A Model with Costly-State Verification

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- Tradition of financial accelerator of Bernanke, Gertler, and Gilchrist (1999), Carlstrom and Fuerst (1997), and Christiano, Motto, and Rostagno (2009).

- Elements:

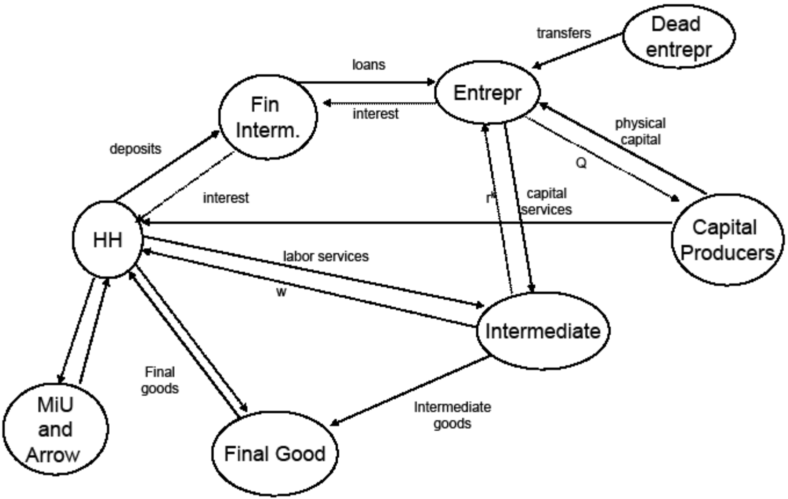
  1. Information asymmetries between lenders and borrowers$\Rightarrow$costly state verification (Townsend, 1979).

  2. Debt contracting in nominal terms: Fisher effect.

  3. Changing spreads.

- We will calibrate the model to reproduce some basic observations of the U.S. economy.

Flowchart of the Model



Households

- Representative household:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t e^{d_t} \left\{ u\left(c_t, l_t\right) + \upsilon \log\left(\frac{m_t}{p_t}\right) \right\}$$

- d_t is an intertemporal preference shock with law of motion:

$$d_t = \rho_d d_{t-1} + \sigma_d \varepsilon_{d,t},\ \varepsilon_{d,t} \sim \mathcal{N}(0, 1).$$

- Why representative household? Heterogeneity?

Asset Structure

- The household saves on three assets:

  1. Money balances, m_t.
  2. Deposits at the financial intermediary, a_t, that pay an uncontingent nominal gross interest rate R_t.
  3. Arrow securities (net zero supply in equilibrium).

- Therefore, the household's budget constraint is:

$$c_t + \frac{a_t}{p_t} + \frac{m_{t+1}}{p_t} = w_t l_t + R_{t-1} \frac{a_{t-1}}{p_t} + \frac{m_t}{p_t} + T_t + F_t + tre_t$$

where:

$$tre_t = \left(1 - \gamma^e\right) n_t - w^e$$

Optimality Conditions

- The first-order conditions for the household are:

$$e^{d_t} u_1(t) = \lambda_t$$
$$\lambda_t = \beta \mathbb{E}_t \left\{ \lambda_{t+1} \frac{R_t}{\Pi_{t+1}} \right\}$$
$$-u_2(t) = u_1(t) w_t$$

- Asset pricing kernel:

$$SDF_t = \mathbb{E}_t \beta \frac{\lambda_{t+1}}{\lambda_t}$$

and standard non-arbitrage conditions.

The Final Good Producer

- Competitive final producer with technology

$$y_t = \left(\int_0^1 y_{it}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}.$$

- Thus, the input demand functions are:

$$y_{it} = \left(\frac{p_{it}}{p_t} \right)^{-\varepsilon} y_t \qquad \forall i,$$

- Price level:

$$p_t = \left(\int_0^1 p_{it}^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}}.$$

Intermediate Goods Producers

- Continuum of intermediate goods producers with market power.

- Technology:

$$y_{it} = e^{z_t} k_{it-1}^{\alpha} l_{it}^{1-\alpha}$$

where

$$z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_{z,t},\ \varepsilon_{z,t} \sim \mathcal{N}(0,1)$$

- Cost minimization implies:

$$mc_t = \left(\frac{1}{1-\alpha}\right)^{1-\alpha} \left(\frac{1}{\alpha}\right)^{\alpha} \frac{w_t^{1-\alpha} r_t^{\alpha}}{e^{z_t}}$$

$$\frac{k_{t-1}}{l_t} = \frac{\alpha}{1-\alpha} \frac{w_t}{r_t}$$

Sticky Prices

- Calvo pricing: in each period, a fraction $1-\theta$ of firms can change their prices while all other firms keep the previous price.

- Then, the relative reset price $\Pi_t^* = p_t^* / p_t$ satisfies:

$$\varepsilon g_t^1 = (\varepsilon - 1) g_t^2$$
$$g_t^1 = \lambda_t mc_t y_t + \beta\theta \mathbb{E}_t \Pi_{t+1}^{\varepsilon} g_{t+1}^1$$
$$g_t^2 = \lambda_t \Pi_t^* y_t + \beta\theta \mathbb{E}_t \Pi_{t+1}^{\varepsilon-1} \left(\frac{\Pi_t^*}{\Pi_{t+1}^*} \right) g_{t+1}^2$$

- Given Calvo pricing, the price index evolves as:

$$1 = \theta \Pi_t^{\varepsilon-1} + (1-\theta) \Pi_t^{*1-\varepsilon}$$

Capital Good Producers I

- Capital is produced by a perfectly competitive capital good producer.
- Why?
- It buys installed capital, x_t, and adds new investment, i_t, to generate new installed capital for the next period:

$$x_{t+1} = x_t + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t$$

where $S[1] = 0$, $S'[1] = 0$, and $S''[\cdot] > 0$.

