Macroeconomics Effects of Financial Shocks

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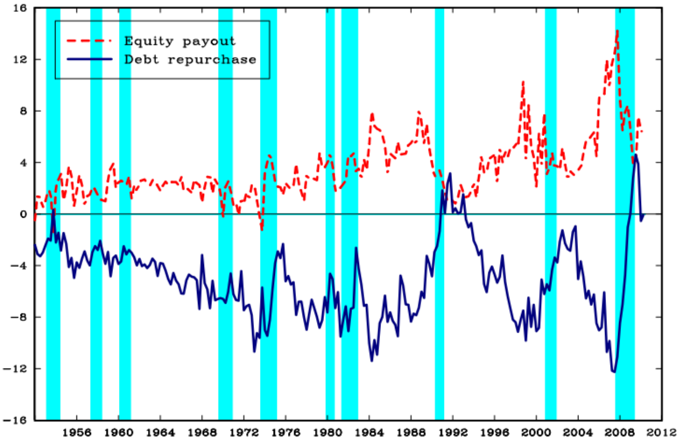
Outline

The question

- They build a model to replicate, simultaneously, real aggregate variables and aggregate flows of financing (debt and equity)
- Central feature of the model: pecking order in the financial decision of firms between equity and debt
  - debt is preferred to equity but firms' ability to borrow is limited by an enforcement constraint
  - enforcement constraint is subject to random disturbances
- Financial shocks are important to explain the dynamics of i) financial variables and ii) real variables.
- The impact on the real variables is through the impact on the demand of labor.

Financial cycle in the U.S economy



Outline

Firms sector I

- Gross revenue function $F(z_t, k_t, n_t) = z_t k_t^\theta n_t^{1-\theta}$
- z_t is stochastic
- Capital law of motion $k_{t+1} = (1-\delta)k_t + i_t$
- Firms use equity and intertemporal debt b_t. Debt is preferred to equity because

  $R_t = 1 + r_t(1-\tau)$

- In addition to intertemporal debt b_t, firms raise funds with an intratemporal loan l_t (without interests) to finance working capital

  $$l_t = w_t n_t + i_t + d_t + b_t - b_{t+1}/R_t.$$

- Note that from the budget constraint

  $$l_t = F(z_t, k_t, n_t)$$

  so the intraperiod loan is related to the scale of production

Firms sector II: Derivation of the enforcement constraint

- The ability to borrow (intra and inter-temporally) is bounded by the limited enforcebility of debt contracts
- Firms can default on their obligations
    - after the realization of revenues but before repaying the intra-period loan. Liabilities: $l_t + b_{t+1}/(1+r_t)$
    - liquidity $F(z_t, k_t, n_t)$can be easily diverted so that the only asset available for liquidation is k_{t+1}
- The enforcement constraint is

$$\xi_t \left(k_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \geq l_t$$

where ξ_t is the probability the lender can recover the full value k_{t+1}. With prob. $1-\xi_t$, the recovery value is zero.

Firms sector II: Derivation of the enforcement constraint

- Where does the enforcement constrain come from?
  - When contracting the loan, the liquidation value $k_{t+1}$is uncertain for both the firm and the lender
  - If the liquidation value is k_{t+1}, the firm has to make the payment $k_{t+1} - \frac{b_{t+1}}{1+r}$ and promise to repay b_{t+1} at $t+1$
    - Ex-post value of defaulting (with ξ_t) is: $l_t + Em_{t+1}V_{t+1} - \left(k_{t+1} - \frac{b_{t+1}}{1+r_t}\right)$
  - If the liquidation value is 0, the best option for the lender is to wait until next period when b_{t+1} is due.
    - Ex-post value of defaulting (with $1-\xi_t$) is: $l_t + Em_{t+1}V_{t+1}$

Firms sector II: Derivation of the enforcement constraint

- Expected liquidation value
  $\xi_t \left(l_t + Em_{t+1} V_{t+1} - \left(k_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \right) + (1 - \xi_t)(l_t + Em_{t+1} V_{t+1})$
- To prevent default in equilibrium:
  $Em_{t+1} V_{t+1} \geq \xi_t \left(l_t + Em_{t+1} V_{t+1} - \left(k_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \right) + (1 - \xi_t)(l_t + Em_{t+1} V_{t+1})$
- and this results in
  $$\xi_t \left(k_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \geq l_t$$

