (Bernanke-Gertler-Gilchrist, 1999, p.1344)

Credit Market Imperfection and the Business Cycle - The Bernanke et al (1999) Model

Conventional Model with Perfect Capital Markets:

- Arbitrage between return to capital and riskless rate makes the financial structure irrelevant

$$E_t \beta \Lambda_{t,t+1} R_{kt+1} = E_t \beta \Lambda_{t,t+1} R_{t+1}$$

Where $\Lambda_{t,t+1}$ is the household stochastic discount factor
With capital market frictions:

1. External finance premium $\Longrightarrow E_t \beta \Lambda_{t,t+1} R_{kt+1} > E_t \beta \Lambda_{t,t+1} R_{t+1}$
2. Premium depends inversely on borrower balance sheets
3. If borrower balance sheets move procyclically, external finance premium move countercyclically:

$\Longrightarrow$feedback betweeen financial and real sectors ("financial accelerator,")
$\Longrightarrow$disturbances originating in the financial sector can have real effects.

Bernanke Gertler (1989) Agency Cost Model

Bernanke, Ben & Gertler, Mark, 1989. "Agency Costs, Net Worth, and Business Fluctuations," American Economic Review, American Economic Association, vol. 79(1),.- Real Business Cycle with Financial frictions

1. Focus on Borrower Net Worth
2. Asymmetric Information Between Borrower and Lender introduces "deadweight losses" (agency cost)
3. Agency cost refers to the cost necessary to overcome asymmetric information contraint
4. Greater the net worth (inside finance) lower the external finance premium
5. Finance accelarator due to procyclicality of net worth

Bernanke Gertler Gilchrist Accelarator Model

Dynamic General Equilibirum Framework with:

1. Money
2. Imperfect Competition
3. Nominal Price Rigidities (Calvo staggered price setting.)
4. Financial Accelerator as in Bernanke/Gertler(1989), featuring asset price mechanism as in Kiyotaki and Moore (1997)

Sectors

1. Households
2. Business Sector
    2.1 entrepreneur/firms
    2.2 capital producers
    2.3 retailers (Monopolistic competition and sticky prices)
3. Central Bank

Household

Objective

$$\max E_t \sum_{i=0}^{\infty} \beta^i \left[\log\left(C_{t+i}\right) + a_m \log\left(\frac{M_{t+i}}{P_{t+i}}\right) - a_n \frac{1}{1+\gamma_n} L_{t+i}^{1+\gamma_n} \right]$$

Subject to

$$C_t + \frac{B_t}{P_t} + \frac{M_t}{P_t} = \frac{W_t}{P_t} L_t + \Pi - T_t + \frac{M_{t-1}}{P_t} + \left(1 + i_t\right) \frac{B_{t-1}}{P_t}$$

Assume Cashless Limit ($a_m \longrightarrow 0$)

Decision Rules (Standard)

Labour Supply

$$\frac{W_t}{P_t} = a_n \frac{1}{1+\gamma_n} L_t^{\gamma_n} / \left(\frac{1}{C_t}\right)$$

Consumption and Savings

$$\frac{1}{C_t} = E_t \left\{ (1+i_t) \frac{P_t}{P_{t+1}} \beta \frac{1}{C_{t+1}} \right\}$$

Entrepreneurs/Firms

- Produce wholesale output (with price P_w)
- Competitive, risk neutral, face capital market frictions.
- A measure of unity in the market anytime
- i.i.d survival probability θ : The expected horizon is accordingly $\frac{1}{1-\theta}$. $1-\theta$ enter to replace exiting entrpreneurs (overlapping generation of firms).

Production Technology and Labour Demand

Production Technology

$$Y_t = \omega A_t K_t^{\alpha} L_t^{1-\alpha}$$

with

$$E\left(\omega_t\right) = 1$$

Labour Demand

$$\frac{W_t}{P_{wt}} = (1-\alpha)\left(\frac{Y_t}{L_t}\right)$$

Capital Demand (1)

Gross Return to Capital

$$E_t\left\{R_{kt+1}\right\} = E_t\left\{\frac{\frac{P_{wt}}{P_t}\alpha\frac{Y_{t+1}}{K_{t+1}} + (1-\delta)\,Q_{t+1}}{Q_t}\right\}$$