- Alternative:
  1. Adjustment cost in capital.
  2. Time to build.

Capital Good Producers II

- Technology illiquidity.
- Importance of irreversibilities?
- The period profits of the firm are:

$$q_t \left(x_t + \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t \right) - q_t x_t - i_t = q_t \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t - i_t$$

where q_t is the relative price of capital.

Capital Good Producers III

- Discounted profits:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left(q_t \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t - i_t \right)$$

Since this objective function does not depend on x_t, we can make it equal to $(1-\delta)\, k_{t-1}$.

- First-order condition of this problem is:

$$q_t \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] - S' \left[\frac{i_t}{i_{t-1}} \right] \frac{i_t}{i_{t-1}} \right) + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} q_{t+1} S' \left[\frac{i_{t+1}}{i_t} \right] \left(\frac{i_{t+1}}{i_t} \right)^2 = 1$$

and the law of motion for capital is:

$$k_t = (1-\delta)\, k_{t-1} + \left(1 - S \left[\frac{i_t}{i_{t-1}} \right] \right) i_t$$

Entrepreneurs I

- Entrepreneurs use their (end-of-period) real wealth, n_t, and a nominal bank loan b_t, to purchase new installed capital k_t:

$$q_t k_t = n_t + \frac{b_t}{p_t}$$

- The purchased capital is shifted by a productivity shock ω_{t+1}:
  1. Lognormally distributed with CDF $F(\omega)$ and
  2. Parameters $\mu_{\omega,t}$ and $\sigma_{\omega,t}$
  3. $\mathbb{E}_t \omega_{t+1} = 1$ for all t.

- Therefore:

$$\mathbb{E}_t \omega_{t+1} = e^{\mu_{\omega,t+1} + \frac{1}{2}\sigma^2_{\omega,t+1}} = 1 \Rightarrow \mu_{\omega,t+1} = -\frac{1}{2}\sigma^2_{\omega,t+1}$$

- This productivity shock is a stand-in for more complicated processes such as changes in demand or the stochastic quality of projects.

Entrepreneurs II

- The standard deviation of this productivity shock evolves:

$$\log \sigma_{\omega,t} = (1-\rho_\sigma)\log \sigma_\omega + \rho_\sigma \log \sigma_{\omega,t-1} + \eta_\sigma \varepsilon_{\sigma,t},\ \varepsilon_{\sigma,t} \sim \mathcal{N}(0,1).$$

- The shock $t+1$ is revealed at the end of period t right before investment decisions are made. Then:

$$\log \sigma_{\omega,t} - \log \sigma_\omega = \rho_\sigma \left(\log \sigma_{\omega,t-1} - \log \sigma_\omega\right) + \eta_\sigma \varepsilon_{\sigma,t}$$
$$\Rightarrow \widehat{\sigma}_{\omega,t} = \rho_\sigma \widehat{\sigma}_{\omega,t-1} + \eta_\sigma \varepsilon_{\sigma,t}$$

- More general point: stochastic volatility.

Entrepreneurs III

- The entrepreneur rents the capital to intermediate goods producers, who pay a rental price r_{t+1}.

- Also, at the end of the period, the entrepreneur sells the undepreciated capital to the capital goods producer at price q_{t+1}.

- Therefore, the average return of the entrepreneur per nominal unit invested in period t is:

$$R_{t+1}^{k} = \frac{p_{t+1}}{p_t} \frac{r_{t+1} + q_{t+1}(1-\delta)}{q_t}$$

Debt Contract

- Costly state verification framework.
- For every state with associated R^k_{t+1}, entrepreneurs have to either:
  1. Pay a state-contingent gross nominal interest rate R^l_{t+1} on the loan.
  2. Or default.
- If the entrepreneur defaults, it gets nothing: the bank seizes its revenue, although a portion μ of that revenue is lost in bankruptcy.
- Hence, the entrepreneur will always pay if it $\omega_{t+1} \geq \overline{\omega}_{t+1}$ where:

$$R^l_{t+1} b_t = \overline{\omega}_{t+1} R^k_{t+1} p_t q_t k_t$$

- If $\omega_{t+1} < \overline{\omega}_{t+1}$, the entrepreneur defaults, the bank monitors the entrepreneur and gets $(1 - \mu)$ of the entrepreneur's revenue.

Zero Profit Condition

- The debt contract determines R^l_{t+1} to be the return such that banks satisfy its zero profit condition in all states of the world:

$$\underbrace{\left[1 - F\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)\right] R^l_{t+1} b_t}_{\text{Revenue if loan pays}}$$

$$\underbrace{+(1-\mu)\int_0^{\overline{\omega}_{t+1}} \omega dF\left(\omega, \sigma_{\omega,t+1}\right) R^k_{t+1} p_t q_t k_t}_{\text{Revenue if loan defaults}} = \underbrace{s_t R_t b_t}_{\text{Cost of funds}}$$

- $s_t = 1 + e^{\overline{s} + \widetilde{s}_t}$ is a spread caused by the cost of intermediation such that:

$$\widetilde{s}_t = \rho_s \widetilde{s}_{t-1} + \sigma_s \varepsilon_{s,t},\ \varepsilon_{s,t} \sim \mathcal{N}(0,1).$$

- For simplicity, intermediation costs are rebated to the households in a lump-sum fashion.

