Credit Shocks and Aggregate Fluctuations in an Economy with Production Heterogeneity

Khan and Thomas (2011)

Discussion by Fernando Leibovici

Introduction

Question

- What are the aggregate real effects of a credit supply shock?
- Can it account for the dynamics of US aggregates at the onset of the crisis?

This paper

- Focus on interaction between investment and financial decisions
- Real effects of aggregate credit supply shocks depend crucially on
  - Use of external finance → Collateral constraints
  - Dynamics of investments to be financed → Partial capital irreversibility
- Write and calibrate model featuring these frictions, use it to study:
  - Credit supply shock vs US aggregate dynamics over the crisis vs TFP shock

Setup

Firms

- Unit measure
- Produce homogeneous output
- DRS technology $\rightarrow y = z\varepsilon F(k, n)$
- Own capital
- Idiosyncratic shocks
  - Productivity ε, AR(1)
  - Exit with exogenous probability η (replaced by new firm)
- Collateral constraints and partial capital irreversibility
- Cannot raise equity

Households

- Unit measure, homogeneous, own firms
- Cannot lend to or borrow from firms

Aggregate shocks

- Productivity z, AR(1)

Timing

1. Begin period in state $(k, b, \varepsilon; z, \mu)$
2. Learn whether survive to the next period
   - Public knowledge $\rightarrow$ If exit, then cannot borrow
3. All firms
   - Hire labor, produce, and pay wage bill
   - Pay debt / receive loan payments
4. Survivors
   - Invest $\rightarrow i$
   - Pay dividends $\rightarrow d$
   - Borrow / save $\rightarrow b'$
5. Households consume and reallocate ownership shares

Real and financial frictions

Partial capital irreversibility

- $k' = (1-\delta)k + i$
- If buy capital, $i \geq 0 \rightarrow$ Spend i units of the good
- If sell capital, $i < 0 \rightarrow$ Earn $\theta_k i$ units of the good, where $\theta_k \in [0,1]$

Borrowing constraint

- $b' \leq \theta_b \theta_k k$, where $\theta_b \geq 0$

Firms cannot issue equity

- Non-negative dividends $\rightarrow d \geq 0$

Financial markets

- Households and firms participate in segmented financial markets

Firms' problem

Start of the period

$$v(k,b,\varepsilon;z,\mu) = \eta v^{exit}(k,b,\varepsilon;z,\mu) + (1-\eta)v^{survive}(k,b,\varepsilon;z,\mu)$$

Exiting firms

$$v^{exit}(k,b,\varepsilon;z,\mu) = \max_n \; z\varepsilon F(k,n) - wn + \theta_k(1-\delta)k - b$$

Firms' problem (cont.)

Continuing firms

$$v^{survive}(k, b, \varepsilon; z, \mu) = \max_{n,k',b',d,i} d + E\left[m'v(k', b', \varepsilon'; z', \mu')\right]$$

subject to

$$d + \Phi(i)i + b + wn \leq z\varepsilon F(k, n) + qb'$$

$$k' = (1 - \delta)k + i$$

$$b' \leq \theta_b \theta_k k$$

$$d \geq 0$$

$$\mu' = \Gamma(z, \mu)$$

$$\Phi(i) \begin{cases} 1 & \text{if } i \geq 0 \\ \theta_k & \text{if } i < 0 \end{cases}$$

Households' problem

$$h(\lambda, z, \mu) = \max_{c, n^h, \tilde{\lambda}, \lambda'} U(c, 1-n) + \beta E\left[h(\lambda', z', \mu')\right]$$

subject to

$$c + \int_S \rho(k,b,\varepsilon)\tilde{\lambda}(k,b,\varepsilon) = wn^h + \int_S \left[\rho(k,b,\varepsilon) + d(k,b,\varepsilon)\right]\lambda(k,b,\varepsilon)$$

$$\mu' = \Gamma(z, \mu)$$

$$\lambda' = \Gamma(z, \tilde{\lambda})$$

Labor and capital accumulation

Labor choice is efficient

- Since wage bill paid after production takes place
- $z\varepsilon F_2(k, n) = w$

Capital accumulation follows two-sided (S, s) rules

- Partial irreversibility leads to
  1. Inaction region
  2. Lower adjustment, conditional on action
- Sunk component to investment decision decreases returns to adjustment
  - Due to negative future potential adjustments

