Strategically Controlling Worldviews

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joint with Danil Dmitriev, Freddie Papazyan, Victoria Hang

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The act of persuasion sits at the core of human interaction

political campaign

advertising

court argument ...

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Persuaders selectively share information and shape how people make sense of them

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Bayesian persuasion

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Cheap talk

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Sender persuades by proposing alternative models/narratives/interpretations/worldviews

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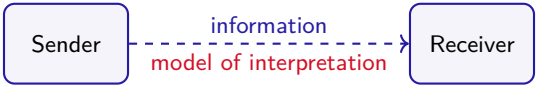
No unifying framework to study how persuaders **combine information and narratives**

Questions

- How does a persuader optimally combine both persuasion techniques?
- Do they interact to deliver outcomes neither could achieve alone?
- How does the answer depend on the information technology available?

Framework

We study a strategic communication game that allows for model switching



The receiver can update not only beliefs but also model of interpreting data

We show that...

Despite that:

- Receiver starts correctly specified and Bayesian updates within models
- Receiver perfectly understands Sender's strategic motives
- Sender faces information constraints, e.g., hard information only or no commitment power

In many cases, Sender **always implements their preferred action**

- **Strategic complementarity** between controlling info. and how it is interpreted

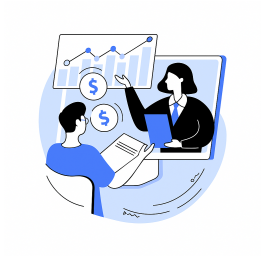
Implication

Results help understand **the Disinformation Puzzle** (Stiglitz and Kosenko, 2024)

> *"But, apart from a very limited literature within economics on fraud, little attention has been paid to concerns about mis and disinformation. This is perhaps **not surprising**, given economists' predilection for rationality and rational expectations. Indeed, the success of mis and **disinformation represents a puzzle** for standard economics, which begins by assuming individual rationality, including an individual's ability to rationally evaluate the accuracy of information and update priors, using Bayes' theorem.*
>
> *...presumably, information from a source that repeatedly provided mis and disinformation would lose credibility and therefore would play no role in decision making - and so would not be a problem...*
>
> *Not surprisingly, much of this dis/misinformation **goes beyond the Bayesian framework** that has been central to the analysis so far."*

Illustrative Example

Invest or not invest?



- A financial advisor wants a client to invest in a risky asset
- The asset pays $+1$ in state G and -2 in state B
- Hence investment is optimal if $\Pr(G) \geq 2/3$
- Advisor observes the realized state but Client doesn't
- Assuming a uniform distribution, Client will **not** invest

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- Consider the **best case for Advisor**: she can send cheap-talk messages and has commitment power
- Canonical Bayesian persuasion (BP) solution:

	state G	state B
send	g	g with prob. $\frac{1}{2}$ b with prob. $\frac{1}{2}$

- Investment happens with prob. $3/4$

Can Providing a Model Help?

- Suppose Advisor sticks to this messaging strategy:

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- Client will switch if it fits the data **twice as well**

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- Should Advisor provide a different interpretation? **Yes**

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- When Advisor sends g, Client sticks to θ_0 since $\Pr(g|\theta_1) = 1/2 < 2 \times 3/4 = 2\times \Pr(g|\theta_0)$, *but* she still **invests**

Lessons

Advisor ensures the Client invests with prob. 1

Full manipulation achieved by jointly designing information structure and model of interpretation

Strategy works even if Advisor is a cheap talker (w/o commitment power)

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Main result

Simple characterization of the sender's optimal info + model strategy in general environments

Framework

Setup

- Two players: a sender (S, she) and a receiver (R, he)
- R chooses between a risky action ($a = 1$) and a safe action ($a = 0$)
- The safe action pays $\omega_0 \in \mathbb{R}$
- The risky action's payoff $=$ state of the world $\omega \in \Omega \subset \mathbb{R}$

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- The safe action pays $\omega_0 \in \mathbb{R}$
- The risky action's payoff $=$ state of the world $\omega \in \Omega \subset \mathbb{R}$
- Nature draws ω from a full-support common prior F
- Assume $\mathbb{E}(\omega) < \omega_0$ s.t. the optimal action is $a = 0$ without any information
- State space Ω contains values $\underline{\omega}$ and $\overline{\omega}$ such that with $\underline{\omega} < \omega_0 < \overline{\omega}$

