Credit Crunches and Credit Allocation in a Model of Entrepreneurship

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Introduction

- Large debate about “credit crunch”
- Perception that small firms are particularly vulnerable
- Output losses may be more persistent
Our Questions and our Goal

Can a shock to an economy’s financial sector generate a large and lasting recession?

- Start from a model that matches well:
  - distribution of wealth
  - size of entr. firms
  - Entry and exit

- Analyze effects of financial shocks
The Economics of the Model

- Good entrepreneurial types very productive, need capital
- Need to pledge collateral, growth limited by own assets
- High implicit return on saving
- Shocks to entrepreneurial assets affect firm size for a long time
Distribution of entrepreneurial wealth, from Cagetti and De Nardi (JPE, 2006)

Fig. 4.—Distribution of the entrepreneurs’ wealth, conditional on wealth being positive. Dash-dot line: data; solid line: baseline model.
Asset Accumulation by Potential Entrepreneurs
Summary of the Actors

- Households (entrepreneurs and workers)
- Corporate firms
- Financial intermediaries
- Government
- No aggregate uncertainty
Household Preferences and Demographics

- Young households: prob $1 - \pi_y$ become old
- Old households: prob $1 - \pi_o$ die, reborn as young (full altruism)
- Period utility: $\frac{c_t^{1-\sigma}}{1-\sigma}$
- Discount factor: $\beta$
Household Occupational Choice

- As workers (young): supply $y_t$ units of effective labor
- As entrepreneurs (young and old): can use $k_t$ and $n_t$ to produce
  \[ \theta_t(k_t^\gamma(1 + n_t)^{(1-\gamma)})^\nu \]
- As retirees (old): collect social security benefits (irreversible choice)
- Markov process for $(y_t, \theta_t)$
Credit Friction: Entrepreneurs

- $k_t$ in excess of own assets must be borrowed from intermediaries
- Entrepreneur can run away with $f_t k_t$, be worker for one period
Young Household Problem: Value Function

Optimal occupation choice:

\[ V_t(a_t, y_t, \theta_t) = \max \{ V^e_t(a_t, y_t, \theta_t), V^w_t(a_t, y_t, \theta_t) \}, \]

Value function as entrepreneur:

\[ V^e_t(a_t, y_t, \theta_t) = \max_{c_t, k_t, n_t, a_{t+1}} \{ u(c_t) + \beta \pi y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1 - \pi y) E_t W_{t+1}(a_{t+1}, \theta_{t+1}) \} \]

Value function as worker:

\[ V^w_t(a_t, y_t, \theta_t) = \max_{c_t, a_{t+1}} \{ u(c_t) + \beta \pi y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1 - \pi y) W^r_{t+1}(a_{t+1}) \} \]
**Young Household Problem: Constraints**

Gross income as entrepreneur:

\[ Y_t^e = \theta(k_t(1+n_t)^{(1-\gamma)})^\nu - \delta k_t - (k_t-a_t)(r_t l_{k_t}>a_t + i_t l_{k_t}<a_t) - w_t n_t; \]

Gross income as worker:

\[ Y_t^w = w_t y_t + i_t a_t; \]

Asset evolution

\[ a_{t+1} = Y_t^i - T_t^i(Y_t^i) + a_t - (1 + \tau^c_t)c_t, \quad i = e, w; \]

Credit limit

\[ u(c_t) + \beta \pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1 - \pi_y)E_t W_{t+1}(a_{t+1}, \theta_{t+1}) \geq V_t^w(f \cdot k_t, y_t, \theta_t); \]

nonnegativity constraints \( a_t \geq 0, k_t \geq 0, n_t \geq 0. \)
Old Household Problem: Value function

Option to continue existing firm:

$$W_t(a_t, \theta_t) = \max \{ W_t^e(a_t, \theta_t), W_t^r(a_t) \},$$

Value function of entrepreneur:

$$W_t^e(a_t, \theta_t) = \max_{c_t, k_t, n_t, a_{t+1}} \{ u(c_t) + \beta \pi_o E_t W_{t+1}(a_{t+1}, \theta_{t+1}) + \beta (1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1}) \}$$

Value function of retiree:

$$W_t^r(a_t) = \max_{c_t, a_{t+1}} \{ u(c_t) + \beta \pi_o W_{t+1}^r(a_{t+1}) + \beta (1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1}) \}$$
Old Household Problem: Constraints

Gross income as entrepreneur (same as before):

\[ Y_t^e = \theta(k_t^\gamma (1+n_t)^{(1-\gamma)})^\nu - \delta k_t - (k_t - a_t)(r_t I_{k_t>a_t} + i_t I_{k_t<a_t}) - w_t n_t; \]

Gross income as retiree:

\[ Y_t^r = p_t + i_t a_t; \]

