Career Concerns and Free Riding in Teams

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Introduction

- Evolution of cooperation and free-riding in *research* teams.
  - benefits are public, costs are private;
  - success is uncertain;
  - effort is unobservable;
- A model of career concerns in human-capital intensive teams:
  - *e.g.* scientists, lawyers, consultants;
  - the team's reputation determines clients' willingness to pay.
- Main implications:
  - free riding incentives, effort reduction & procrastination;
  - knowledge within the team is beneficial;
  - better monitoring need not be.

Related Literature

- Moral hazard in teams:
  - Alchian and Demsetz (1972), Holmström (1982).
- Strategic experimentation:
  - Bolton and Harris (1999), Keller, Rady, and Cripps (2005); Bergemann and Hege (1997, 2005).
- Dynamic contributions to public goods:
  - Admati and Perry (1991), Marx and Matthews (2000).
- Career Concerns:
  - Holmström (1999), Dewatripont, Jewitt, and Tirole (1999); Bar-Isaac (2007).

The Set-Up

n agents are members of a team. Each agent can be **good** or **bad**.

The team is **productive** only if **all** agents are good.

Agents do not know their type. $\Pr(\textit{team is productive}) = \bar{p}$.

Agent i exerts **unobservable** effort at rate $u_{i,t} \in [0, \bar{u}]$ at date t.

A team generates successes (worth €1) at a Poisson rate

$$f(u_{1,t}, \ldots, u_{n,t}) \text{ if the team is good, and 0 otherwise.}$$

Most of the talk, $f(u_{1,t}, \ldots, u_{n,t}) = \sum_{i=1}^{n} (\lambda + u_{i,t})$.

Agents incur a flow cost $c_i(u_{i,t}) = \alpha u_{i,t}$.

Efficiency Benchmark

The planner's beliefs evolve according to:

$$\dot{p}_t = -p_t(1-p_t)\sum_{i=1}^{n}\left(\lambda + u_{i,t}\right).$$

After the first success, she knows the team is good $(p_t = 1)$.

The first success is worth $\bar{V} := 1 + \left(n\left(\lambda + \bar{u}\right) - n\alpha\bar{u}\right)/r$.

Before the first success, she maximizes

$$\int_0^\infty \left(p_t \sum_{i=1}^{n}\left(\lambda + u_{i,t}\right)\bar{V} - \alpha n u_{i,t}\right) e^{-\int_0^t \left(r + p_s \sum_{i=1}^{n}\left(\lambda + u_{i,s}\right)\right)ds} dt.$$

- The social planner induces maximal effort $(u_i = \bar{u})$ as long as

  $$p_t \geq p^* := \alpha\frac{r + n\lambda}{r\bar{V}},$$

  and zero effort afterwards.

The Strategic Problem

A competitive market pays the team a wage equal to its expected flow output.

Assuming (for now) equal shares within the team, each agent gets

$$w_t = \frac{1}{n}\tilde{p}_t \sum_{i=1}^{n} \left(\lambda + \tilde{u}_{i,t}\right),$$

where $\tilde{p}_t$ is the market belief, and $\tilde{u}_{i,t}$ is the expected effort level.

Remember that effort is unobservable.

For the agents then, the wage is just a function of time.

Individual effort must be a best response to other agents' effort, given the wage function w_t.

The Strategic Problem

The first success is worth $\bar{V} = \lambda / r$ to each agent.

Why? After the first success, $\tilde{p}_t = 1$, and no effort can be sustained in equilibrium (so $w_t = \lambda$).

Each agent then maximizes

$$\int_0^\infty \left(p_t \sum_{i=1}^n \left(\lambda + u_{i,t}\right) \bar{V} + w_t - \alpha u_{i,t}\right) e^{-\int_0^t \left(r + p \sum_{i=1}^n \left(\lambda + u_{i,s}\right)\right) ds} dt$$
$$\text{s.t. } \dot{p}_t = -p_t(1 - p_t) \sum_{i=1}^n \left(\lambda + u_{i,t}\right),$$

and in equilibrium we require

$$w_t = \frac{1}{n} p_t \sum_{i=1}^n \left(\lambda + u_{i,t}\right).$$

The Basic Trade-Off

Consider i's value on the equilibrium path.

Compare the **marginal** effect of effort today $(u_i = u_{i,t})$ and tomorrow $(u_i' = u_{i,t+dt})$.

$$\lim_{dt\to 0} \frac{dV_i \,/\, du_i}{dt} \gtrless \lim_{dt\to 0} \frac{dV_i \,/\, du_i'}{dt}.$$

Intertemporal transfers of effort must not be profitable:

$$p \cdot \underbrace{\alpha u_i'}_{\text{cost saved}} = \alpha \cdot \underbrace{p\left(n\lambda + u_{-i} + u_i\right)}_{\text{Pr. of success at } t} - \underbrace{\left(p\left(r\bar{V} - w\right) - \alpha r\right)}_{\text{loss due to delay}}.$$

A role for other agents' effort, and for the (prize-wage) gap.

