Affecting Distributions of Opinions with Evidence

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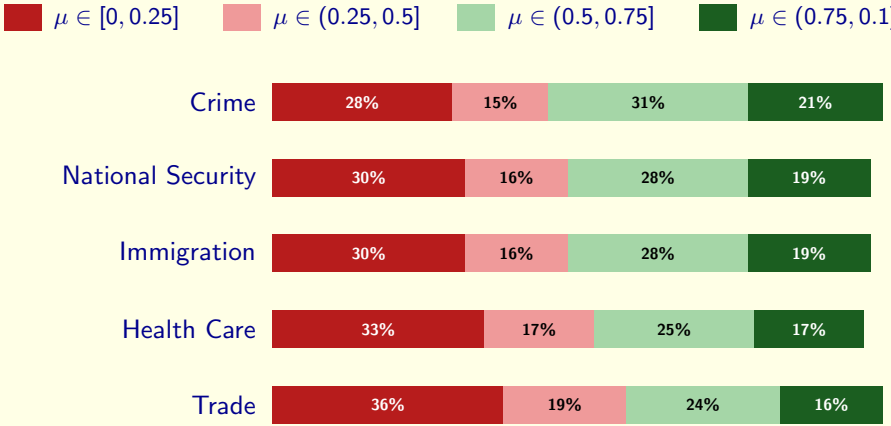
Motivation

How do evidence acquisition and disclosure
affect distributions of opinions on unknown issues?

1. Knowledge about communicator's efforts $\rightarrow$ audience's skepticism?
2. Features of provision technology?
3. Features of initial distributions of opinions?
4. Welfare implications?

Frequency Distributions of Opinions

Opinions μ that Trump's policy-making is good (Economist/YouGov Poll, Apr 25–May 2, 2025)



Frequency Distributions of Opinions

Opinions on good role of A. Cuomo as NY Governor / handling of Covid pandemic:

Siena College Research Institute
January 10-13, 2021
804 New York State Registered Voters
MOE +/- 4.1%

Q25. How would you rate the job that Andrew Cuomo is doing as Governor? Would you rate it as excellent, good, fair, or poor?

		Party			Gender		Political View			Union HH		Region			Ethnicity			Age			Religion				Income		
	Total	Dem	Rep	Ind/ Other	M	F	Lib	Mod	Conserv	Yes	No	NYC	Subs	Upst	White	Afr Amer /Black	Latino	18-34	35-54	55+	Cath	Jewish	Prot	Other	<$50K	$50K-$100K	$100K+
Excellent	24%	32%	10%	20%	21%	27%	36%	22%	16%	27%	23%	27%	29%	17%	22%	34%	32%	21%	28%	21%	26%	21%	24%	23%	23%	24%	26%
Good	32%	41%	19%	28%	32%	33%	43%	33%	21%	35%	31%	37%	27%	31%	30%	43%	27%	32%	33%	33%	30%	27%	34%	36%	32%	36%	31%
Fair	15%	14%	18%	17%	16%	15%	11%	21%	14%	14%	16%	16%	10%	18%	15%	16%	16%	16%	13%	18%	12%	18%	18%	17%	16%	16%	14%
Poor	27%	12%	51%	31%	31%	23%	8%	23%	49%	24%	28%	18%	34%	32%	33%	3%	20%	26%	25%	28%	32%	35%	22%	21%	25%	23%	28%
Don't know/No opinion	2%	1%	1%	4%	1%	2%	3%	2%	0%	0%	2%	1%	1%	3%	1%	4%	6%	5%	1%	0%	0%	0%	3%	3%	4%	1%	0%

Q26. Do you approve or disapprove of the job Andrew Cuomo is doing to address the coronavirus, or COVID-19, pandemic?

