Disclosure by Groups

Paula Onuchic
LSE

João Ramos
USC Marshall

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Introduction

Communication is often done by organizations, rather than by individual actors.

- Political parties collectively agree on "stances" their members should publicly hold regarding politically relevant issues.
- Decisions on what reporting to include in a magazine or newspaper's next issue are normally made by editorial boards.
- Teams of startup founders jointly decide when and how to pitch start up ideas to potential investors.

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Cyert and March (1963): "People have goals; collectivities of people do not."

We consider communication by **groups**: collectives of individuals who reach decisions via the (perhaps uneven) aggregation of their often-conflicting interests.

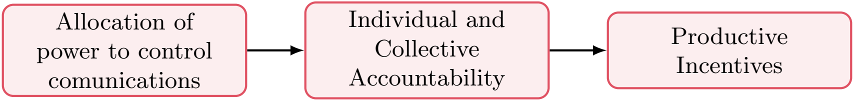
Group Communication

We propose a model of group communication in which a group of senders communicates with a receiver via the disclosure of verifiable information.

- Communication protocol is as in Milgrom (1981), Grossman (1981): Receiver learns either by observing a piece of verifiable information or by inference based on strategic non-disclosure.
- Group members have different preferences over the disclosure/non-disclosure of each information piece, and make disclosure recommendations accordingly.
- These diverse recommendations are aggregated into a collective disclosure decision via a pre-determined deliberation procedure.
- Different agents might have different powers over the communication, and this impacts the inference made by the receiver.

Implications for Incentives

Advertising our next paper



We add a **team production** to our **communication** environment.

- We add a simple productive environment in order to study how equilibrium communication of outcomes affects team members' productive incentives.
- We consider the design of how team's communicate their joint production outcomes to outsiders.
- We interpret our design problem as "designing corporate culture".

Three Types of Results

1. Disclosure by groups differs qualitatively from individual disclosure.
   - The traditional unravelling logic introduced in Milgrom (1981) and Grossman (1981) does not necessarily apply in the group disclosure environment.
   - Typically, there exist equilibria without full disclosure.

2. Results regarding the structure of the equilibrium set.
   - We characterize environments in which the group disclosure game exhibits strategic complementarities between group members.
   - We characterize environments in which full disclosure equilibrium is supported by beliefs satisfying sequential consistency.

3. Comparative statics results relating the group's deliberation procedure and
   - the "amount of disclosure" in equilibrium.
   - the interpretation of "no disclosure" in equilibrium.

Literature Remarks

1. Multi-sender Communication.

Milgrom and Roberts (1986), Battaglini (2002), Gentzkow and Kamenica (2016).

+ Disclosure of Verifiable Information.

Grossman (1981), Milgrom (1981), Dye (1985).

Our paper: model of communication by a group of senders.

2. Models of Communication in Networks or Hierarchies Hagenbach and Koessler (2010), Ambrus, Azevedo and Kamada (2013), Squintani (2020).

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3. This paper is part of a research agenda:

- In Onuchic and Ramos (2023), we show how the design of the deliberation procedure in a productive team can be used as an incentive tool.
- In Avoyan and Onuchic (2024), they implement the group disclosure game in a lab experiment, and document the relationship between a group's deliberation procedure and the interpretation of group communication.

Model - Disclosure in groups

A group is made up of $n \geqslant 2$ group-members. ($N = \{1, ..., n\}$).

Group produces outcome $\omega = (\omega_1, ..., \omega_n)$, drawn from distribution μ.

- $\omega_i \in \Omega_i$, a finite subset of $\mathbb{R}$, with $|\Omega_i| > 1$.
- μ has full support over $\Omega = \Omega_1 \times ... \times \Omega_n$.

After outcome ω realizes, group decides whether to disclose it to an observer.

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Group Member's Payoffs

- If ω is disclosed, then group member i's payoff is ω_i.
- If ω is not disclosed, observer "sees" the absence of disclosure and infers ω_i. group member i's payoff is then

$$\omega_i^{ND} = \mathbb{E}\left[\omega_i | \text{no disclosure}\right].$$

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Possible Interpretations.