Retained earnings vs dividends

- Bond interest rate equals the real interest rate $\rightarrow q = \frac{1}{E(m')}$
- Then, if borrowing constraint binds in some possible future state $\rightarrow d = 0$

Idea

- With non-binding borrowing constraint in all possible future states
  - Return to $b' = \frac{1}{E(m')}$, so indifferent between b' and d
  - Pick equilibrium with **minimum savings** such that constraints are non-binding in all possible future states of the world
  - These firms are **unconstrained**
- With binding constraint in some possible future state
  - Return to b' exceeds $\frac{1}{E(m')}$, so $d = 0$
  - b' pinned down from investment decision and budget constraint
  - These firms are **constrained**

Constrained firms: interaction between savings and investment

- New firms begin with low k and $b = 0 \rightarrow$ Constrained
- Conditional on productivity, gradual increase in debt and capital
  - To increase capital stock, need to borrow
  - To borrow, need to increase capital stock
- Productivity shocks may force firms with high debt to sell capital
  - If debt is high enough, forced to sell capital to repay it
- Firms will underinvest to increase savings, even if constraint doesn't bind
  - Reduce risk of being forced to sell off capital in the future
  - Reduce risk of forced underinvestment due to binding constraint

Stationary steady-state: Life-cycle dynamics

FIGURE 2. Cohort in steady state

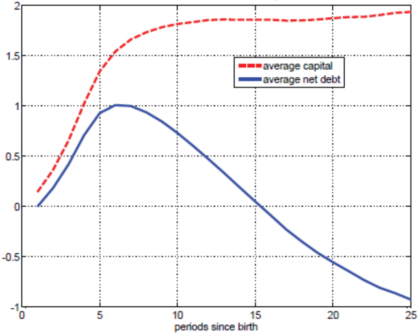
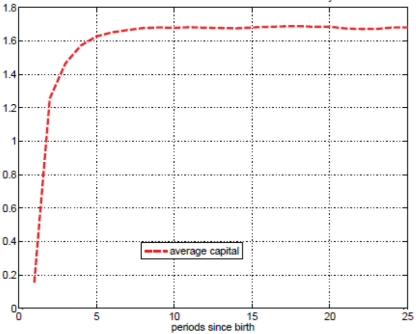


FIGURE 3. Cohort in no-financial-frictions steady state



Credit supply shock

Question

- What are the aggregate real effects of a credit supply shock?

The experiment

- Unexpected drop in θ_b
- Every subsequent period, agents expect θ_b back to normal with 40% probability

How do firms respond in partial eqm?

- Some unconstrained firms become constrained
- Those that remain unconstrained are not affected
- Constrained firms reduce investment, given ↑ risk of future binding constraint

→ Answer depends on the use of external finance, as well as the demand for finance

→ Discipline these to match key moments from US data

Calibration: key parameters

Parameter	Value	Moment	Value
θ_b	1.35	debt/assets ratio (US, 1952-2005 avg)	0.366
ρ_ε	0.653	i/k (avg across US plants)	0.122
σ_ε	0.135	$\sigma_{i/k}$ (avg across US plants)	0.337
θ_k	0.95	i/k autocorrelation (avg across US plants)	0.058

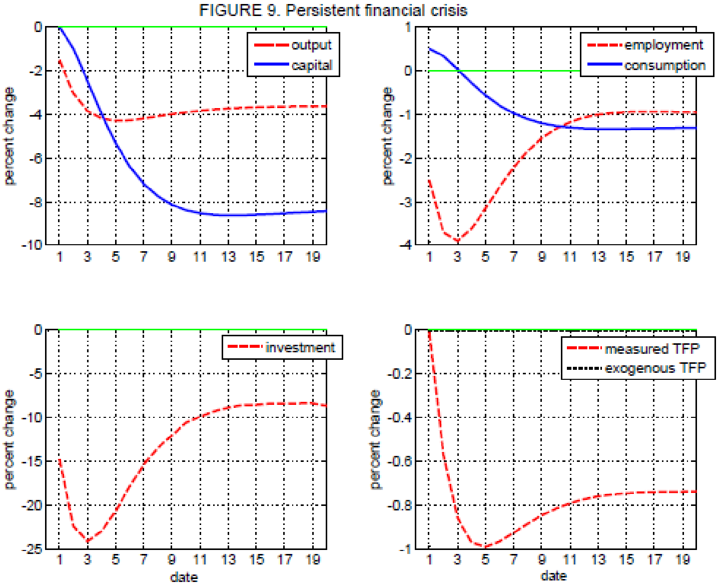
New firms

- $\eta = 0.10$
- $k_0 = \chi \int_S k\mu_{ss}(dS) \rightarrow \chi = 0.10 \rightarrow \approx$ relative size of new firms in data
- $b_0 = 0$