Providing information

- S has state-independent preference: she gets 1 whenever $a = 1$ and 0 otherwise
- S privately observes ω and then sends R a message $m \in M(\omega) \subseteq M$
  - Assume M is sufficiently rich
  - This general setup allows us to accommodate a variety of environments
  - Information is unverifiable if $M(\omega) \equiv M, \forall \omega \in \Omega$
  - Information is perfectly verifiable if $M(\omega) = \{\omega, \varnothing\}$, where $\varnothing$ is a null message
- Denote S's chosen **messaging strategy** as $\sigma : \Omega \to \Delta M$ and all feasible policies as Σ

Providing a model

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  - He understands S's incentives and decision environment
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  - He understands S's incentives and decision environment
  - If R keeps this model, he correctly anticipates S's true messaging strategy in equilibrium
- S may propose an alternative model about how she communicates, denoted as θ_1
  - S proposes a behavioral model that she will use messaging strategy $\sigma' \in \Sigma$
  - We assume S proposes the model **before** ω realizes to shut down any signaling effect

Model-switching rule

Given m, R chooses which model to believe in using a **Bayes factor** rule (Ba, 2025):

- Let $\alpha \geq 1$ be a switching threshold. R calculates

$$\text{Bayes factor } \lambda(m) \coloneqq \frac{\Pr(m|\theta_1)}{\Pr(m|\theta_0)} = \frac{\int_\Omega \sigma'(m|\omega)dF}{\int_\Omega \sigma(m|\omega)dF}$$

- If $\lambda(m) \geq \alpha$, R switches to θ_1; otherwise, R sticks to θ_0
- Threshold α serves as a measure of R's resistance

Timeline

1. S **proposes model** $\theta_1 = \sigma'$
2. Nature draws ω and S observes its realization
3. S **sends message** m according to messaging strategy σ
4. Upon receiving m, R **decides whether to switch** to θ_1
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- We leave unspecified yet if S has commitment power in messaging

Results

Preview of results

- Theorem 1: conditions for **full manipulation** with **unverifiable information**
- Propositions 1 & 2: **Cheap talk** & **Bayesian persuasion**

- Work in progress: extending Theorem 1 to allow constraints in info technologies
- Proposition 3: **Perfectly verifiable information**

Understand the demand and budget for a model switch

Absent model switching, strategy σ gives rise to winning messages and losing messages:

$$\text{winning} \quad M_+(\sigma) = \{m \in M : \mathbb{E}(\omega|\sigma, m) \geq \omega_0\}$$
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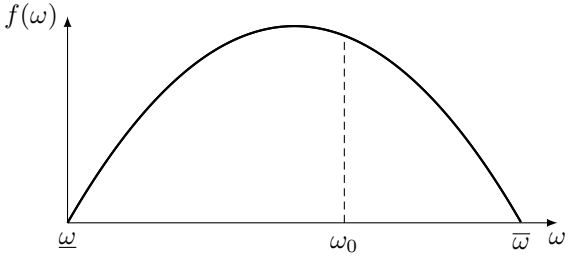

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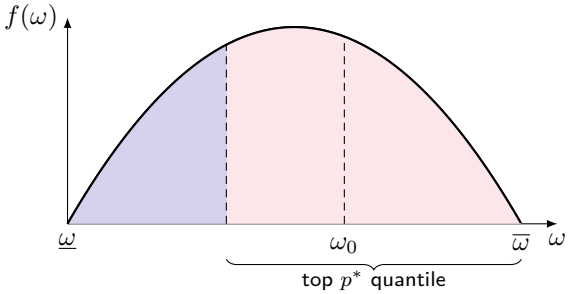

Suppose $\sigma = \sigma' = \sigma_{BP}$:

Let $\hat{\omega}(p) :=$ mean of top p quantile

Find $p^* \in (0,1)$ s.t. $\hat{\omega}(p^*) = \omega_0$

Group top p^* quantile and bottom $1 - p^*$ quantile into two messages

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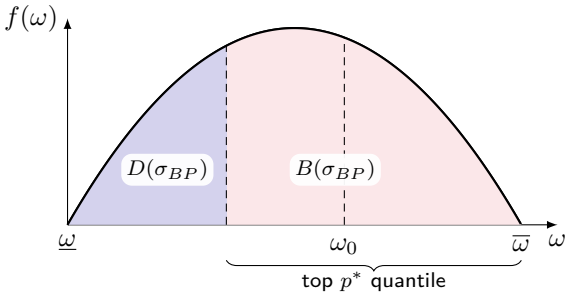

