4 Things Nobody tells you about Online News

a Model with Social Networks and Competition

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Introduction

How good can ad-funded online news outlets get?

- Why a model?
  - Social media changed news market:
    - ★ Advertisement revenues → profits from social media attention
    - ★ Sharing content → consumers play incentivizing role on spreading news
  - ⇒ "Old" market environment → new effects?

- Why does it matter?
  - Insights into topical issues
    - ★ More than 50% of adults get news online [Pew Research Center]
    - ★ Fear of market segmentation: paywalled vs. free information
  - Need for policy recommendations
    - ★ Can we trust outlets relying on online shares?
    - ★ Should competition be encouraged?
    - ★ What kind of interventions work?

Overview

- This model does not deal with:
  - Psychological bias – agents are Bayesian
  - Partisanship – agents care about the truth(*)
  - Reputation – initial viewership exogenous
- This model deals with a two-sided market:
  - Producers, paid-per-view → ad revenue
  - Consumers, share news → networks
- Sketch of the model:
  - Underlying reality – state of the world (SoW)
  - Consumers care about sharing true news; receive private information
  - Producers care about views through shares

    → invest if true article makes more views than false article

Results

- High news quality can be achieved only when topic already well-known
  - Consumers believe news more easily if corresponds to:
    - ★ their private information ⇒ news quality bounded
    - ★ their prior ⇒ news articles more valuable in likely SoW

  → Share buttons are not good enough incentives

- Competition does not necessarily help
  - More quality because followers harder to reach
  - Less quality because smaller potential readership

  → Particularly relevant with (almost) free entry for online outlets

- Welfare created through entertainment, hardly by better decisions

  → Ad-funded news outlets are barely *news* outlets

- Flagging can help; quality certification less

  → Timing of fact checking matters

Literature

- News market:
  - Two-sided news markets with producer competition.
    - ★ e.g. Allcott and Gentzkow (2017).

  → *Introduce*: networks
  - Two-sided news markets with networks.
    - ★ only Kranton and McAdams (2019) – KM hereafter.

  → *Introduce*: competition (& welfare).
- Learning in Networks:
  - Dynamic learning communicating over beliefs/actions.
    - ★ e.g. see Golub and Sadler (2017) for a review.
    - ★ Hsu et al. (2019) deals with behavioral sharing casquade without competition

Outline

1. Model
2. Equilibrium
3. Welfare
4. Evaluation of Interventions

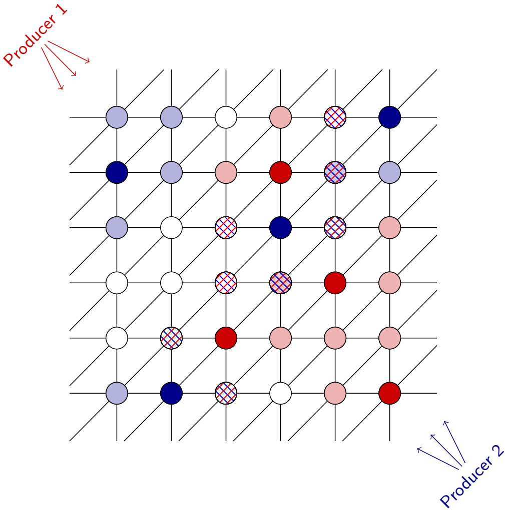
Model

Environment

- Binary SoW, documented through news articles & private signals
- Producers publish one article each:
  - Reach exogenous number of influencers
  - Choose the quality of the outlet $x :=$ Pr(article reports true SoW)
  - Do not directly chose the article's content!
- Consumers receive private signal + at most one article
  - Consumers are arranged on lattice of degree d
  - *Influencers* come across articles → decide whether to share z
  - *Followers* read article if a neighbor shared
    - ★ If different articles shared, only one appears to follower (random source)

(Timing: simultaneous / equilibrium concept: NE)

Model



Objectives: Influencers

- Payoff from sharing $= \begin{cases} 1 & \text{if article true} \\ -1 & \text{otherwise} \end{cases}$