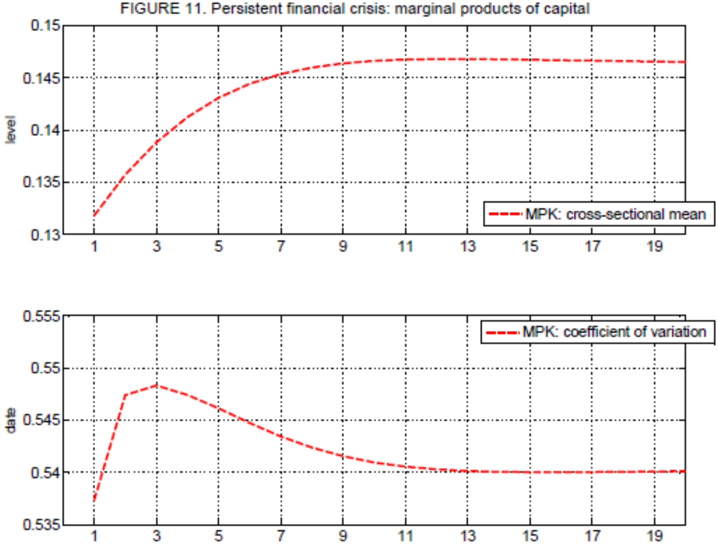
Functional forms

- $U(c, 1-n) = \log c + \phi(1-n)$
- Cobb-Douglas production function

Credit supply shock: θ_b from 1.35 to 0.8 with no recovery



Credit supply shock: misallocation and endogenous TFP fluctuations



Credit supply shock vs TFP shock vs US data

Credit supply shock vs US aggregate dynamics

TABLE 4. Peak-to-Trough Changes: U.S. 2007 Recession and Model

$x =$	GDP	I	N	C	TFP
Data	-4.14	-25.75	-6.89	-1.36	-0.60
Model (fig. 9)	-4.20	-22.98	-3.62	-0.58	-0.97

Negative exogenous TFP shock

- Similar response to shock as in frictionless economy
- No initial increase in C
- Need very large TFP shock to get drop in I and N as in the data
- Except for consumption, no hump-shaped response

Appendix

Capital accumulation

- FOC i with extra $i \geq 0$ constraint $\rightarrow -\gamma^{bc} + \gamma^{k} \leq 0$
- FOC i with extra $i \leq 0$ constraint $\rightarrow -\theta_k \gamma^{bc} + \gamma^{k} \geq 0$
- Then,

$$i = \begin{cases} i^{+} > 0 & \text{if } \gamma^{k} > \gamma^{bc} \\ = 0 & \text{if } \gamma^{k} \in \left[\theta_k \gamma^{bc}, \gamma^{bc}\right] \\ i^{-} < 0 & \text{if } \gamma^{k} < \theta_k \gamma^{bc} \end{cases}$$

Unconstrained firms: minimum savings policy b'_{min}

- $b'_{min} \rightarrow$ Such that unconstrained future investment and never binding constraints
- $\tilde{b} \rightarrow$ Minimum start-of-period savings that allow to implement b'_{min}
- Recursive definition

$$\tilde{b} = z\varepsilon F(k, n^*_{unc}) - wn^*_{unc} + q \min\left\{b'_{min}, \theta_b \theta_k k\right\} - \Phi(i^*_{unc}) i^*_{unc}$$