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$$D(\sigma_{BP}) = 1 - p^*$$
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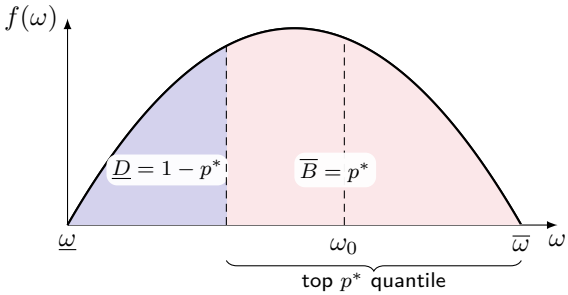

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$$\underline{D} := \min_{\sigma \in \Sigma} D(\sigma) = D(\sigma_{BP}) = 1 - p^*$$

$$\overline{B} := \max_{\sigma' \in \Sigma} B(\sigma') = B(\sigma_{BP}) = p^*$$

Full manipulation

Theorem 1

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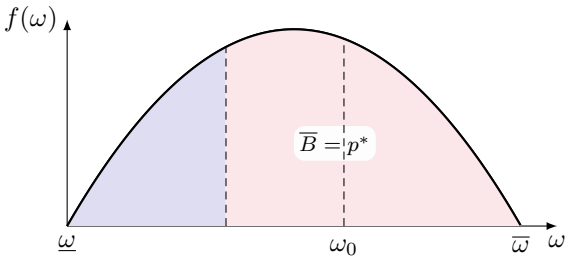
$f(\omega)$
$\overline{B} = p^*$
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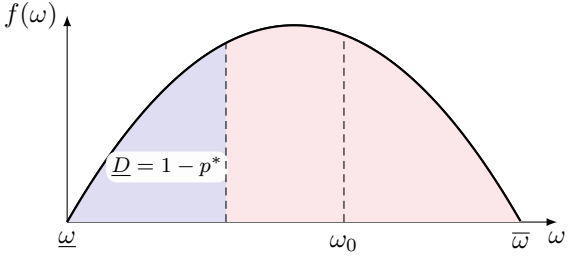
$\overline{\omega}$
ω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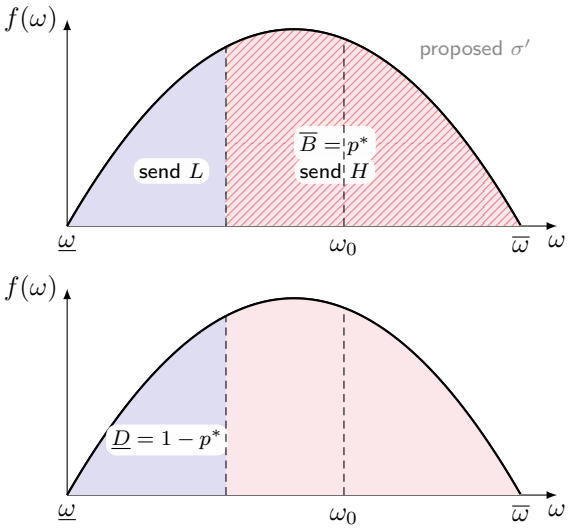

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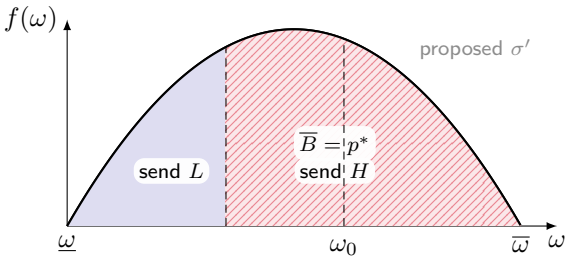

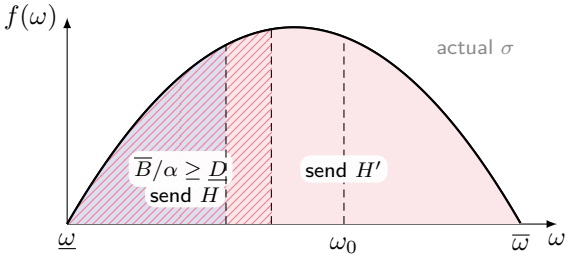

S proposes θ_1:

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but then behaves according to θ_0:

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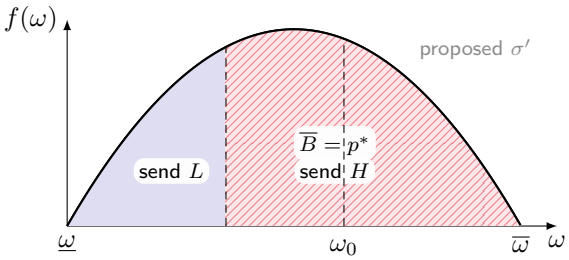

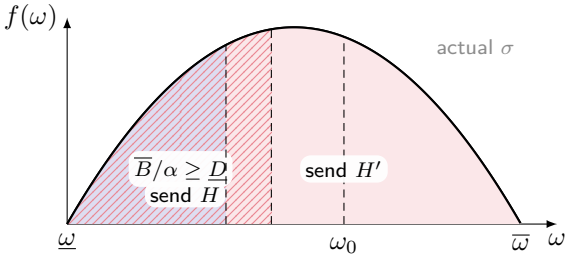

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Strategy only works if $\overline{B} \geq \alpha \times \underline{D}$

Most efficient use of budget for demand

Observations

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  When $\alpha = 1$, full manipulation $\Leftrightarrow p^* \geq 1/2$, i.e., average of the best 50% states exceeds ω_0

  W/o model persuasion, S can only guarantee $a = 1$ if the unconditional mean exceeds ω_0

Next: What happens if full manipulation is not achievable?

- It depends on what S can do about the remaining states
- **Case 1**: Cheap talk w/o commitment

  In a Perfect Bayesian equilibrium*, $\sigma(\cdot|\omega)$ maximizes S's payoff for every ω

  (* adapted to allow model-switching)
- **Case 2**: Cheap talk with commitment (aka. Bayesian persuasion)

  S chooses σ beforehand and commits to it

Cheap talk: either full or no manipulation

Proposition 1

Suppose S can send unverifiable information and does not have commitment power. In any PBE:

(i) If $\overline{B} \geq \alpha \times \underline{D}$, S **fully manipulates** R.

(ii) If $\overline{B} < \alpha \times \underline{D}$, S **cannot manipulate** R, and R must take $a = 1$ with probability 0.

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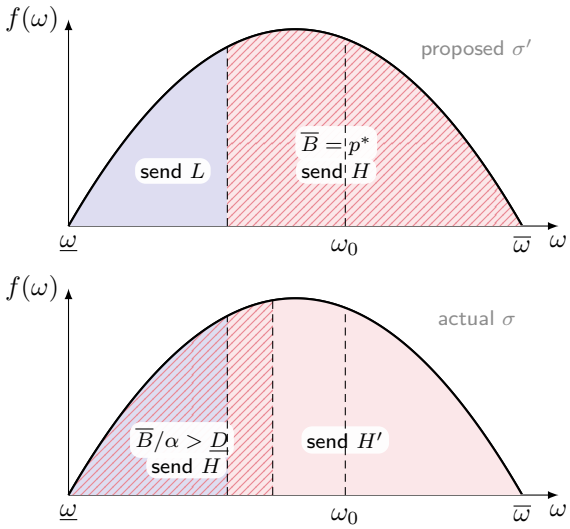

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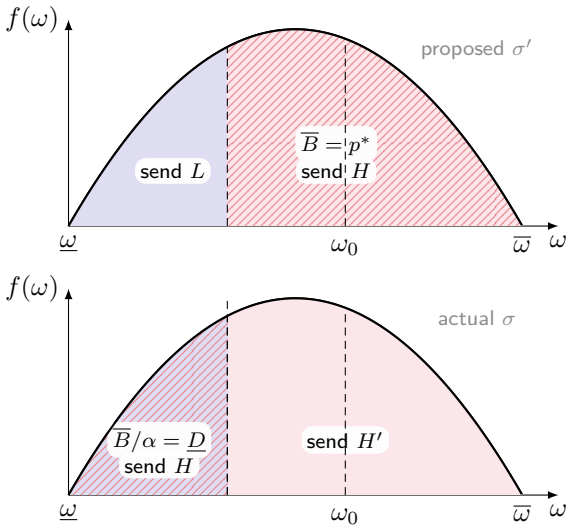

