Envy effects on conflict dynamics in supervised work groups

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Outline

Motivation

A research question from Organization theory:

How can the net production of a supervised work group be maximized?

Different answers from the literature:

- Economics
- Sociology
- Psychology

Motivation

A research question from Organization theory:

How can the production of a supervised work group be maximized?

Economics:

- employees are generally responsive to financial incentives and adjust their performance accordingly (Young at al., 1987)
- individuals are rational decision makers subject to both upward and downward comparisons (Fehr and Schmidt, 1999)
- contracting parties are rational individuals who aim to achieve the highest possible payoff (Bolton and Dewatripont, 2005)
- individuals are rational decision makers subject to downward comparisons (Grund and Sliwka, 2005)
- individuals are rational decision makers and have purely self-regarding preferences (Camerer and Fehr, 2006)
- monetary incentives can be more effective if considered with relational incentives (Davis and Hyndman, 2018)

Motivation

A research question from Organization theory:

How can the production of a supervised work group be maximized?

Sociology:

- performance pay rewards may enhance effort (Leventhal, 1976)
- monetary compensation is a powerful motivator (Rynes et al., 2005)

Psychology:

- distributive justice has consequences on dissatisfaction in organizations (Deutsch, 1987)
- consequences of upward or unfavorable social comparison (Taylor et al., 1990)
- distributive (in)justice causes shame and depression (Gilbert, 2000)
- upward and downward comparisons divert responses from targets (Gerber, 2018)

The theoretical model

The production function of the work group is:

$$(u_1 + u_2)^{\alpha} (l_1 + l_2)^{\beta}$$

where

- α: output elasticity with respect to the joint effort with the supervisor
- β: output elasticity with respect to the joint effort with the partner
- $0 \leq \alpha \leq 1$ and $\beta = 1 - \alpha$

We assume that the production is sold at unitary price

The theoretical model

Agents' compensation is:

$$s_i = w + b_i u_i + b_g \left(u_1 + u_2\right)^{\alpha} \left(l_1 + l_2\right)^{\beta} \quad \forall i = 1, 2$$

where:

- w is a fixed wage sufficient to meet the participation constraint of the agent
- b_i is the incentive given to subordinate i for its individual effort with supervisor
- b_g is the incentive given both for team output.

We assume that:

- the supervisor declares the incentive scheme
- the subordinates decide their efforts in order to maximize their compensation.

The theoretical model

The supervisor can only observe u_1, u_2 :
She must design a linear compensation scheme (b_g, b_1, b_2) to maximize net production (bilevel programming problem)

$$\max_{b_g, b_1, b_2} (1 - 2b_g)(u_1 + u_2)^{\alpha} (l_1 + l_2)^{\beta} - b_1 u_1 - b_2 u_2$$

s.t. given b_g, b_1, b_2 the subordinates solve:

$$\max_{u_1, l_1} \quad w + b_g (u_1 + u_2)^{\alpha} (l_1 + l_2)^{\beta} + b_1 u_1$$

$$\max_{u_2, l_2} \quad w + b_g (u_1 + u_2)^{\alpha} (l_1 + l_2)^{\beta} + b_2 u_2$$

The Agent's Problem

Assume agents maximize the gross production

$$\max_{u_1, u_2, l_1, l_2} (u_1 + u_2)^{\alpha} (l_1 + l_2)^{\beta} \quad \texttt{sub} \quad u_i + l_i \leq \bar{c}_i, \quad i = 1, 2$$

There is a continuum of solutions

$$\begin{cases} u_1 + u_2 & = & \frac{\alpha}{\alpha+\beta} (\bar{c}_1 + \bar{c}_2) \\ l_1 + l_2 & = & \frac{\beta}{\alpha+\beta} (\bar{c}_1 + \bar{c}_2) \end{cases}$$

a rather natural effort allocation is

$$(u_i, l_i) = (\frac{\alpha}{\alpha + \beta} \bar{c}_i, \frac{\beta}{\alpha + \beta} \bar{c}_i), \quad i = 1, 2$$

which is **focal** in the sense of Schelling (1960)

The Supervisor's Problem

Supervisors maximize the net production

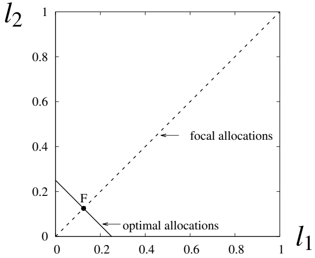
$$\max_{b_g, b_1, b_2} (1 - 2b_g)(u_1 + u_2)^{\alpha} (l_1 + l_2)^{\beta} - b_1 u_1 - b_2 u_2$$

With fully rational agents the solution is

$$b_g = \varepsilon > 0 \quad , \quad b_1 = 0 \quad , \quad b_2 = 0$$

Some pictures...

