Contracts, Risk-sharing and Incentives: Part 1.

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Introduction

Focus: The labor contract in the presence of *asymmetric information* at the time of contracting (often an analysis in partial equilibrium).

Some stylized facts about labor contracts in the formal economy:

- A wage relationship is *often* a long-term one based on a written labor contract.
- Such a contract does not specify what the worker has to do in all circumstances. Instead, the employee will exercise his profession under the authority of the employer.
- Firms use variety of tools to pay their workers:
  - Long-term contracts;
  - Combination of hourly wage and performance pay (Bloom and Van Reenen, 2011);
  - "Tournaments" = wage differences based upon relative differences between individuals;
  - Promotions based on worker's seniority.

Introduction

- With
  - Perfectly competitive markets, hence perfect information e.g. about worker's effort and ability, and
  - Risk-neutral workers,

  It may be enough to pay wages that fluctuate with business cycle conditions.

- However workers are risk-averse and private insurers do not typically cover earnings risk. Incomplete insurance markets $\Rightarrow$ Workers care about labor contracts that provide some insurance against fluctuations $\Rightarrow$ *Risk-sharing* enters the scene.

- In-work effort is often to some extent a worker's choice $\Rightarrow$ There is room for "*moral hazard*", and hence labor contracts also intends to "incentivize". workers.

Aims

Providing answers to some of the questions:

- Why do firms and workers engage in long-term relationships?
- How the trade-off between insurance and incentives acts upon the remuneration rule for labor?
- Why firms make use of hierarchical promotions and internal markets?
- When is there a link between seniority and wages?
- When are contracts much simpler? The so-called “efficiency wage theory”.

To answer those questions, do we need a broader view about preferences? What do we learn then?

Standard = A stylized (narrow) view about human motivation: Employees seek to earn as much money as possible with minimal effort on the job (or minimal hours worked).

- The work done has no value *per se*.
- No possibility of identification with the firm (hence, no effort of the firm to affect employee's identification).
- No norms of behavior (No room for questions such as: Which effort is "normal"? What is a "fair" wage?).
- Worker's *preferences* are the same whether or not there is an incentive scheme or a supervisor.

This first set of slides follow this standard approach. Next, so-called "*social preferences*" will be considered.

References for the first set of slides:
- Chap. 6 of Cahuc, Carcillo and Zylberberg (2014),
- Garibaldi (2006) and some articles.

Some limitations

- These slides only feature workers in a relation of a subordination to a profit-maximizing (typically risk-neutral) employer.
- The moral hazard problem is due to private information on the worker side. Although it appears later on, the emphasis is not on the private information on the employers' side.
- The broader problem is the one of economic cooperation between parties who do not share the same objectives in the presence of asymmetric information. In particular, these slides neglect:
  - That employers could be risk averse.
  - That non-profit organizations and the public sector face similar insurance-incentives trade-offs.
- "Adverse selection" is to a large extent left aside (No private information about the potential gains from trade is typically assumed).

Road-map

1. 1. The Labor Contract

2. 2. Standard narrow view about motivation
   - 2.1. Incentives with verifiable results
   - 2.2. Incentives in the Absence of Verifiable Results

3. 3. Social Preferences (Next set of slides)
   - 3.1. Introduction and Motivation
   - 3.2. Fairness and reciprocity
   - 3.3. Intrinsic Motivation
   - 3.4. Envy

1. The Labor Contract

Contract Theory

Contract theory explains how such contracts can be understood as a rational response to:

1. *Uncertainty in the environment*;
2. *Private information of the employee*.

Uncertainty $\Rightarrow$ To what extent do labor contracts ensure workers against risks?

Private information $\Rightarrow$ How do labor contracts provide incentives so that workers deliver the “right” effort level ? (“right" needs to be defined)

The economics of human resource management is often called “Personnel Economics” (Lazear, 1995, Garibaldi, 2006).

Typology of contracts

Key questions:
Can the employee's (and the employer's) activity be observed and if so is it *verifiable* by a "third party" (= a judge when the matter is referred to the court)?

Two types of contract can be distinguished:

1. *Complete* contracts $\Leftrightarrow$
   - All clauses of the contract can be verified by a "third party" and
   - At the moment of signing, all circumstances can be foreseen.
2. *Incomplete* contracts $\Leftrightarrow$
   - All the clauses of the contract cannot be verified by a "third party" or circumstances are too numerous;
   - The contract must then be *self-enforcing*: both parties have a mutual interest in continuing the relationship.

Two textbook cases:

1. Employee's effort is observed and verifiable but employee's output is random.
   The focus is on how earnings risks should be shared.
   Covered by Chap. 6 of Cahuc, Carcillo and Zylberberg (2014).
   But not here.
   Generalizations:
   ◊ Optimal risk sharing when there is a risk of being laid off (Rosen, 1985).
   ◊ Optimal risk sharing when some workers (in particular, young ones who leave education) are not covered by long-term labor contracts (Drèze and Gollier, 1993).

2. Employee's effort is not verifiable: Employer faces a *moral hazard* problem. This is discussed now.

Agency model or principal-agent model

We study contracts within a *principal-agent* framework:

- The principal (=employer) proposes a contract;
- The agent (=employee) can either accept or refuse.

Here, by assumption,

- No search-matching frictions,
- Workers have no bargaining power,
- It makes sense to talk about "the output of the agent."
  OK e.g. for a salesman.
  However, one often only measures the output of a team of workers! These slides do not deal with "incentives in teams".

2. Standard Narrow View About Motivation

2.1. Incentives if results are verifiable

The principal-agent model with hidden action

The problem

1. Actions followed by the realization of some random process lead to *results* of an agent's activity.
2. Actions of the agent (*effort*) are not verifiable by a third party,[2] but *results* of actions (i.e. the production) are.
3. Consequence: a trade-off between providing incentives (to induce effort) and insurance.

[2] In the words of some authors: effort is not contractible.