		Party			Gender		Political View			Union HH		Region			Ethnicity			Age			Religion				Income		
	Total	Dem	Rep	Ind/ Other	M	F	Lib	Mod	Conserv	Yes	No	NYC	Subs	Upst	White	Afr Amer /Black	Latino	18-34	35-54	55+	Cath	Jewish	Prot	Other	<$50K	$50K-$100K	$100K+
Approve	63%	79%	41%	53%	61%	65%	82%	63%	43%	67%	61%	68%	62%	56%	58%	86%	57%	59%	64%	65%	61%	48%	67%	66%	62%	64%	65%
Disapprove	32%	18%	50%	40%	36%	27%	13%	30%	53%	29%	33%	27%	33%	37%	37%	12%	29%	34%	30%	30%	32%	48%	28%	28%	32%	30%	31%
Vol: Mixed/Both	2%	1%	3%	2%	1%	3%	1%	3%	1%	2%	2%	2%	2%	3%	3%	0%	2%	0%	3%	3%	2%	2%	1%	2%	1%	3%	2%
Don't know/No opinion	4%	2%	5%	5%	2%	5%	4%	4%	3%	2%	4%	3%	3%	4%	3%	2%	11%	7%	3%	2%	4%	1%	4%	3%	6%	3%	2%

Frequency Distributions of Opinions

Opinions on good effects of tariffs:

The New York Times | **2024 ELECTIONS** | Cross-Tabs: September 2024 Times/Siena Polls in Michigan, Ohio and Wisconsin

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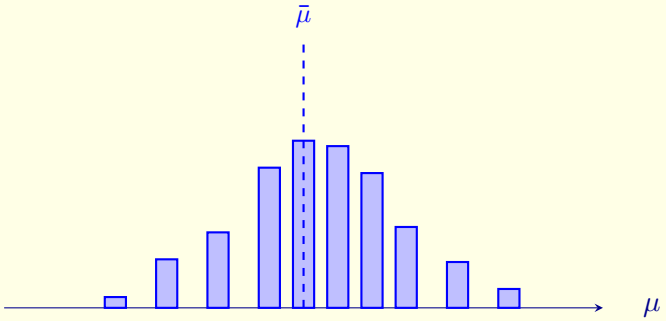
Expanding tariffs on products made outside the United States.	**MI, OH AND WI LIKELY ELECTORATE**	**MI**	**OH**	**WI**	**MEN**	**WOMEN**	**18-29**	**30-44**	**45-64**	**65+**	**WHITE**	**BLACK**	**OTH.**	**B.A.+**	**NO B.A.**	**WHITE, COLLEGE**	**WHITE, NO COLLEGE**	**NON-WHITE, COLLEGE**	**NON-WHITE, NO COLLEGE**	**CITY**
Strongly support	29%	33%	30%	25%	37%	22%	19%	24%	33%	32%	31%	15%	26%	20%	34%	20%	36%	20%	22%	20%
Somewhat support	25%	24%	27%	24%	22%	28%	36%	28%	23%	21%	26%	12%	24%	28%	24%	29%	25%	22%	17%	20%
Somewhat oppose	17%	16%	15%	20%	16%	18%	24%	20%	17%	13%	16%	28%	16%	22%	15%	22%	13%	21%	22%	21%
Strongly oppose	21%	20%	20%	22%	20%	22%	11%	19%	21%	27%	20%	32%	24%	23%	20%	22%	19%	28%	28%	25%
[VOL] Don't know/Refused	8%	7%	8%	9%	5%	10%	10%	10%	5%	8%	7%	12%	10%	7%	7%	7%	7%	10%	12%	14%
NET Support	54%	57%	57%	49%	59%	50%	55%	51%	56%	53%	57%	28%	51%	48%	58%	50%	61%	41%	39%	41%
NET Oppose	38%	36%	36%	42%	36%	40%	35%	39%	38%	40%	36%	60%	39%	44%	35%	44%	32%	49%	50%	45%
Number of respondents	1,690	557	567	566	800	865	261	338	589	457	1,370	133	147	731	950	592	775	122	158	302
Percentage of total electorate	100%	33%	33%	33%	47%	51%	13%	20%	34%	30%	83%	7%	8%	36%	63%	30%	53%	6%	9%	16%