- Career Concerns in a Heterogeneous Team
- Board of Editors with Heterogeneous Editorial Biases

Deliberation Procedure

Each member $i \in N$ sees ω and makes a disclosure recommendation $x_i(\omega)$.

- $x_i(\omega) = 1$ indicates that i favors disclosure
- $x_i(\omega) = 0$ indicates that i does not favor disclosure

Recommendations are summarized by $X(\omega) \subseteq N$, the set of group members who favor disclosure of outcome ω.

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Deliberation procedure $D : \mathcal{P}(N) \to [0,1]$ aggregates the recommendations of all group members, so that the group discloses outcome ω with probability

$$d(\omega) = D\big(X(\omega)\big).$$

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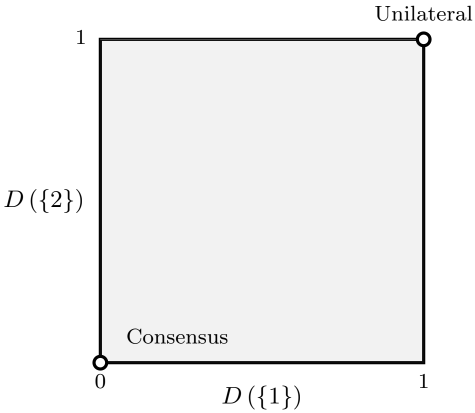
Assumptions. The deliberation procedure D

1. Respects unanimity: $D(\varnothing) = 0$ and $D(N) = 1$.
2. Is monotone: $X' \subseteq X$ implies $D(X) \geqslant D(X')$.

Deliberation in Two-Person group



- Protocol can be fully described by $D(\{1\})$ and $D(\{2\})$, because $D(\varnothing) = 0$ and $D(\{1,2\}) = 1$.

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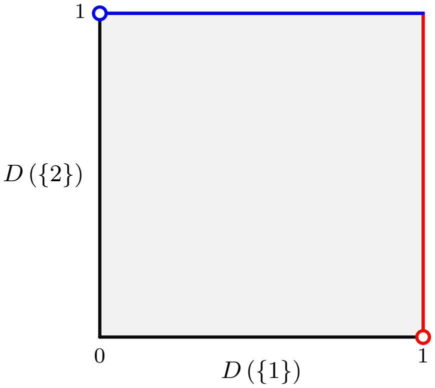

- Protocol can be fully described by $D(\{1\})$ and $D(\{2\})$, because $D(\varnothing) = 0$ and $D(\{1,2\}) = 1$.
- In **red** are protocols where group-member 1 can unilaterally choose disclosure.
- In **blue** are protocols where group-member 2 can unilaterally choose disclosure.

Equilibrium

We consider weak Perfect Bayesian Equilibria: disclosure recommendations x_i for $i \in N$, and no-disclosure posteriors ω_i^{ND} for $i \in N$ such that x is individually rational given ω^{ND} and ω^{ND} is Bayes-consistent if no disclosure happens on path.

Two Refinements:

1. Individual disclosure strategies are as if pivotal:

$$\omega_i > \omega_i^{ND} \Rightarrow x_i(\omega) = 1 \text{ and } \omega_i < \omega_i^{ND} \Rightarrow x_i(\omega) = 0.$$

2. Individual disclosure recommendations are determined by own outcome values:

$$\omega, \hat{\omega} \in \Omega \text{ with } \omega_i = \hat{\omega}_i \Rightarrow x_i(\omega) = x_i(\hat{\omega}).$$

We refer to a weak PBE that satisfies the two refinements as an equilibrium.

Individual Disclosure

Observation 1.

Suppose that μ is such that outcomes are perfectly correlated across agents. Then, for any deliberation procedure D, the **unique** equilibrium outcome is full disclosure.

Disclosure Environment

Equilibrium Group Disclosure

The Equilibrium Set

Comparative Statics

Sequential Consistency

Conclusion

Equilibrium Group Disclosure

Theorem 1. Given a deliberation procedure D, let $I \subseteq N$ be the set of group members who can unilaterally choose disclosure.

The following is true about the equilibrium set:

1. A full-disclosure equilibrium exists. An equilibrium without full disclosure exists if and only if the set $I \neq N$.