- External finance premium.

Optimality of the Contract

- This debt contract is not necessarily optimal.
- However, it is a plausible representation for a number of nominal debt contracts that we observe in the data.
- Also, the nominal structure of the contract creates a Fisher effect through which changes in the price level have an impact on real investment decisions.
- Importance of working out the optimal contract.

Characterizing the Contract I

- Define share of entrepreneurial earnings accrued to the bank:

$$\Gamma\left(\overline{\omega}_{t+1},\sigma_{\omega,t+1}\right)=\overline{\omega}_{t+1}\left(1-F\left(\overline{\omega}_{t+1},\sigma_{\omega,t+1}\right)\right)+G\left(\overline{\omega}_{t+1},\sigma_{\omega,t+1}\right)$$

where:

$$G\left(\overline{\omega}_{t+1},\sigma_{\omega,t+1}\right)=\int_{0}^{\overline{\omega}_{t+1}}\omega dF\left(\omega,\sigma_{\omega,t+1}\right)$$

- Thus, we can rewrite the zero profit condition of the bank as:

$$\frac{R_{t+1}^{k}}{s_t R_t}\left[\Gamma\left(\overline{\omega}_{t+1},\sigma_{\omega,t+1}\right)-\mu G\left(\overline{\omega}_{t+1},\sigma_{\omega,t+1}\right)\right]q_t k_t=\frac{b_t}{p_t}$$

which gives a schedule relating R_{t+1}^{k} and $\overline{\omega}_{t+1}$.

Characterizing the Contract II

- Now, define the ratio of loan over wealth:

$$\varrho_t = \frac{b_t / p_t}{n_t} = \frac{q_t k_t - n_t}{n_t} = \frac{q_t k_t}{n_t} - 1$$

- and we get

$$\frac{R^k_{t+1}}{s_t R_t} \left[\Gamma \left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1} \right) - \mu G \left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1} \right) \right] \left(1 + \varrho_t \right) = \varrho_t$$

  that is, all the entrepreneurs, regardless of their level of wealth, will have the same leverage, ϱ_t.

- A most convenient feature for aggregation.

- Balance sheet effects.

Problem of the Entrepreneur

- Maximize its expected net worth given the zero-profit condition of the bank:

$$\max_{\varrho_t, \overline{\omega}_{t+1}} \mathbb{E}_t \left\{ \begin{array}{c} \frac{R^k_{t+1}}{R_t} \left(1 - \Gamma\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)\right) + \\ \eta_t \left[\frac{R^k_{t+1}}{s_t R_t} \left[\Gamma\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right) - \mu G\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)\right] - \frac{\varrho_t}{1+\varrho_t} \right] \end{array} \right\}$$

- After a fair amount of algebra:

$$\mathbb{E}_t \frac{R^k_{t+1}}{R_t} \left(1 - \Gamma\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)\right) = \mathbb{E}_t \eta_t \frac{n_t}{q_t k_t}$$

where the Lagrangian multiplier is:

$$\eta_t = \frac{s_t \Gamma_\omega\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)}{\Gamma_\omega\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right) - \mu G_\omega\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)}$$

- This expression shows how changes in net wealth have an effect on the level of investment and output in the economy.

Death and Resurrection

- At the end of each period, a fraction γ^e of entrepreneurs survive to the next period and the rest die and their capital is fully taxed.

- They are replaced by a new cohort of entrepreneurs that enter with initial real net wealth w^e (a transfer that also goes to surviving entrepreneurs).

- Therefore, the average net wealth n_t is:

$$n_t = \gamma^e \frac{1}{\Pi_t} \left[\left(1 - \mu G\left(\overline{\omega}_t, \sigma_{\omega,t}\right)\right) R_t^k q_{t-1} k_{t-1} - s_{t-1} R_{t-1} \frac{b_{t-1}}{p_{t-1}} \right] + w^e$$

- The death process ensures that entrepreneurs do not accumulate enough wealth so as to make the financing problem irrelevant.

The Financial Intermediary

- A representative competitive financial intermediary.
- We can think of it as a bank but it may include other financial firms.
- Intermediates between households and entrepreneurs.
- The bank:
    1. Lends to entrepreneurs a nominal amount b_t at rate R^l_{t+1},
    2. But recovers only an (uncontingent) rate R_t because of default and the (stochastic) intermediation costs.
    3. Thus, the bank pays interest R_t to households.

The Monetary Authority Problem

- Conventional Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left(\frac{\Pi_t}{\Pi}\right)^{\gamma_\Pi (1-\gamma_R)} \left(\frac{y_t}{y}\right)^{\gamma_y (1-\gamma_R)} \exp\left(\sigma_m m_t\right)$$

  through open market operations that are financed through lump-sum transfers T_t.

- The variable Π represents the target level of inflation (equal to inflation in the steady-state), y is the steady state level of output, and $R = \frac{\Pi}{\beta}$ the steady state nominal gross return of capital.

- The term ε_{mt} is a random shock to monetary policy distributed according to $\mathcal{N}(0, 1)$.

Aggregation

- Using conventional arguments, we find expressions for aggregate demand and supply:

$$y_t = c_t + i_t + \mu G\left(\overline{\omega}_t, \sigma_{\omega,t}\right)\left(r_t + q_t\left(1-\delta\right)\right)k_{t-1}$$

$$y_t = \frac{1}{v_t} e^{z_t} k_{t-1}^{\alpha} l_t^{1-\alpha}$$

where $v_t = \int_0^1 \left(\frac{p_{it}}{p_t}\right)^{-\varepsilon} di$ is the inefficiency created by price dispersion.