Assumptions and Notations: Timing of decisions

Decisions unfold in the following sequence:

1. The principal offers a contract;
2. The agent accepts the contract, or turns it down;
3. If the agent turns it down, the protagonists go their separate ways, but if the agent accepts it, he or she then supplies an effort;
4. A random event ε occurs, which affects the result (output) of the agent's effort;
5. The principal and the agent observe the result;
6. The principal remunerates the agent according to the terms of the contract.

Assumptions and Notations

A1 Preferences of the agent of the *CARA* type:

$$U[W - C(e)] = -\exp(-a[W - C(e)]) \tag{1}$$

where

- W is wage income,
- e the agent's *unverifiable* effort,
- $C(e)$ is the cost of effort, with $C' > 0$, $C(0) = 0$ and $C'' > 0$,
- Below we adopt a simple specification with a single parameter $c > 0$:

$$C(e) = \frac{c\,e^2}{2} \quad \text{and}$$

- $a = -U''/U' > 0$ designates "absolute risk aversion".

A2 The worker has an "outside option" that yields an exogenous utility level $\overline{U}$, which can be also written as $-exp(-a\overline{x})$ for some exogenous income $\overline{x}$.

Assumptions and Notations

Continued

A3 Effort results in a certain level of *verifiable* but random production:

$$y = e + \varepsilon,$$

where ε is a normal random variable with zero mean and standard error σ: $\varepsilon \sim \mathcal{N}(0, \sigma^2)$.

A4 The explicit performance wage contract is linear in y:

$$W = w + by,$$

where

- w is a fixed wage and
- b is a piece-rate on production
  (also called the variable wage component; the product by is also called "the bonus").

The agent's effort level

If the agent accepts the contract, she takes the wage contract as given and chooses her effort as to maximize expected utility:

$$\begin{aligned} EU &= E\{-exp(-a[w + b(e + \varepsilon) - C(e)])\} \\ &= E\{-exp(-a[w + be - C(e)]) \cdot exp(-a\,b\,\varepsilon)\} \\ &= -\exp(-a[w + be - C(e)]) \cdot E\{\exp(-a\,b\,\varepsilon)\} \\ &= -\exp\left(-a\left[w + be - C(e) - \frac{a\,b^2\sigma^2}{2}\right]\right) \end{aligned}$$

since:

◊ $a\,b\,\varepsilon \sim \mathcal{N}(0, a^2b^2\sigma^2)$ and

◊ The exponential of a Normal random variable $X \sim \mathcal{N}(\mu, \sigma^2)$ is log-normally distributed with mean $\exp\left[\mu + \frac{\sigma^2}{2}\right]$.

The agent's effort level

Differentiating with respect ot e in order to find the FOC yields:

$$C'(e^*) = b$$

or with the simple specification of the cost of effort:

$$e^* = \frac{b}{c}$$

The best chosen effort, e^*, trades off the benefits and costs of marginally increasing effort.

The risk-neutral Principal's Behavior

Remembering that $W = w + by$, the expected profit of the principal is

$$\begin{aligned} E(y - W) &= E\left(e^* + \varepsilon - w - b\left(e^* + \varepsilon\right)\right) \\ &= E(1-b)(e^* + \varepsilon) - w \\ &= (1-b)e^* - w. \end{aligned}$$

Therefore, the principal chooses w and b so that:

$$\begin{aligned} &\underset{\{w,b\}}{\text{Max}}(1-b)e^* - w \\ &\text{subject to} \\ &C'(e^*) = b \quad \Leftrightarrow \quad e^* = b/c, \\ &EU \geq \overline{U} = -exp(-a\overline{x}) \end{aligned} \tag{2}$$

(Strong) implicit assumptions: The principal knows the relationship $e \mapsto C(e)$, the preference of the worker, and the outside option!

The Principal's Behavior

Continued

The principal has no reason to offer more than $\overline{U}$.

So, the *binding* participation constraint can be rewritten as:

$$w = \bar{x} - be^* + C(e^*) + \frac{ab^2\sigma^2}{2} \tag{3}$$

The optimisation problem can therefore be rewritten as:

$$\underset{\{b\}}{\text{Max}} \quad \left[e^*(b) - C[e^*(b)] - \frac{ab^2\sigma^2}{2} - \bar{x} \right] \quad \text{i.e. with above specification}$$

$$\underset{\{b\}}{\text{Max}} \quad \left[\frac{b}{c} - \frac{c}{2}\left(\frac{b}{c}\right)^2 - \frac{ab^2\sigma^2}{2} - \bar{x} \right]$$

The Optimal Remuneration Rule

The first-order condition gives the piece rate

$$b^* = \frac{1}{1 + ac\sigma^2} < 1 \quad \text{Generalization: } b^* = \frac{1}{1 + aC''(e^*)\sigma^2} \tag{4}$$

This equation captures the trade-off between providing incentives and insurance. The magnitude of the piece rate decreases with

- Absolute risk-aversion ($a > 0$);
- The variance of the noise ε ($\sigma^2 > 0$);
- the concavity of the cost of effort, i.e. how the marginal cost of effort varies at the margin ($c > 0$).

The optimal value w of the fixed part of the remuneration is:

$$w^* = \bar{x} - \frac{1 - ac\sigma^2}{2c(1 + ac\sigma^2)^2}$$

Note 1: risk-aversion is taken into account by the principal because of the participation constraint $EU \geq \overline{U}$ *is binding*.

Note 2: Is it worth hiring the agent?
The expected profit of the principal

$$\begin{aligned} E(y - W) &= E(1 - b^*)(e^* + \varepsilon) - w = (1 - b^*)e^* - w \\ &= (1 - b^*)e^* - \left(\bar{x} - b^* e^* + C(e^*) + \frac{ab^{*2}\sigma^2}{2}\right) \\ &= e^* - \left(\bar{x} + C(e^*) + \frac{ab^{*2}\sigma^2}{2}\right) \end{aligned}$$

has to be non-negative (or bigger than an outside opportunity of the principal, if any).
Put another way, $\bar{x}$ cannot be too high compared to the expected output (e^*).