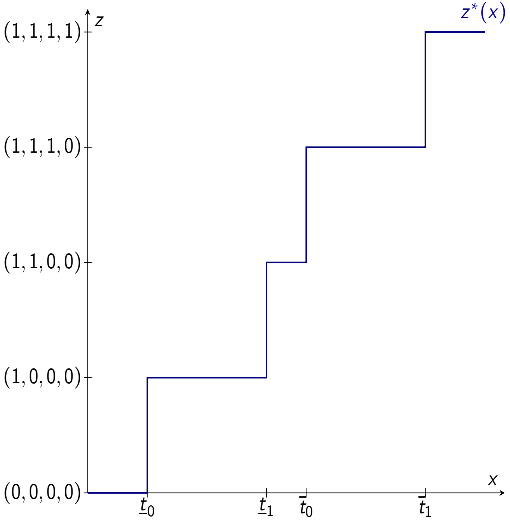
  $\Rightarrow$ share if probability that the article is true $\geq \frac{1}{2}$ $\rightarrow$ depends on:

  - ★ article content n
  - ★ private signal s
  - ★ outlet precision x

  - Note: strategy $z_{n,s}(x)$ = probability of sharing article

- Share content n if x high enough given s $\rightarrow$ thresholds.
  - Sharing is (weakly) monotone in x
  - Share anything if $x \geq$ private signal's precision

Objectives: Influencers



Shape of Influencers' Best Response

Objectives: Producers

- Costs: C strictly convex; $c(x)$ marginal cost
- Revenues: expected portion of views:
  - depends on the sharing behavior of influencers → on z
  - depends on whether *my* article is true → on x
  - depends on whether *others'* article is true → on x_{others}

  Note: $V_{w,n}(z)$ = expected revenue from content n when SoW is w

  $\Rightarrow$ Revenues: $w_0[xV_{0,0} + (1-x)V_{0,1}] + (1-w_0)[xV_{1,1} + (1-x)V_{1,0}]$
- Best-response, i.e. *incentive to invest*:

$$x^*(z) = c^{-1}\Big(w_0[\underbrace{V_{0,0}(z) - V_{0,1}(z)}_{\substack{\text{extra value of true article} \\ \text{when SoW is 0}}}] + (1-w_0)[\underbrace{V_{1,1}(z) - V_{1,0}(z)}_{\substack{\text{extra value of true article} \\ \text{when SoW is 1}}}]\Big)$$

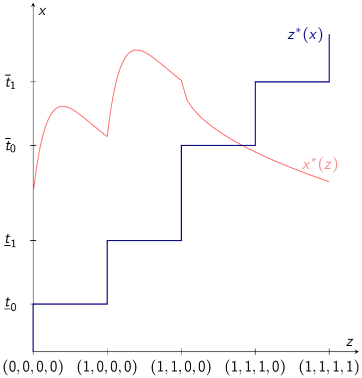
Note: $V_{w,n}(z) = \frac{b}{|U|} + (1-b)\sum_m \Pr(m|w)\frac{p_{u|w,n}}{p_{u|w,n}+p_{-u|w,m}}\left(1-(1-p_{u|w,n}-p_{-u|w,m})^d\right)$

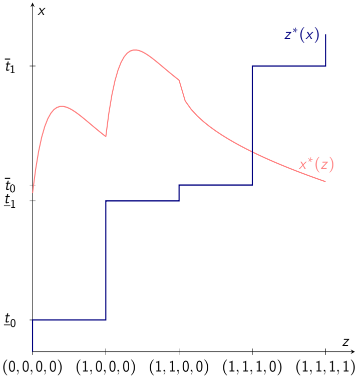
Equilibrium

Without Competition

Proposition 1

Unique NE characterized by news' quality:
$x^M = \max\{\min\{x^*(1,1,0,0), \bar{t}_0\}, \min\{x^*(1,1,1,0), \bar{t}_1\}\}$





Without Competition

Proposition 2

The incentive to invest is single peaked in d

Intuition: big $d \Rightarrow$ can rely on *few* nodes to share

Lemma 2

The incentive to invest is increasing with the certainty about the SoW

Intuition: articles more valuable in more likely SoW

With Competition

- Call producers a and b.
- Simplification: $w_0 = 1/2$
  - $\rightarrow$ consider only subset of all possible undominated strategies:

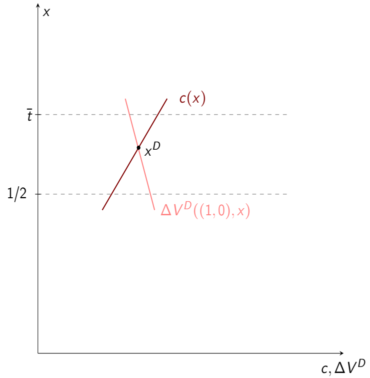
$$z_{a|0,0} = z_{a|1,1} = z_{aT} \text{ and } z_{a|0,1} = z_{a|1,0} = z_{aF}$$

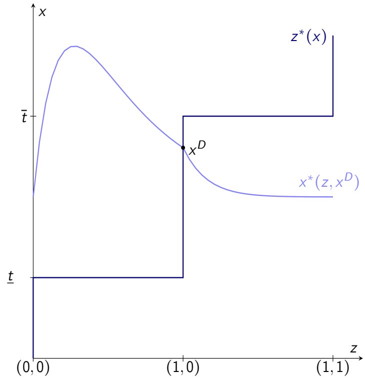
  - $\Rightarrow$ two relevant thresholds $\underline{t}, \overline{t}$
- Symmetric equilibria: $z_a^* = z_b^*$ and $x_a^* = x_b^*$

With Competition

Proposition 3

Unique symmetric NE characterized by news precision
$x^D = \arg\min_{x \in [1/2, \gamma]} \left| \Delta V^D\big((1,0); x\big) - c(x) \right|$.

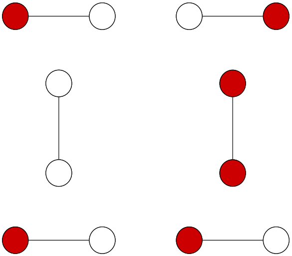




Effects of Competition

Theorem 1

Monopoly leads to higher incentives to invest for $d < \bar{d}$, while duopoly leads to more investment for $d > \bar{d}$



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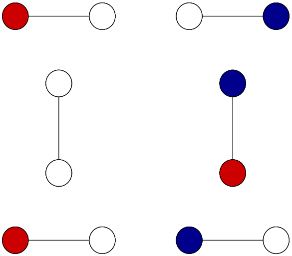

Smaller reward

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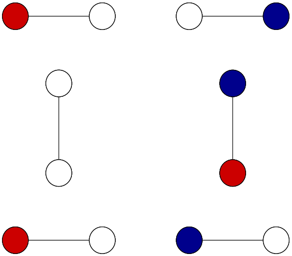

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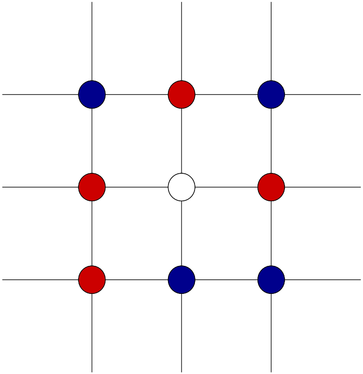

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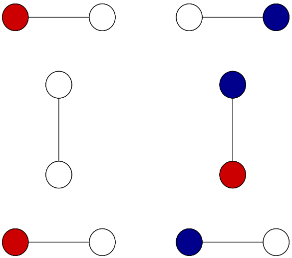

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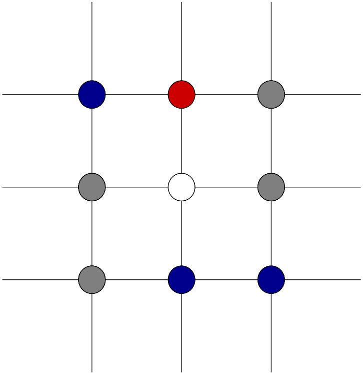

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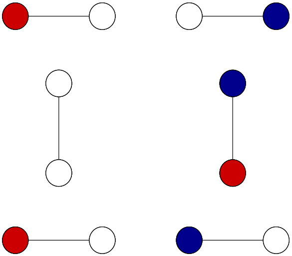

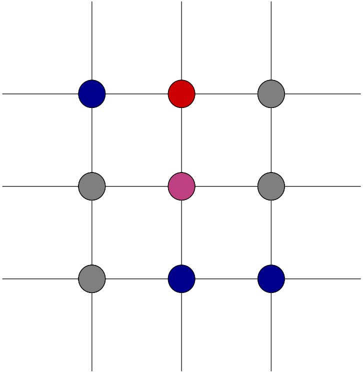

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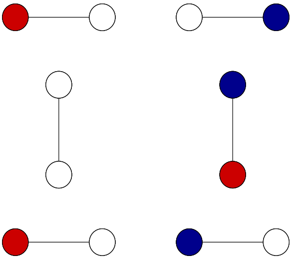