- By the properties of Calvo pricing, v_t evolves as:

$$v_t = \theta \Pi_t^{\varepsilon} v_{t-1} + \left(1-\theta\right)\Pi_t^{*-\varepsilon}.$$

- We have steady state inflation Π. Hence, $\widehat{v}_t \neq 0$ and monetary policy has an impact on the level and evolution of measured productivity.

Equilibrium Conditions I

- The first-order conditions of the household:

$$e^{d_t} u_1(t) = \lambda_t$$

$$\lambda_t = \beta \mathbb{E}_t \{ \lambda_{t+1} \frac{R_t}{\Pi_{t+1}} \}$$

$$-u_2(t) = u_1(t) w_t$$

Equilibrium Conditions II

- The first-order conditions of the intermediate firms:

$$\varepsilon g_t^1 = (\varepsilon - 1) g_t^2$$

$$g_t^1 = \lambda_t mc_t y_t + \beta\theta \mathbb{E}_t \Pi_{t+1}^{\varepsilon} g_{t+1}^1$$

$$g_t^2 = \lambda_t \Pi_t^* y_t + \beta\theta \mathbb{E}_t \Pi_{t+1}^{\varepsilon-1} \left(\frac{\Pi_t^*}{\Pi_{t+1}^*} \right) g_{t+1}^2$$

$$k_{t-1} = \frac{\alpha}{1-\alpha} \frac{w_t}{r_t} l_t$$

$$mc_t = \left(\frac{1}{1-\alpha} \right)^{1-\alpha} \left(\frac{1}{\alpha} \right)^{\alpha} \frac{w_t^{1-\alpha} r_t^{\alpha}}{e^{z_t}}$$

Equilibrium Conditions III

- Price index evolves:

$$1 = \theta \Pi_t^{\varepsilon-1} + (1-\theta) \Pi_t^{*1-\varepsilon}$$

- Capital good producers:

$$q_t \left(1 - S\left[\frac{i_t}{i_{t-1}}\right] - S'\left[\frac{i_t}{i_{t-1}}\right]\frac{i_t}{i_{t-1}}\right)$$

$$+\beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} q_{t+1} S'\left[\frac{i_{t+1}}{i_t}\right]\left(\frac{i_{t+1}}{i_t}\right)^2 = 1$$

$$k_t = (1-\delta) k_{t-1} + \left(1 - S\left[\frac{i_t}{i_{t-1}}\right]\right) i_t$$

Equilibrium Conditions IV

- Entrepreneur problem:

$$R^k_{t+1} = \Pi_{t+1} \frac{r_{t+1} + q_{t+1}(1-\delta)}{q_t}$$

$$\frac{R^k_{t+1}}{s_t R_t} \left[\Gamma\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right) - \mu G\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right) \right] = \frac{q_t k_t - n_t}{q_t k_t}$$

$$\mathbb{E}_t \frac{R^k_{t+1}}{R_t} \left(1 - \Gamma\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)\right) =$$

$$\left(\mathbb{E}_t s_t \frac{1 - F\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)}{1 - F\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right) - \mu \overline{\omega}_{t+1} F_\omega\left(\overline{\omega}_{t+1}, \sigma_{\omega,t+1}\right)} \right) \frac{n_t}{q_t k_t}$$

$$R^l_{t+1} b_t = \overline{\omega}_{t+1} R^k_{t+1} p_t q_t k_t$$

$$q_t k_t = n_t + \frac{b_t}{p_t}$$

$$n_t = \gamma^e \frac{1}{\Pi_t} \left[\left(1 - \mu G\left(\overline{\omega}_t, \sigma_{\omega,t}\right)\right) R^k_t q_{t-1} k_{t-1} - s_{t-1} R_{t-1} \frac{b_{t-1}}{p_{t-1}} \right] + w^e$$

Equilibrium Conditions V

- The government follows its Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left(\frac{\Pi_t}{\Pi}\right)^{\gamma_\Pi (1-\gamma_R)} \left(\frac{y_t}{y}\right)^{\gamma_y (1-\gamma_R)} \exp\left(\sigma_m m_t\right)$$

- Market clearing

$$y_t = c_t + i_t + \mu G\left(\overline{\omega}_t, \sigma_{\omega,t}\right)\left(r_t + q_t\left(1-\delta\right)\right) k_{t-1}$$

$$y_t = \frac{1}{v_t} e^{z_t} k_{t-1}^{\alpha} l_t^{1-\alpha}$$

$$v_t = \theta \Pi_t^{\varepsilon} v_{t-1} + \left(1-\theta\right) \Pi_t^{*-\varepsilon}$$

Equilibrium Conditions VI

- Stochastic processes:

$$d_t = \rho_d d_{t-1} + \sigma_d \varepsilon_{d,t}$$
$$z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_{z,t}$$
$$s_t = 1 + e^{\overline{s} + \widetilde{s}_t}$$
$$\widetilde{s}_t = \rho_s \widetilde{s}_{t-1} + \sigma_s \varepsilon_{s,t}$$
$$\log \sigma_{\omega,t} = (1 - \rho_\sigma) \log \sigma_\omega + \rho_\sigma \log \sigma_{\omega,t-1} + \eta_\sigma \varepsilon_{\sigma,t}$$

Calibration

- Utility function:

$$u(c_t, l_t) = \log c_t - \psi \frac{l_t^{1+\vartheta}}{1+\vartheta}$$

ψ: households work one-third of their available time in the steady state and $\vartheta = 0.5$, inverse of Frisch elasticity.