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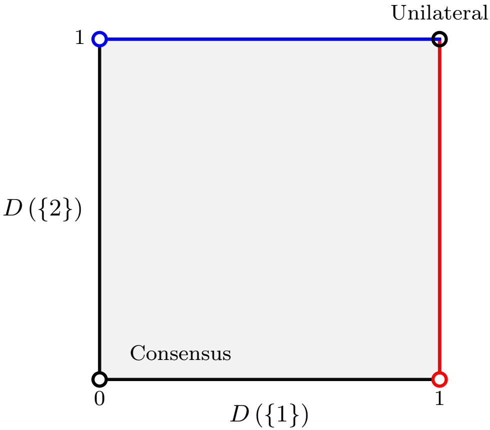
1. A full-disclosure equilibrium exists. An equilibrium without full disclosure exists if and only if the set $I \neq N$.

2. In any equilibrium without full disclosure,

$$\omega_i^{ND} \begin{cases} = \min(\Omega_i), \text{ if } i \in I \\ > \min(\Omega_i), \text{ if } i \notin I. \end{cases}$$

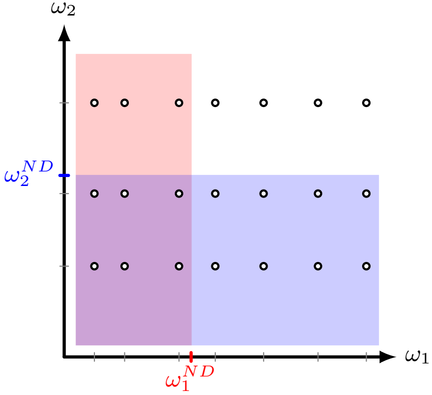
Equilibrium Group Disclosure



Proof Intuition with $n = 2$

Suppose there are two agents in the group, $n = 2$.

Conjecture an equilibrium with $\omega_1^{ND} > \min(\Omega_1)$ and $\omega_2^{ND} > \min(\Omega_2)$.



red region $\rightarrow$ 1 recommends ND.

blue region $\rightarrow$ 2 recommends ND.

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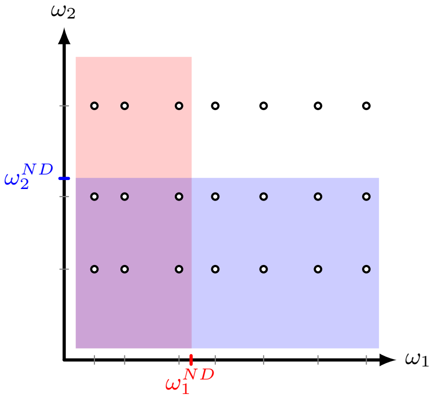

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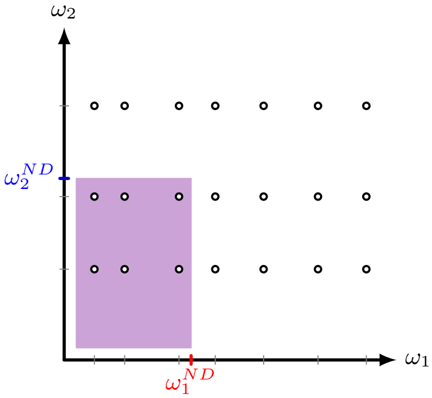
Suppose both individuals can unilaterally disclose, so that $D(\{1\}) = D(\{2\}) = 1$.

Proof Intuition with $n = 2$

Suppose there are two team-members, $n = 2$.

Conjecture an equilibrium with $\omega_1^{ND} > \min(\Omega_1)$ and $\omega_2^{ND} > \min(\Omega_2)$.



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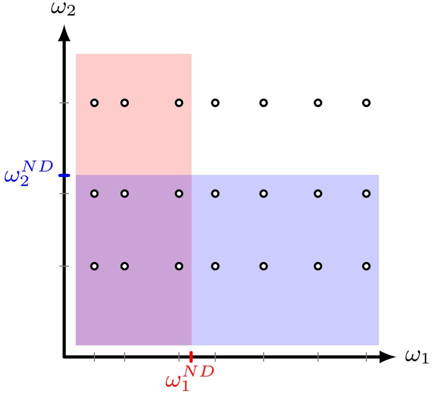
Suppose both individuals can unilaterally disclose, so that $D(\{1\}) = D(\{2\}) = 1$.