From Frequency to Theoretical Distributions



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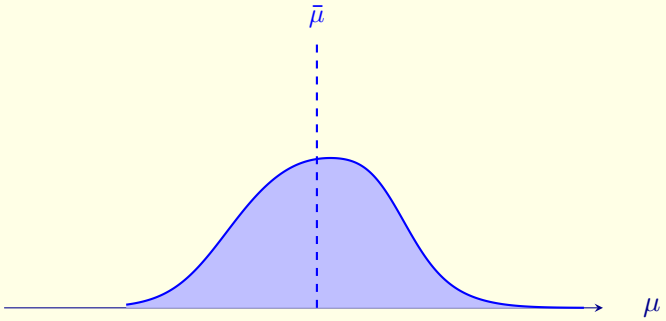


This Paper

Basic consideration: communicators care about features of distributions of opinions: Adams et al. (2024); Sommer-Topcu (2009); Lawrence et al. (2011); Pereira (2009); Monroe (1998); Walgrave et al. (2022); Durovic and Schanatterer (2025)

Beliefs elicited? theory for lab, **Brier 1950's elicitation**; in practice, opinion surveys, popular consultation, feedback from plebiscites

This Paper

Interested in two **goals of communicators** in political scenarios:

1. To shift the average opinion towards the communicator's preferred one

2. To raise the dispersion of opinions: Iyengar et al., (2012); Iyengar and Westwood (2015); Iyengar et al. (2019); Reiljan et al. (2024); Bäck et al. (2023); Glaeser et al. (2005)

Evidence to Affect Opinions

Use of evidence to affect distributions of opinions:

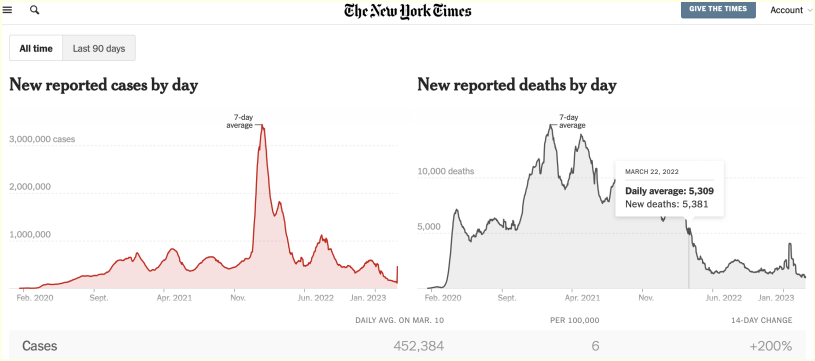
Political leaders, e.g., socioeconomic evidence to *affect opinions on* policy-making quality

Firm managers, e.g., earnings evidence to *affect opinions on* future shareholder returns

Government agencies, e.g., medical evidence to *affect opinions on* the state of a pandemic

How Does Evidence Look Like?

Example – evidence to *affect opinions on* the state of Covid pandemic:



Relevant state $\omega \in \Omega \equiv \{0, 1\}$ and generic prior $\beta \equiv \mathbb{P}(\omega = 1)$ of an audience of Receivers

β is not deterministic: $\boldsymbol{\beta} \sim F(\beta)$ with $\bar{\beta} = E[\boldsymbol{\beta}]$ and $\sigma^2 = \mathrm{Var}[\boldsymbol{\beta}]$

One interpretation: $F(\beta)$ approximates a frequency distribution (e.g., histogram from survey)

Each prior β revised upon observing **signal** $s \in \mathbb{R} \cup \{n\}$:

- $s \in \mathbb{R}$ is a **piece of evidence**
- $s = n$ is **no evidence**

The Game

A Sender chooses an observable **effort** $x \in [0,1] = \mathbb{P}(s \in \mathbb{R}) \Rightarrow \mathbb{P}(s = n) = 1 - x$

Effort cost $c : [0,1] \to \mathbb{R}$, twice-differentiable, strictly increasing and convex, with $c(0) = 0$, and Inada conditions $c'(0) = 0$ and $c'(1) \geq 1$