Suppose the equilibrium is symmetric. The indifference condition is

$$(n-1)\,u^*(p) = \frac{r\bar{V} - w^*(p)}{\alpha} - \frac{r}{p} - n\lambda,$$

where in equilibrium we have

$$w^*(p) = p\left(\lambda + u^*(p)\right).$$

Effort and wage as a function of p are given by:

$$\begin{aligned} u^*(p) &= \frac{\lambda\left(1-p-\alpha n\right) - \alpha r/p}{\alpha\left(n-1\right)+p} \\ w^*(p) &= \frac{p\lambda\left(1-\alpha\right) - \alpha r}{\alpha\left(n-1\right)+p}. \end{aligned}$$

- Individual effort $u^*(p)$ is decreasing in n and in p (for r low).
- The equilibrium wage $w^*(p)$ is increasing in p.
- But all this is assuming effort is positive...

When Does It End?

As $p_t \to 0$, marginal product of effort $\to 0$: effort must stop.

Lemma 1

There exists a critical p_L such that $u^*(p) = 0$ for all $p < p_L$.

For all α, r/λ, and n, equilibrium effort stops inefficiently early ($p^* < p_L$).

The threshold belief p_L is increasing in α, r/λ, and n.

p_L is determined by indifference condition when no one ever works again, and the market pays $w_t = p_t\lambda$ forever.

Inefficiencies arise because:

- success is worth less (no effort later);
- market wage represents an outside option.
- higher $n \Rightarrow$more likely to succeed due to pure talent.

Symmetric Equilibrium

Before p reaches p_L, effort is given by $u_i = u^* \left(p \right)$.

But recall that effort is also just a function of time.

Theorem 1

There exists a unique symmetric equilibrium, with effort given by

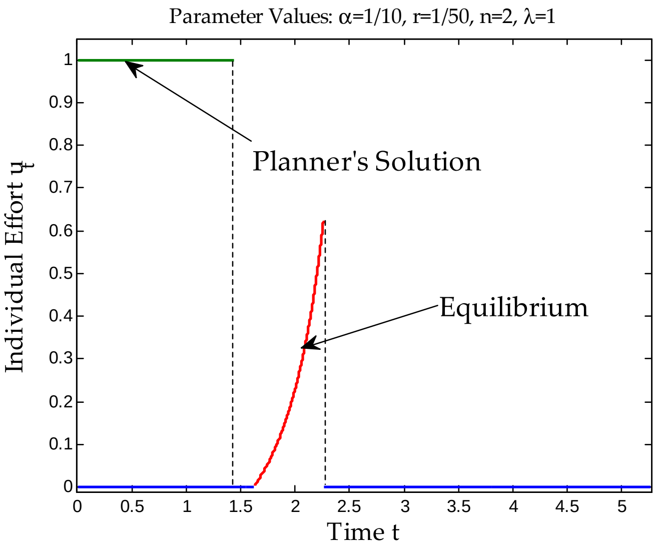
$$u^*_{i,t} = \max \left\{ \frac{\lambda \left(1 - p_t - \alpha n \right) - \alpha r / p_t}{\alpha \left(n - 1 \right) + p_t}, 0 \right\} \text{ for all } p_t \leq p_L .$$

The belief p_t is the solution to

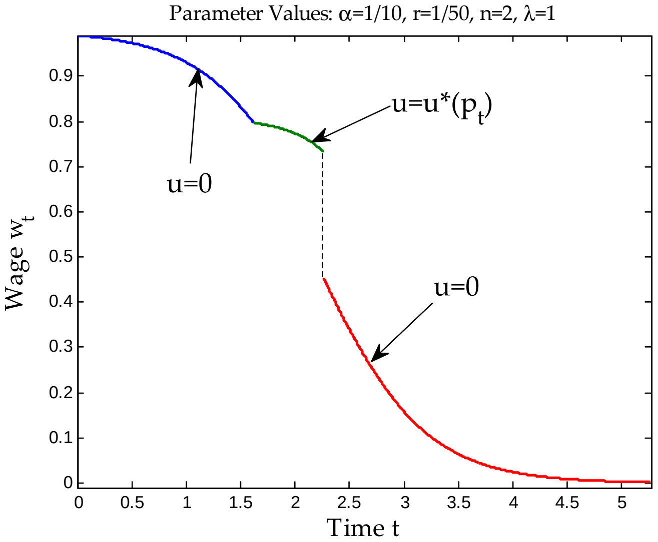
$$\dot{p}_t = -p_t(1 - p_t) n \left(\lambda + u^*_{i,t} \right) .$$

All effort stops at the time T where $p_T = p_L$.