The conjectured equilibrium unravels.

Proof Intuition with $n = 2$

Suppose there are two team-members, $n = 2$.

Conjecture an equilibrium with $\omega_1^{ND} > \min(\Omega_1)$ and $\omega_2^{ND} > \min(\Omega_2)$.



red region → 1 recommends ND.

blue region → 2 recommends ND.

If instead neither team-member can unilaterally disclose, so that $D(\{1\}) = D(\{2\}) = 0$.

Unraveling logic breaks,
and one such equilibrium exists.

Skepticism in Group Communication

Two Lessons from Theorem 1

1. The existence of disclosure equilibria in which "failures" are concealed.

(In contrast with result in a parallel model of individual disclosure.)

2. A relationship b/w an individual's power to disclose the outcome and the observer's skepticism about that individual's value upon seeing no-disclosure.

(New mechanism introduced in a model of group disclosure.)

Next Results:

1. How the structure of the disclosure procedure impacts what is disclosed in equilibrium.
2. How an individual power to disclose the outcome (determined by D) impacts the no-disclosure skepticism targeted at that individual (measured by ω_i^{ND}).

Disclosure Environment

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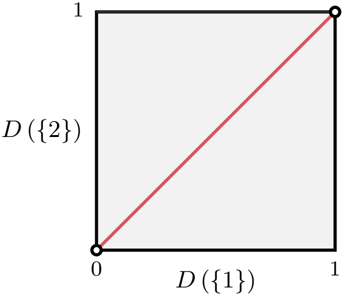
Example 1

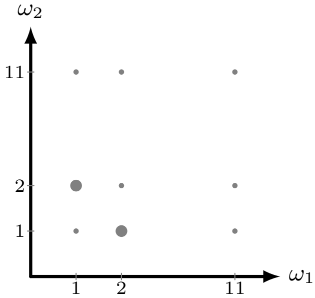
Group: Two group members $i \in \{1, 2\}$.

Deliberation Procedure: $D(\varnothing) = 0$, $D(\{1, 2\}) = 1$, $D(\{1\}) = D(\{2\}) = \delta < 1$.

Outcome Distribution: $\Omega_1 = \Omega_2 = \{1, 2, 11\}$.

$\omega = (1, 2)$ and $\omega = (2, 1)$ occur with probability $4/15$ each, while every other possible outcome occurs with probability $1/15$.

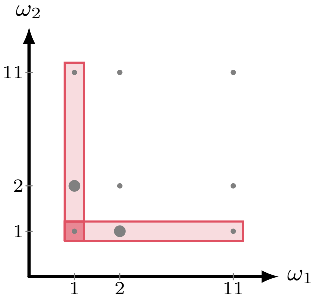




Example 1 – Large δ

Suppose first that δ is large: $\delta \geqslant 3/4$.

- Both group members have sufficiently large power to enforce disclosure.
- In this case, there exists **one equilibrium without full disclosure**.
- In it, each group member recommends to disclose iff their own outcome value is strictly larger than 1.



No-disclosure beliefs are, for $i \in \{1, 2\}$,

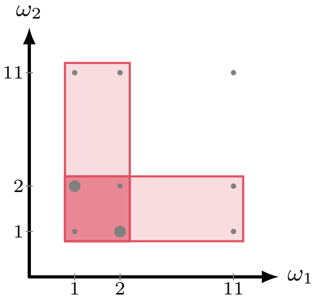
$$\omega_i^{ND} = \frac{1 + 24(1-\delta)}{1 + 10(1-\delta)} \in [1, 2],$$

which justify the conjectured strategy.

Example 1 – Small δ

Suppose now that δ is small: $\delta \leqslant 12/17$.

- Both group members have sufficiently large power to enforce disclosure.
- In this case, there exists **one equilibrium without full disclosure**.
- In it, each group member recommends to disclose iff their own outcome value is strictly larger than 2.



