Collective versus Relative Incentives

Pierre Fleckinger[⋆,⋄]

[⋆]MINES ParisTech

[⋄]Paris School of Economics

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Competition...

... or teamwork?

WILL YOU PLEASE GO HANG AROUND IN SOMEONE ELSE'S CUBICLE? I NEED TO FINISH MY PROJECT.
scottadams@aol.com
www.dilbert.com
HEY, I SEE WALLY IS HELPING ON THE PROJECT. GOOD TEAMWORK, WALLY!
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I HOPE YOU DO GOOD WORK. I HAVE A REPUTATION TO MAINTAIN.

Overview

What this is

- Takes the lens of **incentive theory** to tackle the following question: how to best motivate a group of agents?
- A reexamination of the widespread claim by economists that competition is "the best" motivational tool (including, often to the surprise of other scholars, inside organizations)
- A **methodological** toolbox–ideally a swiss knife

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What this is not

- By no means a final answer
- ... Not even in the principal-agent framework (no adverse selection)
- ... Nor a full exposition of the survey (see the paper)
- By no means an absolute and exclusive truth (yes, not all economists are imperialist)

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A general setting, flexible and abstract enough to fit various applications:

- Compensation in organizations (division managers, sales)
- ...and across organizations (CEOs, traders)
- Regulatory design (delegation of service, regulated firms)
- Financial delegation (incentives for money managers)

The Survey

	Relative	Independent	**Collective**
Production	Substitutability	Independence	Complementarity Help and sabotage
Information	Positive correlation	Independence	Negative correlation Mutual monitoring
Agents' Interaction			Transfers feasible Peer pressure Repeated interaction
Behavioral	Status-seeking preferences Self-overconfidence		Inequity aversion Overconfidence in others
Commitment Issues	Multilateral relationship Principal's moral hazard	Agents' side	

A few concrete examples

- Salesmen operating in two distinct areas
- Division managers in product or functional organizations
- Workers operating along the same assembly line
- Compensation and corporate culture in startups

- Agency theory adopts the **principal**'s perspective (the head of sales the department, the executive, the foreman, the founder), who is the designer

Literature Milestones

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- Fast growing empirical literature since 15 years

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2x2x2 Moral hazard model

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- the important function–distribution of outcomes:

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- Incentive scheme: $w_{R_i R_{-i}}$, i.e.

$$\mathbf{w} = \{w_{HH}, w_{HL}, w_{LH}, w_{LL}\}$$

Collective vs Relative Incentive schemes

Standard incentive schemes

An incentive scheme exhibits **Collective Performance Evaluation** (CPE) when:

$$(w_{HH}, w_{LH}) > (w_{HL}, w_{LL})$$

An incentive scheme exhibits **Relative Performance Evaluation** (RPE) when:

$$(w_{HL}, w_{LL}) > (w_{HH}, w_{LH})$$

An incentive scheme exhibits **Independent Performance Evaluation** (IPE) when:

$$(w_{HH}, w_{LH}) = (w_{HL}, w_{LL})$$

The design problem

under limited liability and risk-neutrality

The principal chooses $\mathbf{w}$ to induce effort pair $(1, 1)$.
Incentive constraint:

$$U_i(\mathbf{w}|1,1) \geq U_i(\mathbf{w}|0,1) \quad \text{for } i = 1,2 \tag{1}$$

Limited liability:

$$\mathbf{w} \geq 0 \tag{2}$$

Participation constraint:

$$U_i(\mathbf{w}|1,1) \geq \overline{U} \quad \text{for } i = 1,2 \tag{3}$$

The principal program is:

$$\min_{\mathbf{w}} \mathbb{E}_{\mathbf{R}}\left[w_{\mathbf{R}}|1,1\right]$$

$$\text{subject to } (1), (2) \text{ and/or } (3)$$

The incentive constraint

$$\sum_{\mathbf{R}} Prob(\mathbf{R}|1,1)w_{\mathbf{R}} - c \geq \sum_{\mathbf{R}} Prob(\mathbf{R}|0,1)w_{\mathbf{R}}$$

Hence:

$$\text{marginal (incentive) benefit of } w_{\mathbf{R}} = Prob(\mathbf{R}|1,1) - Prob(\mathbf{R}|0,1)$$

$$\text{marginal cost of } w_{\mathbf{R}} = Prob(\mathbf{R}|1,1)$$

A key lemma

Characterizing the optimal incentive scheme

Definition

For any pair of results $\mathbf{R}$, the **incentive efficiency** of $w_{\mathbf{R}}$ is:

$$I(\mathbf{R}) = \frac{Prob(\mathbf{R}|1,1) - Prob(\mathbf{R}|0,1)}{Prob(\mathbf{R}|1,1)}$$

Lemma

- The optimal wages are ranked according to their incentive efficiency.
- In addition, under risk-neutrality and limited liability, an optimal incentive scheme entails positive wages only for the result(s) with the highest incentive efficiency.