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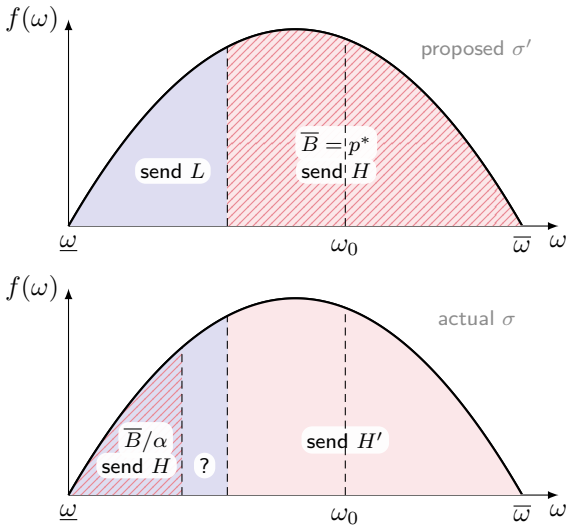
Cheap talk: either full or no manipulation



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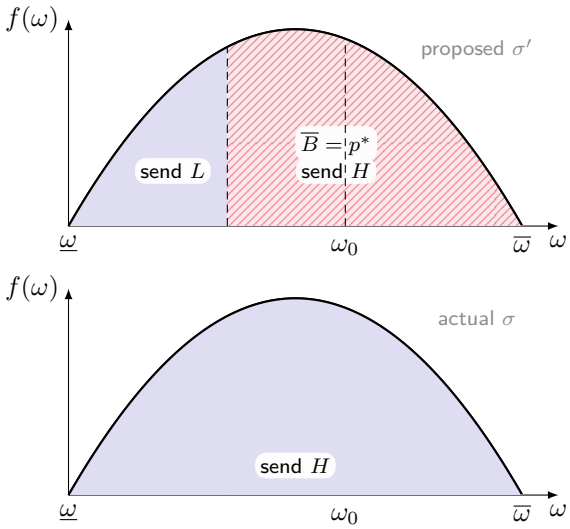

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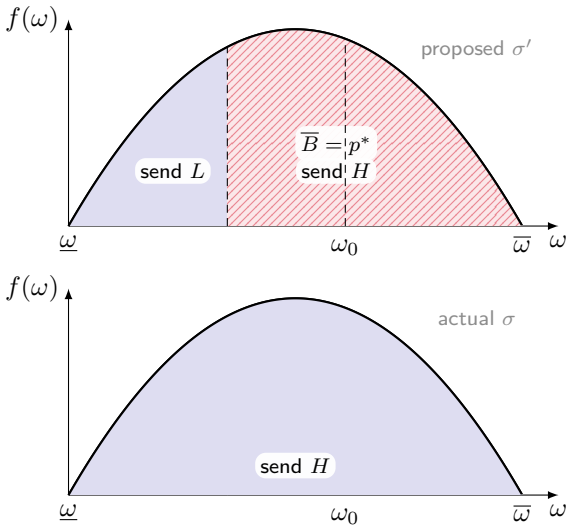

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Remark. Model persuasion has no bite unless the cheap talker can pass as a KG sender with commitment within R's reasonable doubt

Cheap talk with commitment: partial manipulation

Proposition 2

Suppose S can send unverifiable info and has commitment power. In any PBE:

(i) If $\overline{B} \geq \alpha \times \underline{D}$, S **fully manipulates** R.

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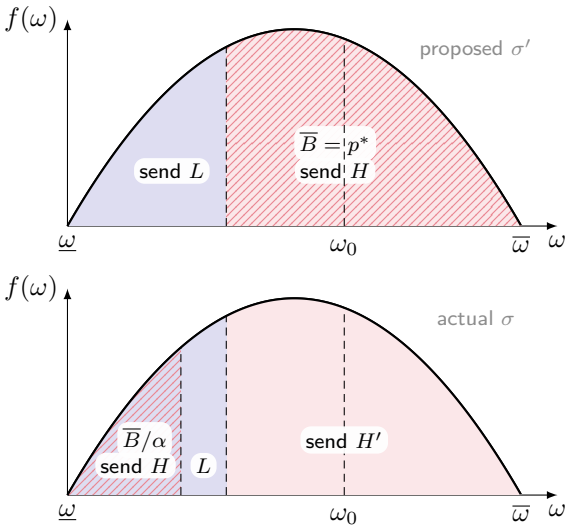
Cheap talk with commitment: partial manipulation