No-disclosure beliefs are, for $i \in \{1, 2\}$,

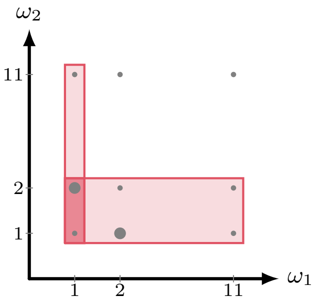
$$\omega_i^{ND} = \frac{15 + 25(1-\delta)}{10 + 4(1-\delta)} \in [2, 11],$$

which justify the conjectured strategy.

Example 1 – Intermediate δ

Suppose now that δ is intermediate: $\delta \in (12/17, 3/4)$.

- There are **two equilibria without full disclosure**, which are both asymmetric despite the environment being symmetric both in terms of the outcome distribution and the deliberation procedure.
- One group member (group member 1, say) recommends to disclose iff their own outcome value is strictly larger than 1. The other group member recommends to disclose iff their own outcome value is strictly larger than 2.



No-disclosure beliefs are:

$$\omega_1^{ND} = \frac{5+33(1-\delta)}{5+8(1-\delta)} \in (1,2),$$

$$\omega_2^{ND} = \frac{9+20(1-\delta)}{5+8(1-\delta)} \in (2,11),$$

which justify the conjectured strategy.

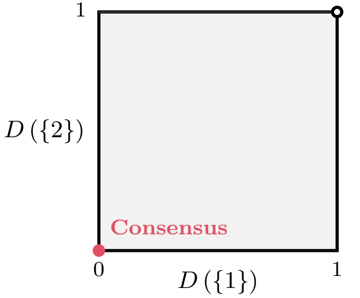
Example 2

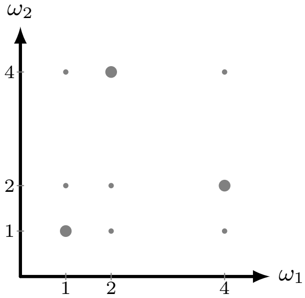
Group: Two group members $i \in \{1, 2\}$.

Consensus Procedure: $D(\varnothing) = 0$, $D(\{1, 2\}) = 1$, $D(\{1\}) = D(\{2\}) = 0$.

Outcome Distribution: $\Omega_1 = \Omega_2 = \{1, 2, 4\}$.

$\omega = (1, 1)$, $\omega = (2, 4)$ and $\omega = (4, 2)$ occur with probability $4/18$ each, while every other possible outcome occurs with probability $1/16$.

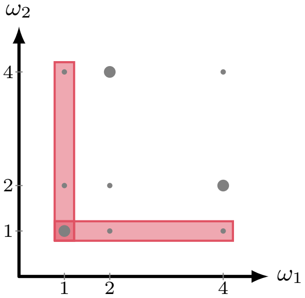




Example 2

In this example, there are **two equilibria without full disclosure**, which are ordered in terms of the amount of disclosure:

- Equilibrium 1: each group member recommends disclosure if and only if their own outcome value is strictly larger than 1.
- Equilibrium 2: each group member recommends disclosure if and only if their own outcome value is strictly larger than 2.



Structure of the Equilibrium Set

The Examples Illustrate:

1. That there may be one or more equilibria without full disclosure.

2. Equilibria may or may not be comparable in terms of amount of disclosure.

3. Equilibria can be asymmetric in a symmetric environment.

(Determined by the outcome distribution μ and the deliberation procedure D.)

Our next results characterize environments in which group members' disclosure recommendations are strategic complements to each other. When that is the case,

- There are extremal equilibria, in terms of amount of disclosure.
- We can perform comparative statics, relating the deliberation procedure to the amount of disclosure in equilibrium, as well as to the equilibrium no-disclosure belief vector ω^{ND}.

Strategic Complementarity

For each group member i, consider the set of threshold disclosure recommendation strategies, each indexed by $t_i \in \Omega_i$:

- i recommends disclosure if their own outcome value is strictly larger than t_i,
- i recommends no disclosure otherwise.

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- i recommends disclosure if their own outcome value is strictly larger than t_i,
- i recommends no disclosure otherwise.

