The breakdown and recovery of cooperation in large groups: Exploring the role of formal structure using a field experiment

Francisco Brahm         London Business School
Christoph Loch           Cambridge Judge Business School
Cristina Riquelme       University of Maryland

Strategy Science Conference

May 1, 2020
Breakdown of cooperation with scale?

Cooperation: “costly effort that benefits co-workers and the group as whole”

Cooperation is crucial for performance of organizations (Gibbons and Henderson, 2013; Fehr, 2018; Barnard, 1938; Schein, 2010; Organ et al, 2005; Grennan, 2014).

Cooperation and size

Theory: more difficult (e.g., Graham et al., 2018; Holmström, 1982; Gibbons, 2006)

Breakdown of cooperation with scale?

Cooperation: “costly effort that benefits co-workers and the group as whole”

Cooperation is crucial for performance of organizations (Gibbons and Henderson, 2013; Fehr, 2018; Barnard, 1938; Schein, 2010; Organ et al, 2005; Grennan, 2014).

Cooperation and size

Theory: more difficult (e.g., Graham et al., 2018; Holmström, 1982; Gibbons, 2006)

RQ1: How does cooperation varies with size?

This paper: Using detailed administrative data, we provide evidence from a specific setting, probing at the mechanism
Formal structure favours cooperation at scale?

Formal structure: “grouping the workers of the organization into separate areas/units, and the elements required for these areas/units to be functional (e.g., decision rights, incentive systems, reporting lines, etc.)”

Main benefit: Grouping promotes learning and specialization (Puranam, 2018)

Main cost: Separation hinders cooperation (Puranam, 2018; Roberts & Gibbons, 2013)

Really? Evolutionary theory suggests otherwise (Nowak, 2006; Boyd and Richerson, 1988; Takezawa and Price, 2010; Rand and Nowak, 2013)
Formal structure favours cooperation at scale?

Formal structure: “grouping the workers of the organization into separate areas/units, and the elements required for these areas/units to be functional (e.g., decision rights, incentive systems, reporting lines, etc.)”

Main benefit: Grouping promotes learning and specialization (Puranam, 2018)

Main cost: Separation hinders cooperation (Puranam, 2018; Roberts & Gibbons, 2013)

Really? Evolutionary theory suggests otherwise (Nowak, 2006; Boyd and Richerson, 1988; Takezawa and Price, 2010; Rand and Nowak, 2013)

RQ2: Can formal structure promote cooperation at scale?

This paper: Using a pre-registered field experiment, we study whether a randomly placed formal structure promotes cooperation at scale. (By being random, the specialization benefit is muted.)
Setting and data (1/3)

BAPP methodology

We collaborated with DEKRA Insight

We study BAPP, a methodology for workplace safety

BAPP is a great setting to study cooperation as it scales

Contact rate = \[
\frac{\text{observations}}{\text{workers}} = \frac{\text{observations}}{\text{observers}} \times \frac{\text{observers}}{\text{workers}} = \text{“Effort”} \times \text{“Diffusion”}
\]
Administrative data

Access to a dataset of ~1,300 projects between 1990 and 2013

We use of a sample of 88 implementations
  Accidents window of -24 and +36 months around BAPP start
  Sample is representative (using ~ 10 observables)

Highly detailed data on the ~1,300,000 observations
Observations / workers = observations / observers × observers / workers

"contact rate" = "effort" × "diffusion"

Setting and data (3/3)

Average site

Mean Contact Rate
Mean Diffusion
Mean Effort

Month of BAPP Implementation

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36

Effort

Contact Rate
Diffusion

p25
p75
Cooperation breakdown (1/3)

Theory and hypothesis

For any worker, defection occurs if this inequality holds:

\[
\text{effort} \times \frac{(\text{observers}-1)}{\text{workers}} > \text{effort} \times \frac{\text{observers}}{\text{workers}} - \text{cost}
\]