Intuition

- We rewrite the enforcement constraint
$$\left(\frac{\xi_t}{1-\xi_t}\right)\left[(1-\delta)k_t - b_t - w_t n_t - d_t\right] \geq F(z_t, k_t, n_t)$$
- Suppose is binding. k_t and $b_t$are given.
- If the firm wants to keep the production and if $\downarrow \xi_t$, then $\downarrow d_t$
- But if the firm cannot reduce d_t(because is costly), then it has to cut n_t
- Whether the financial shocks hit employment or not depends on the cost associated to change the financial structure
- To formalize this, given d_t we can assume that the actual cost of the firm is
$\varphi(d_t) = d_t + \kappa \cdot (d_t - \bar{d})^2$
    - so that if $\kappa > 0$, then substitution between debt and equity becomes costly.

Problem of the firm

$$V(\mathbf{s}; k, b) = \max_{d,n,k',b'} \left\{ d + Em'V(\mathbf{s}'; k', b') \right\}$$

subject to:

$$(1-\delta)k + F(z,k,n) - wn + \frac{b'}{R} = b + \varphi(d) + k'$$

$$\xi \left(k' - \frac{b'}{1+r} \right) \geq F(z,k,n).$$

Problem of the firm II (FOCs)

$$F_n(z,k,n) = w \cdot \left(\frac{1}{1-\mu\varphi_d(d)}\right),$$

$$E\, m' \cdot \left(\frac{\varphi_d(d)}{\varphi_d(d')}\right)\left[1-\delta+\Big(1-\mu'\varphi_d(d')\Big)F_k(z',k',n')\right]+\xi\mu\varphi_d(d)=1,$$

$$RE\, m' \cdot \left(\frac{\varphi_d(d)}{\varphi_d(d')}\right)+\xi\mu\varphi_d(d)\left(\frac{R}{1+r}\right)=1,$$

- Suppose $\kappa = 0$, then the second FOC becomes $REm' + \xi\mu R/(1+r) = 1$
- $\downarrow \xi_t \Rightarrow \uparrow \mu$
- And this impact on labor through the first FOC: $\downarrow n$

Households sector

They maximize $E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, n_t)$
subject to

$$w_t n_t + b_t + s_t(d_t + p_t) = \frac{b_{t+1}}{1 + r_t} + s_{t+1} p_t + c_t + T_t$$

General Equilibrium

DEFINITION 1 (Recursive equilibrium): *A recursive competitive equilibrium is defined as a set of functions for (i) households' policies* $c^h(\mathbf{s})$, $n^h(\mathbf{s})$ *and* $b^h(\mathbf{s})$*; (ii) firms' policies* $d(\mathbf{s};k,b)$, $n(\mathbf{s};k,b)$, $k(\mathbf{s};k,b)$ *and* $b(\mathbf{s};k,b)$*; (iii) firms' value* $V(\mathbf{s};k,b)$*; (iv) aggregate prices* $w(\mathbf{s})$, $r(\mathbf{s})$ *and* $m(\mathbf{s},\mathbf{s}')$*; (v) law of motion for the aggregate states* $\mathbf{s}' = \Psi(\mathbf{s})$*. Such that: (i) household's policies satisfy conditions (7)-(8); (ii) firms' policies are optimal and* $V(\mathbf{s};k,b)$ *satisfies the Bellman's equation (3); (iii) the wage and interest rates clear the labor and bond markets and* $m(\mathbf{s},\mathbf{s}') = \beta U_c(c',n')/U_c(c,n)$*; (iv) the law of motion* $\Psi(\mathbf{s})$ *is consistent with individual decisions and the stochastic processes for* z *and* ξ.

Two special cases to illustrate the properties of the model

1. Deterministic steady state
2. $\tau = 0$ and $\kappa = 0$

Deterministic steady state

Proposition: In a deterministic steady state, if $\tau > 0$, then the enforcement constraint is always binding

Proof: In a deterministic sstate, we have
$m = \frac{1}{1+r}$ and $\varphi_d(d) = \varphi_d(d') = 1$
and the FOC wrt debt simplifies to
$\frac{1+r(1-\tau)}{1+r}\left(1+\overline{\xi}\mu\right) = 1$ so that $\mu > 0$ (binding constraint)

- And in a stochastic steady state?

