# Lecture 19: Contracting, or The Rules of the Game, or Mechanism Design

**(See McMillan, Chap. 8 & 9, and DixitSkeathReiley Chap. 14)**

**Topics:**

1. **Strategising versus Economising**
2. **Using Game Theory to Enhance Efficiency**
3. **Creating Incentives**
4. **Designing Contracts**
5. **Application to Financial Contracts**

# 1. Strategising versus Economising

## *Strategising ...*

**(See Williamson's paper in the Package: he shared the Nobel prize in 2009, for "analysis of economic governance, especially the boundaries of the firm".)**

**Game Theory is usually applied to issues of *"strategising"*, i.e., beating rivals or consumers:**

- **Pre-emptive threats/entry deterrence.**
- **Cartel enforcement.**
- **Bargaining and bidding.**

## *... versus Economising*

***Economising* — the positive-sum, efficiency-enhancing aspects — often neglected in game theory (and in corporate strategy).**

**Why is it neglected?**

**There are two illusions:**

1. **Illusion from micro theory that it's easy to minimise costs: set Wage = Value of the Marginal Product of Labour.**

   **But this is very difficult and costly to monitor on the shop floor.**

2. **Illusion that powerful tools from game theory don't help to economise, in Finance or in Human Resource Management.**

**But game theory can be very useful, especially for economising.**

## Contracts Integrate ...

**Contracts integrate game theory and standard microeconomics:**

- ***A contract:*** **an agreement that supports exchange between supplier (seller) and buyer (demander).**
- **Standard microeconomics: Supply = Demand (and produce where Marginal Cost = Price) is just the Nash equilibrium of a game where no-one's decisions affect the welfare of anyone else. (Perfect competition, and all are price-takers.)**
- **Costless contracts: Even with small numbers, we can achieve the perfect competition outcome.**

## Prediction and Design

**Game Theory helps in a real world of costly contracts — twice:**

1. **Predicts (or analyses) what will happen under different contractual arrangements.**
   **What are the *incentives*?**
2. **Allows us to choose (or to design) the *best* one, (Choosing the Game).**
   **e.g.:**
   - **Make or Buy? (production integration)**
   - **Debt or Equity? (capital structure)**
   - **Privatised or Publicly Owned? (ownership)**
   - **Division or Spin Off? (organisational structure)**

# 2. Using Game Theory to Enhance Efficiency

## General Principles

1. Game theory is often taught via simple examples, chosen on an ad-hoc basis. e.g. battles, interactions, kids and credibility.
2. The Contracting perspective, by contrast, is:
   - ➢ *choose* the rules of the game, the contract,
   - ➢ solve (or simulate) for the equilibrium of this game, of this contract,
   - ➢ *then* ask:
     - — are the players *pleased* with the outcomes?
     - — what could they do to achieve a *better* outcome? How?

## Choosing the rules of engagement

3. **Basic idea: when you negotiate a contract with someone, you are proposing to play a game, structured by the contract (the rules).**

   **Since you, the Principal, must get them to play, *and* they solve for the equilibrium as you do, it *pays you to choose the game (the contract) with the most efficient outcome*, to maximise the size of the pie, given a claim over fixed % slice.**

   **e.g. employment contract — pay, conditions, work, supervisor's interests, etc;**

   **e.g. financing contract**

   **e.g. franchise contract**

   **e.g. outsourcing contract**

# 3. Creating Incentives

**Q: How can you make it in another person's interest to behave as you want? Especially with a divergence of interests, aims.**

**Q: How can you create appropriate *incentives*?**

**A: Rewards & punishments — carrots & sticks.**

➢ **The pervasive *Principal–Agent* problems:**
- **— author v. publisher**
- **— debt v. equity**
- **— landlord v. tenant**
- **— subcontractor v. price contractor**
- **— employer v. employee**
- **— insured v. insurer**

➢ **Whereas HRM: change the Agent's goals → the Principal's goals, now on the contrary ...**

➢ **Here: we focus on the use of monetary rewards — important (although not necessary) and simple to understand.**