Asset evolution (same as before):

\[ a_{t+1} = Y_t^i - T_t^i(Y_t^i) + a_t - (1 + \tau_t^c)c_t, \quad i = e, r; \]

Credit limit

\[ u(c_t) + \beta\pi_o E_t W_{t+1}(a_{t+1}, \theta_{t+1}) + \beta(1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1}) \geq W_t^r(f \cdot k_t). \]

nonnegativity constraints \( a_t \geq 0, k_t \geq 0, n_t \geq 0. \)
Corporate Sector

- Neoclassical production function:

\[ F(K_t^c, L_t^c) = A(K_t^c)^\alpha (L_t^c)^{1-\alpha} \]
Corporate Sector

- Neoclassical production function:
  \[ F(K_t^C, L_t^C) = A(K_t^C)^\alpha (L_t^C)^{1-\alpha} \]
- Needs outside financing for fraction \( \xi_t \) (exogenous)
Corporate sector: Optimization Problem

Firm owns its capital and can use some retained earnings:

\[
J_t(A_t^C) = \max_{K_t^C, L_t^C, B_t, A_{t+1}^C} F(K_t^C, L_t^C) + (A_t^C + B_t - K_t^C)(1 + i_t) -
\]

\[
w_t L_t^C - (1 + r_t)B_t - \delta K_t^C - A_{t+1}^C + \frac{1}{1 + i_{t+1}} J_{t+1}(A_{t+1}^C),
\]

subject to

\[
K_t^C \leq A_t^C + B_t
\]

and minimum external financing

\[
B_t \geq \xi_t K_t^C.
\]
Optimality Conditions for Corporate Firms

Labor:

\[ F_L(\hat{K}_t^C, \hat{L}_t^C) = w_t, \]

Capital (except possibly period 0):

\[ F_K(\hat{K}_t^C, \hat{L}_t^C) = \delta + (1 - \xi)i_t + \xi r_t, \quad t > 0 \]
Financial Intermediaries

- Competitive, CRS technology
- Requires (exogenous) $\phi_t$ units of goods to intermediate 1 unit of capital

$$r_t = i_t + \phi_t$$
Government

- Spends a constant amount
- Pays a constant fraction of wages as pensions
- Levies taxes on income (labor+capital) and consumption
Preferences, Technology, and Demographics

\[ \sigma = 1.5 \quad \text{Attanasio et al (1999)} \]
\[ \delta = 0.06 \quad \text{Stokey and Rebelo (1995)} \]
\[ \alpha = 0.33 \quad \text{Gollin (2002)} \]
\[ \phi = 0.015 \quad \text{Baa-Treasury spread} \]
\[ \xi = 0.33 \quad \text{Flow of funds} \]
\[ \pi_y = 0.98 \quad \text{average working life: 45 years} \]
\[ \pi_o = 0.91 \quad \text{average retirement life: 11 years} \]
Labor-Income Process and Social Security Payments

- 5 income states;
- Tauchen-Hussey approximation to AR(1) with autocorrelation .95 (Huggett, 1996, Lillard et al., 1978);
- Replacement ratio: 40% of avg. income (Kolitkoff et al., 1999)
Public expenditure, government debt, and taxes

- Govt spending/GDP: 18.7% (NIPA)
- Govt debt: so that SS interest payments are 3% of GDP (Altig et al., 2001)
- Consumption tax: 11% (Altig et al., 2001)
- Marginal income taxes for workers (income in $25,000):
  \[ T'(Y) = 0.32[1 - (0.22Y^{0.76} + 1)^{-1/0.76}] + \tau^y \]

Marginal income taxes for entrepreneurs:

\[ T'(Y) = 0.26[1 - (0.42Y^{1.4} + 1)^{-1/1.4}] + \tau^y \]

(Functional form: Gouveia and Strauss, 1994; parameter estimates: Cagetti and De Nardi, 2009)

- \( \tau^y \) adjusted to meet govt budget constraint: \( \approx 1\% \)
Remaining Parameters to Match Target Moments

- Discount factor: $\beta = 0.91$
- Entrepreneurial talent levels: $\theta \in \{0, 1.16\}$
- Prob. of switching from low to high: 2.3%
- Prob. of switching from high to low: 22%
- Decreasing returns limits to span of control: $\nu = 0.88$
- Returns to capital in the entrepreneurial sector: $\gamma = 0.80$
- Fraction of working capital that can be absconded: $f = 0.75$
- Tax on bequests: 16% above $\$5.4$ Million
## Target Moments

