Agency costs, net worth, and business fluctuations

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Agency Costs

- Reason
  - divergent management-shareholder objectives
  - information asymmetry
- The costs consist of two main sources:
  - The costs inherently associated with using an agent (e.g., the risk that agents will use organizational resource for their own benefit)
  - The costs of techniques used to mitigate the problems associated with using an agent (e.g., the costs of producing financial statements or the use of stock options to align executive interests to shareholder interests)
- Agency costs in this paper: monitoring cost

Opinion

- The condition of borrowers' balance sheets affects output dynamics
  - Balance sheets - net worth (internal finance)
  - Higher borrower net worth reduces the agency costs of financing real capital investments (the costs of using external finance)
- Business upturns improve net worth, lower agency costs, increase investment, which amplifies the upturn (propagation)
- Shocks that affect net worth can initiate fluctuations (source)

Framework

- Stochastic neoclassical growth model (aggregate productivity shocks, microfoundation, rational expectation...)
- Lender borrower heterogeneity
- Overlapping generation model: two periods
  - entry and exit of firms from credit market
  - A period: the length of a typical financial contract

Aside: Start writting a research paper

- Where to embed your idea?
- A standard framework: Peter Diamond (1965) OG
  - Each generation lives for 2 periods
  - Individuals earn labor income only in first period of life
  - Save to finance second period consumption
  - Saving: by investing in physical capital or buying government bonds
- Differences from Diamond (1965)
  - Consumption good-inventories (instead of bonds)
  - Shocks to aggregate production

Significant Distinction

- Replace simple capital production technology (in which output is transformed to capital one to one)
- A technology that involves asymmetric information: (costly state verification (Townsend 1979))
    - only the entrepreneurs who direct physical investment can costlessly observe the returns to their individual projects
    - outside lenders must jointly incur a fixed cost to observe those returns

Objective

- Draw a connection between the condition of borrower ballance sheets (net worth) and these agency costs
- Demonstrate how this connection may play a role in the business cycle

Model

- Time: infinite t
- Agents:
  - initial old in period zero
  - agents live for two periods
- Countable infinite number of agents (or measure one of a continnum of agents)
- Two types of agents
  - an exogeneous fraction η entrepreneurs
  - the rest "lenders"
  - Differ in endowment and preferences
  - Only entrepreneurs have assess to investment technology

Entrepreneurs - heterogeneous

- Uniformly distributed, index $\omega \in (0, 1)$
- Low ω has a low cost of investment
  $x(\omega)$ unit of input required in one investment project, $x'(\omega) > 0$

Goods

- Output in period t
  - be consumed
  - be invested in the production of the capital good
  - be stored: return $r \geq 1$ in period $t+1$
- Capital good: production of output (depreciate completely after one period)

Production technology

- Output production technology:

$$y_t = \tilde{\theta}_t f(k_t)$$

  k_t capital per head, $\tilde{\theta}_t$ random aggregate productivity, i.i.d over time, mean θ
- Investment technology: Projects (non-divisible units)
  - Each entrepreneur is endowed with one of these projects
  - input requisite: exact $x(\omega)$ unit of output good
  - output: discrete random ξ_i $(i = 1, 2)$, $\xi_2 > \xi_1$, probability of ξ_i is π_i, expected outcome is ξ

Asymmetric information

- Output of projects known only by their owners (entrepreneurs)
- Other agents can learn the realized outcome of projects by employing auditing technology: auditing incurs a cost γ and reveals the outcome of the audited project without error (to every one)
  - Assume auditing is random: lenders pre-commit the probability of auditing (possibly depends on the report of outcome)

Time line

- Projects outcomes are realized
- Announcements are made
- Auditing takes place
- The current value of $\tilde{\theta}$ is known