Theoretical solution
(benchmark)



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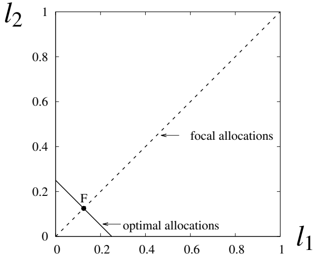
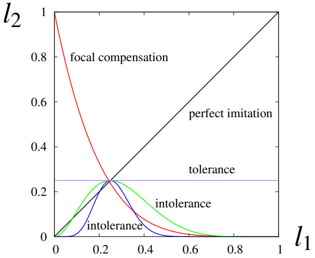
Theoretical solution (benchmark)



A taxonomy of reaction functions



Dal Forno and Merlone (2013)

$$
l_i(t+1) = \begin{cases} \frac{e_i}{\theta_i}\left(l_j(t)\right)^{a_j-1}\left(C_j - l_j(t)\right)^{b_i-1} & \text{if } a_i > 1 \text{ and } b_i > 1 \\ e_i\left(C_j - l_j(t)\right)^{b_i-1} & \text{if } a_i = 1 \text{ and } b_i > 1 \\ e_i\left(l_j(t)\right)^{a_i-1} & \text{if } a_i > 1 \text{ and } b_i = 1 \\ e_i & \text{if } a_i = b_i = 1 \end{cases}
$$

$$
\theta_i = \left(C_j \frac{a_i - 1}{a_i + b_i - 2}\right)^{a_i-1}\left(C_j - C_j \frac{a_i - 1}{a_i + b_i - 2}\right)^{b_i-1} \quad i = 1, 2
$$

The piecewise definition of the map comes from considering the extremes of interval $[0, C_j]$ which, when either $a_i = 1$ or $b_i = 1$ or both, could otherwise cause an indecision form; forcing $0^0 = 1$ the map expression could be simpler:

$$l_i(t+1) = r_i(l_j(t)) = \frac{e_i}{\theta_i}(l_j(t))^{a_i-1}(C_j - l_j(t))^{b_i-1} \quad a_i, b_i \geq 1$$

with

$$\theta_i = \begin{cases} \left(C_j \frac{a_i-1}{a_i+b_i-2}\right)^{a_i-1}\left(C_j - C_j \frac{a_i-1}{a_i+b_i-2}\right)^{b_i-1} & \text{if } a_i > 1 \text{ and } b_i > 1 \\ 1 & \text{otherwise.} \end{cases}$$

Goal

Starting from the following available ingredients:

- theoretical model (Mathematics)
- variables of interest from the literature (Economics, Sociology, Psychology):
  - incentives
  - wage
  - work group production
  - colleague's effort
- plausible reaction functions (Game Theory, Psychology, Biology)

our goal is to define a dynamical model:

- based on empirical observations
- which –together with the stability analysis of the equilibria– may overcome in explanation what would be obtained with a OLS (instability of real work group, withholding of effort, etc.)
- which can have practical implication in organization theory

Hypotheses

Three interdependent research hypotheses:

Hypothesis 1

The effort allocation in the two tasks depends on the incentive scheme.

Hypothesis 2

Controlling for all the observable variables, the colleague's past effort exerted in the common task is the most significant variable affecting the effort allocation.

Hypothesis 3

A model which considers the marginal effect of the colleague's past exerted effort explains more variability than its comparable model which considers only the linear effect.