A General Characterization

Proposition

1. The optimal incentive scheme is CPE if and only if $Prob(R_i, R_{-i}|e_i, 1)$ is (strictly) log-supermodular in (R_{-i}, e_i) for all R_i, i.e. if

$$Prob(R_i H|1,1)Prob(R_i L|0,1) > Prob(R_i H|0,1)Prob(R_i L|1,1) \quad \forall R_i$$

2. The optimal incentive scheme is RPE if and only if $Prob(R_i, R_{-i}|e_i, 1)$ is (strictly) log-submodular in (R_{-i}, e_i).
3. The optimal incentive scheme is IPE if and only if production is completely independent.

In words: CPE is associated to a generic form of complementarity, while RPE is associated to a generic form of substitutability.

Technology

Production is informationally independent if:

$$Prob(R_i R_{-i}|e_i, e_{-i}) = Prob(R_i|e_i, e_{-i}) Prob(R_{-i}|e_i, e_{-i})$$

(R_i and R_{-i} are 'conditionally' independent)
Using the notations

$$p_{e_i e_{-i}} \equiv Prob(R_i = H|e_i, e_{-i})$$

Proposition

When production is informationally independent, the optimal scheme exhibits CPE when $p_{11} > p_{10}$, RPE when $p_{11} < p_{10}$, and IPE when $p_{11} = p_{10}$. That is, if efforts are complements, CPE is optimal, while if they are substitutes RPE is optimal.

Multidimensional Effort

Introducing more effort dimensions in the picture:

- Help (e.g. Itoh, 1991)
- Sabotage (e.g. Lazear, 1989)
- Influence activities (e.g. Milgrom, 1988)

NB keep a single output dimension

Proposition

Collective incentives are more likely to be optimal under multidimensional effort, since externalities are then better internalized.

- In a way: the richer the interaction, the better it is to rely on self-organization under a common goal

Information

Production is technologically independent if:

$$Prob(R_i|e_i, e_{-i}) = Prob(R_i|e_i) \equiv p_{e_i} \quad \forall R_i, e_i, e_{-i}$$

(no cross-effect of effort on outcome)

- If production is technologically independent, then we are left with pure informational effects,
- such as: correlation, ex-post measurement errors, subjective assessment etc.

Information: the value of comparison

Pure comparison dimension: ranking function

- q probability of ranking agent i higher when $e_i < e_{-i}$.
  i.e. (1-q) is the quality of ex-post distinguishability

NB interpret R_i's as signals

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Proposition

Under fully independent production, the optimal tournament strictly dominates independent contracts provided enough ordinal information is generated ($q < \frac{1}{2}\frac{p_0}{p_1}$). Moreover, if comparison is perfect ($q = 0$), the first best can be attained even in absence of any cardinal information on the performances ($p_1 = p_0$).

- Interpretation in Lazear & Rosen (1981)
- Disentangling the different factors in the ex-ante correlation

Information: pure correlation

Production is technologically independent if:

$$Prob(R_i|e_i, e_{-i}) = Prob(R_i|e_i) \quad \forall R_i, e_i, e_{-i}$$

Lazear & Rosen-type correlation:

$$Prob(R_i = R_{-i}|e_i, e_{-i}) = Prob(R_i|e_i)Prob(R_{-i}|e_{-i}) + \gamma$$

$$Prob(R_i \neq R_{-i}|e_i, e_{-i}) = Prob(R_i|e_i)Prob(R_{-i}|e_{-i}) - \gamma$$

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Proposition

When production is technologically independent, the optimal scheme exhibits RPE when $\gamma > 0$, CPE when $\gamma < 0$, and IPE when $\gamma = 0$.