The principal-agent model with hidden action

The first-best outcome

"First-best" means here that the "non-verifiability" of e disappears
$\Rightarrow$ e is now part of the contract chosen by the principal, who solves:

$$\underset{\{w,b,e\}}{\text{Max}} \; [e-(w+be)] \text{ subject to } w+be-C(e)-\frac{ab^2\sigma^2}{2} \geq \bar{x}$$

$$\underset{\{b,e\}}{\text{Max}} \left[e-\bar{x}-C(e)-\frac{ab^2\sigma^2}{2} \right]$$

Indexing the first-best with superscript o:

$$b^o=0; C'(e^o)=1 \text{ or } e^o=1/c; w^o=\overline{x}+C(e^o)$$

i.e. Full insurance! And $e^o > e^*$!

Here also $\overline{x}$ cannot be too high so that $E(y-W) \geq 0$.

The principal-agent model with hidden action

Risk-neutral workers

Risk-neutral workers:

$$EU = E(W - C(e)) = E(w + be + b\varepsilon - C(e)) = w + be - \frac{ce^2}{2}$$

Maximizing expected utility wrt effort still gives $e^* = b/c$.

The principal maximizes expected profits:

$$\underset{\{b,w\}}{\text{Max}} E(y - W) = \underset{\{b,w\}}{\text{Max}} E((1 - b)e^* - w) \text{ st } e^* = b/c \text{ and } EU \geq \bar{x}$$

The binding participation constraint:

$$w = \bar{x} - be^* + \frac{c(e^*)^2}{2}$$

The principal-agent model with hidden action

Risk-neutral workers

Substitute participation constraint in expected profits

$$\underset{\{b\}}{\text{Max}} E(y - W) = \underset{\{b\}}{\text{Max}} E\left\{\frac{b}{c} - \bar{x} - \frac{b^2}{2c}\right\}$$

Maximizing expected profits wrt b yields

$$b^* = 1 \Rightarrow e^* = 1/c = e^0,$$

i.e. (i) no insurance with respect to the stochastic nature of output and (ii) the first-best effort level!

The principal-agent model with hidden action

Risk-neutral workers

The expected profit of the principal

$$\begin{aligned} E(y - W) &= E(1 - b^*)(e^* + \varepsilon) - w = -w \\ &= -(\bar{x} - e^* + C(e^*)) = -\bar{x} + \frac{1}{c} - \frac{1}{2c} \end{aligned}$$

has to be non-negative. So, the fixed part of the explicit performance contract has to be non-positive ($w \leq 0$). As $e^* - C(e^*) = 1/(2c) > 0$, it is not worth hiring the agent if $\overline{x} > \frac{1}{2c}$.

With risk-neutral agents, the optimal explicit performance contract is a *Franchising Scheme* since

- The worker becomes the residual claimant since $b^* = 1$;
- The worker rents his job by paying $\mid w \mid$ to the principal if it is worth hiring the agent.

Exercise

Assume a one-worker-one-firm setting where the worker has the following utility function:

$$U(W, e) = EW - \lambda VarW - c\frac{e^2}{2}, \qquad \lambda > 0, c > 0,$$

where $W = \alpha + \beta \cdot x$*, the output* $x = e + \eta$*,* e *designates the unobservable effort of the worker, and* η *is a random shock with mean zero and variance* $v > 0$*.*

Adopt the principal-agent framework and the timing of decisions introduced above. What are the optimal parameters α *and* β *of the explicit performance contract if the outside option of the worker is denoted* $u \geq 0$ *and the expected profit of the firm is* $E(p \cdot x - W)$*,* $p > 0$ *being some exogenous deterministic output price? Interpret the role of parameters in* β*. The outside option of the principal is* $E(p \cdot x - W) \geq 0$*.*

Empirical findings

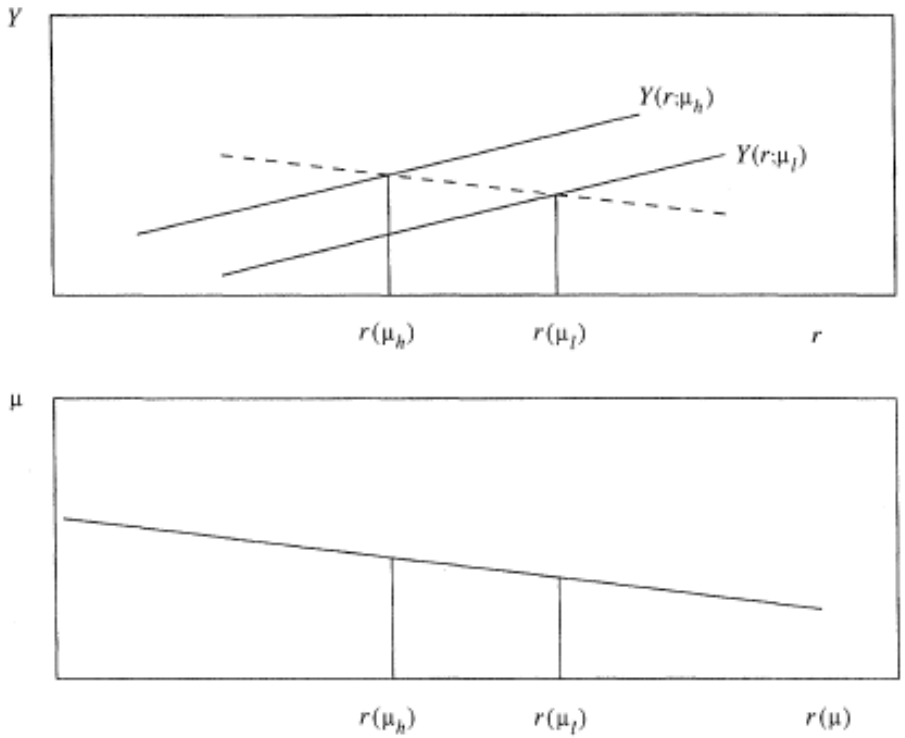
Paarsch and Shearer (1999)

- Empirical studies evaluate how workers react to economic incentives and compensation policies.
- Firms may select a compensation system based on elements that are unobservable to the econometrician but which affect worker productivity.
- OLS regressions that use the observed covariation between worker productivity and the payment system to identify the incentive effect, may fail to provide a consistent estimate of this effect.
- Paarsch and Shearer (1999) find a negative association between the level of the piece rate and output (number of trees planted).
  - Piece rates are chosen by the firm after planting conditions are observed: e.g. a flat terrain with loose soil vs steep rocky hillsides.
  - Piece rates are higher under unfavorable conditions.