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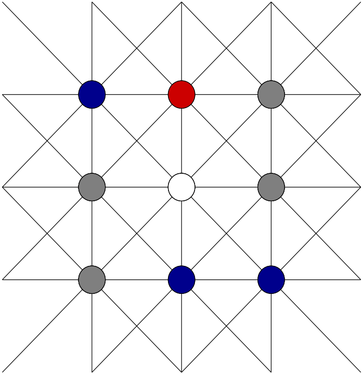

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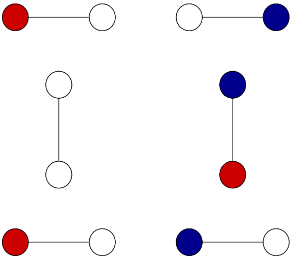

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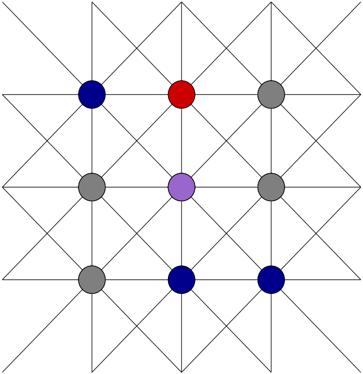


Reward harder to get

Welfare

Framework

Proposition 5

Any equilibrium outcome on an ad-based news market is Pareto inefficient

Welfare evaluation? → add *bet*:

- After articles spread, all consumers can take action a to match SoW

$$u_j(a_j|\omega = w) = \begin{cases} 1 & \text{if } a_j = w \\ -1 & \text{otherwise} \end{cases}$$

Three aspects of welfare :

- Entertainment: expected utility from sharing
- Guidance: expected utility from bet (no opting out)
- Driver: expected utility from costly bet

Welfare Analysis

Disclaimer: Literal interpretation of one signal per agent.

- Sharing strategy ≈ betting strategy
- News quality increases *entertainment*, not necessarily *guidance*

Lemma 5 (Preliminary)

With $w_0 = 1/2$, news outlets are not providing *guidance* to influencers

- Intuition: news quality bounded by private signal

Theorem 2 (Preliminary)

In terms of *guidance*, only followers can benefit from competition

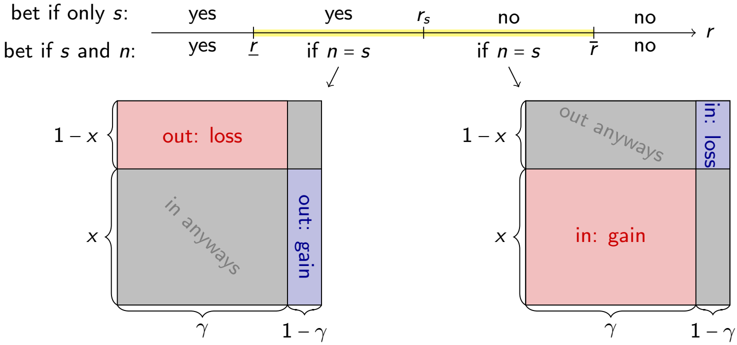
- Influencers do not take better decisions
- Cost of production doubles
- Network filters bad articles out for followers

Welfare Analysis

What about the *driver* aspects? → price r to enter bet

- Receiving news article can:
  - Motivate agents to take the bet – they would not have with s only
  - Discourage agents to take the bet – because $n \neq s$ → can backfire

→ ambiguous, depends on r



Evaluation of Interventions

Flagging

False articles are flagged (before sharing) with some probability
Note: flagging is not noisy.

- Consumers care about truth → flagged article worthless to producer

Remark 3

Flagging removes bound on news quality

- Intuition: flagging ≈ private signal

Proposition 6

With $w_0 = 1/2$, flagging has stronger effects in monopoly than duopoly

- Competition → strategic considerations: competitor could be flagged!
- Reward harder anyways; readership smaller with competition
  → if all false articles flagged, monopoly outperforms duopoly on quality

Quality Certification

Move to a sequential game

- Can help: internalize effect investment on sharing
- Depends on *total* cost function

Remark 4

Observable news' quality imposes the same bounds on outlets' informativeness.