For each vector of threshold strategies t_{-i} for i's fellow group members, define the following individual rationality mapping for group member i:

$$\Psi_i(t_{-i}) = \left\{ t_i \in \Omega_i : t_i \leqslant \mathbb{E}\left[\omega_i \middle| \text{ no disclosure, } (t_i, t_{-i})\right] \leqslant t_i^+ \right\},$$

$$\text{where } t_i^+ = \min\left\{\omega_i \in \Omega_i : \omega_i > t_i\right\}.$$

Definition. We say the group disclosure game has strategic complementarities if $\Psi_i(t_{-i})$ is weakly increasing in t_{-i} for each i.

Restricted Game and Restricted Consensus

Definition. Let I be the set of group members who can unilaterally choose disclosure. The restricted game is the group disclosure game defined for group members $N \setminus I$ when every group member $i \in I$ recommends no disclosure if and only if they draw their worst possible value, $\min(\Omega_i)$.

Definition. A deliberation procedure D is a restricted-consensus procedure if, for some $I \subseteq N$, and for each $J \subseteq N$,

$$D(J) \begin{cases} = 1, \text{ if } J \cap I \neq \varnothing \\ \in [0,1], \text{ if } J \cup I = N \\ 0, \text{ otherwise.} \end{cases}$$

Strategic Complementarity in Disclosure

Theorem 2. There exists a set of deliberation procedures $\mathbb{D}$, which includes every restricted-consensus procedure, such that, if the group's disclosure procedure is $D \in \mathbb{D}$, then the restricted group disclosure game has strategic complementarities.

The original game has an equilibrium with **most disclosure** — the full disclosure equilibrium — and an equilibrium with **least disclosure**.

Strategic Complementarity in Disclosure

Proposition 1.

(i) If $n = 2$ and μ is such that group members' values are (weakly) positively correlated, $\mathbb{D}$ includes all deliberation procedures.

(ii) If $n \geqslant 2$ and μ is such that group members' values are independent, $\mathbb{D}$ includes every deliberation that is restricted-supermodular.

$$D(K) - D(K \setminus \{i\}) \geqslant D(J) - D(J \setminus \{i\}) \text{ for all } i \in N \setminus I \text{ and } J \subseteq K \subseteq N \setminus I,$$

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The Amount of Disclosure

Definition. We say that an equilibrium x' for procedure D' has more disclosure than an equilibrium x for procedure D if, for each $\omega \in \Omega$,

$$D'(x'(\omega)) \geqslant D(x(\omega)).$$

Definition. Disclosure is easier under procedure D' than procedure D if

$$D'(I) \geqslant D(I) \text{ for every } I \subseteq N.$$

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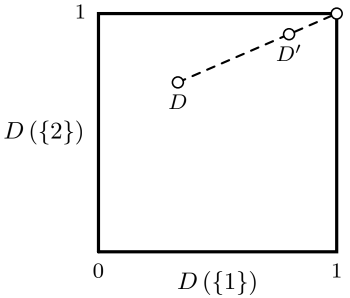


Definition. Disclosure is proportionally easier under procedure D' than procedure D if there exists $\alpha \in [0,1]$ such that, for every $\varnothing \neq I \subseteq N$,

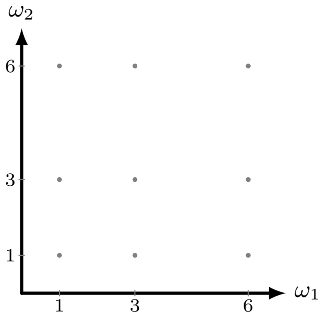
$$D'(I) = \alpha D(I) + (1-\alpha).$$

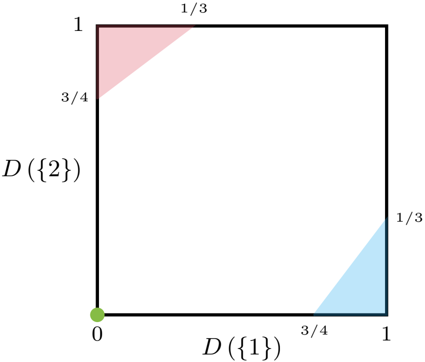
Example 3

Group: Two group members $i \in \{1, 2\}$.

