Agency Models and Implications to Finance

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Motivation

- Finance is about how to get money from investors (to make positive NPV projects).
- In a rational world without Ponzi scheme, the only way to get financed today is to make sure investors will be paid back later on.
- There are two kinds of frictions that prevent payback.
  - **Moral hazard**. Managers will take actions that benefit themselves but hurt the firm's financial situation.
  - **Adverse selection**. Firms have different qualities and they know who they are (so-called private information). Then only bad firms without payback ability are approaching you—lemon problem leads to market failure.
- Today I will focus on moral hazard issue.

Plan of the talk

- The simplest static principal-agent model.
  - Could be entrepreneur seeks financing from investors, or investors hire a manager.
- We will study the optimal contracting problem, and illustrate the working of the static agency friction.
- What if the contracting relationship is long-term? Recent progress in dynamic agency models.
- Then we talk about applications.
  - Put in banks/intermediaries who can alleviate agency friction through monitoring. But faces the exact same agency friction themselves.
  - Place the model in general equilibrium to study asset pricing implications.

Simple static agency model

- The entrepreneur (agent) has personal wealth A, but the positive project requires an investment of $I > A$.
- Optimal contract to make sure that investors (principal) get back $I - A$ in expectation.
- Simple agency friction. The project has binary payoff, R or 0.
  - If taking the first-best action (working/behaving), $\Pr(R) = p$.
  - If taking the suboptimal action (shirking), $\Pr(R) = p - \Delta$.
  - The binary action choice is unobservable. Shirking gives the agent a private benefit of B.
- Working is the first-best action, i.e., $\Delta R > B$. We focus on implementing working.
- Limited liability. Entrepreneur does not bear personal obligation against firm's liability.

Formulating the optimal contracting problem

- The only contracting variable is the payment to the agent given success, $0 < a \leq R$.
  - The only issue is how to split the pie after success.
- The optimal contract solves

$$\max_{a \in [0,R]} \quad pa$$

$$s.t. \quad p\left(R - a\right) = I - A\text{: investors' break-even condition}$$

$$IC \text{ constraint so that the agent is working.}$$

- Incentive-Compatibility: How to make sure the agent is working?

$$\underbrace{pa}_{\text{expected pay by working}} \geq \underbrace{\left(p - \Delta\right) a}_{\text{expected pay by shirking}} + \underbrace{B}_{\text{private benefit by shirking}}$$

  - As a result, IC constraint requires that $a \geq B/\Delta$.

Optimal contract

- Investors' break-even condition $p(R-a) = I - A$ implies that

$$a = R - \frac{I - A}{p}.$$

  - And, agent wants to put his money in, which requires that $pa > A \Rightarrow pR > I$. Positive NPV.
- But the *IC* constraint says that $a \geq B/\Delta$.
- Optimal contract: If $R - \frac{I-A}{p} \geq B/\Delta$, or

$$p\left(R - \frac{B}{\Delta}\right) > I - A$$

  then setting $a^* = R - \frac{I-A}{p}$, and the project takes place. Otherwise, the project cannot be financed.
- Second best: some positive NPV projects is passed.

Pledgeable and non-pledgeable payoffs

- The key issue for financing is to make sure that investors can get payback from tomorrow's cash flows.
- Agency issue says that only part of R can be paid out to investors.
- Pledgeable part is the part that investors can potentially grab, non-plegeable part is what must go to agent due to his expertise.
- In this model, incentive provision implies that the bonus a has to be above B/Δ. B/Δ is the non-pledgeable part.
- So the project's expected pledgeable payoff is $p\left(R - B/\Delta\right)$. For rational investors (ignore discounting etc) it is also the upper limit of possible financing.
- This is why financing need $I - A$ must be below the upper limit $p\left(R - B/\Delta\right)$.

Simple analysis

- *Finance* becomes fundamentally important only when the investors (who have money) and the project's best users (who knows how to operate the project) are different persons.
  - The non-pledgeablity is one important reason that why funds are not always flowing to the best hands.
  - There are other stories to generate non-pledgeablity.
- In the second-best world, the socially optimal project gets financed when
  - R is high. Better projects are more likely to get funding.
  - A is high. That is why Bill Gates, with billions of personal wealth, can fund any profitable projects.
  - B/Δ is low. If the private benefit of misbehaving is low, easier to get financed.
    - One way to reduce B is by borrowing from banks or VC, etc.