Sender (privately) obtains $s \in \mathbb{R} \cup \{n\}$ and (publicly) reports $m \in \mathbb{R} \cup \{n\}$

Hard evidence: if $s = n \Rightarrow m = n$; if $s \in \mathbb{R} \Rightarrow m \in \{s, n\}$

The Game

Sender's **disclosure strategy**: $d : \mathbb{R} \cup \{n\} \to \{0,1\}$ with $d(s) = \mathbb{P}(m = s \mid s)$ s.t. $d(n) = 1$. Sender's **overall strategy**: (x, d)

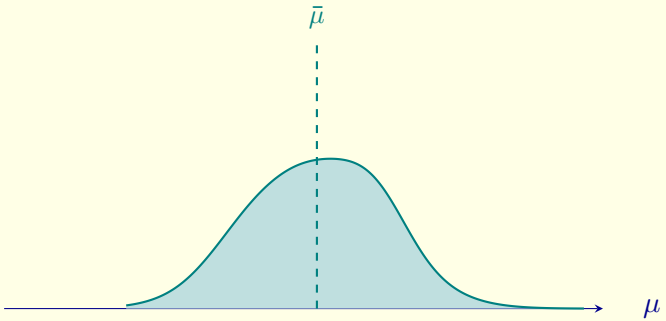
Receiver with prior β updates to $\mu_m^x(\beta) = \mathbb{P}(\omega = 1 \mid m; x, d)$. Strategy (x, d) induces **distribution of posteriors** $G_m^x(\mu)$ for $\mu = \mu_m^x$

Sender's interim payoff: $v(G_m^x)$

Shifting Average Opinion

Normalization consideration: Sender prefers audience to believe that $\omega = 1$

Motivation I: $v(G_m^x) = E[\mu_m^x]$



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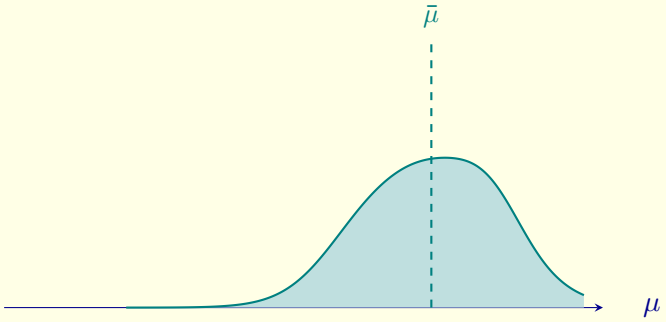
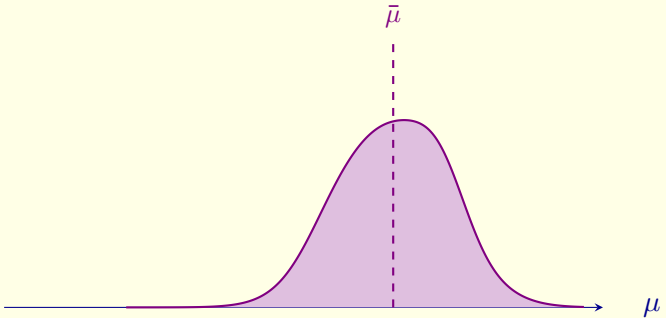