- Technology:

α	δ	ε	$S''[1]$
0.33	0.023	8.577	14.477

- Entrepreneur:

μ	σ_ω	w^e	$\bar{s}$
0.15	2.528	$\frac{n}{n-k} \approx 2$	$25bp.$

- For the Taylor rule, $\Pi = 1.005$, $\gamma_R = 0.95$, $\gamma_\Pi = 1.5$, and $\gamma_y = 0.1$ are conventional values.
- For the stochastic processes, all the autoregressive are 0.95.

Computation

- We can find the deterministic steady state.
- We linearize around this steady state.
- We solve using standard procedures.
- Alternatives:
  1. Non-linear solutions.
  2. Estimation using likelihood methods.

Figure 3.1: Shock to Preferences, 1

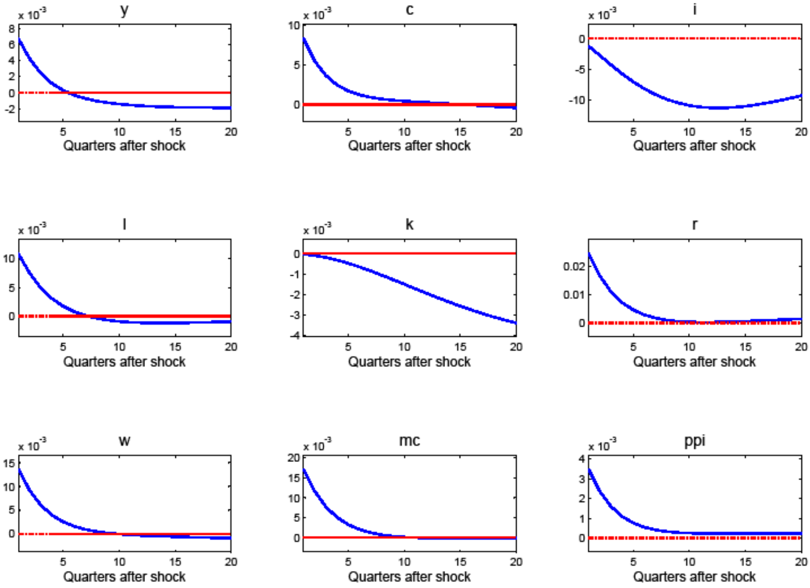


Figure 3.2: Shock to Preferences, 2

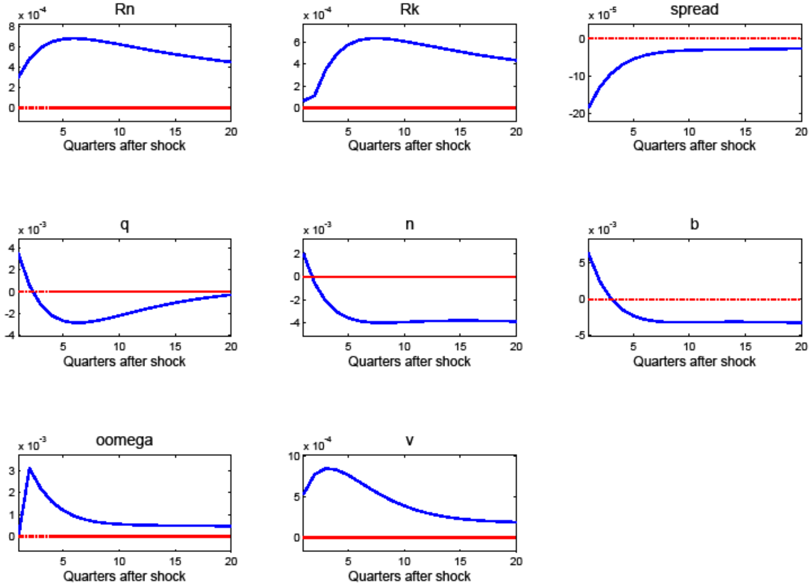


Figure 3.3: Shock to Productivity, 1

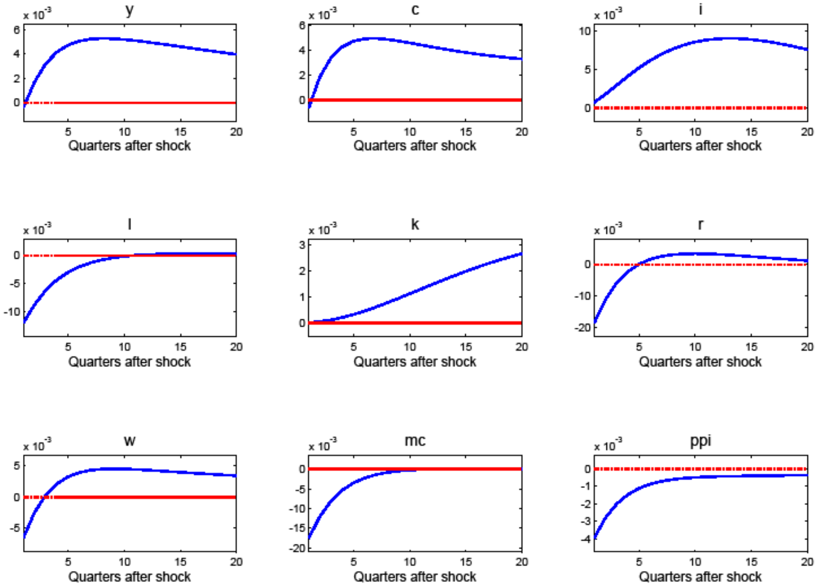


Figure 3.4: Shock to Productivity, 2

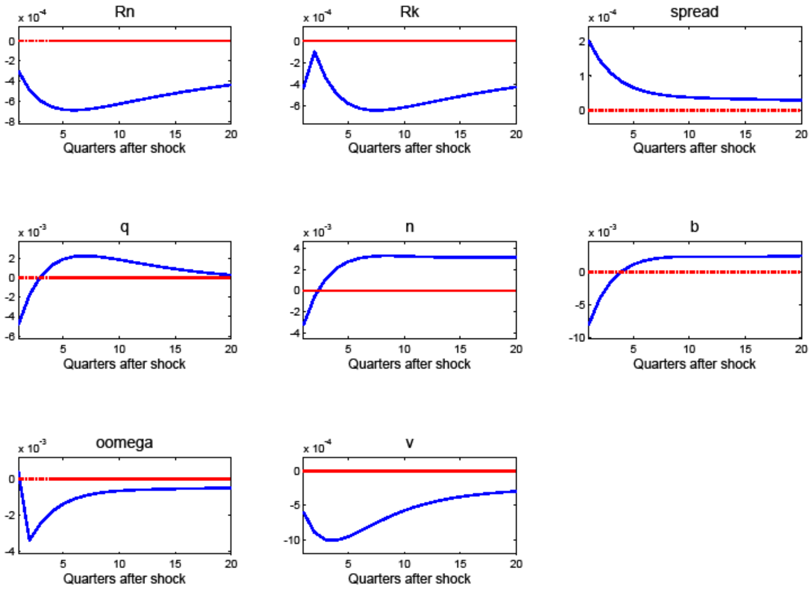