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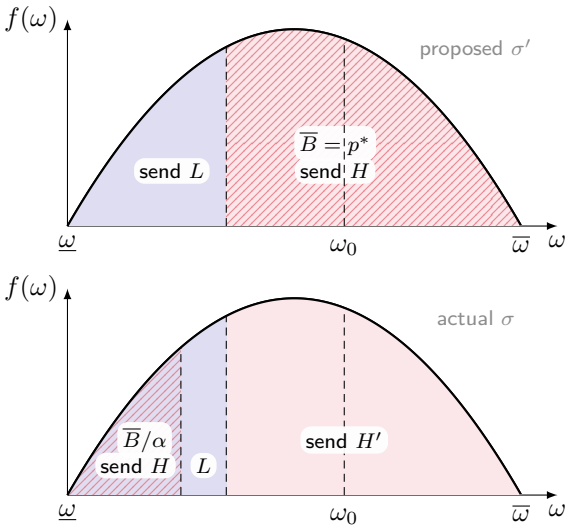

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Remark. When $\alpha = 1$, model persuasion **doubles** the prob. of the risky action.

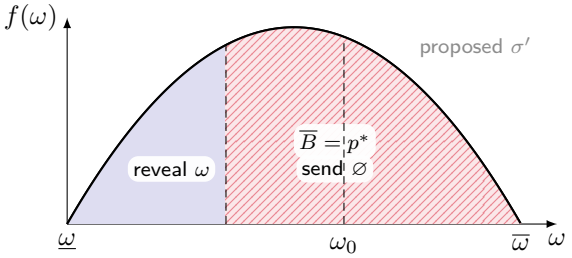
Constraints in information technology

- When S is **constrained** in her information technology, $M(\omega) \subsetneq M$ for some $\omega \in \Omega$ and we may have $M(\omega) \neq M(\omega')$ for $\omega \neq \omega'$
- The budget for model persuasion may not be **fungible** for the demand
- However, a version of Theorem 1 still applies for **perfect verifiable information**

Perfect verifiable information

Suppose in each state $\omega \in \Omega$, S can only send $M(\omega) = \{\omega, \varnothing\}$

Perfect verifiable information

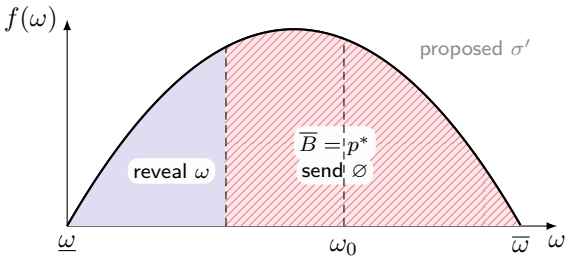


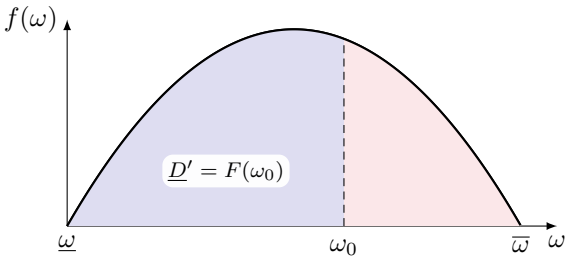
Suppose in each state $\omega \in \Omega$, S can only send $M(\omega) = \{\omega, \varnothing\}$

S proposes θ_1:

"I sound the alarm only when things go wrong; no news is good news"

Perfect verifiable information





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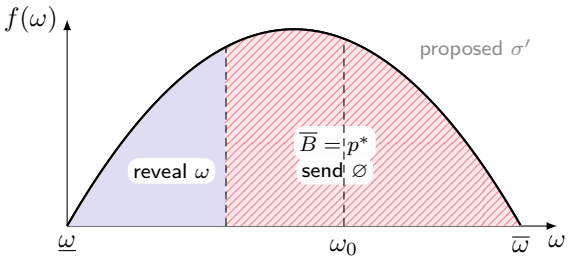