What is the general feature of optimal contract?

- Suppose that $\widetilde{R} = R_h$ or R_l. What is the optimal contract $\{a_h, a_l\}$?
- IC constraint $a_h - a_l \geq \frac{B}{\Delta}$:

$$\underbrace{pa_h + (1-p)\,a_l}_{\text{expected pay by working}} \geq$$

$$\underbrace{(p-\Delta)\,a_h + (1-p+\Delta)\,a_l}_{\text{expected pay by shirking}} + \underbrace{B}_{\text{private benefit by shirking}}$$

- One can show that $a_h^* - a_l^* = \frac{B}{\Delta}$ in the optimal contract.
- From investors' break-even condition, we have

$$a_l^* = \underbrace{E\widetilde{R} - I}_{\text{project's NPV}} + \underbrace{A}_{\text{personal wealth}} - \underbrace{pB/\Delta}_{\text{Non-pledgeable rent}}$$

- Limited liability $a_l^* \geq 0$ gives lowest possible A to guarantee financing.

How can we approach dynamic agency problem

- The important lesson we learn from static agency model is that incentive-wedge:

$$\text{payoff\_after\_up} = \text{payoff\_after\_down} + \text{bonus}$$

  where the bonus B/Δ is determined by agency friction.
- It turns out this simple result can be carried through in dynamic setting, where the agent takes action every period.
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- Given this, from discrete-time to continuous-time is obvious.
- Intuitively, this suggests linearity of optimal compensation with respect to the agent's performance.
  - It should remind you the famous Holmstrom-Milgrom (1987) result.
- Important caveat: this argument relies on the fact that the agent takes action at every period.
  - Famous Mirlees result. If the agent only takes one-time action, then in general we can achieve first-best result by imposing sufficiently strong penalty.

Dynamic agency models

- One observation: if we can set a_l arbitrarily low, then we can always find incentive-compatible contract. Given risk-neutrality, the first-best outcome is always achievable.
- Two approaches:
  1. Risk averse agent with exponential utility, with unbounded a_l. Performance-sensitive pay provides incentives but brings about cost due to risk-aversion. Holmstrom-Milgrom (1987).
  2. Risk-neutral agent, but set $a_l \geq 0$ as limited liability.
- Literature 1 has passed its prime time. But its tractability allows for studying tougher problems such as persistent private information.
- Literature 2 is burgeoning. DeMarzo-Fishman (2007).
  - The key is that the agent's continuation payoff, which is the expected value of his future compensation, is linear to his performance at any period.
  - In that model, optimal long-term financing contract is a combination of long-term debt and credit line.
  - Continuous-time version is DeMarzo-Sannikov (2006).

Application (1). Introducing intermediaries

- One role of financial intermediaries (say banks, venture-capital etc.) is to provide monitoring.
- Holmstrom-Tirole (1997) explore this idea.
- In this model, suppose that banks monitoring reduces entrepreneur's shirking benefit B to b.
- But bankers have incentive problems as well. They need to get paid to monitor.
- Monitoring requires c private cost.

Optimal contracting (1)

- Imagine that we have plenty of entrepreneurs and investors.
- Without banks, B is large so that direct financing is impossible.
- Bankers are scarce with capital M, and enjoy the potential rent from the project.
- Consider one agent-banker-investor pair. Suppose banker gets m, agent gets a, and investor gets $R - m - a$. Then the optimal contract solves

$$\max_{m \in [0,R], a \in [0,R], a+m \in [0,R]} \quad pm$$

$$
\begin{aligned}
s.t. \quad & p\left(R - a - m\right) = I - A - M\text{: investors' break-even condition;} \\
& pa = A\text{: investors' break-even condition;} \\
& IC \text{ constraint so that the agent is working} \Leftrightarrow a \geq b/\Delta; \\
& IC \text{ constraint so that the banker is monitoring} \Leftrightarrow m \geq c/\Delta.
\end{aligned}
$$

Optimal contracting (2)

- Agent's break-even condition implies that $a^* = A/p \geq b/\Delta$.
- Then using investor's break-even condition, we have

$$m^* = R - \frac{I - M}{p}.$$

- Similarly, we require that $m^* \geq c/\Delta$, which says that the project gets financed if

$$p\left(R - \frac{A}{p} - \frac{c}{\Delta}\right) \geq I - A - M,$$

  or M is sufficiently high.
- Intermediary capital is important in improving investment efficiency.

