Financial Frictions

Applied Macroeconomics

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"To motivate interest in a paper on financial factors
in business fluctuations it used to be necessary
to appeal either to the Great Depression
or to the experiences of many emerging market economies.
This is no longer necessary."

– Gertler and Kiyotaki (2009)

Financial frictions

- Crisis detected important channels of the monetary/credit transmission mechanism
- Matter for our understanding of driving forces in the economy
- Place discussion of financial variables within a consistent framework
- Paramount when dealing with issues related to financial stability
- Interactions between macroprudential and monetary policy
- Brunnermeier, Eisenbach and Sannikov (2012)
  Macroeconomics with Financial Frictions: A Survey

Central banks' DSGE models

- General equilibrium models with financial frictions before the financial crisis – Kiyotaki and Moore (1997), Bernanke, Gertler and Gilchrist (1999), Iacoviello (2005)
- Financial frictions were absent from DSGE models at central banks at the time of the financial crisis
- Usual simplifications of financial mechanisms
  - Modigliani-Miller theorem holds
    – balance sheet positions do not affect real decisions
  - Financial markets' state summarized by one interest rate
  - No heterogeneity (in terms of discounting)
    – no borrowing and lending in equilibrium
- Feedback from financial markets to real economy hard to analyze
- Many central banks have now implemented financial frictions/spillovers in core DSGE models

Shortcomings of standard DSGE models

- "Linear" framework (Taylor expansions around steady state)
  - Abstracts from nonlinearities, higher order effects of risk/uncertainty
  - Not suitable for analyzing precautionary saving/hoarding
  - Or movements in asset prices, where risk is an important factor
- Rational expectations
  - Make the existence of bubbles unlikely
  - Analyzing non-fundamental developments is hard

Financial market frictions

- Due to asymmetric information (combined with moral hazard and/or costly state verification), lenders will generally require that borrowers post collateral and/or pay a credit premium to obtain funding.
- Starting with Akerlof (1970), there is a large literature on optimal financial contracts that link the net worth (balance sheet) of borrowers to their access to credit
- Since net worth is determined by assets in place, movements in asset prices will determine agents access to credit
- When asset values increase, the borrower's stake in the project increases, implying that the incentives to default decreases, leading in turn the lender to reduce the finance premium
- Establishes direct link between asset prices and credit
- Hence, financing costs become countercyclical, which will strengthen the effects of a given shock

Costly state verification

- Townsend (1979), Bernanke and Gertler (1989), Carlstrom and Fuerst (1997), Bernanke, Gertler and Gilchrist (1999), Christiano, Motto and Rostagno (2003, 2005, 2014)
- Entrepreneurs borrow funds to finance risky projects
- Project outcome is known ex post to the entrepreneur only
  – information assymetry
- If the project outcome is low entrepreneur defaults on the loan
- But successful entrepreneurs are temped to default as well
  – moral hazard
- Verification of the project success by outsiders is costly
- Optimal contract: fixed rate loan, verification in case of default
- Endogenous premium on loans

Bernanke, Gertler and Gilchrist (1999) model

- New Keynesian model with entrepreneurial sector which requires external funding to invest in new projects
- Entrepreneurs identical up to an idiosyncratic productivity shock a_E
- Funds provided by intermediary sector financed from household deposits
- Asymmetric information, costly state verication (Townsend, 1979)
- External finance premium (credit premium) is a decreasing function of the share of project financed by net worth (equity)
- Net worth equals retained profits by surviving entrepreneurs
- Gives rise to a financial accelerator mechanism

Households

Utility maximization problem

$$\begin{array}{rl} \max & E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma}}{1-\sigma} - \phi \frac{h_t^{1+\eta}}{1+\eta} \right) \\ \text{subject to} & P_t c_t + D_t + P_t g_t = W_t h_t + R_{t-1} D_{t-1} + Div_t \end{array}$$

Lagrangian

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{c} \frac{c_t^{1-\sigma}}{1-\sigma} - \phi \frac{h_t^{1+\eta}}{1+\eta} \\ +\lambda_t \left[w_t n_t + \left(R_{t-1} / \Pi_t \right) d_{t-1} + div_t - c_t - d_t - g_t \right] \end{array} \right]$$

FOCs

$$\begin{array}{rcl} c_t & : & c_t^{-\sigma} = \lambda_t \\ h_t & : & \phi h_t^{\eta} = \lambda_t w_t \\ d_t & : & \lambda_t = \beta E_t \left[\lambda_{t+1} \left(R_t / \Pi_{t+1} \right) \right] \end{array}$$