Empirical findings

Paarsch and Shearer (1999)

- Output (Y) in bad (μ_l) and favorable (μ_h) planting conditions plots for a given piece rate (r).
- OLS finds a negative association between the piece rate and output if not controlling for planting conditions.



Empirical findings

Paarsch and Shearer (1999) and Shearer (2004)

- To solve the endogeneity problem, Paarsch and Shearer (1999) develop a method to link the firm's choice of the piece rate level to planting conditions.
- Their estimated elasticity of effort (= number of trees) with respect to the piece rate is about 2, holding planting conditions constant.

- Shearer (2004) performs a field experiment in a tree-planting firm: He randomly assigns workers to a performance pay system or a fixed wage.
  - Output is higher in the performance pay system;
  - Yet, the sample of workers is small.

Empirical findings

Lazear (2000)

- A large autoglass installer in the US moved from a fixed hourly pay to a piece rate scheme.
- Close to 3000 workers over the 19-month phase-in period. Typically data for an individual under both regimes + entrants in new regime.
- Before - After descriptive comparison: The average number of glass units installed per worker and per eight hours increases by 20%.
- Possible interpretations:
  1. Incentive effect: Output of the workers increase when moving to a piece rate scheme.
  2. Sorting effect: Average quality of the workforce increases.
  3. “Hawthorne effect” understood as “Any change in an organization leads to a temporary effect on its output”.

Empirical findings

Lazear (2000). PPP = Performance Pay Plan.

TABLE 3—REGRESSION RESULTS

Regression number	Dummy for PPP person-month observation	Tenure	Time since PPP	New regime	R^2	Description
1	0.368 (0.013)				0.04	Dummies for month and year included
2	0.197 (0.009)				0.73	Dummies for month and year; worker-specific dummies included (2,755 individual workers)
3	0.313 (0.014)	0.343 (0.017)	0.107 (0.024)		0.05	Dummies for month and year included
4	0.202 (0.009)	0.224 (0.058)	0.273 (0.018)		0.76	Dummies for month and year; worker-specific dummies included (2,755 individual workers)
5	0.309 (0.014)	0.424 (0.019)	0.130 (0.024)	0.243 (0.025)	0.06	Dummies for month and year included

Notes: Standard errors are reported in parentheses below the coefficients.
Dependent variable: ln output-per-worker-per-day.
Number of observations: 29,837.

Empirical findings

Oyer and Schaefer (2011)

Is greater risk associated with weaker pay-for-performance incentives? Very hard to confirm empirically (Oyer and Schaefer, 2011, p.1779-81). The econometrician faces several problems:

- Measurement of "risk";
- Incentives are stronger (b^* is higher) when:
  - The agent is less risk averse
  - The agent is more responsive to strong incentives (lower c)
  - The marginal return of effort ($\partial y/\partial e$) is higher.

These parameters are largely unobservable and any correlation between these unobservables and σ^2 "can confound tests of the risk/incentive tradeoff" (p.1781)

Empirical findings

Benabou and Tirole (2003)

Financial incentives can have counterproductive effects:

"Experimental and field evidence indicates that *extrinsic* motivation (contingent rewards) can sometimes conflict with *intrinsic* motivation (the individual's desire to perform the task for its own sake)" (Benabou and Tirole, 2003, p. 490).

$\Rightarrow$ In what cases should financial incentives be used with caution? A growing literature that requires a less narrow view about human motivation...

Should Remuneration Always Be Individualized?

Initial idea: Why a contract influenced exclusively by individual production?
If there are other verifiable variables, their utilization could lead to more efficient contracts.
The Agency Model with Two Signals

A5 The principal observes a verifiable signal $\tilde{\varepsilon} \sim N(0, \sigma^2)$ that is possibly correlated with the component of individual production y that is unrelated to effort, i.e. with $\varepsilon \sim N(0, \sigma^2)$: $cov(\varepsilon, \tilde{\varepsilon}) = \rho\sigma^2$.

Main application: If the results of the agent's effort are correlated to the results of colleagues (because, say, of common random shocks).

A4' The linear wage contract takes the following form: $W = w + by - \tilde{b}\tilde{\varepsilon}$

The Agency Model with Two Signals

Now, the expected utility is:

$$\begin{aligned} EU &= -E\exp\{-a[W-C(e)]\} \\ &= -E\exp\left\{-a\left[w+be+b\varepsilon-\tilde{b}\tilde{\varepsilon}-C(e)\right]\right\} \\ &= -\exp\{-a[w+be-C(e)]\}\cdot E\left[\exp(-a\left[b\varepsilon-\tilde{b}\tilde{\varepsilon}\right])\right] \\ &= -\exp\left\{-a\left[w+be-C(e)-\frac{a\sigma^2}{2}\left(b^2+\tilde{b}^2-2\rho b\tilde{b}\right)\right]\right\} \end{aligned}$$

The random variable $-a(b\varepsilon-\tilde{b}\tilde{\varepsilon})$ follows a normal distribution with mean zero and variance $a^2\sigma^2(b^2+\tilde{b}^2-2\rho b\tilde{b})$. The random variable $exp(-a(b\varepsilon+\tilde{b}\tilde{\varepsilon}))$ has a log-normal distribution with mean $a^2\sigma^2(b^2+\tilde{b}^2-2\rho b\tilde{b})/2$.