Capital

- Outcomes of investment projects are independent: no aggregate uncertainty
- Capital per capita:

$$k_{t+1} = (\xi - h_t\gamma)\, i_t$$

  where i_t is the number of projects undertaken in period t
  h_t is the proportion of projects initiated in period that are audited
- Assumption to guarantee that it is always profitable for some but not all entrepreneurs to operate

$$\theta f'(0)k > rx(0) + \gamma$$

$$\theta f'(\xi\eta) < rx(1)$$

Endowment

- Fixed, must be used in first period of life
  - Entrepreneur: L^e
  - Lender: L
  - Normalize $\eta L^e + (1 - \eta) L = 1$

Preference

- Utility over consumption goods, no disutility from labor
- Entrepreneurs care only expected consumption when old
  - risk neutral
  - do not consume when young
- Lenders

$$U(z_t^y) + \beta E_t(z_{t+1}^o)$$

  - risk neutral with respect to $t+1$ consumption
    Focus on agency costs, rather than risk-sharing

Saving

- Saving of Entrepreneurs

$$S_t^e = w_t L^e$$

- Saving of Lenders

$$S_t = w_t L - z_y^*(r)$$

link between saving S_t and wage rate (marginal productivity of labor) w_t

Equilibrium with perfect information

- Competitive equilibrium where auditing is free ($\gamma = 0$), information is perfect
- Equilibrium cut-off value of entrepreneurs who invest

$$\hat{q}_{t+1}\xi - rx\left(\bar{\omega}\right) = 0$$

where $\hat{q}_{t+1}$ is the expected (as of t) relative price of capital in $t+1$
opotunity cost of investment for entrepreneur ω: $rx\left(\omega\right)$

Equilibrium with perfect information

- Assume that economywide savings always exceed the amount required by profitable projects

$$\eta S^e + (1 - \eta) S > \int_0^{\bar{\omega}} x(\omega) d\omega$$

- Entrepreneurial sector needs to be a relatively small part of the economy
- Some saving always funds inventory accumulation in equilibrium and the marginal rate of return is always r

Capital supply and demand

- Profitable investment

$$i_t = \bar{\omega}\eta$$

i_t is the number of projects undertaken (investment per capita)

$$k_{t+1} = \xi i_t$$

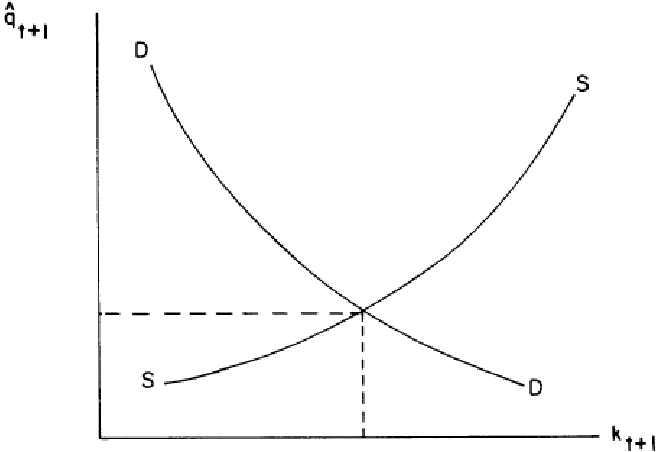
- Capital supply curve (SS): given that $\hat{q}_{t+1}\xi - rx(\bar{\omega}) = 0$

$$\hat{q}_{t+1} = rx\left[k_{t+1}/\left(\xi\eta\right)\right] / \xi$$

- Capital demand curve (DD): the expected price of capital equals its expected marginal product

$$\hat{q}_{t+1} = \theta f'(k_t)$$

Capital supply and demand



Dynamics in the perfect information case

- $\hat{q}$ and k are constant over time
- Investment is fixed
- Output good fluctuates in proportion to the productivity shock (serially uncorrelated)
- Consumption is positively serially correlated

Equilibrium with asymmetric information

- $\gamma > 0$
- Entrepreneurs intend to borrow:
  - an entrepreneur intends to undertake his project, but $x(w) > S^e$
- Lenders lend with a price
  - an opportunity cost of r
- Optimal financial contract (partial equilibrium)
  - take savings S^e, the expected relative price in the next period $\hat{q}$ and r as given

Entrepreneurs' problem (revelation principle)