Define $\Lambda_{t,t+j} = \lambda_{t+j} / \lambda_t$

Final goods producers

Profit maximization problem under perfect competition

$$\begin{aligned} \max \qquad & P_t y_t - \int_0^1 P_t(i)\, y_t(i)\, \mathrm{d}i \\ \text{subject to} \qquad & y_t = \left(\int_0^1 y_t(i)^{\frac{1}{\mu}}\, \mathrm{d}i \right)^{\mu} \end{aligned}$$

Resulting in

$$\begin{aligned} y_t(i) &= \left(\frac{P_t(i)}{P_t} \right)^{\frac{\mu}{1-\mu}} y_t \\ P_t &= \left(\int_0^1 P_t(i)^{\frac{1}{1-\mu}}\, \mathrm{d}i \right)^{1-\mu} \end{aligned}$$

Intermediate goods producers I

Cost minimization problem

$$\begin{aligned}
\min \quad & w_t h_t(i) + r_t^k k_{t-1}(i) \\
\text{subject to} \quad & y_t(i) = z_t k_{t-1}(i)^{\alpha} h_t(i)^{1-\alpha}
\end{aligned}$$

Resulting in

$$\begin{aligned}
w_t &= mc_t (1-\alpha) z_t k_{t-1}^{\alpha} h_t^{-\alpha} \\
r_t^k &= mc_t \alpha z_t k_{t-1}^{\alpha-1} h_t^{1-\alpha}
\end{aligned}$$

Intermediate goods producers II

Profit maximization problem

$$\begin{aligned} \max \quad & E_0 \sum_{t=0}^{\infty} (\beta\theta)^t \Lambda_{0,t} \left[\left(\frac{\tilde{p}_0(i)}{\Pi_{0,t}} - mc_t \right) y_t(i) \right] \\ \text{subject to} \quad & y_t(i) = \left(\frac{\tilde{p}_0(i)}{\Pi_{0,t}} \right)^{\frac{\mu}{1-\mu}} y_t \end{aligned}$$

Resulting in

$$\begin{aligned} \tilde{p}_0(i) &= \mu \frac{E_0 \sum_{t=0}^{\infty} (\beta\theta)^t \lambda_t mc_t y_t \Pi_{0,t}^{\frac{\mu}{\mu-1}}}{E_0 \sum_{t=0}^{\infty} (\beta\theta)^t \lambda_t y_t \Pi_{0,t}^{\frac{1}{\mu-1}}} \\ \tilde{p}_t &= \mu \frac{Num_t}{Den_t} \\ Num_t &= \lambda_t mc_t y_t + \beta\theta E_t \Pi_{t+1}^{\frac{\mu}{\mu-1}} Num_{t+1} \\ Den_t &= \lambda_t y_t + \beta\theta E_t \Pi_{t+1}^{\frac{1}{\mu-1}} Den_{t+1} \end{aligned}$$

Inflation, price dispersion, policies and shocks

$$
\begin{aligned}
\Pi_t^{\frac{1}{1-\mu}} &= \theta + (1-\theta)\left(\tilde{p}_t \Pi_t\right)^{\frac{1}{1-\mu}} \\
\Delta_t &= \theta \Delta_{t-1} \Pi_t^{\frac{\mu}{\mu-1}} + (1-\theta)\, \tilde{p}_t^{\frac{\mu}{1-\mu}} \\
y_t &= z_t k_t^{\alpha} h_t^{1-\alpha} / \Delta_t \\
\ln g_t &= (1-\rho_g) \ln\left(\bar{g}/\bar{y}\right) + \rho_g \ln g_{t-1} + \varepsilon_{g,t} \\
R_t &= R_{t-1}^{\gamma_R} \left(\bar{R} \left(\frac{\Pi_t}{\bar{\Pi}} \right)^{\gamma_\Pi} \left(\frac{y_t}{\bar{y}} \right)^{\gamma_y} \right)^{1-\gamma_R} \exp\left(\varepsilon_{R,t}\right) \\
\ln z_t &= \rho_z \ln z_{t-1} + \varepsilon_{z,t}
\end{aligned}
$$

Capital goods producers

Profit maximization problem

$$\max \qquad E_0 \sum_{t=0}^{\infty} \beta^t \Lambda_{0,t} \left[q_t \left(k_t - (1-\delta) k_{t-1} \right) - i_t \right]$$

$$\text{subject to} \qquad k_t = (1-\delta) k_{t-1} + \left(1 - \frac{\kappa}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right) i_t$$

where $q_t = Q_t / P_t$ is the real price of capital goods
and κ measures cost of adjusting investment

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta^t \Lambda_{0,t} \left[q_t \left(1 - \frac{\kappa}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right) i_t - i_t \right]$$

Resulting in

$$\begin{aligned} 1 = & q_t \left(1 - \frac{\kappa}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 - \kappa \left(\frac{i_t}{i_{t-1}} - 1 \right) \frac{i_t}{i_{t-1}} \right) \\ & + \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} q_{t+1} \kappa \left(\frac{i_{t+1}}{i_t} - 1 \right) \left(\frac{i_{t+1}}{i_t} \right)^2 \right] \end{aligned}$$

