Credit frictions and the cleansing effect of recessions

Authors

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Presenter

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October 10, 2014
Motivation

- During recessions, firm exit rate increases

![Graph showing firm exit rate over time from 1994 to 2012.](image)


- This could motivate the idea that recessions cleanse the economy
  - Caballero and Hammour (1994)
  - Market selects the most productive firms
Do credit frictions reverse this cleansing effect of recessions?

This paper builds a model of firm dynamics to study how credit frictions affect:

- Selection of exiting firms.
- Selection of entering firms

Result: Credit frictions do not reverse the cleansing effect of recessions

- Average productivity increases after an adverse aggregate productivity shock
- Average productivity also increases after a financial shock, although the increase is weaker
Firms are heterogeneous with respect to productivity and net worth, \( e \).

**Productivity has three components**

- \( Z \), stochastic aggregate total factor productivity common across firms
- \( \theta \), persistent idiosyncratic productivity
- \( \epsilon \), non persistent idiosyncratic productivity

**Timing**

- At the beginning of the period, firms know \( \theta \), \( Z \), and \( e \)
- They choose capital \( k \) and produce \( Z(\theta + \epsilon)k^\alpha \) with cost \( c \)
- Firm finances \( k \) and \( c \) with \( e \). If \( c + k > e \), firms borrow at free interest rate \( r \)
- Firms are left with \( q = Z(\theta + \epsilon)k^\alpha + (1 - \delta)k - (1 + r)(c + k - e) \)
- At the end of the period, firms observe \( \theta' \), \( Z' \), and decide \( e' \) and whether stay or exit the market
Frictionless Economy

The value of the firm at the beginning of the period is:

\[ V_{FL}(e, \theta, Z) = \max_k E \int \max \left[ q, \max_{e'} \left( q - e' + \beta V_{FL}(e', \theta', Z') \right) \right] d\phi(\epsilon) \]

\[ q = Z(\theta + \epsilon)k^\alpha + (1 - \delta)k - (1 + r)(c + k - e) \]

Modigliani Miller holds and the value of the firm is independent of its net worth, e.

When credit markets are perfect, firms exit when they are not productive enough \( \theta' < \theta_{FL}(Z') \), where \( \theta \) is such that the value of distributing everything to the shareholders is higher than producing.
Credit frictions

- Credit constraints arise from **asymmetric information between the firm and the financial intermediary.**

- After production takes place, $\epsilon$ is observed only by the firm, whereas the financial intermediary observes $\epsilon$ at a cost $\mu k^\alpha$

- The financial contract depend on $\theta$, $e$ and $Z$, all observable with no cost by firm and intermediary

- Firm finances $k$ and $c$ using its equity $e$, and if $c + k > e$, the firm borrows $(c + k - e)$ at an interest rate $\tilde{r}$

- Firms can default, there is a **default threshold** $\bar{\epsilon}$
  
  $$Z(\theta + \bar{\epsilon})k^\alpha + (1 - \delta)k = (1 + \tilde{r})(c + k - e)$$
Break even condition for intermediary

- **Intermediaries will lend to firms only if:**
  \[
  (1 + \tilde{r})(k + c - e)[1 - \phi(\bar{e})] + \int_{-\infty}^{\bar{e}} [Z(\theta + \epsilon)k^\alpha + (1 - \delta)k - \mu k^\alpha] d\phi(\epsilon)
  \geq
  (1 + r)(k + c - e)
  \]

- Let's rewrite this condition
  \[
  Z[\theta + G(\bar{e})]k^\alpha + (1 - \delta)k - \mu k^\alpha \phi(\bar{e}) \geq (1 + r)(k + c - e)
  \]

- Given \( \theta \) and \( Z \), there is a unique **threshold** \( e_b(\theta, Z) \) below which the financial intermediary refuses to lend any fund.
  \[
  Z[\theta + G(\bar{e}_b)]k_b^\alpha + (1 - \delta)k_b - \mu k_b^\alpha \phi(\bar{e}_b) = (1 + r)(k_b + c - e_b)
  \]
Firms problem

- If $e < e_b(\theta, Z)$, then they cannot cover the fixed cost of production, and therefore exits the market.