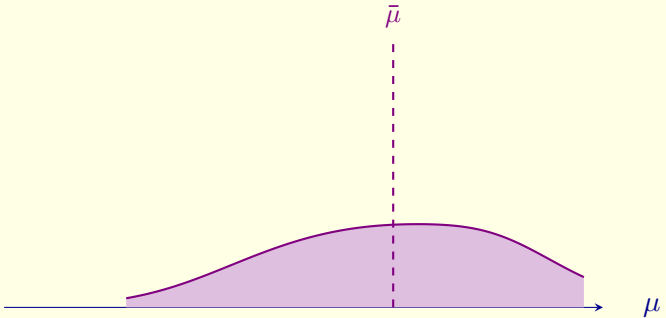
Raising Dispersion of Opinions

Motivation II: $v(G_m^x) = E[(\mu_m^x)^2]$



Sender wants to raise dispersion of opinions

Motivation II: $v(G_m^x) = E[(\mu_m^x)^2]$



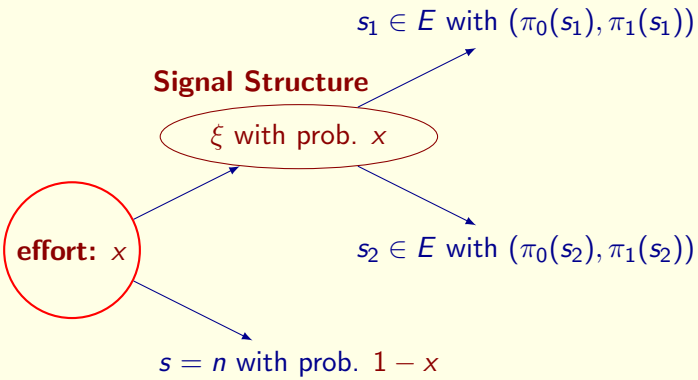
Evidence Provision Technology

$(\mathbb{R}, \mathcal{B})$, measurable space of pieces of evid. with a σ-finite reference measure.

For $\omega \in \{0, 1\}$, prob. measure $\mathbb{P}_\omega$ over space $(\mathbb{R}, \mathcal{B})$ (absolutely continuous w.r.t. to reference measure $\Rightarrow$ $\mathbb{P}_\omega$ admits Radon-Nikodym derivatives): densities $\pi_\omega(s) > 0$ and cdfs $\Pi_\omega(s) = \int_0^s \pi_\omega(t)dt$

$\xi \equiv (\mathbb{P}_0, \mathbb{P}_1)$, an evidence provision structure $\equiv$ a Blackwell experiment

Time Line


$s_1 \in E$ with $(\pi_0(s_1), \pi_1(s_1))$
Signal Structure
ξ with prob. x
effort: x
$s_2 \in E$ with $(\pi_0(s_2), \pi_1(s_2))$
$s = n$ with prob. $1 - x$

Equilibrium

Interim stage: Sender discloses $s \in \mathbb{R}$ whenever $v(G_s^x) \geq v(G_n^x)$

Ex ante stage: Sender chooses $x \in [0,1]$ to maximize:

$$V(x;d) = E_{\beta \sim F}\Big\{(1-x)v(G_n^x) + xE_{\boldsymbol{s} \sim Q_\beta}\big[[1-d(\boldsymbol{s})]v(G_n^x) + d(\boldsymbol{s})v(G_{\boldsymbol{s}})\big]\Big\} - c(x)$$

$Q_\beta \equiv \beta\Pi_1 + (1-\beta)\Pi_0$

Results – Threshold Disclosure

Theorem

d^* discloses piece of evidence $s \in \mathbb{R}$ such that $\pi_0(s)\pi_1(s) > 0$ iff

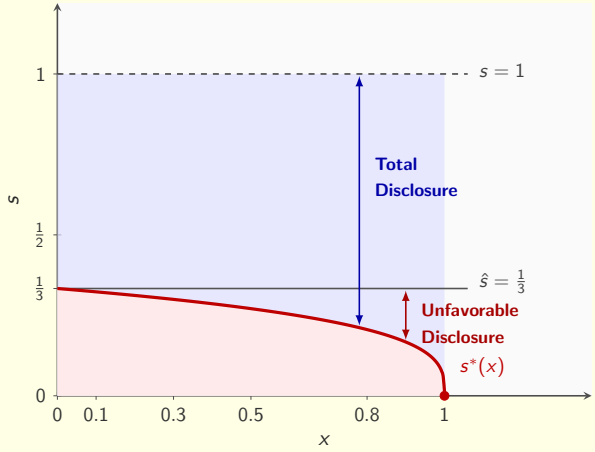
$$\lambda(s) \equiv \frac{\pi_1(s)}{\pi_0(s)} \geq \frac{(1-x) + xE_{\boldsymbol{s}\sim\Pi_1}[1 - d^*(\boldsymbol{s})]}{(1-x) + xE_{\boldsymbol{s}\sim\Pi_0}[1 - d^*(\boldsymbol{s})]}$$