## Piece Rates, Commissions, & Royalties

**Performance incentives are ubiquitous —**

- **piece rates/bonuses/commissions for production workers**
- **pay for performance (bonuses, share options)**
- **sales representatives paid by commission**
- **professional sports? (tournaments, winner-takes-most)**
- **academic salary supplements**
- **forecasters' pay $\propto$ accuracy (?)**

## Contracts can also be used in *cost minimisation* instead of maximum output:

- cost-minimisation is costly
- contracts vary from one extreme to another — who bears the risk? The Principal or the Agent?
  - fixed-price contracts?
  - cost-plus contracts?
  - incentive contracts?

*A verbal contract isn't worth the paper it's written on.*

— Samuel Goldwyn

## Marginal Incentives

**If the Principal can cheaply, perfectly, monitor the Agent's "effort":**

**then no problem:**
**$\rightarrow$ the Principal simply links the Agent's payments to effort.**

**But usually impossible or costly to monitor the Agent's effort, so**

- **link Agent's pay to *performance*, not *effort*, or link Agent's pay to *output*, not *input***
- **OK if constant, predictable relationship: Agent's effort $\Rightarrow$ Agent's performance**
- **but random events, uncertainties intervene i.e. the Agent may be unlucky or lucky.**
- **the Agent may "slack" or "shirk"**

## Principals' and Agents' interests may diverge.

So:
1. Divergence of interests.
2. Imperfectly observable "efforts" of the Agent.
   - not necessarily how hard the Agent works
   - but to what end does the Agent toil? (profits, or size, etc.?)

The incentive effect — is at the *margin*,

where costs of extra effort = gain to the Agent from extra effort.

The higher the commission rate $\lambda$, then the greater the Agent's selling effort.

## Carrots & Sticks

**Look at from the worker's (the Agent's) point of view:**

- **if she performs better, do her pay or rewards increase?**
- **if she performs worse, does her pay fall or her punishment increase?**

**Ideally the Principal would like to set:**

- **Piece rates or commission as a continuum:**

$$\frac{\Delta \text{ reward}}{\Delta \text{ performance}} > 0$$

**where performance is measurable.**

## But incentive schemes can distort behaviour.

- They are often discontinuous:

$$\frac{\Delta \text{ reward}}{\Delta \text{ performance}} = 0 \text{ or } \frac{\Delta \text{ punishment}}{\Delta \text{ performance}} = 0$$

  - threat of firing, loss of contract
  - fines
  - legal liabilities
  - prizes, promotions, bonuses

- But discontinuous incentive schemes can substitute for continuous:
  - wage ($/hr) + punishment after monitoring (firing)
  - wage ($/hr) + reward after monitoring (promotion)

## Multi-Dimensional Performance

A danger:

- not that incentive schemes fail, but
- but that they work too well...

And Agents concentrate on the goal with explicit incentives, often quantity (easy to count).

One tradeoff: *Quality*

- quantity v. quality
  e.g. jet engine blades
  e.g. production-line workers,
  "shirking" = higher defect rates
- when quality is hard to monitor
  e.g. solution: pay all but the quality-control workers by the piece, since it is difficult to control the quality of quality control (:-)

## Moral hazard might be suspected

— even with time payment, the Principal can use discontinuous rewards/punishments to mimic continuous incentive schemes.

e.g. Sears ended its commissions to its mechanics (the Agents), to enhance its credibility with its customers, who suspected over-servicing of their cars as a result of the mechanics' incentives.

Sears' mechanics became regular employees, paid by the week.