The Agency Model with Two Signals

The chosen effort still verifies:

$$C'(e^*) = b \text{ which defines } e^* = b/c \text{ with } C(e) = \frac{c\,e^2}{2}$$

Expected profit of the principal:

$$\begin{aligned} E(y - W) &= E(e + \varepsilon - w - by + \tilde{b}\tilde{\varepsilon}) \\ &= E(e + \varepsilon - w - be - b\varepsilon + \tilde{b}\tilde{\varepsilon}) \end{aligned}$$

As $E\varepsilon = E\tilde{\varepsilon} = 0$, the problem of the principal is:

$$\underset{\{w,b,\tilde{b}\}}{\text{Max}} \; [(1-b)e^* - w] \text{ s.to } C'(e^*) = b,\; EU \geq -\exp\{-a \cdot \overline{x}\}$$

The Optimal Compensation Rule

The *binding* participation constraint can be rewritten as:

$$w = \bar{x} - be^* + C(e^*) + \frac{a\sigma^2}{2}\left(b^2 + \tilde{b}^2 - 2\rho b\tilde{b}\right) \tag{30}$$

The optimisation problem can therefore be rewritten as:

$$\underset{\{b,\tilde{b}\}}{\text{Max}}\left[e^* - C[e^*] - \frac{a\sigma^2}{2}\left(b^2 + \tilde{b}^2 - 2\rho b\tilde{b}\right) - \bar{x}\right]$$

$$\underset{\{b,\tilde{b}\}}{\text{Max}}\left[\frac{b}{c} - \frac{b^2}{2c} - \frac{a\sigma^2}{2}\left(b^2 + \tilde{b}^2 - 2\rho b\tilde{b}\right) - \bar{x}\right]$$

The Optimal Compensation Rule

From the f.o.c.'s:

$$
\begin{aligned}
b^* &= \frac{1}{1+ac\sigma^2(1-\rho^2)} \leq 1 \Rightarrow \frac{\partial b^*}{\partial |\rho|} > 0; \frac{\partial b^*}{\partial a}, \frac{\partial b^*}{\partial \sigma^2} < 0, \\
\tilde{b}^* &= \rho b^* \qquad \Rightarrow \frac{d\tilde{b}^*}{d\rho} = b^* + \rho \cdot \frac{\partial b^*}{\partial \rho} > 0 \text{ if } \rho > 0, \\
W^* &= w^* + b^* y - \tilde{b}^* \tilde{\varepsilon},\ w^* \text{ from (30)}
\end{aligned}
$$

1. $\rho = 0 \Rightarrow \tilde{b} = 0$:
   The second signal just adds in "noise" $\Rightarrow$ ignore it
2. $1 \geq \rho > 0 \Rightarrow b^* \geq \tilde{b}^* > 0$.
   An increase in the signal $\tilde{\varepsilon}$ reduces the compensation W^* since the positive correlation induces that y is higher "because" ε is bigger, too.
3. $-1 \leq \rho < 0 \Rightarrow \tilde{b}^* < 0 < b^*$.

Some reasons why performance pay may be inefficient

A. Multitasking

- The productive activities of most workers have not one but many dimensions.
- Some of these activities are verifiable but some others not because they are much harder to measure.
  - Take the case of teacher in compulsory education.
  - Test scores of their pupils are verifiable.
  - Several other achievements (being able to work together in groups, to explain orally a result and the like) are much less easy to measure.
- If the agent's remuneration is based on those verifiable outputs only, then the agent has an incentive
  - To orient all his/her effort in order to rise those verifiable outputs
  - And to neglect non verifiable outputs.
- Brown (1990) shows that incentive pay is less likely in jobs with a variety of duties than in jobs with a narrow set of routines.

Some reasons why performance pay may be inefficient

A. Multitasking

So, whenever it's difficult to measure the performance of one task, performance pay becomes inefficient if the various effort levels $e_i, i \in \{1, 2, ...\}$ are substitutable.
Alternatives?

- Where feasible, use an aggregate (verifiable) index of performance that is well aligned with the principal objective.
  E.g. Stock option compensation in the case of CEOs:
  - Aim: to link their remuneration directly to share prices to give an incentive to increase shareholder value.
  - However, due to asymmetric information, there are examples of accounting scandals (MCI, Enron,...).
- Replace "objective" performance measures by "subjective" assessments of performance (by a supervisor or through peer reviews). However, these assessments lack verifiability and thus cannot be enforced by courts.

B. Supervision and rent-seeking

- Often the principal does not observe agent's output
- But well supervisors who are themselves agents:
  1. To avoid friction with collaborators, supervisors tend to write favorable performance reports $\Rightarrow$ problem of measurement of performance.
  2. Or, agents try to influence performance reports by undertaking actions that attempt to "impress" supervisors: rent-seeking or lobbying.

Here, we focus on case 2.

A Model with Rent-Seeking

An agent can exert two types of effort denoted e and α. But α has no productive value: Assumption **A3** is maintained: $y = e + \varepsilon$.

A1" Preferences and cost of effort as in Assumption **A1**. In addition, there is a cost for rent-seeking activity α: $K(\alpha)$, where $K' > 0$ and $K'' > 0$. Specification below: $K = \frac{k\alpha^2}{2}$.
Thus, agent's preferences are described by:

$$U = -exp\{-a[W - C(e) - K(\alpha)]\}$$

A4"' Output is y but the supervisor reports to the principal that it is $y + \alpha \Rightarrow W = w + b(y + \alpha)$

A Model with Rent-Seeking

The agent's behavior

Expected utility of an agent is given by:

$$EU = -exp\left\{-a[w + b(e + \alpha) - C(e) - K(\alpha) - \frac{ab^2\sigma^2}{2}]\right\}$$

Optimal effort for the agent, and therefore incentive constraint:

$$C'(e) = K'(\alpha) = b \qquad \text{here: } e^* = \frac{b^*}{c} \text{ and } \alpha^* = \frac{b^*}{k}$$

Participation constraint ($EU \geq \bar{U}$)

$$w + b(e + \alpha) - C(e) - K(\alpha) - \frac{ab^2\sigma^2}{2} \geq \bar{x}$$

A Model with Rent-Seeking

The Optimal Pay Scheme

The principal maximizes expected profits ($E(y - W)$):

$$\underset{w,b}{\text{Max}}\,[(1-b)e^* - b\alpha^* - w] \text{ s. t. } C'(e^*) = K'(\alpha^*) = b \text{ and } EU \geq \bar{U}$$