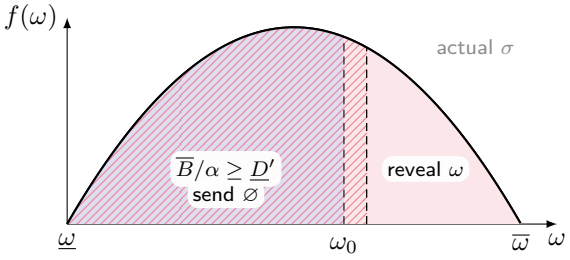

Suppose in each state $\omega \in \Omega$, S can only send $M(\omega) = \{\omega, \varnothing\}$

S proposes θ_1:

"I sound the alarm only when things go wrong; no news is good news"

but then behaves according to θ_0:

"I stay quiet about bad states, but I make sure to share good ones"

Strategy only works if $\overline{B} \geq \alpha \times \underline{D}'$

Perfect verifiable info: either full manipulation or unraveling

Proposition 3

Suppose S can send either reveal the state or stay silent. In any PBE:

(i) If $\overline{B} \geq \alpha \times \underline{D}'$, S **fully manipulates** R.

(ii) If $\overline{B} < \alpha \times \underline{D}'$, S **cannot manipulate** R. Moreover, R takes $a = 1$ when $\omega \geq \omega_0$.

- Since $\underline{D}' \geq \underline{D}$, full manipulation is harder than under unverifiable info
- When full manipulation is impossible, model persuasion has no bite, and **unraveling** is the unique equilibrium

Comparing information technologies

Without the model proposal stage, S prefers

$$\text{Bayesian persuasion} \succ \text{verifiable disclosure} \succ \text{cheap talk}$$

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soft information leaves room for manipulation

Comparing information technologies

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- Connect back to the Disinformation Puzzle

Conclusion

Literature

Strategic communication

- Cheap talk: Crawford and Sobel (1982), Lipnowski and Ravid (2020)
- Verifiable disclosure: Grossman (1981), Milgrom (1981), Dye (1985)
- Information design and persuasion: Kamenica and Gentzkow (2011)
- Limited commitment: Fréchette, Lizzeri, and Perego (2022), Lin and Liu (2024)
- Boundedly rational receiver: De Clippel & Zhang (2019), Bloedel & Segal (2021)

Model persuasion and misspecification

- Galperti (2019), Schwartzstein and Sunderam (2021, 2024), Ichihashi and Meng (2021), Jain (2023), Ambuehl and Thysen (2024), Barron and Fries (2024), Eliaz and Spiegler (2025), Aina (2025), Ba (2025)

Reputation games

- Jehiel and Samuelson (2012), Best and Quigley (2024)

Summary

- **Unifying framework** that combines information-based and model-based persuasion
- **Characterization** of when full manipulation is possible and how to achieve it
- **Simple strategy**: claim to be a KG sender, then deviate (a formalization of gaslighting?)
- **Comparing soft v.s. hard information**: wiggle room for manipulation v.s. credibility
- Possible explanation for **the Disinformation Puzzle**

Thank you for listening!

Feedback is greatly appreciated :D

Email: bacuimin@gmail.com

Perfect Bayesian Equilibrium (PBE)

go back

Definition (PBE)

1. S proposes **alt. model σ'^*** to maximize their ex ante expected payoff, anticipating their messaging strat. σ^* and R's behavior (model choice θ^*, belief π^*, and action a^*).
2. Given any proposed alt. model, S chooses **message $\sigma^*(\omega)$** to maximize their expected payoff in every state $\omega \in \Omega$, anticipating R's behavior (θ^*, π^*, a^*).
3. R selects **model θ^*** $\in \{\sigma'^*, \sigma^*\}$ using the Bayes factor rule, whenever possible.
4. R updates **beliefs π^***, under each model using Bayes' rule, whenever possible.
5. R chooses **action a^*** $\in \{0, 1\}$ that maximizes their expected payoff, given their beliefs and chosen model, $\pi^*(\cdot|\cdot, \theta^*)$.