- **Firm's problem with credit friction**

  $$V(e, \theta, Z) = \max_{(k)} \mathbb{E} \left\{ \int l(q)q + (1 - l(q)) \max_{(e')} \left[ q, \max_{(e')} (q - e' + \beta V(e', \theta', Z')) \right] d\phi(\epsilon) \right\}$$

  $$l(q) = \begin{cases} 0 & \text{if } q \geq e_b(\theta', Z') \\ 1 & \text{if } q < e_b(\theta', Z') \end{cases}$$

subject to:

$$Z[\theta + G(\bar{\epsilon})]k^\alpha + (1 - \delta)k - \mu k^\alpha \phi(\bar{\epsilon}) \geq (1 + r)(k + c - e)$$

$$e_b(\theta', Z') \leq e' \leq q$$

$$q = \begin{cases} Z(\theta + \bar{\epsilon})k^\alpha + (1 - \delta)k - (1 + \bar{r})(c + k - e) & \text{if } \epsilon > \bar{\epsilon} \\ 0 & \text{if } \epsilon \leq \bar{\epsilon} \end{cases}$$
Exit threshold 1

- Productivity is not anymore the only determinant of firm survival. Weak balance sheet position is important too.

- At the end of the period, firms might exit because
  - Level of net worth is not high enough for the participation of the financial intermediary to be satisfied \((q < e_b(\theta, Z))\)
  - Level of net worth is not high enough for the participation constraint \((q < e_f(\theta, Z))\)

- Trade off when choosing capital:
  - Higher level of capital increases its next period level of production.
  - It increases its probability to default as the default threshold required by the lender increases with amount borrowed
The exit thresholds $e_f(\theta, Z)$ and $e_b(\theta, Z)$ are both decreasing functions of the persistent component of productivity $\theta$.

This implies that low productivity firms have a higher probability of exiting the market.
Credit frictions and steady state I

- How credit frictions modify the exit decisions of firms at the steady state

(Left) Exit probability declines with net worth
- High initial net worth reduces probability of falling below the net worth exit threshold

(Right) High productivity firms have lower exit rate
- Accumulate net worth faster
- Have lower probability of falling below the net worth exit threshold
Credit frictions and steady state II

- (Left) High productive firms have larger fraction of firms at high levels of net worth
- (Right) In the credit frictions world, exiting firms are not the less productive firms. This might make us think that cleansing effect will be reversed
Let's consider now the effect on the economy after a recession:

- Recession == decline in average productivity $Z$
- $Z$ follows a symmetric Markov chain, and takes two values, 1 and 0.97

How do credit frictions affect the cleansing effect of recession?

Contrary to the intuition, the cleansing effect of recessions is not reversed:

- Exit and entry rates barely changes
- Average productivity rises after a negative aggregate shock.
Credit frictions and recession II

- The aggregate shock raises the net exit rate of low productivity firms more than that of high productivity firms. Three mechanisms:
  - Increase in $\theta$
  - Increase in $e_f$
  - $\text{corr } q, \theta > 0$

- In presence of credit shocks:
  - Fall of number of firms concentrated at the bottom of distribution
  - Bigger increase of exit threshold for less productive firms
Sensitivity analysis

Let’s change the economy conditions and how credit frictions affects cleansing effect

These changes are made by exploiting the exogenous distribution of entrants

The role of the correlation between net worth and productivity

<table>
<thead>
<tr>
<th></th>
<th>avg. productivity</th>
<th>exit rate</th>
<th>entry rate</th>
<th>net exit rate</th>
<th>corr(q, θ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frictionless</td>
<td>0.48</td>
<td>1.15</td>
<td>-0.29</td>
<td>1.44</td>
<td>n.a.</td>
</tr>
<tr>
<td>Positive correlation</td>
<td>0.60</td>
<td>1.18</td>
<td>-0.89</td>
<td>2.07</td>
<td>0.56</td>
</tr>
<tr>
<td>$[c(θ), e_{entry}]$</td>
<td>0.55</td>
<td>1.22</td>
<td>-0.70</td>
<td>1.93</td>
<td>0.52</td>
</tr>
<tr>
<td>Negative correlation</td>
<td>0.54</td>
<td>1.25</td>
<td>-0.67</td>
<td>1.92</td>
<td>0.48</td>
</tr>
</tbody>
</table>