Taking the value of w from the participation constraint, this becomes:

$$\underset{b}{\text{Max}}\left[e^* - C(e^*) - K(\alpha^*) - \frac{a\,b^2\sigma^2}{2} - \bar{x}\right] \text{ s. t. } C'(e^*) = K'(\alpha^*) = b$$

$$\underset{b}{\text{Max}}\left[e^* - \frac{c\,e^{*2}}{2} - \frac{k\,\alpha^{*2}}{2} - \frac{a\,b^2\sigma^2}{2} - \bar{x}\right] \text{ s. t. } e^* = \frac{b^*}{c} \text{ and } \alpha^* = \frac{b^*}{k}$$

$$\Leftrightarrow \underset{b}{\text{Max}}\left[\frac{b}{c} - \frac{b^2}{2c} - \frac{b^2}{2k} - \frac{ab^2\sigma^2}{2} - \bar{x}\right]$$

A Model with Rent-Seeking

The Optimal Pay Scheme

Set the derivative wrt b to zero to obtain the optimal remuneration rule:

$$b^* = \frac{1}{1 + \frac{c}{k} + ac\sigma^2}$$

- The less costly rent-seeking (smaller k), the smaller b.
- With risk-neutral agents ($a = 0$) the first-best solution, $b^* = 1$, can no longer be obtained.

In this model, supervisors are passively transmitting the perceived output level.
What if supervisors are themselves taking hidden decisions and are subject to a performance-pay scheme? See next slide.

Empirical evidence of the role played by supervisors

Bandiera et al., 2009

- Study managerial incentives in an English fruit-picking company.
- Workers are paid a piece-rate (per weight of fruit gathered).
- Field experiment: change in incentives for managers, from a fixed wage to introducing a bonus depending on overall quantity of fruit gathered by team.
- If managers paid a fixed wage, managers tend to favor workers to whom they are socially connected. The ability of the workers play no role.
- Upon introduction of the bonus, managers distribute their attention more to high ability workers so as to actually maximize production.

Conclusion of Subsection 2.1

- Performance pay can be a good way to provide both incentives and insurance in a context where performance is verifiable.
- Potential problems:
  - Multitasking is frequent and some dimensions of worker's output not verifiable or not measurable.
  - Room for rent-seeking behavior.
  - Financial incentives might crowd out intrinsic motivation.
- If performance is not verifiable, then other contractual arrangements might be designed to provide incentives
  - Promotions on the basis of relative performance;
  - Seniority rules in long-term contracts.

2.2. Incentives when results are not verifiable

What if both, effort *and* individual performance are unverifiable?

- Double moral hazard problem:
  - The agent can provide too little effort.
  - The principal can lie about the performance.

Answers:

- An *internal market* + a system of *promotions*
  If *relative* performance (= *ordinal*) is easier to measure than *absolute* performance (= *cardinal*),
  The principal can publicly announce in advance the wage increase to which the promotion entitles and the number of promoted workers = verifiable clauses.
  = The literature on “tournaments”.
- Efficiency wages or compensation rules based on seniority

Promotions and Tournaments

A (single period) Tournament Model

A1P A firm has only two workers (j and k) and there are two jobs. Workers compete against one another and the winner will become the "boss" and will earn W_1 while the loser becomes the "operator" and will earn W_2. No wages are paid before the end of the contest.

A2P (Homogeneous) workers are risk-neutral: $U = W - c\frac{e^2}{2}$, where $c > 0$.

A3P Effort ($e \geq 0$) results in a level of unverifiable and random production: $q_j = e_j - \frac{1}{2}\varepsilon$, and $q_k = e_k + \frac{1}{2}\varepsilon$, where ε is uniformly distributed over $[-b, b]$.

Properties of the uniform distribution:

$$E(\varepsilon) = 0, Var(\varepsilon) = b^2/3, P(\varepsilon \leq x) = \frac{x+b}{2b}$$

A Tournament Model

The behavior of the Agents

The probability that agent j wins the contest is

$$P(q_j > q_k) = P\left(e_j - \frac{1}{2}\varepsilon > e_k + \frac{1}{2}\varepsilon\right) = P(\varepsilon < e_j - e_k) = \frac{e_j - e_k + b}{2b}$$

Worker j chooses effort to maximize his/her expected utility:

$$e_j^* = \arg\max_{e_j} \frac{e_j - e_k + b}{2b} W_1 + \left(1 - \frac{e_j - e_k + b}{2b}\right) W_2 - c\,\frac{e_j^2}{2}$$

F.O.C. for worker j: $\frac{W_1 - W_2}{2b} = c\, e_j^*$ and similarly for worker k, so that both choose the same effort level $e^* = \frac{W_1 - W_2}{2bc}$.

The participation constraint is $EU = \frac{W_1 + W_2}{2} - c\frac{(e^*)^2}{2} \geq \overline{U}$.

A Tournament Model

The Behavior of the Principal

The principal maximises expected profits *per worker* taking the incentive and participation constraints into account.

$$
\begin{aligned}
W_1^*, W_2^* &= \underset{W_1, W_2}{\arg\max}\ e^* - \frac{W_1 + W_2}{2} \\
\text{s.to} \quad & e^* = \frac{W_1 - W_2}{2bc} \\
& \frac{W_1 + W_2}{2} - c\frac{e^{*2}}{2} \geq \overline{U} \\
W_1^*, W_2^* &= \underset{W_1, W_2}{\arg\max}\ e^* - \frac{ce^{*2}}{2} - \overline{U}
\end{aligned}
$$

The tournament elicits the efficient effort level $e^* = 1/c$.

A Tournament Model

The behavior of the Principal

Substitute the optimal effort level $e^* = 1/c$ into the two constraints to solve for W_1^* and W_2^*. Combining the FOC, i.e. $W_1 - W_2 = 2b$ and the participation constraint yields:

$$\begin{aligned} W_1^* &= \overline{U} + b + \frac{1}{2c} \\ W_2^* &= \overline{U} - b + \frac{1}{2c} \end{aligned}$$

Testable predictions:

- Effort increases with the wage spread $W_1^* - W_2^*$;
- Effort decreases with b and hence with the variance of ε;
- The optimal wage spread is increasing in the variance of ε.