## The Principal's Ideal Payment Scheme

**"The shortest and best way to make your fortune is to let people see clearly that it is in their interests to promote yours."**
**— Jean de La Bruyère (1645–1696)**

**Q: But how?**

**A: The Principal sets the Agent's marginal payment scheme $\lambda$ (commission, royalty, piece rate, etc.) at 100%.**

## Example: the salesperson example:

**Q: What is the ideal amount of the Agent's effort, from the Principal's viewpoint?**

- **Assume the Agent's costs equal the Principal's; and assume diminishing return to effort.**
- **If the Principal acted alone, then she would get 100% of the benefits and incur 100% of the costs. So the Principal would exert effort to the point where marginal costs equal marginal returns or effort: marginal cost (effort) = marginal returns ($P = MC$?)**
- **When the Agent acts, he bears the full cost of any marginal effort, whatever the commission rate $\lambda$.**

## Optimal commission? How to raise money?

- At $\lambda = 30\%$, the Agent would exert effort up to the point where the cost of \$100 extra sales is \$30, which is less than the Principal's effort (of \$100).
- With $\lambda = 100\%$, the Agent reaps the full benefits, and exerts effort up to the point where the cost of \$100 extra sales is \$100, as does the Principal.
- Thus $\lambda = 100\% \Rightarrow$ the Agent's interests and the Principal's are identical, and the gain from trade to be divided between the Principal and the Agent is maximised.

Q: But with $\lambda = 100\%$, how does the Principal earn anything from the deal?

## How about a fixed payment by the Agent as well?

- As well as the commission rate $\lambda$, the deal includes a fixed payment $f$ from A to P.
- The Principal uses the rate $\lambda$ to induce appropriate actions by the Agent at the margin, and the fixed fee $f$ to get some of the gains to trade for herself. (Limited by the Agent's alternatives, given the Agent's veto.)
- The fixed fee $f$ is a payment from the Agent to the Principal.

$\therefore$ In effect the Principal sells the Agent the right to be the Agent:
self-employed, arm's-length relationship.

e.g. Lord Cornwallis in Bengal, in the late 18th century, sold the right to collect taxes to private individuals, (who were hated).

# 4. Designing Contracts

**Ideal contracts (100% marginal payment schemes) are seldom seen.**

**Two flaws:**
**Contracts do more than generate incentives for effort:**

1. **(asymmetric information): if the Principal can't know how productive the Agent is, then she may want to offer a "menu" of contracts to induce the Agent to reveal his productivity — private information; *screening*, sorting.**
2. **the Agent's performance is a function of outside events, with the Agent bearing all of the risk — but if the Agent is *risk averse*, it may not be in the Principal's interest to force the Agent to bear the risk.**

## Contracting with Private Information

**e.g. The sales manager (the Principal) knows only that the value of a particular area is either high or low, but only the salesperson (the Agent) knows which.**

**Possible for the manager to offer the Agent a different package (commission rate $\lambda < 100\%$ and base salary $B$) depending on whether the Agent reports his sales potential as high or low, subject to the Agent's fallback position.**

**Accountability for what they report?**

## Honesty?

**Possible (with appropriate packages — see McMillan Ch. 9) to induce the *A*gent to give an honest report:**

- **Total package payments must be higher when the potential is correctly reported as high than when correctly reported as low.**
- **Commission rate $\lambda$ must be higher, and the base salary *B* lower, for a report of high potential than for a report of low potential.**

## How well does the Principal do?

**The commission rate $\lambda$ must do double duty:**

1. **elicit information, and**
2. **elicit effort (as above)**

$\therefore$ **it must be less than 100%,**

$\therefore$ **the Agent's private information costs the Principal.**
**(We saw a similar cost when Sally tried to screen Burt, in Lecture 12.)**

**Useful to use salespeople's information in contracts and in corporate planning.**

## Differential wages

**500 U.S. firms in footwear and clothing (after controlling for sex, union status, etc.): Why did piece-rate workers earn 14% more than workers on fixed wages? Three possibilities:**

1. ***self-selection*: more skillful workers choose companies with piece-rate payments, while others prefer fixed salaries;**
2. ***incentives:* people work harder when rewarded for the results of their extra effort;**
3. **since piece-rate workers' pay is not only higher but more volatile than fixed-wage workers' pay, to some extent the higher earnings are *compensation for higher risk* borne by the piece-rate workers.**

## Risk-Sharing versus Incentives

**Performance-based contracts subject the Agents to risk.**

**Most people are *risk-averse*: insure against risk by forgoing some of their anticipated earnings.**

**The Agent is often more risk averse than the Principal: a firm is better able to bear risks than its individual employees are.**