Which simplifies to:

\[
\frac{\text{effort}}{\text{workers}} > \text{cost}
\]

\[\Rightarrow \text{diffusion doesn’t matter?!?}\]
Cooperation breakdown (1/3)

Theory and hypothesis

For any worker, defection occurs if this inequality holds:
\[
\text{effort} \times \frac{\text{observers} - 1}{\text{workers}} > \text{effort} \times \frac{\text{observers}}{\text{workers}} - \text{cost}
\]

Which simplifies to:
\[
\frac{\text{effort}}{\text{workers}} > \text{cost} \implies \text{diffusion doesn’t matter}?!?
\]

Thus, in order for diffusion to reduce cooperation,
\[
\text{effort} = f(\text{diffusion}) \text{ such that } \frac{\partial \text{eff}}{\partial \text{diff}} < 0.
\]

Two mechanisms in BAPP:
1. Decreasing impact of effort on accidents ➔ Affects all observers
2. Decreasing reputation/promotion benefits ➔ Affects newer observers
Cooperation breakdown (1/3)

Theory and hypothesis

For any worker, defection occurs if this inequality holds:

\[
\text{effort} \times \frac{(\text{observers}-1)}{\text{workers}} > \text{effort} \times \frac{\text{observers}}{\text{workers}} - \text{cost}
\]

Which simplifies to:

\[
\frac{\text{effort}}{\text{workers}} > \text{cost} \implies \text{diffusion doesn’t matter?!?}
\]

Thus, in order for diffusion to reduce cooperation,

\[
\text{effort} = f(\text{diffusion}) \text{ such that } \frac{\partial \text{eff}}{\partial \text{diff}} < 0.
\]

Two mechanisms in BAPP:

1. Decreasing impact of effort on accidents \(\Rightarrow\) Affects all observers
2. Decreasing reputation/promotion benefits \(\Rightarrow\) Affects newer observers

Hypothesis 1:

“Cooperation in BAPP, and therefore its impact on accidents, will be reduced as the number of observers increase.”
Cooperation breakdown (2/3)

Results for H1 - “After ~20 observers, adding more is detrimental”
Cooperation breakdown (2/3)

Results for H1 - “After ~20 observers, adding more is detrimental”

\[ \text{ACC}_{it} = b_1 + b_2 \times \text{BAPP}_{it} + b_3 \times \text{TREND}_{it} + b_4 \times \text{BAPP}_{it} \times [Q1\text{eff} + \ldots + Q5\text{eff}] + b_5 \times \text{BAPP}_{it} \times [Q1\text{diff} + \ldots + Q5\text{diff}] + \text{CONTROLS} + U_i + \text{ERROR}_{it} \]

Where, \( \text{BAPP} = 1 \) after the implementation and \( \text{TREND}_{it} = (t - \theta_i) \)

- **Contact rate** = “Effort” \( \times \) “Diffusion”

% decrease in accidents in the site

- 0 -> 2.7 (0 -> 0.04)
- 2.7 -> 3.8 (0.04 -> 0.08)
- 3.8 -> 5 (0.08 -> 0.12)
- 5 -> 7.1 (0.12 -> 0.21)
- More than 7.1 (more than 0.21)

**Effort** (range of value and corresponding quintile)

- 0% -> 7%
- 7% -> 9%
- 9% -> 6%
- 6% -> -1%

**Diffusion** (range of value and corresponding quintile)

- 0% -> 10%
- 10% -> 20%
- 20% -> 22%
- 22% -> 28%
- 28% -> 32%

- 32% -> 35%
Mechanism - “Newer observers exert less effort, and rotate more”
“A result of decreasing reputation/promotion benefits”
Cooperation breakdown (3/3)

Mechanism - “Newer observers exert less effort, and rotate more”
“A result of decreasing reputation/promotion benefits”

![Graph showing cooperation breakdown over years and effort levels](image-url)

- First quintile
- Second quintile
- Third quintile
- Fourth quintile
- Fifth quintile