The experiment

In order to test the hypotheses we designed an organizational experiment (Camerer and Weber, 2013).
With the data gathered from the experiment we estimate variants of the following equation:

$$l_{i,t} = f\left(b_{g,t}, b_{i,t}, l_{j,t-1}, R_{i,t-1}, P_{g,t-1}\right)$$

where:

- $b_{g,t}$ is the collective incentive
- $b_{i,t}$ is the individual incentive
- $l_{j,t-1}$ is the colleague's past effort exerted in the group task
- $R_{i,t-1}$ is the performance-contingent reward
- $P_{g,t-1}$ is the net group production of the aggregated efforts
- $l_{i,t}$ is the effort allocated to the group task (dependent variable)

Participants

- 36 undergraduate students in Business Administration
- 19 females and 17 males

Students participation issues:

- students are appropriate to test theoretical ideas to be extended later to managers (Gordon et al., 1986)
- "Pay enough or don't pay at all" (Gneezy and Rustichini, 2000)
- (self-selected) students are an appropriate subject pool for the study of social behavior (Exadaktylos et al., 2013)
- concerns regarding external validity (Aguinis and Bradley, 2014)
- "overall much of the big picture seems the same whether one looks at professionals or students in laboratory experiments testing economic models" (Frechette, 2015)

Descriptive statistics and correlations of the observable variables in the experiment

Variable	Mean	S.D.	Min.	Max.	1	2	3	4	7
1. *Group incentive*	0.02	0.03	0.00	0.20					
2. *Individual incentive*	0.03	0.04	0.00	0.30	0.67***				
3. *Effort*	1.77	1.77	0.00	9.00	0.06	0.13			
4. *Individual wage*	2.23	0.21	2.00	3.40	0.73***	0.76***	0.18*		
5. *Group net production*	4.83	1.39	0.00	6.29	−0.43***	−0.37***	0.04	−0.25***	
6. *Colleague's past effort*					0.07	−0.10	−0.46***		
7. *Past wage*					0.65***	0.71***	0.25***		
8. *Past net production*					−0.56***	−0.33***	−0.03		−0.37***

Analysis

- Data obtained through the experiment are in the form of panel
- In order to test the research hypotheses, we tested for data poolability to investigate whether it is suitable to assume the constancy of the relationships over time

The poolability test statistic (Chow, 1960) gives:

$F_{(35,72)} = 0.650$ with $p > 0.05$ when considering the colleagues' effort

$F_{(35,72)} = 0.647$ with $p > 0.05$ when considering the given group incentive

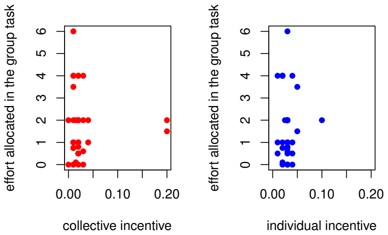
We can conclude that:

- there is no evidence for a structural shift in the relation over the experiment stages (5 rounds) at any significance level
- no panel models need to be specified, as all rounds are sufficiently homogeneous

Results - Hypothesis 1

Pearson's correlation test:

$$\text{collective incentive: } r\,(34) = 0.01,\, p = 0.961;$$
$$\text{individual incentive: } r\,(34) = 0.02,\, p = 0.931$$



No other kind of association is evident, even after the outliers were removed.

Results - Hypothesis 1

Result of Pearson's correlation test:

- is not in support of Hypothesis 1
- is in contrast to the economic perspective which considers individuals opportunistic (Osterloh and Frey, 2000)
- is in contrast to empirical evidence (Prendergast, 1999): there is always evidence but in both directions!

Regression estimates explaining the effort exerted by the agents.

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	2.571***	2.700***	2.360	3.318***	3.545***	4.201
	(0.331)	(0.538)	(2.727)	(0.419)	(0.604)	(2.648)
Group incentive	−1.908			3.954		
	(4.829)			(4.523)		
Individual incentive		−2.659			−5.366	
		(13.872)			(12.936)	
Colleague's past effort	−0.518***	−0.516***	−0.513***	−1.452***	−1.405***	−1.416***
	(0.124)	(0.124)	(0.130)	(0.376)	(0.375)	(0.390)
$(Colleague's\ past\ effort)^2$				0.151*	0.144***	0.145*
				(0.058)	(0.058)	(0.059)
Past wage			0.187			−0.205
			(0.971)			(0.918)
Past production			−0.035			−0.073
			(0.178)			(0.167)
R^2	0.345	0.342	0.344	0.459	0.450	0.450

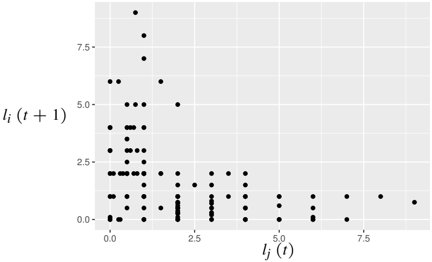
The marginal effect of colleague's past exerted effort is considered in Models (4)-(6). Standard errors are in parentheses.

