Strategic Communication Networks

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Introduction

Strategic Situations : Each agent wants to take an action that is

- close to other players' actions : **strategic complementarities**
- close to his own "ideal action" that depends on a common state of nature and on a personal taste : **heterogeneous preferences**

Each player has some **private information** about the unknown state of nature

Before playing this coordination game with incomplete information, heterogeneous players are offered the opportunity to transmit their private information to each other

Objective : To study decentralized and strategic information transmission taking place during the **communication stage**

- How information is revealed : **who speaks to whom**?
- Difference between **efficient** and **strategic** information transmission ?
- How incentives to transmit information are affected by the fact that messages are sent **privately** or **publicly**?

Novelty : we characterize information transmission between the players by a Strategic Communication Network

Applications :

- Coordination between decisions of the members of a **multi-divisional organization** with local conflict of interests
- Proximity between predictions of **financial analysts** with heterogeneous preferences towards such announcements
- Cohesion of the members of a **political party** advocating for the best policies but heterogeneity in activists' preferences

Model

A Class of Coordination Games with Incomplete Information :

- Players $N = \{1, \dots, n\}$, action profiles $a = (a_1, \dots, a_n) \in \mathbb{R}^n$
- Unknown state of nature $\theta(s_1, \dots, s_n) = \sum_i s_i$
- Private and independent signals $s_i \in S_i = \{\underline{s}_i, \bar{s}_i\}$ for every player i
- Payoff function:

$$u_i(a_1, ..., a_n; \theta(s)) = \underbrace{-(1-\alpha)(a_i - \theta(s) - b_i)^2}_{(1)} \underbrace{-\frac{\alpha}{n-1}\sum_{j \neq i}(a_i - a_j)^2}_{(2)}$$

(1) quadratic loss in the distance between i's action and his ideal action, $\theta(s) + b_i$ with $b_i \neq b_j \Rightarrow$ **heterogeneity in ideal actions**

(2) **miscoordination** quadratic loss

First Stage : The Cheap Talk Communication Stage

Every player i can send a different (costless) message $m_i^j \in M_i$ to every other player $j \neq i$

Communication strategy : $\sigma_i = (\sigma_i^j)_{j \neq i}$, with $\sigma_i^j : S_i \to M_i$

A communication strategy profile is characterized by a **communication network** $(R_i)_{i \in N}$, where player i's **set of receivers**

$$\boxed{R_i \equiv \{j \in N \backslash \{i\} : \sigma_i^j(\underline{s}_i) \neq \sigma_i^j(\bar{s}_i)\}}$$

is the set of players player i reveals his type to, and $|R_i| = r_i$

A way of building networks that completely differs from usual network formation games :

- players' strategies do not consist in choosing desired contacts but in transmitting private information

- costs and benefits of formed links are not exogenous but are driven by the use of sent and received information when taking payoff-relevant actions

- since the informational framework is formalized, incentives to misrepresent or hide information can be examined

Second Stage : The Decision Stage

Each player chooses an action depending on his type, the messages sent and the messages received. Second-stage equilibrium actions (unique) :

$$a_i^* = \sum_{j \in \{k : i \in R_k\} \cup \{i\}} \frac{\alpha(n - r_j - 1)E(s_j) + (1-\alpha)(n-1)s_j}{n - 1 - \alpha r_j} + \sum_{j \in \{k \neq i : i \notin R_k\}} E(s_j) + \frac{[(n-1) - (n-2)\alpha]b_i + \alpha \sum_{j \neq i} b_j}{n + \alpha - 1}$$

Efficient Communication Networks

Proposition 1 : We consider two communication networks $R = (R_i, R_{-i})$ and $R' = (R'_i, R_{-i})$ such that $R_i \subsetneq R'_i$. **While an increase in the set of receivers who learn player i's type is strictly beneficial, ex-ante, for player i and thoses receivers, such an increase makes players who do not learn player i's type strictly worse off, ex ante.**

Communication networks cannot always be ranked in the sense of Pareto

Proposition 2 : We consider two communication networks $R' = (R'_i)_{i \in N}$ and $R = (R_i)_{i \in N}$ such that $|R'_i| \geq |R_i|$, $\forall\ i \in N$. **The welfare is larger, ex-ante, with the communication network R' than with the communication network R.**