**$\therefore$ We might expect a smaller average payment to the Agent in return for the Principal absorbing some of the risk.**

**But this will weaken the Agent's incentives:**

***NB: Any contract will be a compromise between risk-bearing and incentives.***

## What is the Principal's best tradeoff between "risk-bearing" and "incentives"?

**Two questions:**

1. **How much discretionary scope does the Agent have to produce variations in performance?**
2. **How much money would the Agent be prepared to forgo to have the risk associated with the task removed from his shoulders?**

**The commission rate $\lambda$ should depend on the relative size of these two numbers.**

**So long as the Principal is less risk-averse than the Agent, sharing risk is a win-win proposition.**

## Risk-Sharing via Contracts

**Three types of contracts:**

***A fixed-price contract*** **will give the Agent — the firm or person contracting with the firm or government (with the Principal) — the incentive to choose the effort level that maximises the total return from the transaction, but at a risk.**

***A cost-plus contract*** **puts the risk on the Principal, but has the disadvantage of giving the Agent no incentive to limit production costs.**

***An incentive contract*** **is an intermediate form: allows the Agent to pass on some fraction of added cost as a higher price to the Principal.**

## Relative Performance Evaluation

**With perfect information, in order to infer the Agent's actions, the Principal could design a contract to elicit the desired actions.**

**The Principal can obtain more information than just the Agent's output: the outputs of others.**

**This can be obtained through *benchmarking* with other firms, or though tournaments among Agents, with prizes and rewards.**

**(See McMillan Ch. 10 on Setting Executives' Incentives.)**

# 5. Application to Financial Contracts (e.g. Hollywood)

**Or: Why standard finance theory doesn't tell you much about choice of contract.**

**1. Fundamentals:**

- **The Entrepreneur (the Principal) has a risky project that costs $1 million to start.**
- **It pays:** $\begin{cases} \$10 \text{ million with probability } = 3/4 \\ \$0 \text{ with probability } = 1/4 \end{cases}$
- **Investors (Agents) are risk-neutral; and the market interest rate is 0% p.a.**

**Hence, expected NPV** $= \$10 \times 3/4 + 0 \times 1/4 - \$1$
$= \$6.5 \text{ mn} > 0.$

## Finance theory and contracts.

**2. Two common ways to raise capital: Equity, Debt.**

➢ ***Equity contracts:***

**The Entrepreneur promises a share $\lambda$ of returns ($0 \leq \lambda \leq 1$) to Investors.**

**To raise \$1 million, she promises $\lambda$ to solve:**

$$\lambda\,[10 \times \tfrac{3}{4} \;+\; 0 \times \tfrac{1}{4}\,] \;\geq\; 1,$$

**which $\Rightarrow \lambda \geq 0.133 = 13.3\%$ (because their Expected Net Return $\geq 0$)**

**The Entrepreneur gets $(1-\lambda) \times \tfrac{3}{4} \times 10 \leq$ \$6.5 mn, the net wealth created.**

## ... and Debt Contracts

- *Debt:* The Entrepreneur promises to pay the first $\$D$ dollars to Investors if a Success. Solving:

  $$D \times 3/4 = 1, \Rightarrow D = \$1.33 \text{ million}$$

  The Entrepreneur gets $(10 - 1.33) \times 3/4 = \$6.5$ million

- Financing choice (debt or equity) is irrelevant (Modigliani-Miller).
  But if bankruptcy has cost $b$, then stay away from debt, as it gives Entrepreneur an expected value of $6.5 - \frac{b}{4}$, where the probability of bankruptcy is 1/4.

Q: So why are most projects like this (large inside ownership) financed with debt?