$N = 36$. $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$ (two-tailed test).

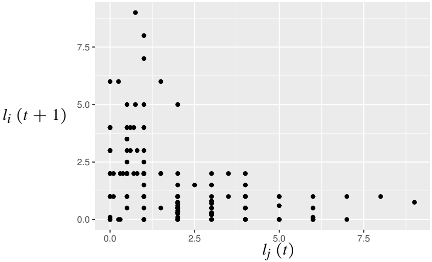
Results - Hypothesis 2

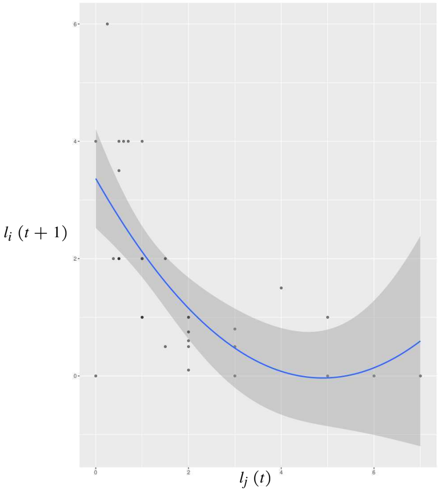
- Even if not statistically significant, increased individual incentives results in decreased effort allocated in the collective task
- Higher levels of colleague's effort cause significant drops in effort. Controlling for the group incentive, an addition of a unitary effort of the colleague's past exerted effort results in an average drop of about half unitary effort in the effort allocated in the common task
- This indicates that a dynamic model of the effort allocation which depends only on the colleague's past effort might provide a simpler and better fit to the data than a much more complicated model
- These results support Hypothesis 2

Results - Hypothesis 3



Results - Hypothesis 3





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Results - Hypothesis 3

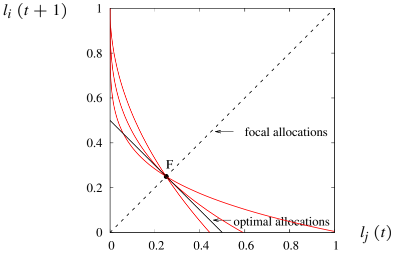
- By including the quadratic function of the colleague's past exerted effort, Models (4)-(6) explain on average about 10.93% of the variability in the exerted effort more than Models (1)-(3).
- Controlling either for the incentives or the organization variables, there is evidence that the colleague's past effort and its quadratic term are the only ones to be statistically significant.
- The effect is decreasing and marginally increasing, producing evidence to the compensating reaction behavior.

Results - Hypothesis 3

- The average turning point is at the effort value $l_j = 4.86$:
  - only about 10.42% of the participants had a colleague who exerted an effort greater than this value.
  - an increase in the colleague's past exerted effort from, say, two to three effort unit, on average decreases the future effort by about 0.84 effort units.
  - an increase in the colleague's past exerted effort from, say, five to six effort units increases the future effort on average by about 0.04, an almost negligible –even if positive– effect.
- These results support Hypothesis 3.

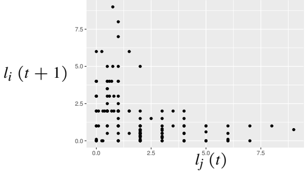
Results - Summary

- Modeling the effort allocations does not need to consider too many variables.
- Colleague's behavior is the most significant determinant and there is evidence that this causal relation is not linear, suggesting a compensative behavior.



parameters:
$a_i = 1$, b_i varies.

Modeling unfavorable social comparison



- When both agents compensate, the work group reach the optimal and focal stable equilibrium (theoretically).
- However, real groups are characterized by instability (Fuhrimam and Burlingame, 1994; Arrow 1997).
- For low values of the colleague's past exerted effort not all responses were compensating, as they exhibit a large variability.

Why?