Where Q_t is the price of capital and δ the depreciation rate
Opportunity Cost

$$E_t\left\{(1+i)\,\frac{P_{t+1}}{P_t}\right\}$$

Capital Demand (2)

Under perfect capital markets, capital demand given by:

$$E_t\left\{R_{kt+1}\right\} = E_t\left\{(1+i)\,\frac{P_{t+1}}{P_t}\right\}$$

With imperfect capital markets:

$$E_t\left\{R_{kt+1}\right\} > E_t\left\{(1+i)\,\frac{P_{t+1}}{P_t}\right\}$$

Capital Demand (3)

The finance of capital is divided between net worth and debt

$$Q_t K_{t+1} = N_t + \frac{B_t}{P_t}$$

Costly State Verification

- costly state verification and limited liability
- one period contracts
- payouts based only on firm-specific contingencies

$\Longrightarrow$:

1. Debt with costly default is optimal (risk of default on lender)
2. Agency costs of external finance (expected default costs)
3. Collateral reduces expected default costs

Optimal Choice of Capital (1)

$$Q_t K_{t+1} = v \left(\frac{E_t \{R_{kt+1}\}}{E_t \left\{ (1+i) \frac{P_{t+1}}{P_t} \right\}} \right) N_t$$

Optimal Choice of Capital (2)

Aggregate Demand of Capital

$$E_t \{R_{kt+1}\} = (1-\chi_t)\, E_t \left\{ (1+i) \frac{P_{t+1}}{P_t} \right\}$$

Where

$$\chi_t = \chi \left(\frac{Q_t K_{t+1}}{N_t} \right)$$

and

$$\chi'() > 0, \chi(0) = 0, \chi(\infty) = \infty$$

Evolution of Net Worth

$$N_t = \theta V_t + (1 - \theta) D$$

Where

$$V_t = (1 - m_t) R_{kt} Q_{t-1} K_t - \left[(1 + i_{t-1}) \frac{P_{t-1}}{P_t} \right] \frac{B_t}{P_{t-1}}$$

with

$$R_{kt} = E_t \left\{ \frac{\frac{P_{wt}}{P_t} \alpha \frac{Y_t}{K_t} + (1 - \delta) Q_t}{Q_{t-1}} \right\}$$

$$m_t = \mu G \left(\omega^*_{t-1} \right)$$

Evolution of Net Worth

- Main Sources of Net Worth Fluctutions Unexpected movements in Q_t and P_t
- Irving Fisher's debt-deflation hypothesis: unanticipated declines in price level raise real debt burdens.

The Role of Leverage

Given

$$Q_{t-1}K_t = N_{t-1} + \frac{B_{t-1}}{P_{t-1}}$$

we have

$$V_t = \left\{\left[\left(1 - m_t\right) R_{kt} - R_t\right] \phi_{t-1} + R_t\right\} N_{t-1}$$

where

$$\phi_{t-1} = \frac{Q_{t-1}K_t}{N_t}$$

$$R_t = \left(1 + i_{t-1}\right) \frac{P_{t-1}}{P_t}$$

The sensitivity of net worth to unanticipated returns is increasing in the leverage ratio ϕ_{t-1}

Capital Producers

- Capital Producers are competitive. They produce new capital and sell at the price Q_t
- Evolution of Capital (with adjustment cost)

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta) K_t$$

$$\Phi' > 0, \Phi'' < 0, \Phi\left(\frac{I}{K}\right) = \frac{I}{K}$$

Optimal Choice of Investment

$$E_{t-1}\left\{Q_t - \left[\Phi'\left(\frac{I_t}{K_t}\right)\right]^{-1}\right\} = 0$$

Q is increasing in Investment - as in Tobin Q theory

Retailers

- Buy wholesale output and sell as differentiated product
- Set prices on a staggered basis as in Calvo (1983)

$$\frac{P_t}{P_{t-1}} \approx \left(\mu \frac{P_t^w}{P_t}\right)^{\lambda} E_t \left(\frac{P_{t+1}}{P_t}\right)^{\beta}$$

$$\pi_t = \lambda(p_{wt} - p_t) + \beta E_t \pi_{t+1}$$

- Note:$p_t - p_{wt}$ is the log price markup.