# The Simplest Answer (with asymmetric info, such as Hollywood and little investors):

**Cannot contract directly on realised returns, since only the *insider* knows whether the project succeeded or failed (or how successful the project was). Now compare the two securities:**

## 5.1 Equity finance:

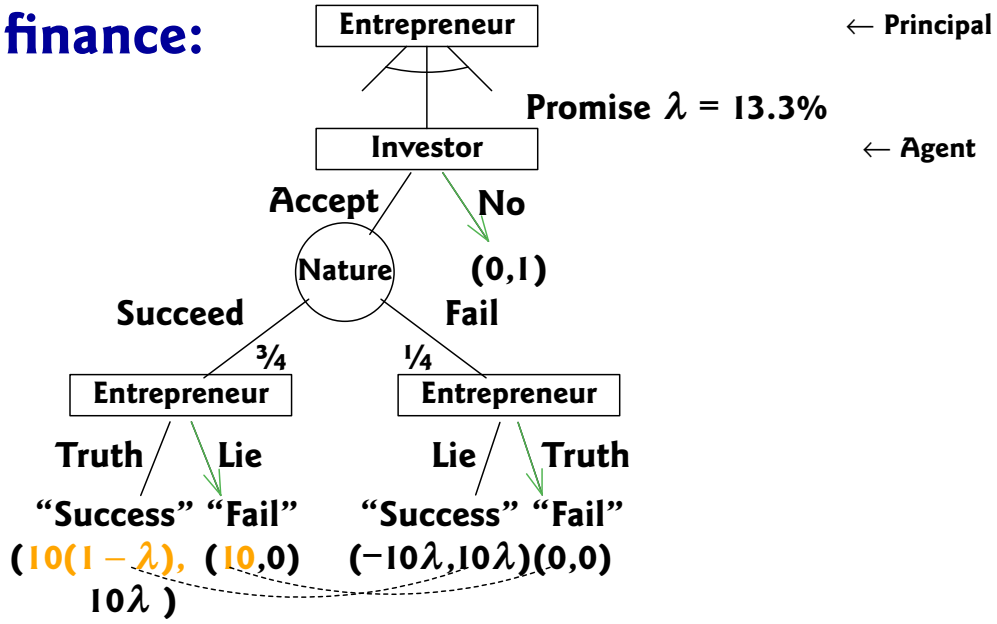


*Fig 1: Equity Finance* (Entrepreneur, Investor)

## No investment — Inefficient outcome

**The outside Investor's information set: he knows what the Entrepreneur says, but not Nature's outcome (whether there has been success or not).**

- $\therefore$ **The Entrepreneur announces "Failure" in *both* cases: $10 > 10(1-\lambda)$ (Probability 1)**
- $\therefore$ **The Investor says No, no investment: because $1 > 0$**
- $\succ$ **Mutual tragedy — inefficient.**