Equilibrium Effort



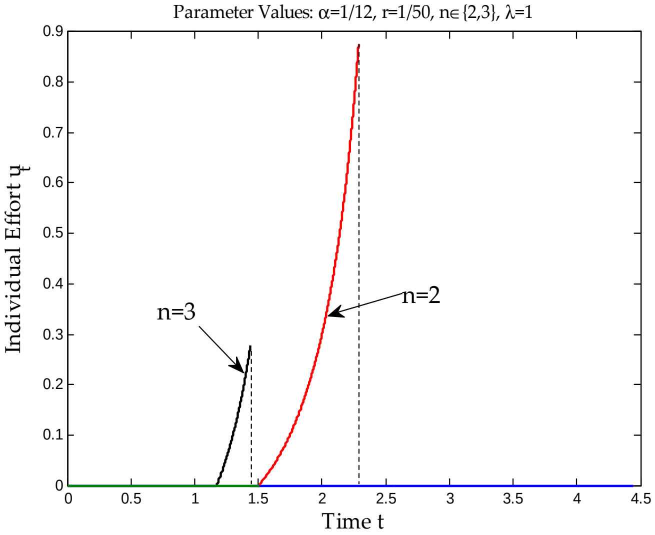
Equilibrium Wage



Symmetric Equilibrium: Summary

- Effort "begins" at $p = p_H$, where $u(p_H) = 0$.
- Effort ends at $p = p_L$ where $u(p_L) > 0$ (jump to zero).
- The range of beliefs $[p_L, p_H]$ is shrinking as α or n increase.
- Effort cannot be sustained when beliefs are higher than p_H.
- Compared to 1st best, both effort reduction and **delay**.

Equilibrium Effort



Asymmetric Equilibria

An example: only one agent works, and exerts effort:

$$u_1(p) = n\frac{\lambda(1 - p_t - \alpha n) - \alpha r / p_t}{p_t}.$$

Trade-off between *efficiency* and *fairness* of equilibria: compared to the symmetric equilibrium:

- the thresholds p_H and p_L are the same;
- team effort (as a function of p) is higher, and it is equal to the cooperative level.

This is the unique equilibrium with asymmetric players or unequal shares.

Complementarities

C.E.S. "production function"

$$f(u_t) = \left(\sum_{i=1}^{n} (\lambda + u_{i,t})^{\rho}\right)^{1/\rho}, \text{ where } \rho \in (0,1].$$

Theorem 2

There exists a unique symmetric equilibrium, with effort given by

$$\begin{aligned} u_{i,t}^{*} &= \frac{\lambda n^{\frac{1}{\rho}-1} - \alpha\left(\lambda + (1/p_t)\, r n^{1-\frac{1}{\rho}}\right)}{p_t n^{\frac{1}{\rho}-1} + \alpha(n-1)} - \lambda. \\ \dot{p}_t &= -p_t(1-p_t) n^{1/\rho}\left(\lambda + u_{i,t}^{*}\right). \end{aligned}$$

Effort is decreasing in ρ for each p_t.
The range of beliefs $\left[p_L(\rho), p_H(\rho)\right]$ is decreasing in ρ.

Known Team Type

Suppose the team knows its own type.

A bad team will never work.

The market posterior $\tilde{p}$ declines over time.

Suppose so does the wage.

Then the good team's incentives are increasing over time.

Known Team Type

Theorem 3

There is a unique symmetric equilibrium, in which each member of a good team exerts effort level

$$\begin{aligned} u_{i,t}^{K} &= \max\left\{\frac{\lambda-\alpha\left(\lambda+r\right)}{\tilde{p}_t+\alpha\left(n-1\right)}-\lambda,0\right\}. \\ \tilde{p}_t' &= -\tilde{p}_t\left(1-\tilde{p}_t\right)n\left(\lambda+u_{i,t}^{*}\right). \end{aligned}$$

Effort $u_{i,t}^{K}$ (weakly) increases over time, and *never stops*.
Effort $u_{i,t}^{K}$ is (weakly) higher than $u_{i,t}^{*}$ (in the unknown type case).

Note that (for r low enough):

1. expected effort (from the market's perspective) is lower than in the unknown type case;
2. ... but the market still learns faster.

When effort is observable, consider Markov strategies $u_i(p, \pi)$, where π denotes the market belief.

Along the equilibrium path, $p = \pi$.

The lower threshold (p_L) is unchanged, but $u(p_L, p_L) = 0$.

In the limit for $r \rightarrow 0$, p_H is also unchanged, but effort is lower for all values of p.

- Strategic substitutes.
- Net present value computations.
- Non-Markov Equilibria?

Taking Stock

1. Unobservable unknown: inefficient threshold, and delay.
2. Unobservable known: more efficient thresholds, but still delay.
3. Observable: same thresholds as in (1), but lower effort ($\Rightarrow$ more delay).

The Next Steps

What happens after a success?

"Juniors" become "seniors": do they stay together?

Do they go an match with non established partners (whose reputation can still be improved)?

Why? Better monitoring? Better screening? Better mentoring?

In a matching model, what's the equilibrium duration of (unsuccessful) partnerships?

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