- Maximize old consumption by choosing $(p, c^a, \; c_1, c_2)$

$$\max \pi_1 \left(pc^a + (1-p)c_1\right) + \pi_2 c_2$$

subject to
participation constraint:

$$\pi_1 \left[\hat{q}\xi_1 - p\left(c^a + \hat{q}\gamma\right) - (1-p)c_1\right] + \pi_2 \left[\hat{q}\xi_2 - c_2\right] \geq r(x - S^e)$$

truth telling:

$$c_2 \geq (1-p)\left[\hat{q}\left(\xi_2 - \xi_1\right) + c_1\right]$$

limit liability:

$$\begin{aligned} c_1 &\geq 0, \; c^a \geq 0 \\ \text{and } 0 &\leq p \leq 1 \end{aligned}$$

Full-collateralization case

- Entrepreneurs net worth is sufficiently large

$$\hat{q}\xi_1 \geq r(x(\omega) - S^e)$$

Optimal auditing probability is zero

- Consumption of entrepreneurs in "full-collateralization" case:

$$\hat{c}_{fc} = \hat{q}\xi - r(x(\omega) - S^e)$$

Incomplete-collateralization case

- Entrepreneurial savings S^e are insufficient

$$\hat{q}\xi_1 < r(x(\omega) - S^e)$$

- Positive auditing probability
- In bad state, borrower (entrepreneur) pays everything produced (capital depreciated completely), $c_1 = 0$, $c^a = 0$
- In good state, borrower (entrepreneur) pays $\hat{q}\xi_2 - c_2$, $c_2 > 0$
- Assume $\pi_2 [\xi_2 - \xi_1] - \pi_1 \gamma > 0$, then p is positive

$$p = \frac{r(x(\omega) - S^e) - \hat{q}\xi_1}{\pi_2 \hat{q} [\xi_2 - \xi_1] - \pi_1 \hat{q} \gamma}$$

- p decreases in S^e

Return of internal fund

- Expected agency costs: $p\pi_1\hat{q}\gamma$
- Consumption (incomplete collateralization)

$$\begin{aligned}\hat{c}_{ic} &= \hat{q}\xi - r(x(\omega) - S^e) - p\pi_1\hat{q}\gamma \\ &> \hat{q}\xi - r(x(\omega) - S^e) - \pi_1\hat{q}\gamma \\ \hat{c}_{ic} &= \alpha\left[\hat{q}\xi - r(x(\omega) - S^e) - \pi_1\hat{q}\gamma\right]\end{aligned}$$

$$\alpha \equiv \frac{\pi_2\hat{q}\left[\xi_2 - \xi_1\right]}{\pi_2\hat{q}\left[\xi_2 - \xi_1\right] - \pi_1\hat{q}\gamma} > 1$$

- Return of internal fund

$$\frac{\partial\hat{c}_{ic}}{\partial S^e} = \alpha r > r$$

Additional inside funds not only replace outside funds but also reduce expected agency costs

Entrepreneurial investment decision

- Whether to invest?
  depends on cost $x(\omega)$, $x'(\omega) > 0$
- With imperfect information, three types of entrepreneurs
  - type 1: good entrepreneurs: $\omega < \omega_{low}$, expected net returns are always positive
  - type 3: poor entrepreneurs: $\omega_{high} < \omega$, negative expected net returns enen if no auditing

- ω_{low} and ω_{high} satisfy

$$
\begin{aligned}
\hat{q}\xi - rx\left(\omega_{low}\right) - \pi_1 \hat{q}\gamma &= 0 \\
\hat{q}\xi - rx\left(\omega_{high}\right) &= 0
\end{aligned}
$$