Intuition: influencers *always sharing* = best producer can achieve

Subscription-Based Revenues

- Setup:
  - Each influencer pays a subscription $t(x)$ in order to read news.
  - Producers' unique revenue: subscriptions.
- Comparing inefficiencies:
  - No possible welfare improvement – marginal benefit = marginal cost.
  - No advertisement revenue – loss of surplus.
- Feasibility (preliminary):
  - The ad-based monopoly outcome is reproducible with subscriptions.
- Open question: When can the gain in news quality compensate the loss of ad-revenues?

Conclusion

How good can online news outlets get?

$\rightarrow$ not so good... without intervention

- High news quality can be achieved only when topic already well-known
- Competition does not necessarily help
- Welfare created through entertainment, hardly by better decisions
- Flagging can help, quality certification not so much

Bibliography

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Benjamin Golub and Evan Sadler. Learning in social networks. *Available at SSRN 2919146*, 2017.

Chin-Chia Hsu, Amir Ajorlou, and Ali Jadbabaie. A theory of misinformation spread on social networks. *Available at SSRN*, 2019.

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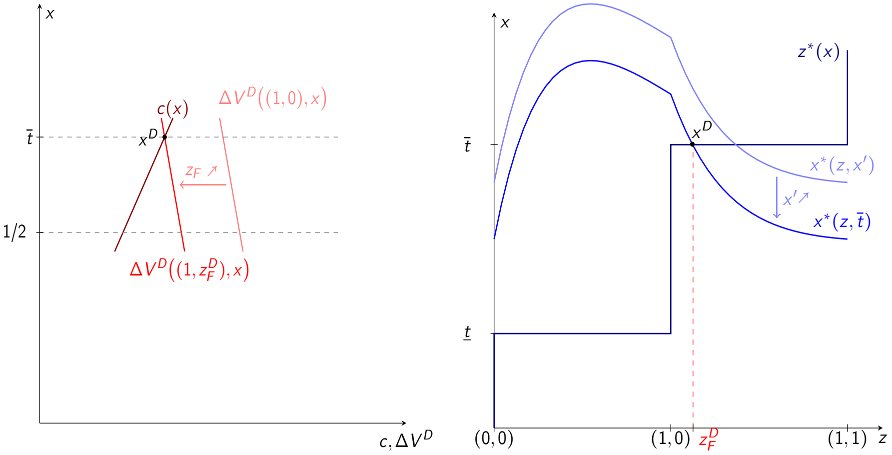
Equilibrium: With Competition



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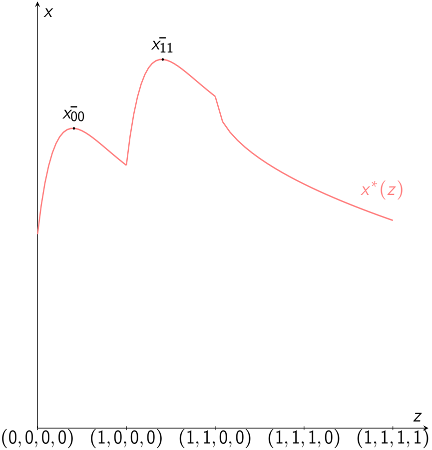
Equilibrium: Monopolist Best-Response



Shape of Monopolist's Best Response

Go Back

Attention-Seeking Influencers

Objective

- Effect of competition **between** influencers, who compete for *likes*
  - Realistic → robustness
  - Trade-off between visibility and veracity
- Assumptions about likes:
  - Only followers (denoted f) can like posts
  - f can like i post only if f saw i's post
  - f only sees the post of **one** of his sharing neighbors **at random**
  - f likes a post iff receive a positive private signal (prior irrelevant)
- Decision rule[1]:

$$\mathbb{E}(\#\text{likes}) \geq \tau$$

- Payoff depends on:
  - Whether news is true or false ($\Rightarrow$ on i's posterior)
  - How many other neighbors of f share ($\Rightarrow$ on $-i$'s sharing decision)

Go Back

[1] $\mathbb{E}(\#\text{likes}) = p_v(s_i; x_v)\gamma \frac{1-b}{p_T}\left(1-(1-p_T)^d\right) + (1-p_v(s_i;x_v))(1-\gamma)\frac{1-b}{p_F}\left(1-(1-p_F)^d\right)$

Attention-Seeking Influencers

Best-Response

Disclaimer: We focus only on symmetric strategies $z_i = z \ \forall i$.