Welfare increases with information transmission

Equilibrium Communication Networks

Proposition 3 : There exists an equilibrium network in which player i's set of receivers is $R_i \subseteq N \backslash \{i\}$ iff for all $R'_i \subseteq R_i$, with $|R_i| = r_i$ and $|R'_i| = r'_i$, we have

$$\left| b_i - \frac{\sum_{j \in R'_i} b_j}{r'_i} \right| \leq \frac{(n - 1 + \alpha)(n - 1 - \alpha r'_i)}{2(n-1)(n - 1 - \alpha r_i)}(\bar{s}_i - \underline{s}_i)$$

Full characterization of equilibrium communication networks as a function of the individuals' preferences : In equilibrium,

- agents are "more prone" to communicate when their preferences present some alignments

- whether or not communication is feasible from a sender to a receiver depends on the other agents the sender communicates with

- a player's incentive to communicate is independent of others' communication strategies

Comparative Statics : The conditions for information transmission become weaker as

- the value of private information, $\bar{s}_i - \underline{s}_i$, increases
- the weight on coordination motives, α, increases
- all biases are reduced by the same scale

General Features of Equilibrium Sets of Receivers :

- If there exists an equi. s.t. $i \to R_i$, then there exists an equi. s.t. $i \to R_i \cup \{j\}$ for every j whose bias is closer to i's bias than any player in R_i.
- There always exists an equi. s.t. R_i includes all the players with the same bias as player i
- If there exists an equi. s.t. $i \to \{j\}$ and players i and j have the same value of private information, then there exists an equi. s.t. $j \to \{i\}$

Mutual Discipline of Coordination : It can be that there exists an equi. s.t. $i \to R_i$ **but no equi.** s.t. $i \to$ subset of R_i

Multiplicity of the Maximal Equilibrium Networks : It can be that there exists an equi. s.t. $i \to R_i$, another equi. s.t. $i \to R'_i$ **but no equi.** s.t. $i \to R_i \cup R'_i$

$\bar{R}$-Group Communication

Every player i must send the same message $m_i \in M_i$ to all the players in the group $\bar{R}_i \subseteq N \backslash \{i\}$ (Public communication, with $\bar{R}_i = N \backslash \{i\}$)

Communication strategy : $\sigma_i : S_i \to M_i$, where $\sigma_i(s_i) = m_i$ is observed by all players in $\bar{R}_i$

Weaker informational incentive constraints than under private communication : **less possible deviations**

Proposition 4 : In the group $\bar{R}$-communication game, there exists an equilibrium network in which player i's set of receivers is $\bar{R}_i$ iff we have

$$\left| b_i - \frac{\sum_{j \in \bar{R}_i} b_j}{\bar{r}_i} \right| \leq \frac{(n - 1 + \alpha)}{2(n-1)}(\bar{s}_i - \underline{s}_i)$$

Group communication improves strategic information transmission : If there exists an equi. s.t. $i \to R_i$ in the private communication game, then there exists an equi. s.t. $i \to R_i$ in a group communication game

Related Literature

Value of Information and Communication Structures in Coordination Problems

- **Morris-Shin [2002 AER], [2007 JEEA]** : Value of public/private information in the same class of games, but **without conflicts of interests**
- **Chwe [2000 RES]**, **Calvo-Armengol-Marti [2007 AER]**: Value of fixed communication networks, **physical constraints**

Strategic Information Transmission (Cheap Talk)

- **Crafword-Sobel [1982 Ecta]** : **One** informed agent with no decision and **one** biased decisionmaker with no information
- **Battaglini [2002 Ecta]**, **Krishna-Morgan [2001, QJE]**, **Morgan-Stocken [2008 AER]** : **Several** informed agents with no decision and **one** biased decision-maker
- **Farrell-Gibbons [1989 AER]** : Public vs. private communication in a binary actions/states model, with **independent decision makers**
- **Dessein-Alonso-Matouschek [2008 AER]** : Communication in a 2-divisions organization with **idiosyncratic state** and coordination motives

Extension to more general communication protocols ?