Empirical evidence on tournaments

DeVaro (2006)

- Estimates a structural model of promotion tournaments (treating as endogenous promotions, worker performance, and the wage spread from promotion)
- Data on promotions, wage spreads from promotion, worker performance, and worker, firm, and job characteristics.
- Results:
  - Promotions are determined by relative worker performance.
  - Employers set wage spreads to induce optimal performance levels.
  - Workers are motivated by larger spreads.

Some problems with tournaments

- In addition to devoting effort, the worker can engage in a rent-seeking activity to impress his supervisor if the latter observes relative output with some noise.
  - Rent-seeking behavior could be limited by assigning outside members to the promotion committee.
- Sabotage by or lack of cooperation between competing colleagues to win the contest (Lazear, 1989).
- If workers are averse to inequality and can respond by retaliating (e.g. lower effort), there is some empirical evidence that the productivity of non-promoted workers is affected by tournaments (see the summary by Rebitzer and Taylor, 2011, p. 728-734).
- Promotions can lead to too high effort (A “Rat race” introduced by Akerlof, 1976).

Evidence of rat race in law firms

Landers, Rebitzer and Taylor, 1996

Study work practices in large US law firms.

- These firms have only two broad classes of professionals:
  1. Young lawyers who start as *salaried* "associates";
  2. Partners (who have purchased an equity stake in the firm).

- Importantly, there is a "sharing of revenues among partners" (non competitive environment). Hence, each partner's income depend on the money made by other partners, whose activities are hard to observe.
  $\Rightarrow$ Strong incentive to "allow in partnership only those associates with a *propensity* to work hard" (p. 330).
  Proxy: Amount of hours worked.

Evidence of rat race in law firms

Landers, Rebitzer and Taylor, 1996

Theory

- Assumptions: Associates are of two *unobservable* types ("Adverse selection" problem). A type is a weight on the disutility of hours worked. Productivity of an hour worked is the same for both types.
- Assumption: How hard associates work will not affect the numbers of promoted ones.
- Property shown: The principal (= the partners) choose a threshold of working time above the first-best one to induce workers to *signal* their type. In that sense the latter "overwork".

Empirical findings in two large firms:

- Associates would prefer to work shorter hours and earn lower salaries, conditional on other associates also working shorter hours.
- Partners use willingness to work long hours as an indicator of motivation to excel.

Exercise

1. *What is an "explicit performance" contract? To answer that question, you do not need to model such a contract. Explain in words the economic assumptions needed for such a contract and the main features of it.*
2. *Why do employers offer such a contract rather than a fixed wage contract?*
3. *Linear performance contracts, maximizing profits, usually index wages only partially and not completely to performance (single task, no rent-seeking). What are the key factors that determine the degree in which wages should be linked to performance? How do they affect the optimal performance contract and thereby profits? What's the intuition behind?*
4. *Why may it be sensible ? rather than directly relating wages to measured performance - to link wages to a system of promotions ?*

Efficiency wages

The "shirking" model (Shapiro and Stiglitz, 1984); inspired by Garibaldi (2006)

Static one-job-one-firm version of the model where the agent's production is not verifiable.

- A1S The worker is risk neutral and exerts two levels of effort: 0 or 1 to which are associated costs of respectively 0 and $c/2, c > 0$: $U = w - \frac{c}{2} \cdot e$.
- A2S *Unverifiable* production $y > 0$ is only realized if $e = 1$ (otherwise nothing is produced), but due to costs of supervision the firm inspects the production level (and therefore effort) only with an *exogenous* probability $p \in (0, 1)$.
- A3S Since effort and the output are *unverifiable*, the employer offers a very simply contract, namely a wage $w > 0$ is paid until the worker is caught shirking; if caught the worker gets nothing and is fired. Then $U = z$.

Efficiency wages

The behavior of the Agent

The worker devotes effort if

$$w - \frac{c}{2} \geq (1-p)w + pz \qquad \Leftrightarrow \qquad w \geq z + \frac{c}{2p}$$

where z denotes the outside option of the worker.

In sum, the worker is ready to work and devote effort at a (reservation) wage $\tilde{w}$ that induces indifference between working or not:

$$\tilde{w} - \frac{c}{2} \cdot 1 = z \quad \Rightarrow \quad \tilde{w} = z + \frac{c}{2}$$

However, because of the lack of verifiability of effort and output *and* because $p \in (0,1)$, the firm chooses to offer more than $\tilde{w}$, namely $z + \frac{c}{2p}$ to induce effort.

Efficiency wages

The behavior of the Principal

The firm's problem is to induce positive effort at the lowest cost. So, the firm chooses the lowest possible wage such that the above condition is met:

$$w = z + \frac{c}{2p}.$$

Therefore, the workers gets "a surplus", utility in employment - in unemployment:

$$U - z = z + \frac{c}{2p} - \frac{c}{2} - z = \frac{c(1-p)}{2p}$$

which is *positive if* $p < 1$.
The job is created if the parameters imply that profits are nonnegative, i.e.:

$$\pi = y - (z + \frac{c}{2p}) \geq 0$$

Efficiency wages

Labor market equilibrium

Imagine an economy populated with firm-worker pairs described above.
Let us relate z to what happens in the labor market. Assume that there is a continuum of homogeneous workers and firms.
It is reasonable to assume that:

$$z = (1-u)\overline{U} + u \cdot b$$

where u is the unemployment rate, $\overline{U}$ is the average utility of holding a job in the economy and b denotes the value in unemployment.

In a symmetric equilibrium $U = \overline{U}$. Hence,

$$z = (1-u)\left(z + \frac{c(1-p)}{2p}\right) + u \cdot b \;\Rightarrow\; z = b + \frac{c(1-p)}{2p}\frac{1-u}{u}.$$

Efficiency wages

Labor market equilibrium

So,

$$w = z + \frac{c}{2p} = b + \frac{c}{2p}\frac{1 - p(1-u)}{u}.$$

This is the wage-setting curve in a symmetric equilibrium ($\partial w/\partial u < 0$).