Disclosure Procedure: $D(\varnothing) = 0$, $D(\{1,2\}) = 1$, $D(\{1\}) \in [0,1]$, $D(\{2\}) \in [0,1]$.

Outcome Distribution: $\Omega_1 = \Omega_2 = \{1, 3, 6\}$, with uniform distribution.





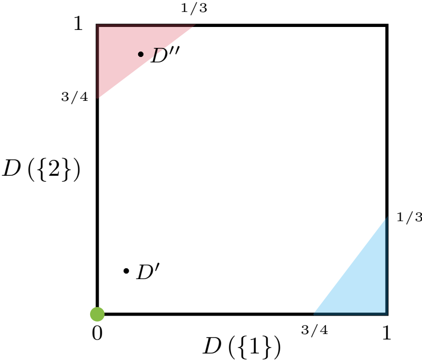
EXAMPLE 3

Least Disclosure Equilibrium:

Green Region:
Recommend disclosure if $\omega_i = 6$.

White Region:
Recommend disclosure if $\omega_i \in \{3, 6\}$.

Pink Region (or Blue Region):
$P1$ recommends disclosure if $\omega_1 = 6$,
$P2$ recommends disclosure if $\omega_2 \in \{3, 6\}$.



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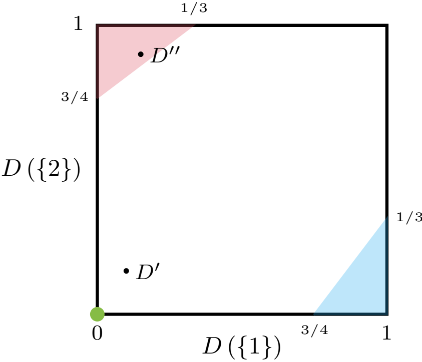

What happens if procedure changes from D' to D"?

1. Disclosure is easier for both (but not proportionally easier).
2. Disclosure in the least disclosure equilibrium does not increase.

   Consider the outcomes $(3, 3)$ and $(1, 6)$. $D'(3, 3) = 1$ and $D''(3, 3) = D''(\{2\}) < 1$, while $D'(1, 6) = D'(\{2\}) < D''(\{2\}) = D''(1, 6)$.

The Amount of Disclosure

Proposition 2. Let $D, D' \in \mathbb{D}$. If disclosure is proportionally easier under D than under D', then the equilibrium with least disclosure under D has more disclosure than the equilibrium with least disclosure under D'.

- This result also implies that the equilibrium set under D has more disclosure than the equilibrium set under D', in the weak set order.
- If disclosure is easier under D than D' — but not proportionally so — then the equilibria with least disclosure under these two procedures are not necessarily ranked in terms of the amount of disclosure.
- In particular, disclosure is not always minimized by the consensus procedure.

The Interpretation of No Disclosure

We also perform comparative statics that relate the equilibrium vector of no-diclosure beliefs in the equilibrium with least disclosure ω^{ND} to the deliberation procedure. This result establishes:

- That the interpretation of group communication depends on the observer's perception of the power balance between members within the group.
- A relationship between an individual's power to enforce disclosure and the observer's skepticism that is targeted at that individual.

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The Gradient $\nabla\omega_i^{ND}$. We denote by $\nabla\omega_i^{ND}$ the vector $\left(\frac{\partial\omega_i^{ND}}{\partial D(I)}\right)_{I\subseteq N}$ of partial derivatives of the observer's no-disclosure belief about i's value with respect to each element of the deliberation procedure.

For each i, the gradient $\nabla\omega_i^{ND}$ exists for almost all $D\in\mathbb{D}$.