Entrepreneurs I

Take loans to finance purchases of raw capital

$$L_t(j) = Q_t k_t(j) - V_t(j) \geq 0$$

where $L_t(j)$ denotes loan and $V_t(j)$ net worth of j-th entrepreneur

Entrepreneurs transform raw capital $k_t(j)$ into productive capital $a_{E,t+1}(j)\, k_t(j)$
Assume $E[a_E] = 1$

Gross return on capital

$$R_{E,t+1}(j) = \frac{R_{k,t+1} a_{E,t+1}(j)\, k_t(j) + Q_{t+1}(1-\delta)\, a_{E,t+1}(j)\, k_t(j)}{Q_t k_t(j)}$$

$$R_{E,t+1} = \frac{R_{k,t+1} + Q_{t+1}(1-\delta)}{Q_t} \longrightarrow R_{E,t+1}(j) = a_{E,t+1}(j)\, R_{E,t+1}$$

Entrepreneurs II

Optimal contract: loan size $L_t(j)$
and gross non-default interest rate $R_{L,t+1}$

$$\tilde{a}_{E,t+1} R_{E,t+1} Q_t k_t(j) = R_{L,t+1} L_t(j)$$

Entrepreneurs with a_E below the threshold level go bankrupt

All their resources are taken over by the banks,
after they pay proportional monitoring costs ψ.

Banks

Perfect competition in banking generates zero profits

$$(1 - F_{t+1}) R_{L,t+1} L_t + (1 - \psi) G_{t+1} R_{E,t+1} Q_t k_t = R_t L_t$$

where

$$\begin{aligned} F_{t+1} &= \int_0^{\tilde{a}_{E,t+1}} dF_{t+1}(a_E) \\ G_{t+1} &= \int_0^{\tilde{a}_{E,t+1}} a_E dF_{t+1}(a_E) \end{aligned}$$

Equivalently

$$R_{E,t+1} Q_t k_t \left[\tilde{a}_{E,t+1} (1 - F_{t+1}) + (1 - \psi) G_{t+1}\right] = R_t L_t$$

Optimal contract

Entrepreneur return on equity maximization

$$\max \quad E_t \left[\frac{\int_{\tilde{a}_{E,t+1}}^{\infty} \left[R_{E,t+1} Q_t k_t (j) \, a_E - R_{L,t+1} L_t (j) \right] dF_{t+1} (a_E)}{R_t V_t (j)} \right]$$

subject to constraint on banks' zero profits

Resulting in (derivation skipped)

$$E_t \left[\begin{array}{c} \frac{R_{E,t+1}}{R_t} \left[1 - \tilde{a}_{E,t+1} (1 - F_{t+1}) - G_{t+1} \right] + \\ \frac{1 - F_{t+1}}{1 - F_{t+1} - \psi \tilde{a}_{E,t+1} F'_{t+1}} \left[\frac{R_{E,t+1}}{R_t} \left(\tilde{a}_{E,t+1} (1 - F_{t+1}) + (1 - \psi) \, G_{t+1} \right) - 1 \right] \end{array} \right] = 0$$

where if $\psi = 0$ then $E_t \left[R_{E,t+1} \right] = R_t$ – frictionless financial markets

Optimal contract is summarized by leverage ratio $\varrho_t = (Q_t k_t) / V_t$ and threshold value $\tilde{a}_{E,t+1}$

Resulting gross interest rate on loan is

$$R_{L,t+1} = \frac{\tilde{a}_{E,t+1} R_{E,t+1} \varrho_t}{\varrho_t - 1}$$

Closing the model

Net worth evolution

$$V_t = v\left[R_{E,t}Q_{t-1}k_{t-1} - \left(R_{t-1} + \frac{\psi G_t R_{E,t}Q_{t-1}k_{t-1}}{L_{t-1}}\right)L_{t-1}\right] + T_E$$