Resource Constraint

Let C_t^e be the entrepreneurial consumption and M_t be the total monitoring costs

$$Y_t = C_t + C_t^e + I_t + G_t + M_t$$

with

$$C_t^e = (1 - \phi)(V_t - D)$$

$$M_t = m_t R_t Q_{t-1} K_t$$

Monetary and Fiscal Policy

Monetary Rule

$$i_t = \rho i_{t-1} + (1-\rho_n)(\gamma_\pi \pi_t + \gamma_y y_t) + \epsilon_t^{rn}$$

$$i_t = r_{t+1} - E\pi_{t+1}$$

$$i_t = \rho i_{t-1} + (1-\rho_n)(\gamma_\pi \pi_t + \gamma_y y_t + \gamma_q q_t)$$

Fiscal Policy
Gov't spending exoxgenous and finance by lum sum taxes.

Investment, Finance and Monetary Policy in BGG

$$\frac{I_t}{K_t} = \phi\left(Q_t\right)$$

$$E_t R_{kt+1} = \left(1 + \chi\left(\frac{Q_t K_{t+1}}{N_t}\right)\right)\left\{\left(1+i\right)\frac{P_t}{P_{t+1}}\right\}$$

where

$$E_t R_{kt+1} = E_t\left\{\frac{\frac{P_{wt}}{P_t}\alpha\frac{Y_{t+1}}{K_{t+1}} + \left(1-\delta\right)Q_{t+1}}{Q_t}\right\}$$

Investment, Finance and Monetary Policy in BGG

Notice

$$N_t = \theta \left((1 - m_t) R_{kt} Q_{t-1} K_t - \left[(1 + i_{t-1}) \frac{P_{t-1}}{P_t} \right] \frac{B_t}{P_{t-1}} \right) + (1 - \theta) D$$

Thus:

- Positive feedback between asset prices and investment (financial accelerator)
- Strength depends positively on leverage ratio ratio $\frac{Q_t K_{t+1}}{N_t}$
- Monetary Policy has additional impact via balance sheets

Log Linear Model

Aggregate Demand

$$y_t = \frac{C}{Y}c_t + \frac{G}{Y}g_t + \frac{I}{Y}i_t + \frac{C^e}{Y}c_t^e \tag{1}$$

$$c_t = -r_{t+1} + E_t c_{t+1} \tag{2}$$

$$c_t^e = n_t \tag{3}$$

$$r_{t+1}^k - r_t = -v[n_t - (q_t + k_t)] \tag{4}$$

$$r_t^k = (1-\epsilon)(y_t - x_t - k_{t-1}) + \upsilon q_t - q_{t-1} \tag{5}$$

$$q_t = \phi(in_t - k_{t-1}) \tag{6}$$

Log Linear Model

Aggregate Supply

$$y_t = a_t + \alpha k_{t-1} + (1-\alpha) h_t \tag{7}$$

$$h_t = \frac{\eta_h}{1+\eta_h}(y_t - x_t - c_t) \tag{8}$$

$$\pi_t = -\lambda x_t + \beta E_t \pi_{t+1} \tag{9}$$

Log Linear Model

Evolution of State Variables

$$k_t = \delta i_t + (1 - \delta) k_{t-1} \tag{10}$$

$$n_t = \frac{\gamma RK}{N}(r_t^k - r_{t-1}) + r_{t-1} + n_{t-1} \tag{11}$$

Log Linear Model

Monetary Policy and shock Processes

$$r_t = r_t^n - \pi_t \tag{12}$$

$$r_t^n = \rho r_{t-1}^n + (1-\rho_n)(\nu_b \pi_{t-1}) + e_t^n, \qquad e_t^n \sim N(0, \sigma_n^2) \tag{13}$$

$$a_t = \rho_a a_{t-1} + e_t^a, \qquad e_t^a \sim N(0, \sigma_a^2) \tag{14}$$

$$g_t = \rho_g g_{t-1} + e_t^g, \qquad e_t^g \sim N(0, \sigma_g^2) \tag{15}$$

Calibrating Financial Sector Parameters

Choose (i) survival probability θ, (ii) monitoring costs μ, and (iii) the moments of the idiosyncratic shock to match evidence on:

1. Steady state external finance premium:R_k / R..
2. Steady state leverage ration QK / N
3. Annual business failure rate