The Interpretation of No Disclosure

Proposition 3. Let $v = (v(I))_{I \subseteq N}$ be a direction in the space of procedures. We say v is a direction that increases group member i's relative power if

$$\min\left\{\frac{v_I}{1-D(I)} : i \in I \subsetneq N\right\} \geqslant \max\left\{\frac{v_I}{1-D(I)} : i \notin I \subsetneq N\right\}.$$

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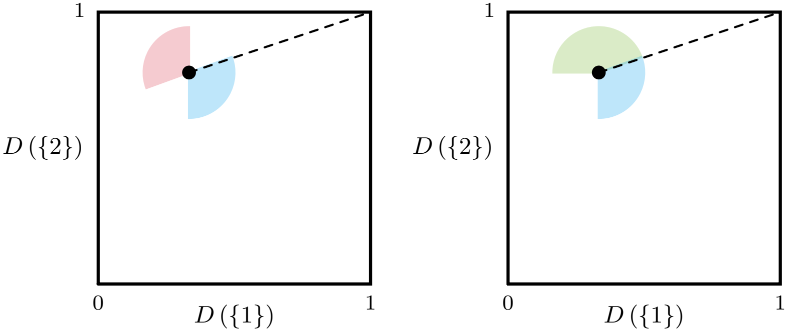
If v is a direction that increases (decreases) i's power, then $\nabla \bar{\omega}_i^{ND} \cdot v \leqslant 0$ ($\geqslant 0$).

The Interpretation of No Disclosure



- **In blue:** Directions that increase group member 1's relative power.
- **In pink:** Directions that decrease group member 1's relative power.
- **In green:** Directions that increase group member 2's relative power.

The Interpretation of No Disclosure

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If v is a direction that increases (decreases) i's power, then $\nabla \bar{\omega}_i^{ND} \cdot v \leqslant 0$ ($\geqslant 0$).

Note. This relationship between individual power and individual skepticism is tested and confirmed in a lab experiment by **Onuchic and Avoyan (2024)**.

Disclosure Environment

Equilibrium Group Disclosure

The Equilibrium Set

Comparative Statics

Sequential Consistency

Conclusion

Satisfying Sequential Consistency

We focused on weak PBE as our equilibrium notion. However, PBE puts no restrictions over out of path beliefs.

- Every weak PBE without full disclosure is also a **sequential equilibrium**, because "no disclosure" happens on path.
- **What about full disclosure equilibria?** There is always a weak PBE with full disclosure, regardless of the deliberation procedure.
  However, the deliberation procedure determines whether full disclosure satisfies **sequential consistency**.

Satisfying Sequential Consistency

Definition.

A full disclosure equilibrium (x, ω^{ND}) — our assessment — satisfies sequential consistency if there exists a sequence of recommendation strategy profiles and beliefs $(x^k, \omega^k)_{k=1}^{\infty}$ that converges to (x, ω^{ND}) such that each strategy profile x^k is completely mixed and beliefs ω^k are derived from x^k using Bayes' rule.

Note: We maintain that individual disclosure recommendations are determined by own outcome values, even on such sequence:

$$\omega, \hat{\omega} \in \Omega \text{ with } \omega_i = \hat{\omega}_i \Rightarrow x_i(\omega) = x_i(\hat{\omega}).$$

Satisfying Sequential Consistency

Theorem 3.

A full-disclosure equilibrium satisfying sequential consistency exists if and only if the procedure D is such that at least one group member can unilaterally choose disclosure.

Note on Proof: The proof relies on constructing (or the impossibility to construct) off-path beliefs of no disclosure such that the observer is maximally skeptical about each individual in a set of group members I such that $D(I) = 1$.

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We proposed a model of **group communication**, in which a group of individuals with often-conflicting interests communicates with a third-party via the disclosure of verifiable information.

- We saw that group communication is qualitatively different from communication done by a single individuals.
- We explored the relationship b/w the balance of power within the group and the structure of the equilibrium set, and the interpretation of “no disclosure.”

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We proposed a model of **group communication**, in which a group of individuals with often-conflicting interests communicates with a third-party via the disclosure of verifiable information.

- We saw that group communication is qualitatively different from communication done by a single individuals.
- We explored the relationship b/w the balance of power within the group and the structure of the equilibrium set, and the interpretation of "no disclosure."

Future elements for this agenda (things I am interested in):

- The design of a "voice rights" in a group.
- Establishing the relationship between the perception power and the interpretation of communication empirically.
- A model with a mis-perceived power structure.
- Communication and the formation of groups.

Thank You!