$\tau = 0$ and $\kappa = 0$

Proposition If $\tau = 0$ and $\kappa = 0$, then changes in ξ have no effect on n and k'

Proof

- If $\kappa = 0$, then $\varphi_d(d) = \varphi_d(d') = 1$
- If $\tau = 0$, then $R = 1 + r(1 - \tau) = 1 + r$
- combining $(1+r)Em' + \xi\mu = 1$ and $\frac{1}{1+r} = Em'$, we have $\xi\mu = 0$

- In that case, we are in a standard RBC model

Outline

Strategy for the quantitative analysis

- Quantitative effects of productivity and financial shocks
- They construct series for z_t and ξ_t using:

$$\hat{z}_t = \hat{y}_t - \theta\,\hat{k}_t - (1-\theta)\,\hat{n}_t$$

$$\xi_t\left(k_{t+1} - \frac{b_{t+1}}{1+r_t}\right) = y_t$$

  - Comment on this
    - To me they overestimate the shock because they assume that it is always binding. And if the overestimate the shock is natural to expect that the constraint in the model is going to bind.

- They estimate

$$\begin{pmatrix} \hat{z}_{t+1} \\ \hat{\xi}_{t+1} \end{pmatrix} = \mathbf{A}\begin{pmatrix} \hat{z}_t \\ \hat{\xi}_t \end{pmatrix} + \begin{pmatrix} \epsilon_{z,t+1} \\ \epsilon_{\xi,t+1} \end{pmatrix}$$

- κ is chosen to match the σ of $\frac{d}{y}$ in the model and in the data
- They solve by log-linearizing and simulate the model

Outline

Findings I

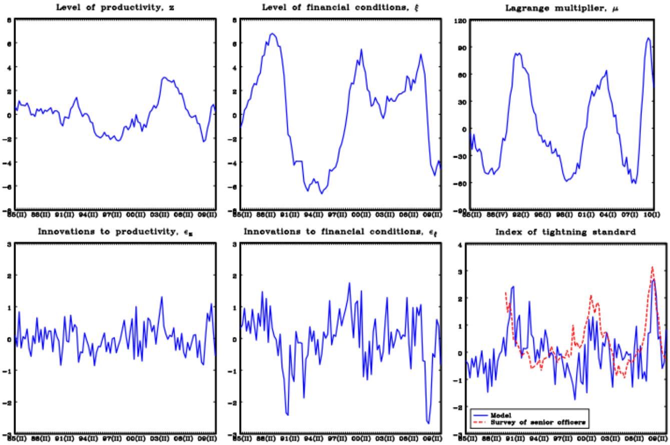


FIGURE 2. TIME SERIES OF SHOCKS TO PRODUCTIVITY AND FINANCIAL CONDITIONS.

Only productivity shocks

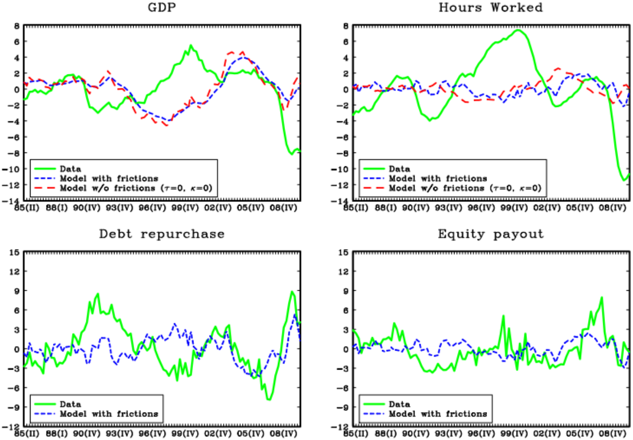


Figure 3. Response to productivity shocks only.

Both shocks

FIGURE 5. RESPONSE TO BOTH PRODUCTIVITY AND FINANCIAL SHOCKS.

Interpretation of working hours with $F_n(z,k,n) = w \cdot \left(\frac{1}{1-\mu\varphi_d(d)}\right)$