Dotted lines: 95% CI

Year of BAPP implementation:
- 1st year
- 2nd year
- 3rd year

Effort levels:
- 8
- 7
- 6
- 5
- 4
- 3
- 2
Theory and hypothesis

Imagine random observations in an average site:

\[
\begin{align*}
P(\text{being observed in } t \text{ by the same observer of } t-1) &= P(\text{repeated interactions}) \\
&= P(\text{being observed}) \times P(\text{same observer}) \\
&= \text{contact rate} \times \frac{1}{\text{Observers}} \\
&= \frac{\text{effort}}{\text{workers}} = \frac{5}{250} = 2.5%
\end{align*}
\]
Theory and hypothesis

Imagine random observations in an average site:
\[ P(\text{being observed in } t \text{ by the same observer of } t-1) = P(\text{repeated interactions}) \]
\[ = P(\text{being observed}) \times P(\text{same observer}) \]
\[ = \text{contact rate} \times \frac{1}{\text{Observers}} \]
\[ = \frac{\text{effort} / \text{workers}}{250} = 2.5\% \]

Formal structure groups workers into areas/units

Imagine “\( g \)” groups with observations restricted within them:
\[ P(\text{being observed in } t \text{ by the same observer of } t-1) = \frac{\text{effort} / \text{workers}}{} \times g \]

If site has 10 groups \( \Rightarrow \) tenfold increase in \( P(\text{repeated interactions}) \)
Theory and hypothesis

Imagine random observations in an average site:
\[ P(\text{being observed in } t \text{ by the same observer of } t-1) = P(\text{repeated interactions}) = P(\text{being observed}) \times P(\text{same observer}) = \text{contact rate} \times \frac{1}{\text{Observers}} = \frac{\text{effort}}{\text{workers}} = \frac{5}{250} = 2.5\% \]

Formal structure groups workers into areas/units

Imagine \( g \) groups with observations restricted within them:
\[ P(\text{being observed in } t \text{ by the same observer of } t-1) = \frac{\text{effort}}{\text{workers}} \times g \]

If site has 10 groups \( \Rightarrow \) tenfold increase in \( P(\text{repeated interactions}) \)

Hypothesis 2:
“Adding structure to BAPP mitigates the reduction in cooperation, and therefore, restore its impact on accidents”
Structure and coop. recovery (2/4)

Experiment

Collaboration with DEKRA Insight and SODIMAC

Implemented the experiment between Jul-17 and May-18

Pre-registration in the AEA registry
Experiment

Collaboration with DEKRA Insight and SODIMAC

Implemented the experiment between Jul-17 and May-18

Pre-registration in the AEA registry

We intervened the BAPP implementation of four stores with three treatments:

T1, main treatment; T2 and T3 to probe other mechanisms

<table>
<thead>
<tr>
<th></th>
<th>Store 1</th>
<th>Store 2</th>
<th>Store 3</th>
<th>Store 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1: Structure</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>T2: Structure + Identity</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3: Structure + Reputation</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Structure and coop. recovery (3/4)

Treatment 1: “Structure”

Typical BAPP implementation

Site
Treatment 1: “Structure”

*Typical BAPP implementation*

*In our experiment*
Treatment 1: “Structure”

Three mechanisms for T1:
1) Small groups increase repeated interactions between observers and workers
2) Small groups facilitate identity (Treatment 2: Identity)
3) Small groups facilitate social pressure (Treatment 3: Reputation)
**Results** - “Structure favours cooperation via repeated interactions”

T1 increased the likelihood of becoming an observer
increased the number of observations (effort)
increased the safe behaviour of workers
decreased the incidence of accidents

T2 reduced the impact of T1

T3 did not affect T1

Three additional tests point at “repeated interactions” as the mechanism
1. **Cooperation and Scale:**

   “Relationship depends on how the benefits of cooperation change with size”

2. **Cooperation and Formal structure:**

   “Structuring interactions around groups favours cooperation at scale”

   “A crucial function of formal organization is the promotion of large scale cooperation”