Output acounting

$$c_t + i_t + g_t + \psi G_t R_{E,t}Q_{t-1}k_{t-1} = y_t$$

Monetary policy shock

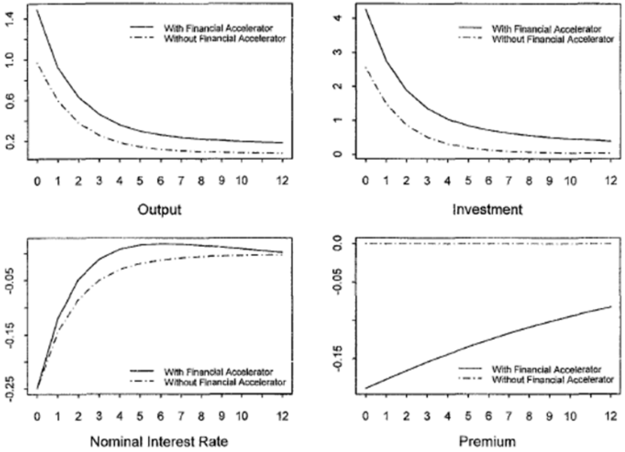
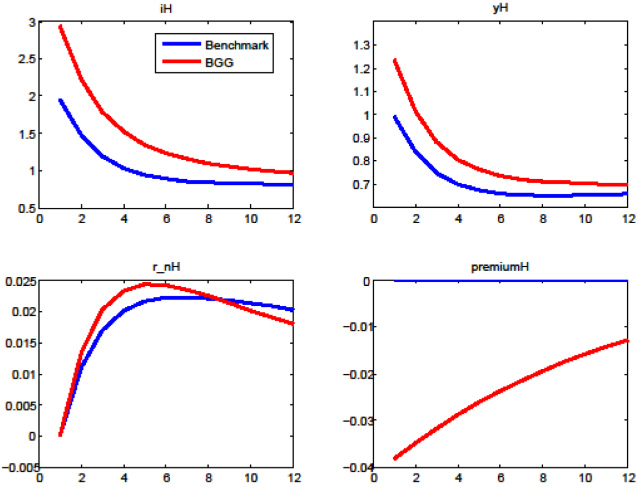
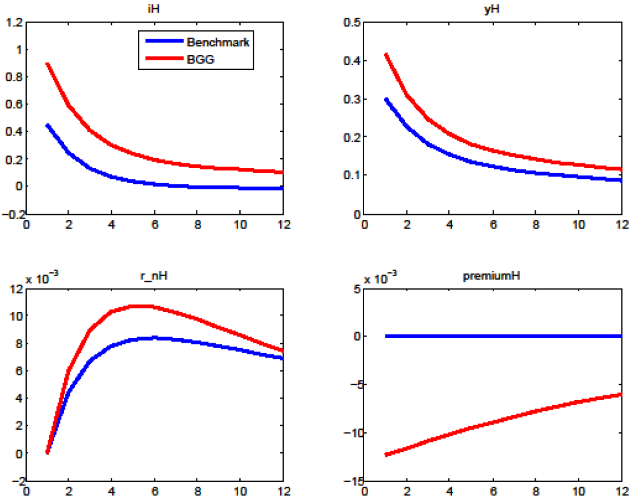


Fig. 3. Monetary shock – no investment delay. All panels: time horizon in quarters.

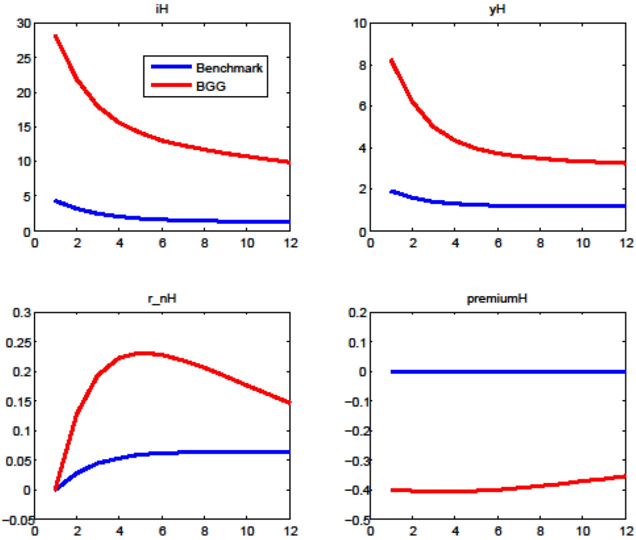
Technology shock



Government spending shock



Net worth shock



Core message

- Due to asymmetric information lenders will generally require that borrowers post collateral and/or pay a credit premium to obtain funding
- BGG use a simple optimal contracting framework to highlight the interaction between financial strength (net worth) and the credit premium
- In particular, the credit premium will vary inversely with net worth
- Hence, to the extent that net worth is procyclical, movements in credit premia will amplify business cycle fluctuations
- This is the financial accelerator
- Hints at the role of asset prices in the transmission mechanism

Limitations

- Rudimentary treatment of banking sector, mainly passive supplier. However, the recent credit freeze can be traced back to financial intermediation
- Assuming risk neutral agents. Aggregate risk does not really matter
- Ignores alternative sources of risk spread (risk aversion, liquidity)
- Rational expectations. Rules out fluctuations due to non-fundamental movements
- Many firms have alternative means of financing. The share of firms dependent on bank finance might not be that significant
- Household credit affecting consumption might be more important.