## *5.2 Debt Finance* with bankruptcy penalty *b* (a dead-weight loss).

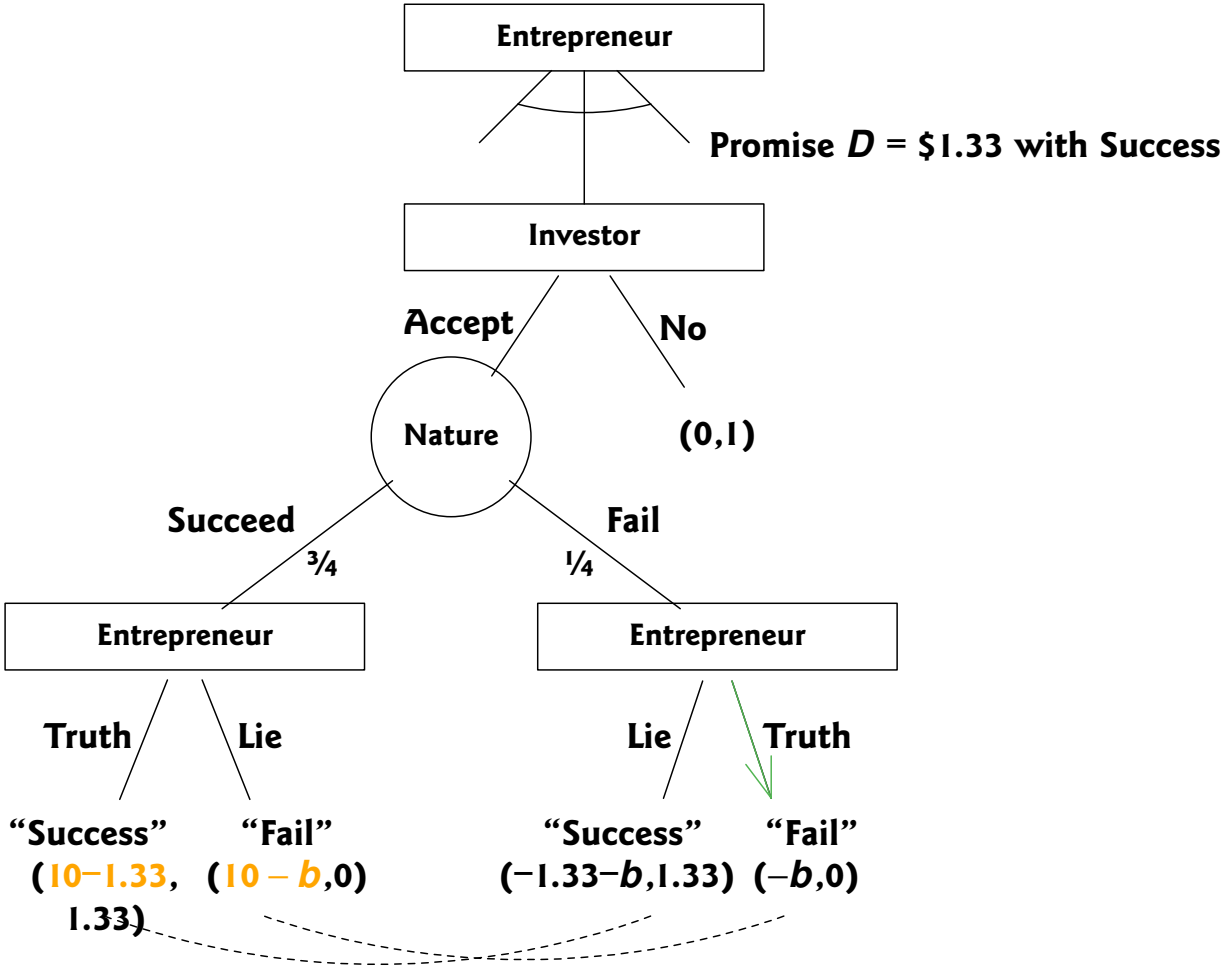


*Fig 2: Debt Finance* (Entrepreneur, Investor)

## The cost of bankruptcy can induce honesty:

- The Entrepreneur tells the Truth with Success if $b \geq \$1.33$ mn, the penalty of bankruptcy.
  (In the real world, the necessary $b$ is scaled down by other forces, e.g., honesty, etc.)
- The Investor then *participates*: Accept.
  Is this efficient?
- The penalty $b$ *must* be invoked when failure occurs or when Entrepreneur announces "Failure".

Small companies (which can hide $ flows) can issue these contracts.

Q: ways to achieve at lower cost to Ent. than $\frac{b}{4}$?

More efficient, because dead-weight loss $b$.

Intermediaries?

Large banks less often?