Figure 3.5: Shock to Volatility, 1

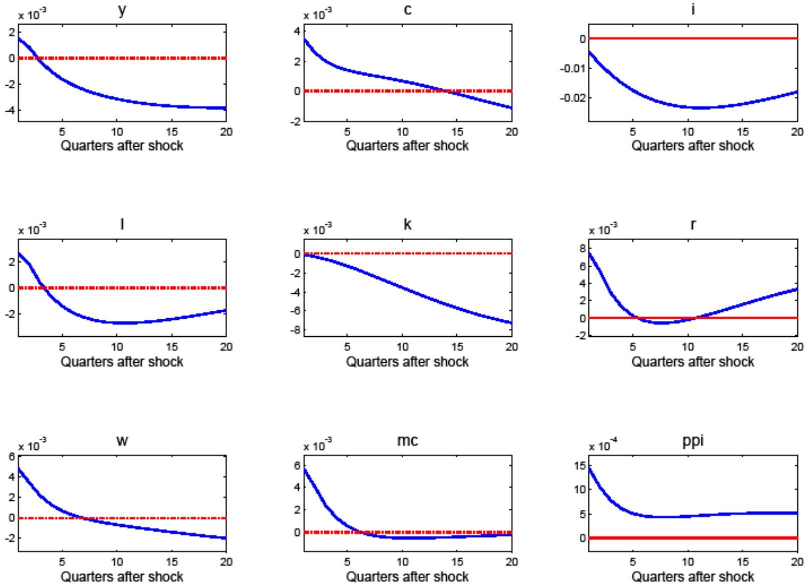


Figure 3.6: Shock to Volatility, 2

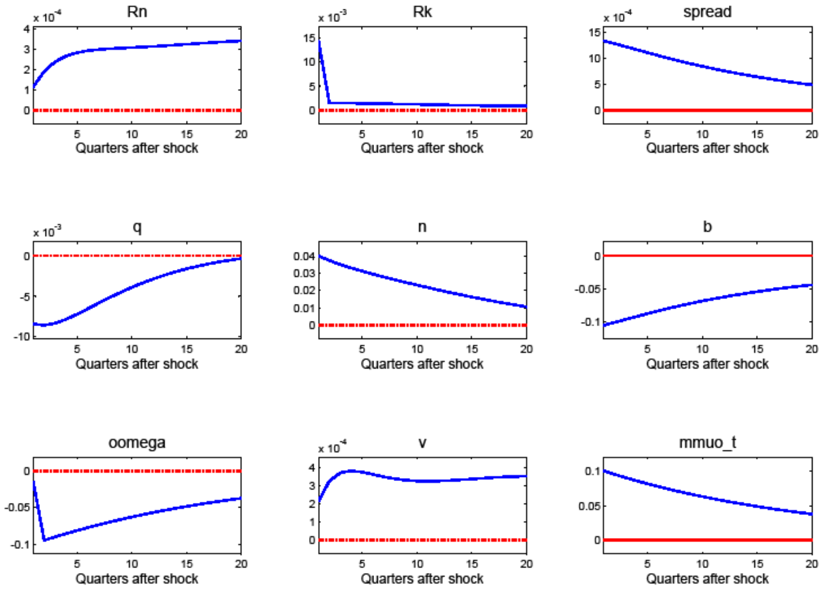


Figure 3.7: Shock to Spread, 1

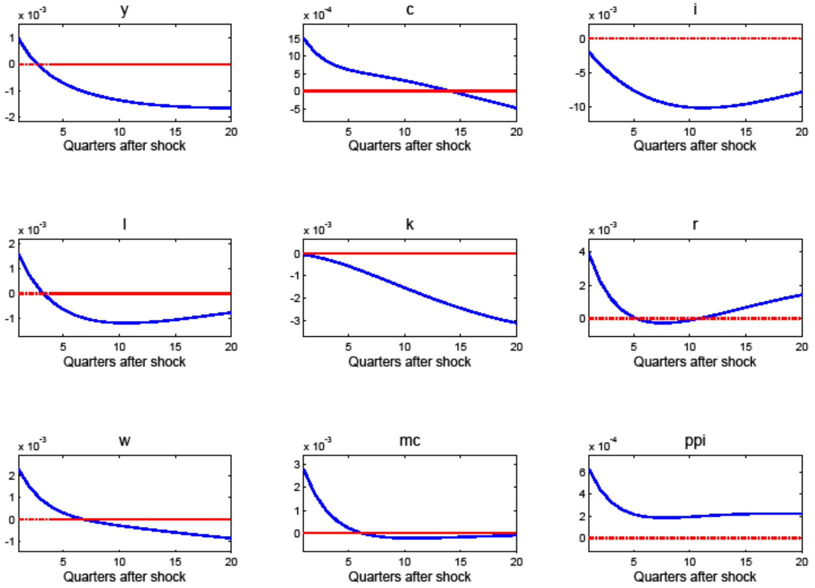
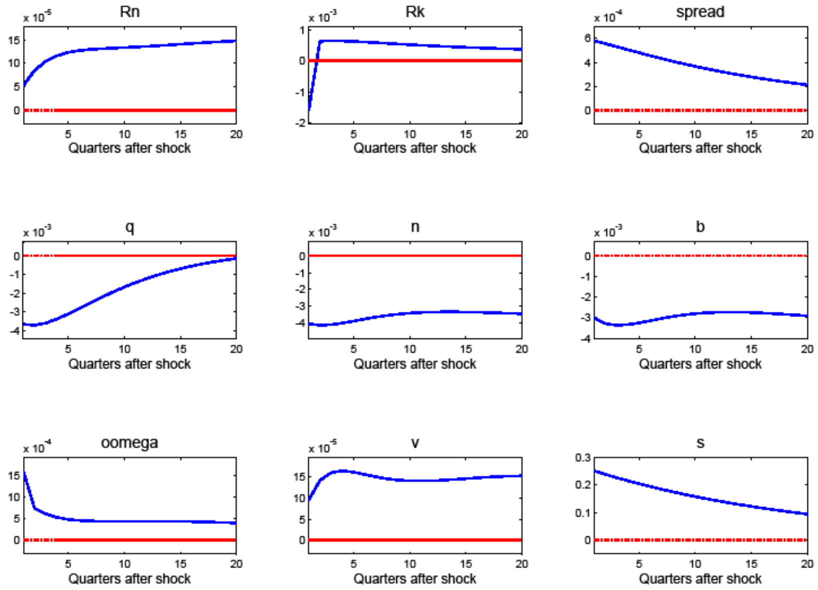


Figure 3.8: Shock to Spread, 2



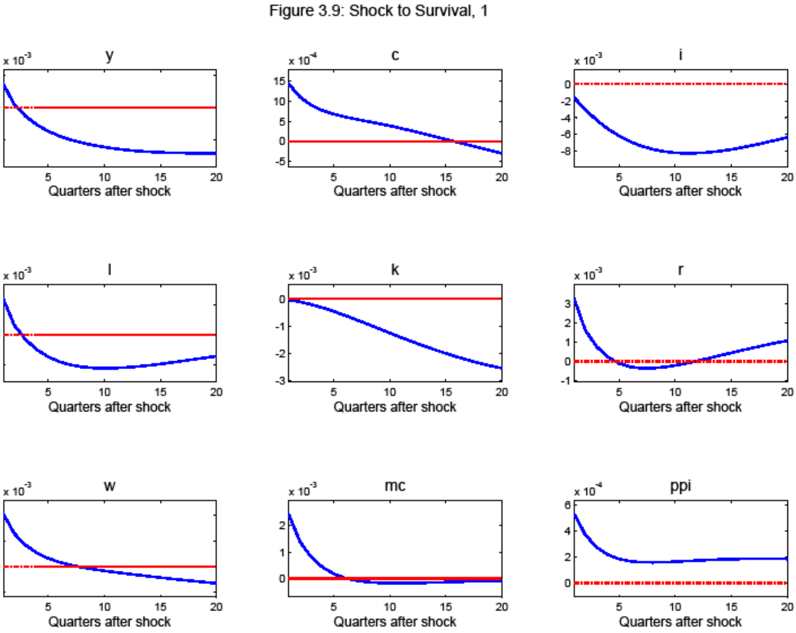


Figure 3.9: Shock to Survival, 1
y
c
i
l
k
r
w
mc
ppi
x 10^-3
x 10^-4
Quarters after shock