- The classic example: salesmen and stochastic demand

Covariance across effort pairs

- All previous models assume either **constant covariance or constant correlation** across effort pairs.
- Assume, more generally that covariance is effort-pair specific, i.e. consider a family $\{\gamma_{e_i e_{-i}}\}$ such that the joint probability distribution of outcomes is given by:

	H	L
H	$p_{e_i} p_{e_{-i}} + \gamma_{e_i e_{-i}}$	$p_{e_i}(1 - p_{e_{-i}}) - \gamma_{e_i e_{-i}}$
L	$(1 - p_{e_i})p_{e_{-i}} - \gamma_{e_i e_{-i}}$	$(1 - p_{e_i})(1 - p_{e_{-i}}) + \gamma_{e_i e_{-i}}$

- Example: consulting two experts that need to gather information

More *equilibrium* covariance calls for less competition

Incentive efficiency of w_{HH} and w_{HL}:

$$I(HH) = 1 - \frac{p_0 q_1 + \gamma_{01}}{p_1 q_1 + \gamma_{11}} \quad \text{and} \quad I(HL) = 1 - \frac{p_0(1-q_1) - \gamma_{01}}{p_1(1-q_1) - \gamma_{11}}$$

Proposition

The optimal incentive scheme is Relative Performance Evaluation if and only if:

$$p_0 \gamma_{11} \leq p_1 \gamma_{01}$$

- Conversely, out of equilibrium covariance calls for more competition.
- In the terms of the characterization, equilibrium covariance creates informational complementarities.

Skip

Technological uncertainty

Technological uncertainty: imperfect (common) knowledge of the probabilities

- Let the $\tilde{p}_e$ be themselves random variables, with

$$p_{e_i} = \mathbb{E}[\tilde{p}_{e_i}], \qquad \sigma^2_{e_i} = var(\tilde{p}_{e_i})$$

- and correlation coefficients:

$$\rho_{e_i e_{-i}} = \frac{cov(\tilde{p}_{e_i}, \tilde{p}_{e_{-i}})}{\sigma_{e_i}\sigma_{e_{-i}}}$$

i.e. there is two-stage uncertainty.

A limit example

Example: Extreme innovation

- same technologies available to both agents
- old technology : no cost, success with known probability p_0.
- new technology : cost c, $\tilde{p}_1 \sim Bin(1, p_1)$

In words: the new technology can be either a perfect fit ($\tilde{p}_1 = 1$) or completely ineffective ($\tilde{p}_1 = 0$).

Then:

$$I(SS) = 1 - p_0, \quad I(SF) = I(FS) = -\infty \quad \text{and} \quad I(FF) = p_0$$

$\Rightarrow$ from the previous analysis, if $p_0 > \frac{1}{2}$, only $w_{FF} > 0$!

The 'Effective efforts' assumption

To rule out situations such as the previous example:

Assumption (Effective efforts)

$$Prob(\tilde{p}_1 \geq \tilde{p}_0) = 1$$

Then:

Lemma

Under this assumption, an optimal incentive scheme entails $w_{FF} = w_{FS} = 0$.

Optimal incentive scheme

Simple calculations show that:

$$\gamma_{e_i e_{-i}} = \rho_{e_i e_{-i}} \sigma_{e_i} \sigma_{e_{-i}}$$

Therefore, combining the preceding results, we have:

Proposition

With effective efforts, the optimal incentive scheme of agent 1 is:

- if $\rho_{11} \frac{\sigma_1}{p_1} < \rho_{01} \frac{\sigma_0}{p_0}$, a RPE scheme
- if $\rho_{11} \frac{\sigma_1}{p_1} > \rho_{01} \frac{\sigma_0}{p_0}$, a CPE scheme
- if $\rho_{11} \frac{\sigma_1}{p_1} = \rho_{01} \frac{\sigma_0}{p_0}$, any scheme (including IPE)

Interpretation

- Criterion for CPE (for positive correlation levels):

$$\frac{\rho_{11}}{\rho_{01}} \geq \frac{\sigma_0/p_0}{\sigma_1/p_1}$$

- LHS: whether effort (of agent 1) increases (> 1) or decreases correlation (< 1).

- RHS: whether effort decreases (> 1) or increases (< 1) adjusted risk.

  The Sharpe ratio $\frac{p}{\sigma}$ is a measure of risk-adjusted return. The inverse $\frac{\sigma}{p}$ is a measure of riskiness of the considered action.

An application

a stylized model of portfolio management

- The 'market' (e.g. investors) usually compensates fund managers on the basis of relative performance, whether explicitly or not.
  The efficacy of such incentives has been questioned on many occasions.