The role of the distribution of net worth

<table>
<thead>
<tr>
<th></th>
<th>avg. productivity</th>
<th>exit rate</th>
<th>entry rate</th>
<th>net exit rate</th>
<th>avg. net worth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frictionless</td>
<td>0.48</td>
<td>1.15</td>
<td>-0.29</td>
<td>1.44</td>
<td>n.a.</td>
</tr>
<tr>
<td>$[c(θ), e_{entry} \times 0.75]$</td>
<td>0.60</td>
<td>1.20</td>
<td>-0.96</td>
<td>2.16</td>
<td>8.97</td>
</tr>
<tr>
<td>$[c(θ), e_{entry}]$</td>
<td>0.55</td>
<td>1.22</td>
<td>-0.70</td>
<td>1.93</td>
<td>9.63</td>
</tr>
<tr>
<td>$[c(θ), e_{entry} \times 1.25]$</td>
<td>0.53</td>
<td>1.24</td>
<td>-0.60</td>
<td>1.84</td>
<td>10.15</td>
</tr>
</tbody>
</table>
Sensitivity analysis: Financial shock

- Financial shock is modeled as an exogenous decrease in firm’s net worth:
  \[ \hat{q} = q(1 - \gamma_t) \]

### The financial shock

<table>
<thead>
<tr>
<th></th>
<th>avg. productivity</th>
<th>exit rate</th>
<th>entry rate</th>
<th>net exit rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z-shock</td>
<td>0.43</td>
<td>1.17</td>
<td>-0.34</td>
<td>1.51</td>
</tr>
<tr>
<td>e-shock</td>
<td>0.34</td>
<td>0.96</td>
<td>-0.57</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Increase in the exit probability: e-shock vs. Z-shock
Conclusions

- This paper builds a model of firm dynamics to analyze the impact of credit frictions on the exit decisions of firms, and its implication for the cleansing effect of recessions.

- It shows that average idiosyncratic productivity increases following a negative productivity shock whatever the level of frictions.

- A financial shock reduces the intensity of cleansing effect.
We can rewrite the problem as follows:

$$\hat{V}_{FL}(\theta, Z) =$$

$$\max_k \mathbb{E} \int \max \left[ Z(\theta + \epsilon)k^\alpha - (r + \delta)k - (1 + r)c \right] d\phi(\epsilon) + \beta \max \left[ 0, \hat{V}_{FL}(\theta', Z') \right]$$
Calibration:

\[ \ln\theta' = \rho\theta \ln\theta + (1 - \rho\theta)\eta + \epsilon \quad \text{with} \quad \epsilon \sim N(0, \sigma_{\theta}) \]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor</td>
<td>(\beta)</td>
<td>0.956</td>
</tr>
<tr>
<td>Risk-free rate</td>
<td>(r)</td>
<td>0.04</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>(\delta)</td>
<td>0.07</td>
</tr>
<tr>
<td>Returns to scale</td>
<td>(\alpha)</td>
<td>0.70</td>
</tr>
<tr>
<td>Aggregate productivity</td>
<td>(Z)</td>
<td>1</td>
</tr>
<tr>
<td>Persistent productivity, mean</td>
<td>(\eta)</td>
<td>-1.2591</td>
</tr>
<tr>
<td>Persistent productivity, volatility</td>
<td>(\sigma_{\theta})</td>
<td>0.1498</td>
</tr>
<tr>
<td>Persistent productivity, persistence</td>
<td>(\rho)</td>
<td>0.9</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>(c)</td>
<td>0.7</td>
</tr>
<tr>
<td>Idiosyncratic volatility</td>
<td>(\sigma)</td>
<td>0.3</td>
</tr>
<tr>
<td>Monitoring cost</td>
<td>(\mu)</td>
<td>0.25</td>
</tr>
<tr>
<td>Entrants net worth upper bound,</td>
<td>(\bar{c}_{\text{entry}})</td>
<td>9</td>
</tr>
</tbody>
</table>