Application (2): Equilibrium asset pricing

- Interpret agents as hedge fund managers.
- Endowment economy with one unit of risky asset, payoff Y or 0.
  - Limited participation. Only hedge funds can trade on this risky asset.
- Agency friction is modeled as diverting Y for private consumption λY, $\lambda \in (0,1)$. So $B = \lambda Y$, .
- Suppose that equilibrium asset price P. Hedge funds (price takers) raise money $I - A$ from investors, and purchase $\frac{I}{P}$ units of asset.
- Let a (per unit of asset) be the agent's pay. The optimal contract solves

$$\max_{a \in [0,Y], I} \frac{I}{P} \cdot pa$$

$$s.t. \qquad \frac{I}{P} \cdot p\,(Y - a) = I - A\text{: investors' break-even condition}$$

$$IC \text{ constraint so that the agent is not diverting} \Leftrightarrow a \geq \lambda Y$$

Application (2): Equilibrium asset pricing

- Optimal contract $a^* = \lambda Y$, and

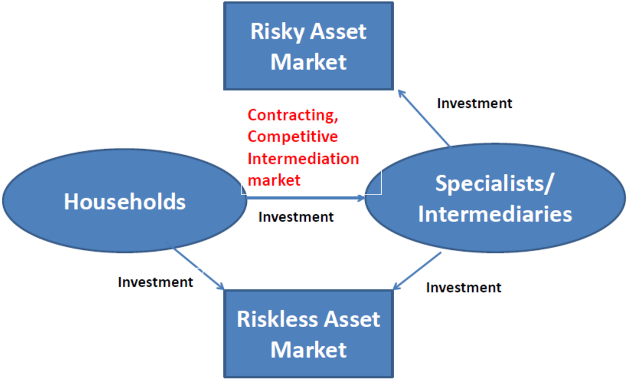
$$I^*(P) = \frac{AP}{P - p(1-\lambda)Y}$$

  This is the demand curve.
- Supply curve is P. Equating $I^*(P) = P$ gives equilibrium price

$$P^* = A + p(1-\lambda)Y$$

  Of course the price is also capped by fundamental value pY.
- The equilibrium price is increasing with hedge funds' capital.
- He-Krishnamurthy (2011) take the above idea into the traditional Lucas tree asset-pricing model.

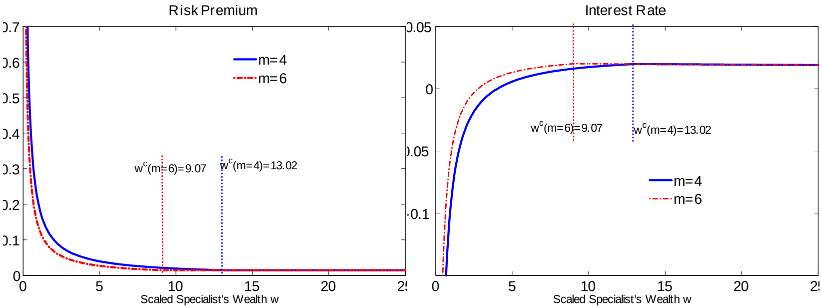
He-Krishnamurthy (2011)



The economy.

- **Intermediation**: 1) Short-term contracting between agents; 2) Equilibrium in competitive intermediation market;
- **Asset pricing**: 3) Optimal consumption/portfolio decisions; 4) GE.

Risk Premium and Interest Rate



- Asymmetry. Crisis like.
- When specialist's wealth is low, specialist bears disproportionally large risk, causing more volatile pricing kernel.
- Flight to quality. 1) Specialists precautionary savings. 2) Household fly to debt market.

Conclusion

- Agency frictions are important for us to understand corporate finance and asset pricing.
- Simple model can help us to understand how basic moral hazard issues introduces inefficiency in the second-best world.
- It is commonly viewed that the current crisis is greatly amplified by the shortage of intermediary capital.
  - Tech bubble burst in 2001 does not hurt banking capital;
  - while 2008 subprime housing bubble burst takes down Lehman, and hurt the whole banking system.
- This literature needs more theoretical and empirical exploration.