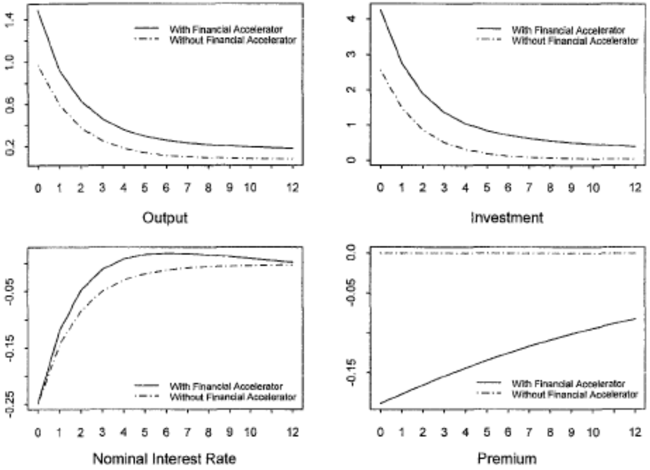


Fig. 3. Monetary shock – no investment delay. All panels: time horizon in quarters.

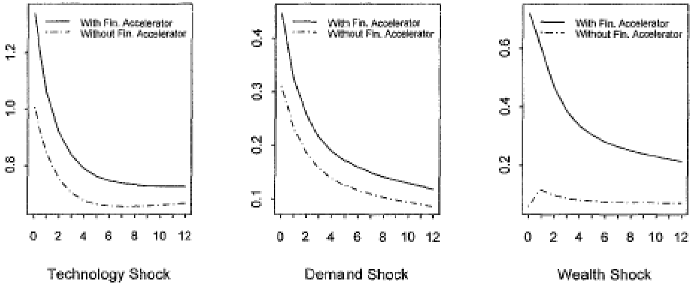


Fig. 4. Output response – alternative shocks. All panels: time horizon in quarters.

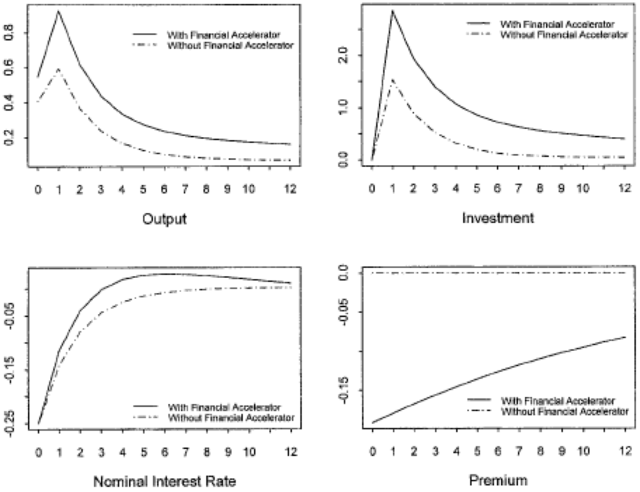


Fig. 5. Monetary shock – one period investment delay. All panels: time horizon in quarters.

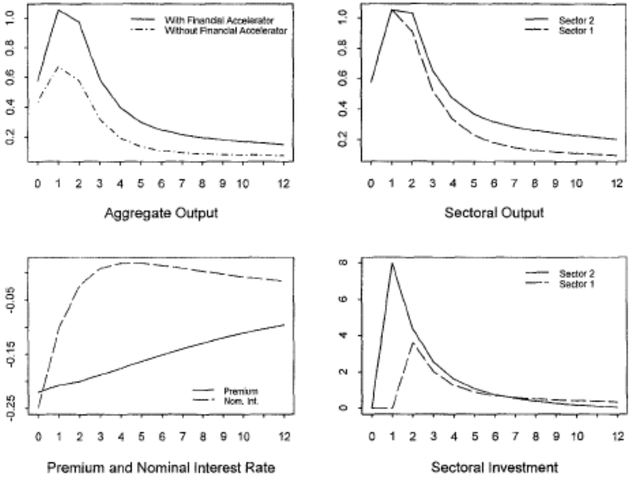


Fig. 6. Monetary shock – multisector model with investment delays. All panels: time horizon in quarters. Aggregate output: models with and without financial accelerator; other panels: model with financial accelerator.

Conclusion

- Dynamic General Equlibrium Model with financial frictions
- Can we use this model to evaluate if monetary policy should target asset prices?
- Is this model useful in understanding the causes (not the propagation) of crisis?