Definition (PBE) – Formal Details

1. S proposes **alt. model σ'^{*}** to maximize their ex ante expected payoff, anticipating their messaging strat. $\sigma^{*}_{\cdot\cdot}$ and R's behavior (model choice $\theta^{*}_{\cdot\cdot}$, belief π^{*}, and action a^{*}).

$$\sigma'^{*} \in \arg\max_{\sigma' \in \Sigma} \mathbb{E}_{\omega \sim F} \mathbb{E}_{m \sim \sigma^{*}_{\cdot\cdot}(\cdot|\omega)} u_s\Big(a^{*}\Big(\pi^{*}\big(\cdot\,|m, \theta^{*}_{\cdot\cdot}(m)\big)\Big)\Big).$$

2. Given any proposed alt. model, S chooses **messaging strategy $\sigma^{*}_{\cdot\cdot}$** to maximize their expected payoff in every state $\omega \in \Omega$, anticipating R's behavior ($\theta^{*}_{\cdot\cdot}$, π^{*}, a^{*}).

$$\sigma^{*}_{\cdot\cdot}(\cdot\,|\omega) \in \arg\max_{\sigma_{\cdot}(\cdot|\omega) \in \Delta M} \mathbb{E}_{m \sim \sigma(\cdot|\omega)} u_s\Big(a^{*}\Big(\pi^{*}\big(\cdot\,|m, \theta^{*}_{\cdot\cdot}(m)\big)\Big)\Big) \qquad \forall \omega \in \Omega$$

3. R selects **model $\theta^{*}_{\cdot\cdot} \in \{\sigma'^{*}, \sigma^{*}\}$** using the Bayes factor rule, whenever possible.

$$\theta^{*}_{\cdot\cdot}(m) = \sigma'^{*} \Leftrightarrow \Pr\big(m|\sigma'^{*}\big)/\Pr(m|\sigma^{*}) \geq \alpha \qquad \forall m \in M$$

4. R updates **beliefs π^{*}**, under each model using Bayes' rule, whenever possible.

$$\pi^{*}(\omega|m, \hat{\sigma}) = \frac{\hat{\sigma}(m|\omega) f(\omega)}{\int_{\Omega} \hat{\sigma}(m|\tilde{\omega}) f(\tilde{\omega}) d\tilde{\omega}} \qquad \forall \omega \in \Omega,\ m \in M,\ \hat{\sigma} \in \{\sigma'^{*}, \sigma^{*}\}$$

5. R chooses optimal **action $a^{*} \in \{0, 1\}$** given their beliefs and chosen model, $\pi^{*}(\cdot|\cdot, \theta^{*}_{\cdot\cdot})$.

$$a^{*}\Big(\pi^{*}\big(\cdot\,|m, \theta^{*}_{\cdot\cdot}(m)\big)\Big) = \arg\max_{a \in \{0,1\}} \mathbb{E}_{\omega \sim \pi^{*}\left(\cdot|m, \theta^{*}_{\cdot\cdot}(m)\right)}[u_R(a, \omega)] \qquad \forall m \in M$$

Definition (PBE) – Formal Details with Commitment Messaging

1. S proposes **alt. model σ'^*** to maximize their ex ante expected payoff, anticipating their messaging strat. $\sigma^*_{\cdot\cdot}$ and R's behavior (model choice $\theta^*_{\cdot\cdot}$, belief π^*, and action a^*).

$$\sigma'^* \in \arg\max_{\sigma' \in \Sigma} \mathbb{E}_{\omega\sim F}\mathbb{E}_{m\sim\sigma'^*(\cdot|\omega)} u_s\Big(a^*\Big(\cdot\,\Big|\,\pi^*\big(\cdot\,\big|m,\theta^*_{\cdot\cdot}(m)\big)\Big)\Big).$$

2. Given any proposed alt. model, S chooses **messaging strategy $\sigma^*_{\cdot\cdot}$** to maximize their expected payoff in every state $\omega \in \Omega$, anticipating R's behavior ($\theta^*_{\cdot\cdot}$, π^*, a^*).

$$\sigma^*_{\cdot\cdot}(\,\cdot\,|\,\cdot\,) \in \arg\max_{\sigma\in\Sigma} \mathbb{E}_{\omega\sim F}\mathbb{E}_{m\sim\sigma(\cdot|\cdot)} u_s\Big(a^*\Big(\pi^*\big(\cdot\,\big|m,\theta^*_{\cdot\cdot}(m)\big)\Big)\Big)$$

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5. R chooses optimal **action a^*** $\in \{0,1\}$ given their beliefs and chosen model, $\pi^*(\cdot|\cdot,\theta^*)$.

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