<table>
<thead>
<tr>
<th>Target Moment</th>
<th>Target</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital-output ratio</td>
<td>2.9-3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>% Entrepreneurs</td>
<td>7.5-7.6</td>
<td>7.7</td>
</tr>
<tr>
<td>% Exiting Entrepreneurs</td>
<td>22.0-24.0</td>
<td>22.4</td>
</tr>
<tr>
<td>% Workers Entering Entrepreneurship</td>
<td>2.0-3.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Median Net Worth of Entr. to Workers</td>
<td>5.3-6.5</td>
<td>6.2</td>
</tr>
<tr>
<td>% People at Zero Wealth</td>
<td>7-13</td>
<td>11.9</td>
</tr>
<tr>
<td>% Entrepreneurs Hiring on the Labor Market</td>
<td>57.4-64.6</td>
<td>58.8</td>
</tr>
<tr>
<td>Revenue from Estate Taxes (% of GDP)</td>
<td>0.2-0.3</td>
<td>0.27</td>
</tr>
<tr>
<td>% Estates Paying Estate Taxes</td>
<td>1.5-2.0</td>
<td>1.9</td>
</tr>
</tbody>
</table>
Outcomes of the model not matched by construction

- Fit the distribution of wealth for both workers and entrepreneurs very well.
- Match that about 50% of total capital is invested in the entr. sector.
- About 35% of efficiency units of labor employed in the entr. sector (data: 50% of bodies)

<table>
<thead>
<tr>
<th>Labor hiring</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCF, # workers</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>18</td>
<td>49</td>
</tr>
<tr>
<td>Model, efficiency units</td>
<td>0</td>
<td>0.4</td>
<td>2.9</td>
<td>8.8</td>
<td>16</td>
</tr>
</tbody>
</table>

Table: Workers hiring in the SCF data and in the model.

Levels of efficiency for each worker in the economy: 
[0.25, 0.44, 0.77, 1.31, 2.37]
First Experiment

- Start from SS in period 1
- Surprise in period 2, perfect foresight from period 2
- $\phi_2 = \phi_3 = \phi_4 = 3.5\%$ for three years, then back to 1.5\%.
Value added across sectors, PE with $g$ adjusting

Entrepreneurial sector (green), corporate (blue), SS=100
Value added across sectors, GE with $\tau$ adjusting

Entrepreneurial sector (green), corporate (blue), SS=100
PE with $g$ adjusting (blue), GE with $g$ adjusting (green), GE with $\tau$ adjusting (red), SS=100
Number of Entrepreneurs

PE with $g$ adjusting (blue), GE with $g$ adjusting (green), GE with $\tau$ adjusting (red), SS=100
Average Capital Employed by an Entrepreneur

PE with $g$ adjusting (blue), GE with $g$ adjusting (green), GE with $\tau$ adjusting (red), SS=100
Employment in the Entrepreneurial Sector Relative to Corporate

GE with $g$ adjusting (green), GE with $\tau$ adjusting (red), SS=100
The role of endogenous credit constraints

- Our shock hits $\phi_t$...
- but it also endogenously tightens borrowing limits!
Avg. Capital Employed by an Entrepreneur, PE, $g$ adjusts

Endogenous borrowing constraints (green), fixed borrowing limits (blue), SS=100
GDP, GE with $\tau$ adjusting

Endogenous borrowing constraints (green), fixed borrowing limits (blue), SS=100
Second Experiment

- Timing as first experiment
- $\xi_t$ varies so as to shield corporate sector from shock
- This means $\xi_t\phi_t$ constant
GDP across sectors, GE, $\tau$ adjusts

Entrepreneurial sector (green), corporate (blue), SS=100
GDP, GE, $\tau$ adjusts

Shock to $\phi$ (green), shock to $\phi$ and $\xi$ (blue), SS=100
Avg. Capital Employed by an Entrepreneur, GE, $\tau$ adjusts

Shock to $\phi$ (green), shock to $\phi$ and $\xi$ (blue), SS=100
Varying $f$

- Timing as first experiment
- $f$ increases, tightening borrowing constraints for entrepreneurs only (from $f = 0.75$ to $f = 0.8$)
- Magnitude such that it roughly matches output in period 5 (after shock, before taxes)
GDP (full GE)

Shock to $\phi$ (green), shock to $f$ (blue), SS=100
Avg. Capital Employed by an Entrepreneur (full GE)

Shock to $\phi$ (green), shock to $f$ (blue), SS=100
Varying TFP

- Timing as first experiment
- TFP drops for three years
GDP, (full GE)

Shock to $\phi$ (green), shock to TFP (blue), SS=100
Avg. Capital Employed by an Entrepreneur, full GE

Shock to $\phi$ (green), shock to TFP (blue), SS=100
Conclusion

• Recessions starve small entrepreneurs of funding
• Long-lasting echo
• When recessions cause tax increases, echo much more prolonged
Thank you!
Asset Accumulation by Potential Entrepreneurs
Adjusting the Tax Rate (GE)
Government Debt (GE)
Aggregate Consumption of Goods

PE with $g$ adjusting (blue), GE with $g$ adjusting (green), GE with $\tau$ adjusting (red), SS=100
Aggregate Investment

GE with $g$ adjusting (green), GE with $\tau$ adjusting (red), SS=100