Under regularity conditions, $s^*(x)$ characterized by:

$$(1-x)[\lambda(s^*(x)) - 1] + x\int_{\underline{s}}^{s^*(x)} \pi_0(s)[\lambda(s^*(x)) - \lambda(s)]ds = 0$$

Example – Beta Technology

$\pi_\omega(s) = (\omega+2)(\omega+1)s^\omega(1-s)$, $s \in [0,1] \Rightarrow \lambda(\hat{s}) = 1$ for $\hat{s} = 1/3$



Results – Sender's Return

Equilibrium Sender's Return

$$V(x; s^*(x)) = v(G_{s^*(x)}) + xE_{s \sim Q_{\tilde{\beta}}}\left[v(G_s) - v(G_{s^*(x)}) \,\middle|\, s \geq s^*(x)\right]$$

Equilibrium Sender's Marginal Return: $MR(x; s^*(x)) \equiv \partial V(x; s^*(x))/\partial x$

Key implication, $s^*(x)$ is invertible (and common for both Motivations of Sender) $\rightarrow$ $MR(s) \equiv MR(y(s); s)$

$y(s) \equiv (s^*(x))^{-1}$ inverse function of $s^*(x)$

Results – Sender's Return

Given s, Sender's marginal return linear on measure of likelihood that ξ provides her pieces evidence more favorable than s

Hazard Rate Dominance (HRD) size:

$$\rho_\xi(s) \equiv \frac{1-\Pi_1(s)}{\pi_1(s)} - \frac{1-\Pi_0(s)}{\pi_0(s)}$$

Then, $MR(s) = A(s) + B(s)\rho_\xi(s)$

How is $MR(s)$ Affected?

Under certain conditions, higher efforts x incentivized by

1. Higher HRD sizes $\rho_\xi(s)$
2. Initial average opinion less aligned with Sender's goal
3. Higher dispersion of initial opinions

Welfare of the Audience

Each Receiver chooses action $a \in A = [0,1]$ and obtains $u(a,\omega) = -(a-\omega)^2$

Measuring ex ante welfare of audience (**in equilibrium**),

$$W(\mu_s) \equiv E_{\beta\sim F} E_{\mu_s(\beta)}[u(a^*(\mu_s(\beta)),\omega)] = -E_{\beta\sim F}\left[\mu_s(\beta)[1-\mu_s(\beta)]\right]$$

Our measure of welfare of audience:

$$W(x; s^*(x)) = xE_{s\sim Q_{\bar\beta}}\Big[W(\mu_s)\,\Big|\, s \geq s^*(x)\Big] + [(1-x) + xQ_{\bar\beta}(s^*(x))]W(\mu_{s^*(x)}).$$

Welfare of the Audience

$W(x; s^*(x))$ increases in $x \Leftrightarrow$ Sender obtains higher $MR(x; s^*(x))$ when she wants to raise dispersion of opinions relative to when she wants of shift average opinion

Policy recommendations on evidence acquisition efforts depend on the goal of the communicator

Mandatory minimum efforts benefit audiences if communicators want to raise dispersions; harm audiences if communicators want to shift average opinions

Related Literature

- Partial provability, **(a) exogenous evidence**: Dye (1985); Jung and Kwon (1988); Shin (1994); Acharya, DeMarzo, and Kremer (2011) **(b) endogenous information acquisition**: Che and Kartik (2009); Kartik, Lee, and Suen (2017)
- Uncertainty about Receivers' preferences: Bond and Zeng (2022)
- Pricing of acquired evidence: Ali, Lewis, and Wasserman (2023)
- Bayesian persuasion with heterogeneous Receivers: Alonso and Camara (2016); Manili (2024)