We call "best-response" $(z_T^*(x), z_F^*(x))$, each maps $x \to [0,1]$ s.t. $z^*(x, \mathbf{z}^*(\mathbf{x})) = z^*(x)$

Theorem 3

(i) For any $\tau \leq \gamma\delta$, $z_T^*(x;\tau) = z_F^*(x;\tau) = 1$ if and only if $x \geq \hat{x}(\tau)$.

(ii) For any $\tau \geq (1-\gamma)d(1-b)$, $z_T^*(x;\tau) = z_F^*(x;\tau) = 0$ if and only if $x \leq \check{x}(\tau)$.

(iii) For any $\tau \in [\tau_1, \tau_2]$, $z_T^*(x;\tau) = 1, z_F^*(x;\tau) = 0$ if only if $x \in [x_1(\tau), x_2(\tau)]$.

Where:

$$\delta(b) = \frac{1-b}{b}[1-(1-b)^d], \quad \tau_1(b) = \frac{1-b}{b}[1-(1-b(1-\gamma))^d], \quad \tau_2(b) = \frac{1-b}{b}[1-(1-b\gamma)^d]$$

And, given $T = \frac{\frac{b\tau}{1-b} - 1 + (1-b(1-\gamma))^d}{(1-b(1-\gamma))^d - (1-b\gamma)^d}$,

$$\hat{x}(\tau) = \frac{\gamma}{2\gamma-1}\frac{\tau-(1-\gamma)\delta}{\tau}, \quad \check{x}(\tau) = \frac{1-\gamma}{2\gamma-1}\frac{\tau-(1-\gamma)d(1-b)}{d(1-b)-\tau}, \quad x_1(\tau) = \frac{(1-\gamma)T}{(1-\gamma)T+\gamma(1-T)}, \quad x_2(\tau) = \frac{\gamma T}{\gamma T+(1-\gamma)(1-T)}$$

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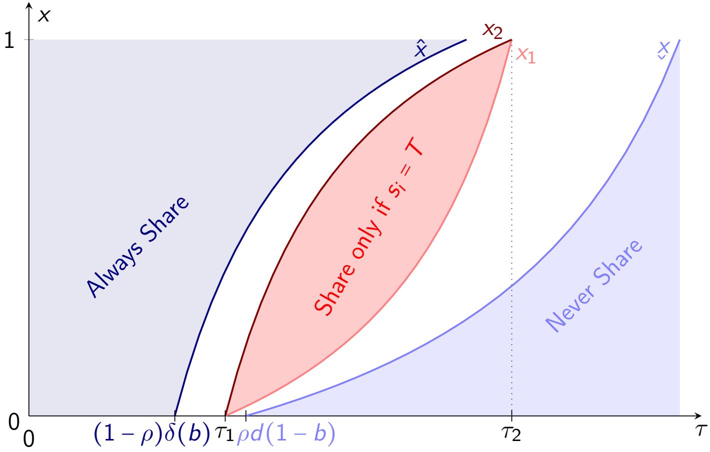

Pure strategy symmetric best-response

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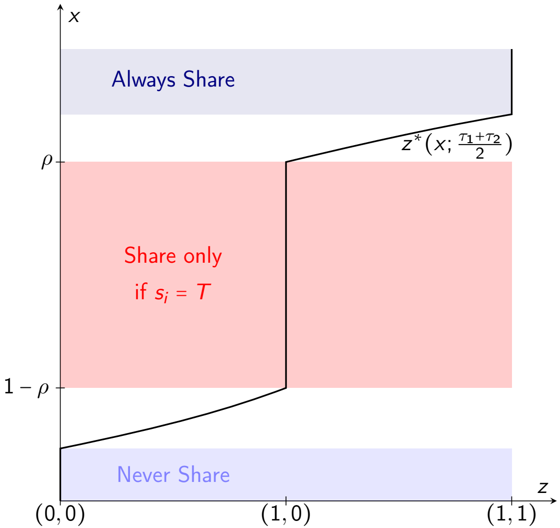

Influencers' best-response for $\tau = \frac{\tau_1+\tau_2}{2}$

Go Back