Participation and endogenous communication costs: Why crowds may not be wise

Willemien Kets
willemien.kets@santafe.edu

SANTA FE INSTITUTE

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A Puzzle

All things being equal, groups composed of men and women together make more money in the stock market than groups composed of men or women only.

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- "Diversity premium"
- cf. Wisdom of Crowds (Surowiecki, 2004).

A puzzle (2)

Gender diversity in management teams is inversely correlated with performance of mutual funds; there is no detectable difference, on average, between funds run only by men and those managed only by women. Both types of single-sex teams outperformed funds run by teams containing both men and women, on average, regardless of the exact makeup of the mixed team.

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- Spiral of silence (Noelle-Neumann, 1974, 1993)

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  - Wisdom of crowds, diversity premium
- Yet, mavericks are not always popular.
  - Spiral of silence
- What do you do when you have a deviant opinion?

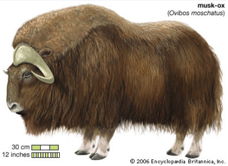
This Talk:

- Diversity in perspectives can lead to superior performance.
- Yet, it sometimes fails to do so.
- Possible explanation: **communication costs.**
  - costs are *endogenous*

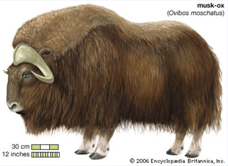
Outline

Wisdom of Crowds

(Surowiecki, 2004)



Wisdom of Crowds



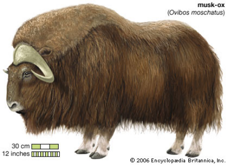
(Surowiecki, 2004)

(Strong Law of Large Numbers) Let $X_1, X_2, \ldots$ be a sequence of independent and identically distributed random variables on some probability space $(\Omega, \mathscr{F}, \mathbb{P})$. Then, when $k \to \infty$,

$$\frac{1}{k}\sum_{\ell=1}^{k} X_\ell \xrightarrow{\text{a.s.}} x \quad \text{for some } x \in \mathbb{R}$$

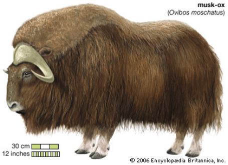
if and only if $\mathbb{E}[\,|X_1|\,] < \infty$. In that case, $x = \mathbb{E}[X_1]$.

Wisdom of Crowds (2)



Basically: if enough people submit their bets, then the average will be close to the true weight.

Wisdom of Crowds (2)



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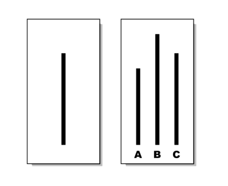
- **representative sample**

Spiral of silence (Noelle-Neumann, 1974, 1993)



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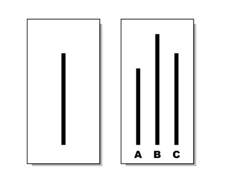

Spiral of Silence: A person is less likely to voice an opinion if he feels that he is in the minority for fear of reprisal or isolation from the majority.

- Dynamic process:
  Predictions about public opinion $\rightsquigarrow$
  fact/ status quo $\rightsquigarrow$
  minority less likely to speak out
  (Miller 2005).

Tradeoff

Hence, interested in setting where agents tradeoff communication costs and estimation loss.

- to improve accuracy/reduce estimation loss, agents want to communicate;
- because of communication loss, agents are hesitant to communicate.

- No manipulation/lying.
- If agents would freely share their information, then crowds will be wise.

Simple Model (1)

- The *state of the world* is a random variable θ with a commonly known distribution on $\mathbb{R}$.
  - stock return, fundamentals of the economy, weight of an ox.
- Each agent *i* receives a noisy *signal* θ_i on the state:

$$\theta_i = \theta + \varepsilon_i$$

- Signals are conditionally independent given the state.

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Law of large numbers/ wisdom of crowds logic holds if all agents share their information.

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Assume they choose their action *strategically*.

- Strategy: function from set of signals $\mathbb{R}$ to $\{S, NS\}$.

Simple model (3)

Agents care about:

- Estimation loss/accuracy of their estimate
  - want to share information
  - relative weight $\gamma \in [0, 1]$
- Communication costs
  - hesitant to share information
  - relative weight $1 - \gamma$

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Hence, goal of agent *i*: Choose $\alpha_i : \mathbb{R} \to \{S, NS\}$ to minimize

$$\begin{aligned} \text{costs}_i(\alpha_i, \alpha_{-i}; \theta_i) = \gamma \mathbb{E}[&\text{Estimation loss}(\alpha_i(\theta_i), \alpha_{-i}) \mid \theta_i] + \\ (1 - \gamma)\mathbb{E}[&\text{Communication costs}(\alpha_i(\theta_i), \alpha_{-i}) \mid \theta_i] \end{aligned}$$

for each θ_i, given strategies α_{-i} of others.