- Consider a situation with two symmetric fund managers
- The investors only observe the performance of the funds
- basic diversified portfolio, characterized by (p_0, σ_0)
- The managers can exert effort to discover the best assets, which allows to choose a new portfolio characterized by (p_1, σ_1) with:

$$p_0 < p_1 \quad \sigma_0 < \sigma_1$$

A stylized model of portfolio management (cont'd)

- if the same portfolios are chosen, $\rho_{11} = \rho_{00} = 1$
- if they are different, $\rho_{01} < 1$ (presumably, the more assets there are, the lower ρ_{01})
- The criterion for Relative performance evaluation is here:

$$\frac{1}{\rho_{01}} \frac{\sigma_1}{\sigma_0} \leq \frac{p_1}{p_0}$$

- therefore if $\rho_{01} << 1$ (for example there are few 'best' assets), Relative performance evaluation is likely to be suboptimal

Agents' interaction

Mutual monitoring, repetition, side-contracting...

A very generic insight (and a fuzzy statement)

Proposition

The more close-knit is the agents' relationship, the lower the value of RPE relative to CPE.

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Proposition

The more close-knit is the agents' relationship, the lower the value of RPE relative to CPE.

- Because of the risk of collusion (e.g. Itoh 1992)
- Because RPE exploits poorly mutual monitoring (e.g. Varian 1990, and a new recent stream of papers)
- Because RPE exploits poorly mutual punishments (e.g. Che & Yoo 2001)

Commitment issues

What happens when contracts are not perfectly enforceable?

- Principal's moral hazard (e.g. Carmichael 1983)
- Relational contracts (e.g. Levin 2002)
- Agents' walking away (e.g. Olsen & Kvaloy 2012)

Proposition

RPE is more efficient at disciplining the principal's moral hazard and commitment problems.
Retaining agents requires a component of IPE.

The problem with risk-averse agents

The insurance view on RPE:

RPE allows better risk-sharing by filtering the (unnecessary fraction of) risk borne by the agents.

- Agents have expected utility:

$$U_i(\mathbf{w}|e_i e_{-i}) = \mathbb{E}_{\mathbf{R}}\left[u(w_{\mathbf{R}})|e_i e_{-i}\right] - c(e_i)$$

- No limited liability, only the participation contraint:

$$U_i(\mathbf{w}|11) \geq \overline{U} \tag{3}$$

- The incentive constraint remains:

$$U_i(\mathbf{w}|11) \geq U(\mathbf{w}|01) \tag{1}$$

Optimal scheme with risk aversion

Proposition

When the agents are risk averse, the optimal wage profile can take four different forms:

- Collective for low results, relative for high results:

$$w_{HL} > w_{HH} > w_{LH} > w_{LL}$$

- Pure RPE:

$$w_{HL} > w_{HH} > w_{LL} > w_{LH}$$

- Collective for high results, relative for low results:

$$w_{HH} > w_{HL} > w_{LL} > w_{LH}$$

- pure CPE:

$$w_{HH} > w_{HL} > w_{LH} > w_{LL}$$

Interpretation and properties

Mixed schemes balance the informational complementarity effect (CPE) and the insurance effect (RPE).

- Profit-sharing + selective promotion (third scheme) or selective firing (fourth scheme).
- Relative carrots vs relative sticks.

- In addition, such schemes may be more robust to sabotage than RPE.
- They may also mitigate the multiple equilibria problem of CPE.

An illustration: Administration versus Business firms

Assume constant (say, positive) correlation.

Bureaucracy:
effort consists of applying routines (e.g. "continuity of the state")

- One has σ_0 large and σ_1 relatively smaller
- Relative carrots are optimal: promotions provide incentives, while bad results do not lead to firing

Business firms:
effort consists of more adventurous strategies (e.g. investment banking)

- One has σ_0 small (conservative position) and σ_1 relatively larger
- Relative sticks are optimal: firing is a powerful threat, up-or-out contracts are used

Takeaway

	Relative	Independent	**Collective**
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Final comments

Two aspects

- When going to the data, should we test if incentive theory is a good description of practices?
- ... or should we test the impact of different incentive schemes?

- The empirical literature identifies "peer effects"–which essentially amounts to put in a single black-box all the mechanisms discussed
- Natural experiments, Field experiment, lab experiments...?
- Real HR data clearly not used enough (in economics)

- Mixed schemes are present everywhere but theoretically poorly understood
  Changing the question from Competition vs Cooperation to: finding the optimal mix and implementing it