Modeling unfavorable social comparison: the role of envy

- A possible answer: unfavorable social comparison may activate envy (Arnocky et al., 2016).
- Envy is "a negative social comparison-based emotion, one that arises when person A compares unfavorably with person B with respect to an attribute, possession, or position that person B has and person A wants" (Alicke and Zell, 2008)
- "Envy includes the motivation to reduce the pain it entails and to improve one's relative standing." (Cohen and Larson, 2016)

What is the object of envy?

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What is the object of envy?

- With the optimal incentive scheme the monetary compensation is the same for both agents $\rightarrow$ envy cannot be triggered by comparing the compensations
- The object might be the colleague's capacity

Assuming $\tilde{C}_j > C_i$:

$$l_i(t+1) = r_i(l_j(t)) = \frac{e_i}{\theta_i}(l_j(t))^{a_i-1}\left(\tilde{C}_j - l_j(t)\right)^{b_i-1} \quad a_i, b_i \geq 1$$

with parameter

$$\theta_i = \begin{cases} \left(\tilde{C}_j \frac{a_i-1}{a_i+b_i-2}\right)^{a_i-1}\left(\tilde{C}_j - \tilde{C}_j \frac{a_i-1}{a_i+b_i-2}\right)^{b_i-1} & \text{if } a_i > 1 \text{ and } b_i > 1 \\ 1 & \text{otherwise.} \end{cases}$$

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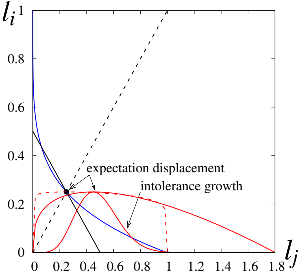
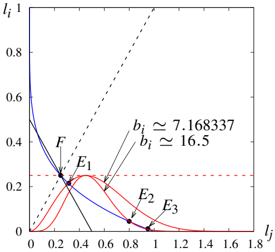
$$\theta_i = \begin{cases} \left(\tilde{C}_j \frac{a_i-1}{a_i+b_i-2}\right)^{a_i-1}\left(\tilde{C}_j - \tilde{C}_j \frac{a_i-1}{a_i+b_i-2}\right)^{b_i-1} & \text{if } a_i > 1 \text{ and } b_i > 1 \\ 1 & \text{otherwise.} \end{cases}$$



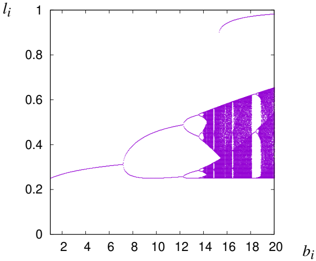
Work group dynamics with an envious agent

Fixing the expected capacity: $\tilde{C}_j = 1.8$



Other parameters value:
$C_j = 1.0, a_j = 1.0, b_j = 5.8, C_i = 1.0, \tilde{C}_j = 1.8$

Focal point $F\,(0.3, 0.25)$.

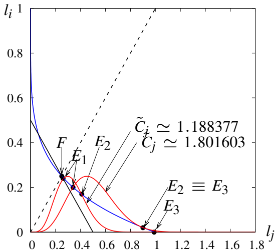


Initial condition:

$l_j\,(0) = 0.1, l_i\,(0) = 0.1.$

Work group dynamics with an envious agent

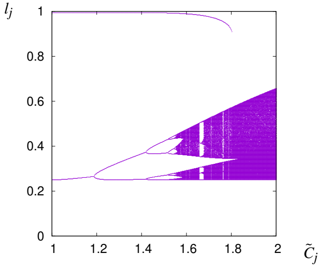
Fixing the intolerance parameters: $a_i \simeq 2.33, b_i \simeq 15.40$



Other parameters value:

$C_j = 1.0, a_j = 1.0, b_j = 5.8, C_i = 1.0, a_i = 5.8,$

$b_i = 15.4.$



Initial condition:

$l_j(0) = 0.25, l_i(0) = 0.5.$

Conclusion

- Bilevel optimization problem: theoretical solution (benchmark):
  - infinitely many solutions $\rightarrow$ focal equilibrium
  - optimal incentive scheme:

$$b_g = \epsilon > 0 \quad , \quad b_i = b_j = 0$$

- Lab experiment:
  - The colleague's past effort is the most significant variables
  - Marginal effects
  - Evidence of a compensative behavior
  - Large variability in response to small colleague's effort
- Dynamical model which takes into account unfavorable social comparison may explain:
  - effort withholding
  - instability of work groups behavior