Type 2: Fair entrepreneurs

- Fair entrepreneurs: $\omega_{low} < \omega < \omega_{high}$, positive expected net returns only if no auditing
  For a firm with ω

$$\begin{aligned} \hat{q}\xi - rx(\omega) - \pi_1 \hat{q}\gamma &< 0 \\ \hat{q}\xi - rx(\omega) &> 0 \end{aligned}$$

  given $x'(\omega) > 0$

- ω_{low} and ω_{high} satisfy

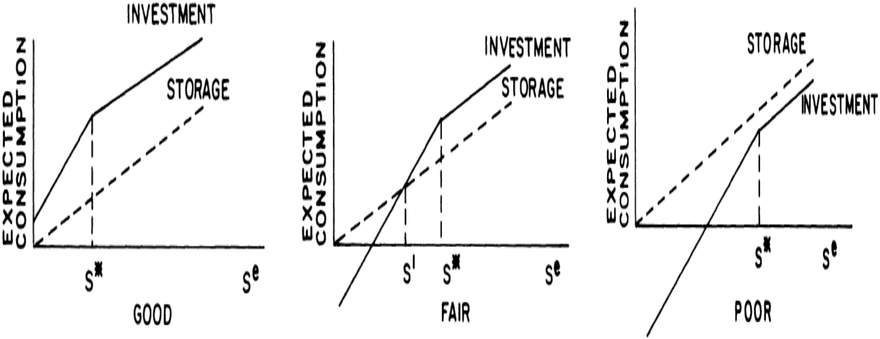
$$\begin{aligned} \hat{q}\xi - rx(\omega_{low}) - \pi_1 \hat{q}\gamma &= 0 \\ \hat{q}\xi - rx(\omega_{high}) &= 0 \end{aligned}$$

Investment

- $S^* (\omega)$ enough saving to avoid monitoring cost

$$S^* (\omega) = x (\omega) - (\hat{q}/r) \xi_1$$

$$\hat{c}_{ic} = \alpha \left[\hat{q}\xi - r(x(\omega) - S^e) - \pi_1 \hat{q}\gamma \right]$$



Fair entrepreneurs like lottery

- Convex for $S \in (0, S^*)$
- Average consumption makes entrepreneurs better off
- Lottery (gammble: put all money in, winners get S^*, losers get 0)
  $\frac{S^e}{S^*}$ proportion of entrepreneurs win the lottery, no auditting for them
  $1 - \frac{S^e}{S^*}$ do not invest

Within-period equilibrium

$$\left.\begin{array}{c}\theta \\ k_t \\ \text{labor inelastic}\end{array}\right\} \Rightarrow \text{output is determined} \Rightarrow \textit{wage} \text{ is determined}$$

$\Rightarrow$entreprenereurial saving is determined $S_t^e = w_t L^e$

- Given expected relative price of capital $\hat{q}$, and S^e, for $\omega < \omega_{low}$

$$p(\omega) = \max\left\{ \frac{r(x(\omega) - S^e) - \hat{q}\xi_1}{\hat{q}\left[\pi_2(\xi_2 - \xi_1) - \pi_1\gamma\right]}, 0 \right\}$$

$p(\omega)$ is decreasing in $\hat{q}$ and S^e, and $p(\omega) = 0$ for $S^e \geq S^*(\omega)$

Fair entrepreneurs' investment rate

- Let $g(\omega)$ be the fraction of fair entrepreneurs of type ω who can invest, given $g(\omega) = \frac{S^e}{S^*(\omega)}$

$$g(\omega) = \min\left\{\frac{rS^e}{rx(\omega) - \hat{q}\xi_1}, 1\right\}$$

- Total investment and capital produced

$$\left[\xi \int_{\omega_{low}}^{\omega_{high}} g(\omega) d\omega\right]$$

Capital supply

$$k_{t+1} = \left[\xi\omega_{low} - \pi_1\gamma\int_0^{\omega_{low}} p(\omega)d\omega\right]\eta + \left[\xi\int_{\omega_{low}}^{\omega_{high}} g(\omega)d\omega\right]\eta$$

$$k_{t+1} = \left\{\xi\omega_{high} - \left[\pi_1\gamma\int_0^{\omega_{low}} p(\omega)d\omega + \xi\int_{\omega_{low}}^{\omega_{high}} (1-g(\omega))\,d\omega\right]\right\}\eta$$