## 5.3 *"Relationship Investing" (Equity plus Monitoring)*

**By spending $X$ mn dollars, the equity Investor *finds out* whether success or failure by monitoring.**

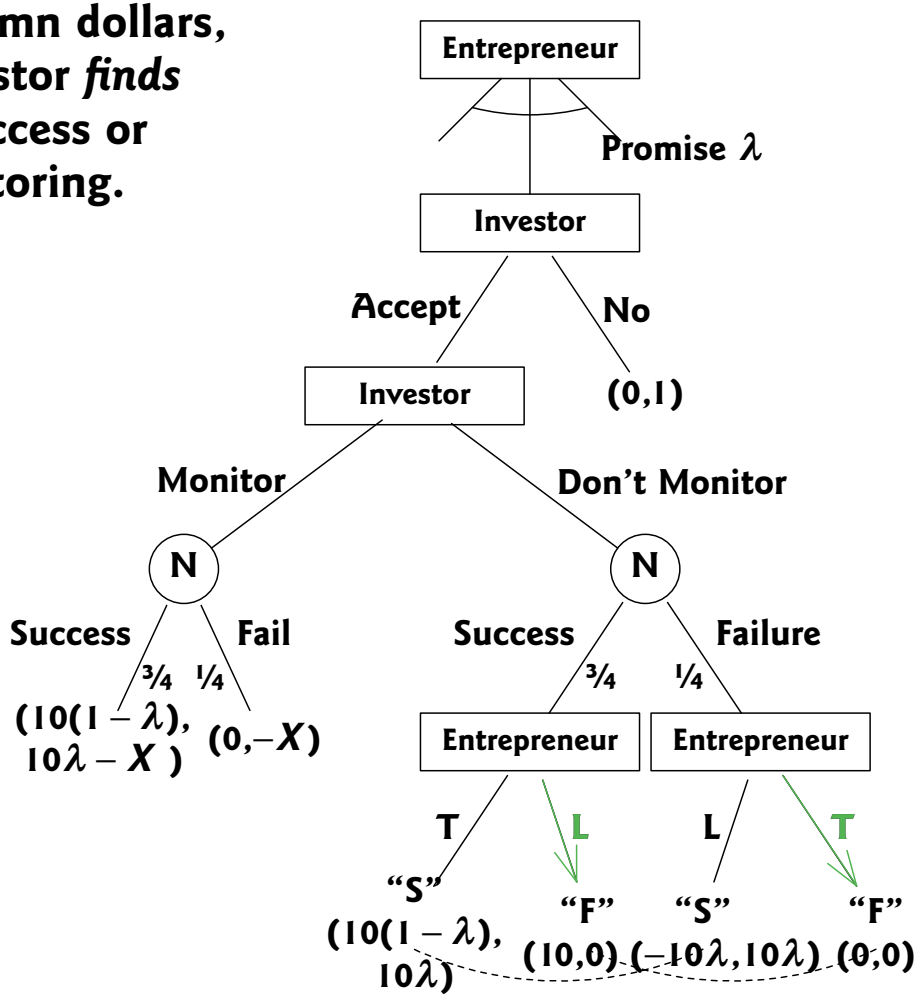


***Fig 3: Relationship Investing* (Entrepreneur, Investor)**

## When will monitoring and investment occur?

- From Fig 3 we see that Investors know that:
  - if they don't monitor, then they get 0 *for certain*, but
  - if they do monitor, then they get
$$\tfrac{3}{4}(10\lambda - X) + \tfrac{1}{4}(-X) = 7.5\lambda - X.$$
- Thus they monitor after investing, if $7.5\lambda - X > 0$,
  i.e., if $X < 7.5\lambda$ million dollars.
- But Investors will only Accept the contract if
$$7.5\lambda - X \geq 1,$$
  so we must have $\lambda \geq 0.133 + \frac{X}{7.5}$,
  where the second term is the compensation for monitoring expense.

## 5.4 *Conclusion*: Debt or Relationship?

**Consider the return to the Entrepreneur in Fig 2. (with $b$ = \$1.33 mn to induce truth-telling) and in Fig 3:**

**then the Entrepreneur will choose Relationship Investing over Debt Finance if the expected return to her is higher for Relationship Investing than for Debt Finance, i.e., if:**

$$7.5(1-\lambda) > \tfrac{3}{4}(10-1.33) - \tfrac{b}{4},$$

**where $\frac{b}{4} = \frac{1.33}{4}$ is the dead-weight loss associated with Debt Financing, and where $\lambda = 0.133 + \frac{X}{7.5}$,**

**i.e., if the monitoring cost $X$ < \$0.33 mn, then the Entrepreneur will choose Relationship Investment (Fig 3).**

**Idea: to have sunk the monitoring cost $X$ before knowing the outcome, then it's redundant if you find out it's successful.**

**But don't have to do messy ex-post bankruptcy.**