Simple model (4)

Estimation error when your signal is θ_i and you have k signals from other agents:

$$\mathbb{E}\left[(\Theta - \hat{\Theta}|_{\Theta_i,\Theta_{j_1},\ldots,\Theta_{j_k}})^2 \mid \Theta_i = \theta_i\right]$$

NB: depends on the strategies α_{-i} of others.

- in particular, may only receive biased signals

Simple model (5)

Communication costs when signal is θ_i and you communicate with k others:

$$k \cdot \mathbb{E}\left[(\Theta_i - \Theta_j)^2 \mid \Theta_i = \theta_i\right]$$

- Depends on signal θ_i: mavericks generally face higher communication costs.
- Depends also on strategies of others
  - in particular, if only non-mavericks communicate, then communication very costly for mavericks.

Simple model (6)

A strategy profile $(\alpha_j)_{j\in N}$ is a (Bayesian-Nash) **equilibrium** if for each agent i, the strategy α_i minimizes the (expected) costs of i for each signal θ_i given α_{-i}.

That is, no agent can gain by deviating given the strategies of others.

Results (1)

The strategy profile in which each player always chooses *NS* regardless of his signal is always an equilibrium.

- No communication.
- No information aggregation.

Intuition: it is useless to communicate if no one else communicates.

Results (2)

There is full information sharing if and only if $1 - \gamma = 0$.

- Crowds can only be wise if $1 - \gamma = 0$.

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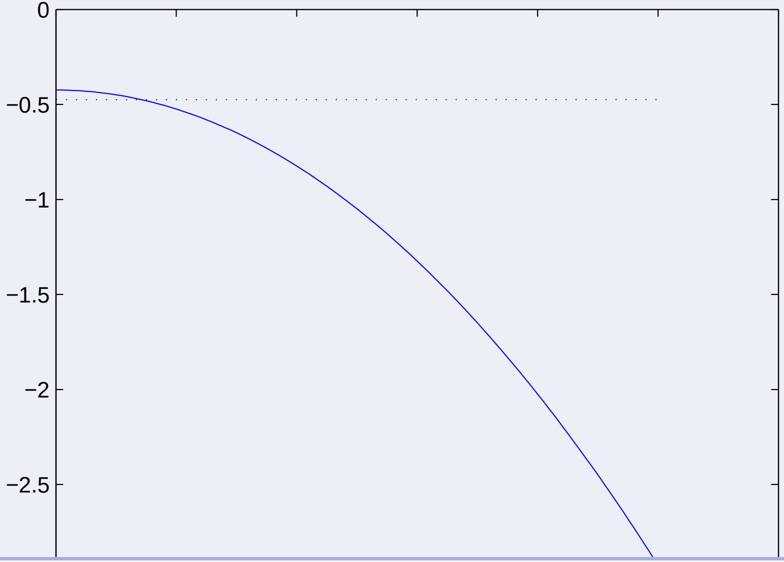
Intuition:
Suppose $1 - \gamma = 0$, then agents can only gain by sharing information.
Suppose $1 - \gamma > 0$, then communication costs grow without bounds for mavericks, while accuracy gain is limited.

No full information sharing when $1 - \gamma > 0$



Question

So,

- nobody sharing their information is always an equilibrium;
- everybody sharing their information is an equilibrium only if there are no communication costs ($1 - \gamma = 0$).

Are there also equilibria with **partial information sharing** when there are costs to communication ($1 - \gamma > 0$)?

- ...or do we get complete unraveling?

Unraveling & Spiral of Silence

- If communication costs need to be taken into account ($1-\gamma > 0$), then mavericks will not share their information.
  - Communication costs prohibitively high.

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- Hence, communication costs will be so high that they decide not to share their information/
- ...

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- If the true mavericks drop out, others who have more moderate signals, will now feel that they are the mavericks.
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- ...
- Is there an equilibrium in which there is only partial unraveling, i.e., in which some agents still share their information?

Partial information sharing

Theorem

There exists $\underline{\gamma} < 1$ such that for all $\gamma \geq \underline{\gamma}$ there is $T > 0$ such that there is an equilibrium in which agents share information if and only if their signal is within T of a priori expected state $\bar{\theta}$.

Intuition:

- for players with signals close to expectation, communication costs will be low (given strategies of others) while their estimation loss decreases when they communicate.
- for players with extreme signals, communication costs will be prohibitively high (given strategies of others).

Nota Bene

- Crowds are not wise in this equilibrium
  - biased sample
- Externality $\rightsquigarrow$ inefficiency
  - Private costs $\leftrightarrow$ social benefits
- Fragile equilibrium?
  - Outcome of unraveling dynamics?

Making it Work

- Capping diversity can help
- Changing the game
  - physical environment affects costs and benefits
  - reward bridges
- identity multi-dimensional and dynamic