$$\begin{aligned}
[\hat{q}\xi - rx(\omega_{low}) - \pi_1\hat{q}\gamma] &= 0 \Rightarrow \omega_{low} \text{ increases in } \hat{q} \\
\hat{q}\xi - rx(\omega_{high}) &= 0 \Rightarrow \omega_{high} \text{ increases in } \hat{q}
\end{aligned}$$

$$p(\omega) = \max\left\{\frac{r(x(\omega) - S^e) - \hat{q}\xi_1}{\hat{q}[\pi_2(\xi_2 - \xi_1) - \pi_1\gamma]}, 0\right\} \Rightarrow p(\omega) \text{ decreases in } \hat{q}$$

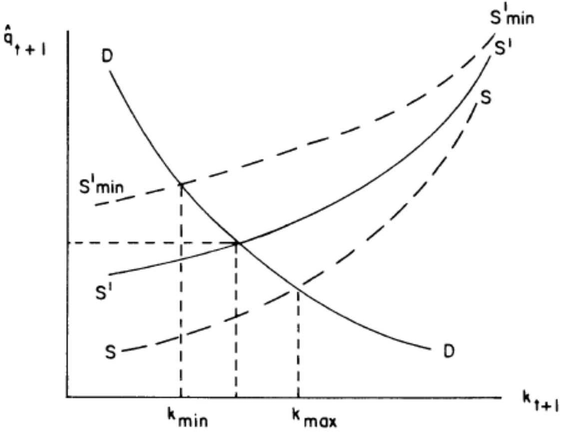
$$g(\omega) = \min\left\{\frac{rS^e}{rx(\omega) - \hat{q}\xi_1}, 1\right\} \Rightarrow g(\omega) \text{ increases in } \hat{q}$$

$$\frac{\partial k_{t+1}}{\partial\hat{q}} > 0$$

Supply and demand curves

Capital demand:

$$\hat{q}_{t+1} = \theta f'(k_t)$$



Supply curve of capital

- S'S' is above SS, less capital stock in the imperfect information case

$$\begin{aligned} k_{t+1} &= \eta \left\{ \begin{array}{c} \xi\omega_{high} - \\ \left[\pi_1\gamma \int_0^{\omega_{low}} p(\omega)d\omega + \xi \int_{\omega_{low}}^{\omega_{high}} (1-g(\omega))\, d\omega\right] \end{array} \right\} \\ &\leq \xi\omega_{high}\eta \end{aligned}$$

  imperfect collateralization when $\gamma > 0$ increases the agency costs for those projects undertaken and leads to a decline in the number of projects that can be profitably initiated
- Position of S'S' depends on a state S^e : higher S^e moves S'S' closer to the full collateralization

Comparative statics

- A rise in current income
  inherited k_t increases or θ_t increases $\Rightarrow$ Higher entrepreneurial savings S^e $\Rightarrow$ lower agency costs $\Rightarrow$ moves S'S' down
- A redistribution of labor endowment from entrepreneurs to lenders
  Lower L^e but raise L
  lower entrepreneurial savings S^e $\Rightarrow$ higher agency costs $\Rightarrow$ moves S'S' up $\Rightarrow$ lower k_{t+1} and higher price of capital $\hat{q}_{t+1}$

- A temporary rise in $\tilde{\theta}$ stimulates investment by increasing entrepreneurail net worth (S^e increases) $\Rightarrow$ S'S' curves shifts rightward $\Rightarrow$ k_{t+1} increases $\Rightarrow$ saving S^e increases

- On the oposite, poor financial health in bad times reduces investment and reinforces the decline in output
- Countercyclical agency costs are crucial to the story

- Widely accepted mechanism on financial frictions
  - Bernenke and Gertler (1989 AER) : agency costs
  - Kiyotaki and Moore (1997 JPE): collateral
- $\begin{cases} \text{Bernenky, Gertler and Gilt (1999) — sticky price - monetary policies} \\ \text{Gertler and Kiyotaki (2010) — bank - unconventional policies during} \end{cases}$
  DSGE models
  Quantitative assessment