$$b'_{min} = \min_{S'} \ \tilde{b}(S')$$

Dividends

- b'_{min} determines d from budget constraint

Market clearing conditions

Ownership shares

$$\lambda' = \mu'$$

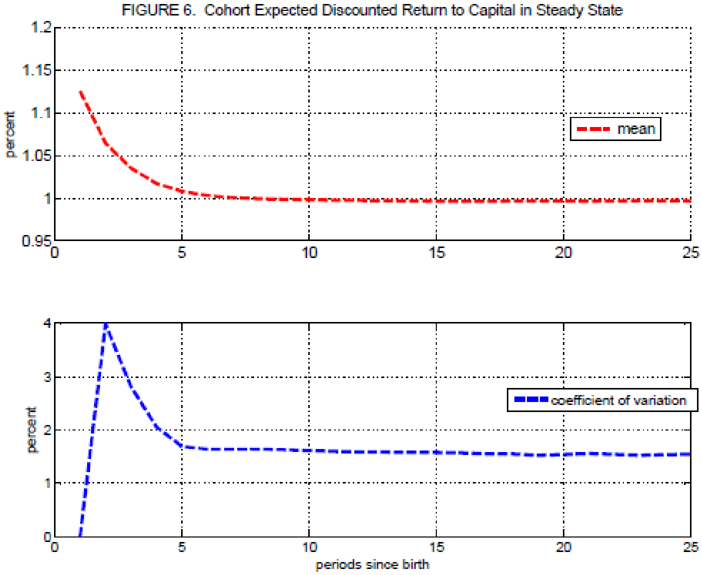
Labor

$$n^h(\mu; z, \mu) = \int_S n(k, b, \varepsilon; z, \mu)\mu(k, b, \varepsilon)$$

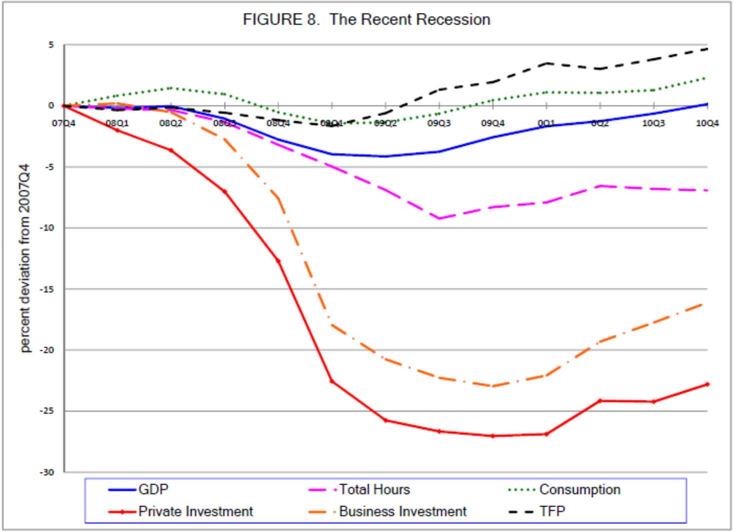
Output

$$c(\mu; z, \mu) + (1 - \eta) \int_S \Phi(i(k, b, \varepsilon; z, \mu))i(k, b, \varepsilon; z, \mu)\mu(k, b, \varepsilon)$$
$$= \eta \int_S \left[z\varepsilon F(k, N(\varepsilon, k; z, \mu)) + \theta_k(1 - \delta)k - k_0\right] \mu(k, b, \varepsilon)$$

Stationary steady state: Misallocation over the life-cycle



US aggregate dynamics over the crisis



TFP shock

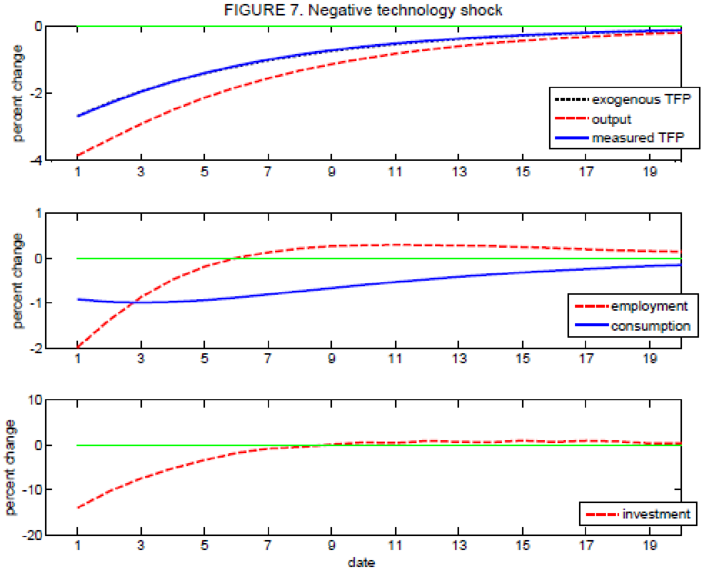


FIGURE 7. Negative technology shock
percent change
0
-2
-4
1
3
5
7
9
11
13
15
17
19
exogenous TFP
output
measured TFP
percent change
1
0
-1
-2
employment
consumption
percent change
10
0
-10
-20
investment
date

Credit shock and recovery in period 5