Assume finally that firms can enter freely the market at a fixed cost $k > 0$. Under free-entry with $e = 1$, the wage has to verify:

$$y - w = k.$$

So, the unemployment rate solves

$$y - k = b + \frac{c}{2p}\frac{1 - p(1-u)}{u}.$$

Efficiency wages

Labor market equilibrium

Hence,

$$u = \frac{c}{2(y-k-b)-c}\frac{1-p}{p}.$$

The parameters such that $u \in (0,1)$ should verify:

- $y > k + b + (c/2)$;
- $p > \frac{c}{2(y-k-b)}$ i.e. "p not too low".

The unemployment rate increases in c and decreases in p.

Summary: Workers are ready to work if they are paid at least $\tilde{w}$. Because asymmetric information prevails, employers pay them more to elicit profitable effort. Hence, employed workers get a "surplus" compared to jobless ones. In equilibrium, unemployment is a genuine phenomenon.

Experimental evidence

1. The above "shirking model" see employees as rational cheaters. Is there evidence about this assumed behavior?

- Nagin et al. (2002) study whether monitoring of workers affects performance.
- They exploit an experiment in a telephone call center that varied the degree of monitoring of workers.
- Results:
  - A significant fraction of the workers increased shirking when the rate of monitoring declined.
  - However, a substantial proportion of the workers did not respond to changes in the monitoring rate.

2. Altmann et al. (2014) develop a lab experiment and show that non-verifiable worker's effort and simple one-period contracts can generate unemployment.

Deferred compensation

A simple example of a compensation based on seniority

Developing *the previous model* in a two-period setting will deeply change the conclusion concerning the "surplus".
More generally, this illustrates the role of implicit assumptions in many *static efficiency wage* models.

Assumptions

A1D The worker lives 2 periods: during the first one, he/she is young (subscript y) and during the second one old (subscript o).[3]

A2D For simplicity there is no discounting. So, intertemporal utility is $U_y + U_o = w_y - \frac{c}{2} \cdot e_y + w_o - \frac{c}{2} \cdot e_o,\ e \in \{0, 1\}, c > 0$. An output is produced only if $e = 1$, effort being unobservable.

A3D The young and the old have the same productivity.

[3] For a similar argument with infinitely lived agents, see CCZ2014 (p. 362-377).

Deferred compensation

Optimal payment scheme

The second period's problem is the static one. Hence, $w_o = z + \frac{c}{2p}$.

The incentive-compatibility constraint for the (forward-looking) young worker is an inter-temporal condition expressing that the young worker prefers not to shirk in the first period:

$$w_y - \frac{c}{2} + w_o - \frac{c}{2} \geq (1-p)\left[w_y + w_o - \frac{c}{2}\right] + p\,2\,z$$

Substituting w_o from above and considering that the principal proposes a wage just enough to guarantee the latter condition:

$$w_y = z + \frac{c}{2p} - \frac{(1-p)c}{2p} < w_o \text{ if } p < 1,$$

which is an example of *deferred payment.* Notice that $w_y < w_o$ despite worker's productivity is the same whether young or old.

Deferred compensation

Optimal payment scheme

It can easily be checked that $w_y = z + \frac{c}{2}$, so that the workers is now indifferent between working (and not shirking) and benefiting from the outside option z:

$$U_y - z = w_y - \frac{c}{2} - z = 0.$$

Put another way, *the young worker gets no "surplus" any more.* Therefore, if there is unemployment (not shown here), entrants (i.e. cohort y) are indifferent between having a job (with the "right" effort level) and staying jobless!

With infinitely lived agents, CCZ2014 show p. 367 that the expected lifetime utility of the (non-shirker) worker equals the outside expected life time utility at the time of recruitment.

Empirical evidence of deferred compensation?

- One often observes a positive relationship between seniority and wages. However, *what is the driving force?*
- *Between* firms: "If some firms pay higher wages than other firms, and employees in the high-paying firms tend to stay longer with the firm, a positive relationship between seniority and wages will emerge in standard wage regressions." (Barth, 1997, p. 495)
- To "test" the theory of deferred compensation, one needs evidence *within* firms: e.g. Kotlikoff and Gokhale (1992) for the US, Barth (1997) for Norway.
- However, other theories can also account for such seniority-wage profile $\Rightarrow$ Difficult task!
  - The accumulation of *specific* human capital renders the worker more productive in a given firm;
  - Revelation of information on the workers' abilities allows to assign them to tasks that better match their abilities and may therefore lead to an increasing relationship between seniority and wages.

Note

Positive link between seniority and wages vs between experience and wages.

Experience on the labor market = the sum of employment durations.

Wages can rise with experience for numerous reasons, among which:

1. The accumulation of post-schooling
   - *General* human capital (general =, strictly speaking, valuable in all firms) or
   - *Transferable* skills (i.e. valuable in some firms);
2. On-the-job search leads to an increasing relationship between experience and wages.

Exercice about efficiency wage theory

Inspired by Solow (1979) and Layard, Nickell and Jackman (1991)

Exercise

Assume that the effort of a worker employed in firm i, E_i, is not verifiable. Assume moreover a black-box relationship $E_i = (w_i - B)^{\lambda}$, $B > 0$, $0 < \lambda < 1$.
1. Assuming that each employer i sets the wage and Labor demand. What are the first-order conditions of the following problem : $\max_{L_i, w_i} \; s_i F_i (E_i \cdot L_i) - w_i L_i$, *where*

- L_i = *Labor demand in firm i;* w_i = *the real wage rate;*
- s_i = *a firm-specific technological parameter* ($s_i > 0$);
- $F_i[...]$ = *the revenue function* ($F' > 0, F'' < 0$).

2. Show that the optimal value of w_i is independent of s_i and is a mark-up over B. So, real wages are fully rigid (i.e. do not respond to changes in the multiplicative parameter s_i).

3. Let $B = (1 - u)w^e + u\,b$, u being the unemployment rate, w^e the average wage in the economy and b the level of unemployment benefit. In general equilibrium, if all firms are identical, one has $w_i = w^e, \forall i$. Assume an exogenous constant replacement ratio β: $b = \beta w^e (0 < \beta < 1)$. Compute the unemployment rate in equilibrium as a function of β and λ. Interpret the role of β and of λ.

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