Figure 3.10: Shock to Survival, 2

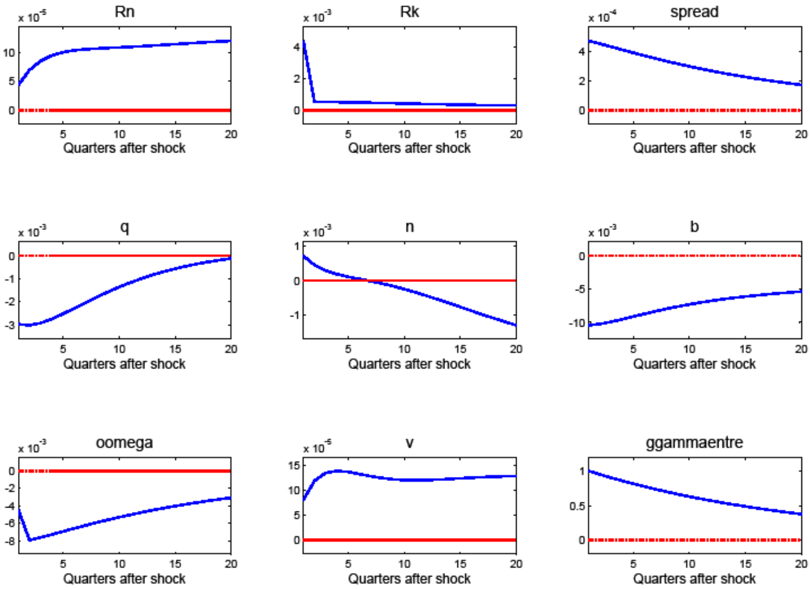


Figure 3.11: Shock to Monetary Policy, 1

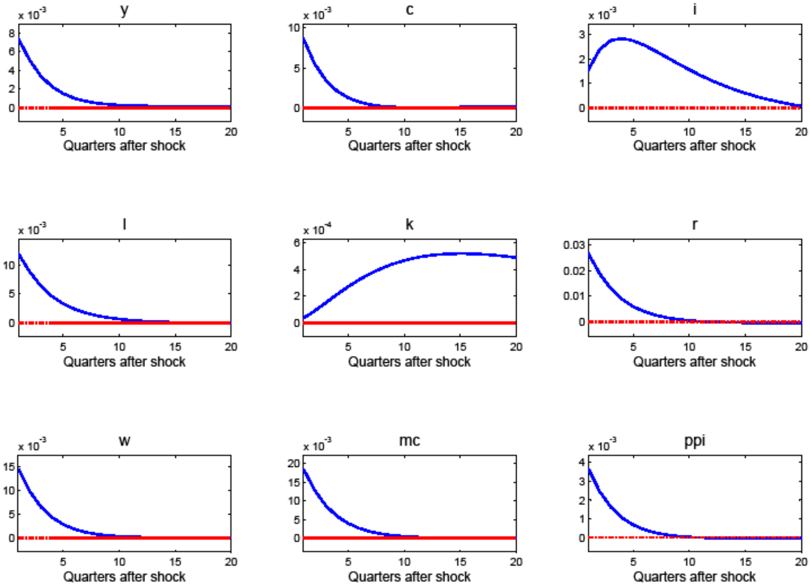
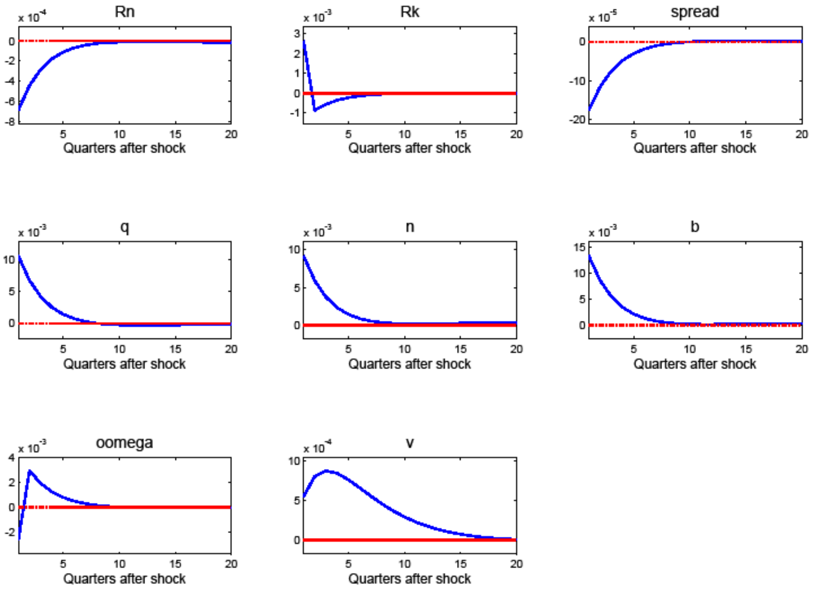


Figure 3.12: Shock to Monetary Policy, 2



How Can We Use the Model?

- Christiano, Motto, and Rostagno (2003): Great depression.
- Christiano, Motto, and Rostagno (2008): Business cycle fluctuations.
- Fernández-Villaverde and Ohanian (2009): Spanish crisis of 2008-2010.
- Fernández-Villaverde (2010): fiscal policy.

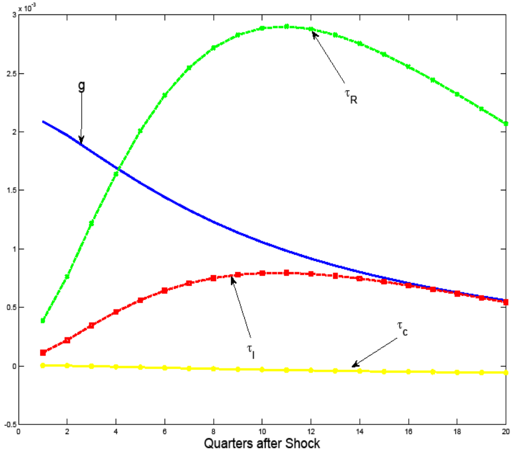


Figure: IRFs of Output to Different Fiscal Policy Shocks